U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

May 28, 1998

MEMORANDUM

SUBJECT: EFED Revised RED Chapter for **Alachlor** (PC Code No. 090501)

TO:
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This memo summarizes the updated EFED science chapter for the alachlor RED. The document has been updated to include the latest studies and monitoring data available to the Agency. EFED also included, where appropriate, answers to questions and comments that the registrant submitted in response to our 1996 Alachlor Science Chapter (Wratten, 1996; MRID 441055-01).

Exposure Characterization

The environmental fate assessment for alachlor, which begins on page 4, shows that

- Alachlor has a low affinity to adsorb to soils and is expected to be highly mobile.
- Alachlor is moderately persistent and dissipates primarily by aerobic soil metabolism processes with a half-life of 2-3 weeks.
- The major acid degradates of alachlor are very mobile and appear to be persistent.
- Field dissipation studies confirm this fate profile (half-life of 6-11 days; leaching through 42-48 inches in one of the studies).

The water resources assessment, which starts in page 7, concludes that

- Alachlor is highly mobile and moderately persistent. These characteristics are observed in chemicals that reach ground water and surface water.

- Alachlor presents a clear hazard to groundwater quality. Reliable monitoring studies have demonstrated that alachlor, used according to label, results in significant groundwater contamination. Alachlor use also results in the majority of groundwater in use areas being contaminated with breakdown products.
- Monitoring studies show that alachlor levels in surface water result in effects on aquatic plants and indirectly on aquatic animals.
- Information available indicates that (surface) drinking water supply systems will rarely fail to comply with the SDWA.

Ecological Effects Characterization

The available toxicity data for alachlor, which is discussed starting on page15, indicate that it is

- Slightly to practically non-toxic to birds on an acute oral basis (LD_{50} of 1500 mg/kg).
- Slightly toxic to mammals, based on a rat study (LD_{50} of 930 mg/kg).
- Slightly toxic to honey bees (LD_{50} >36 ug/bee).
- Slightly to moderately toxic on an acute basis to freshwater fish (LC_{50} 1-33 ppm).
- Highly to moderately toxic to freshwater fish on a chronic basis (NOEC≥0.1 ppm, LOEC≥0.2 ppm).
- Moderately toxic to saltwater fish (3.9 ppm), moderately toxic to saltwater mysid (2.4 ppm) and moderately toxic to shellfish (1.6 ppm).
- Highly toxic to aquatic plants (based on a single species tested: NOEL=0.35 ppb, LOEL=0.69 ppb, EC_{50}=1.64ppb).
- A potential risk to nontarget terrestrial and aquatic plants, and endangered plant species.

The major alachlor degradates appear to be less toxic to aquatic organisms than the parent.

Environmental Risk Assessment

An evaluation of the risk to nontarget organisms from the use of alachlor products, combining toxicity data with potential exposure, indicates that

- Alachlor poses a potential risk to terrestrial animals on a chronic basis. Additional information must be submitted by the registrant to rule out risk.
- The granular formulations and high use rate pose the greatest risk to nontarget organisms.
- Alachlor levels observed in surface water monitoring studies could result in extensive adverse effects on aquatic plants.
- Aquatic animals are not at acute risk due to exposure to alachlor, but chronic effects may be observed under certain circumstances.

The environmental risk assessment begins on page 19 of the science chapter.

Outstanding Data Requirements

The environmental fate database is largely complete. There are several gaps in the available ecotoxicity data base. Overall, EFED considers these information gaps to be very serious with regard to our capacity to characterize the environmental risks of alachlor.

- Two terrestrial field dissipation studies of alachlor were performed in the state of California. These studies are not adequate to fully characterize the range of field conditions to which exposure to alachlor may occur. In addition, these studies may not fully assess conditions where leaching is important. The herbicide alachlor is extensively used throughout the United States. EFED would ordinarily require an additional terrestrial field dissipation study, conducted in a different site, in a high use state (such as Iowa, Illinois, Ohio or Minnesota). While this data requirement is not fulfilled, EFED believes that, given the extensive monitoring information available, an additional field dissipation study will not appreciably change our assessment of the chemical. Therefore, no additional studies will be required.

- **We have only one aquatic plant study** although alachlor is a heavily used herbicide. Most herbicides are required to have 5 species tested to determine the range of expected effects to different types of plants. It is likely that testing of 4 more species will indicate that at least one is more sensitive than the single species tested already.

- The degradate **alachlor-ESA** has been found to be more prevalent in ground and surface water than parent alachlor. The limited toxicity information does not suggest that this chemical is highly toxic to aquatic animals. However, in view of the prevalence of this chemical in the environment, EFED recommends a more complete characterization of its fate and effects properties. For alachlor-ESA, EFED recommends the **normal complement of toxicity measurements for five species of aquatic plants.**

- The Agency does not have studies of effects on **avian reproduction**, despite extensive use during parts of the year when birds will be breeding, and despite the fact that other acetanilides (acetochlor, metolachlor) have been shown to be toxic in avian reproduction studies reviewed by EFED. In the absence of an acceptable avian reproduction study, EFED will assume that alachlor is similarly toxic.

- A requirement for studies to characterize **spray drift** was imposed in 1991. Data from the SDTF is now under review in EFED. EFED is not proposing measures for control of spray drift at this time, beyond label requirements for use of best management practices. We suggest that a decision be made on whether to establish additional mitigation measures for drift, after reviewing information on how much of current alachlor use has the potential to result in drift.

Concerns

The following concerns are discussed in detail in the body of the RED document.

Concerns for Quality of Water Resources

Ground Water. EFED has **significant concerns about the impact alachlor and its degradates may have on ground water quality.** Consideration of environmental chemistry and fate properties indicates that alachlor and a number of alachlor degradates will leach to ground water. An extensive body of groundwater monitoring information has been reviewed (refer to Appendix C). This data confirms that alachlor and alachlor degradates do in fact contaminate groundwater.

Several recent studies have found alachlor degradates in groundwater samples, including alachlor-ESA and alachlor oxanilic acid. These degradates are more persistent than parent alachlor and appear to be widespread in groundwater. Alachlor-ESA has been detected almost 10 times more frequently than alachlor, and is the most frequently reported pesticide related compound in ground water monitoring studies for pesticides in the mid-continent area. Alachlor-ESA has been found up to a maximum concentration of 8.6 µg/L in 45 to 70 percent of Mid-western groundwater wells sampled in a study focused on near-surface aquifers in corn and soybean growing areas. Another study in Massachusetts reported up to 20 alachlor degradation products, with the total concentration of degradates exceeding 2-fold the concentration of the alachlor parent.

Surface water. Alachlor levels observed in monitoring studies (refer to Appendix D) are sufficient to result in effects on aquatic plants and indirectly on aquatic animals. Regarding alachlor contamination of **surface water sources of drinking water**, the monitoring information available to us indicate that drinking water supply systems will rarely fail to comply with the Safe Drinking Water Act because of alachlor in the water sources (i.e., annual averages will rarely exceed the current MCL of 2 µg/L). Particularly relevant sources of monitoring information are recent (1992-1996), extensive data collected by the Acetochlor Registration Partnership monitoring 175 surface water sites, and by the US Geological Survey in reconnaissance surveys of Midwestern streams and reservoirs. Such data may reflect reported substantial decreases in alachlor use. However, we now think that the concentration of alachlor-ESA in surface water needs to be considered carefully from the standpoint of posing a human health risk. The concentration of alachlor-ESA often greatly exceeds the concentration of parent alachlor and often occurs at concentrations of several ppb even in early Spring before alachlor application.

We cannot fully assess the toxicity of alachlor-ESA to humans and certain aquatic species. If the Agency finds that the human health risk of alachlor-ESA requires further evaluation, EFED analysis of surface water and ground water monitoring information will be useful for assessment of the health risk. EFED is recommending additional studies to characterize the ecological effects properties of alachlor-ESA. We are also concerned about the possible risk posed by exposure to other major degradates of alachlor such as DM-oxanilic acid, alachlor oxanilic acid, and alachlor sulfinylacetic acid.

Concerns for Risk to Nontarget Organisms

Terrestrial Organisms. For **terrestrial animals** the EFED does not have concerns for **acute effects**. EFED has tentative concerns for **chronic effects**: The EFED does not have an avian reproduction study for alachlor, but avian reproduction studies for other acetanilides (metolachlor, acetochlor) suggest high toxicity on a chronic basis. Based on this, and on consideration of the scope and seasonal pattern of use (including application at times when birds will be breeding) *EFED has a concern that alachlor may adversely* *affect avian reproduction.* The information available on persistence of alachlor is consistent with a chronic concern: Alachlor is moderately persistent in soil. The major dissipation route in soil is microbially mediated, with half lives of 2-3 weeks under aerobic conditions.

Large scale use of a herbicide ordinarily poses concern for **terrestrial plants** at least in the vicinity of application sites. EFED is not raising special concerns for effects of alachlor on terrestrial plants, relative to other herbicides with extensive use. The evaluation of risk to terrestrial plants indicates high risk from exposure to alachlor drift and runoff. EFED does not have information on toxicity of alachlor degradates to terrestrial plants.

Aquatic Organisms. EFED believes that **alachlor levels observed in surface water monitoring studies could result in extensive effects on aquatic plants.** Such effects could in turn cause population level effects on aquatic animals (including fish and amphibians) via habitat modification or decreased food supply. Information is not available on the effects of degradates on aquatic plants.

For **aquatic animals**, risk quotients based on screening-level exposure estimates do exceed levels of concern for chronic effects. However, the monitoring information available does not suggest widespread effects by *direct* acute or chronic toxicity. The available information does not suggest high toxicity of alachlor degradates to aquatic animals. For estaurine/marine species, risk quotients, based on screening-level exposure estimates, do not exceed level of concerns for acute effects for saltwater fish, saltwater mysid or shellfish.

Based on the **aquatic plant** data (one study), EFED is confident that adverse effects on aquatic ecosystems, including potential for population level effects on aquatic animals, will occur.

Suggestions For Risk Reduction

(i) Ground water resources

In its response to the 1994 and 1996 (MRID# 44105501) draft Reregistration Eligibility Document (RED) for alachlor, Monsanto accepted several ground-water mitigation recommendations:

a) Monsanto will change its alachlor **labels** to include an up-to-date ground-water advisory. A copy of this label is provided in the section on Suggested Label Precaution Language;

b) Monsanto agreed to classify alachlor as a **Restricted Use Pesticide (RUP)** for ground-water concerns;

c) Monsanto has volunteered to add language calling for a 50-foot **setback** of mixing and loading activities from wells, rivers or lakes unless such activity is protected by an impervious pad, as well as other unspecified language meant to "avoid accidental water contamination."

d) Use reductions, as a result of being a member of the Acetochlor Registration Partnership.

e) Ongoing voluntary programs Operation Green Stripes and Well Assistance Programs.

In addition, because of the extent of ground-water concerns for alachlor and its degradates, EFED notes that alachlor has been proposed for inclusion in **State Management Plans** (SMPs) in a recent proposed rule-making (61 FR 33259, June 26, 1996). "Placeholder" language used for earlier SMP candidates such as metolachlor can be updated to reflect the new status of the SMP rule.

Since available monitoring data show that alachlor degradates are more frequently found in water than the parent, validated **analytical methods for these degradates** (including alachlor-ESA) are needed. These methods must have minimum detection limits of equal to or less than 0.1 µg/L in water. In addition to the parent alachlor, EFED recommends that the registrant also supply standards of its degradates (alachlor-ESA, DM-oxanilic acid, alachlor oxanilic acid, and alachlor sulfinylacetic acid) to the pesticide repository.

EFED suggests that the Registrant work with the Agency to identify mitigation measures to manage the use of alachlor in such a way that ground-water resources will not be contaminated as a result of normal uses. The registrant notes that there have been major alachlor use reductions since 1994. EFED also notes that the registrant has agreed to reduce the maximum label application rate from 6 to 4 lb ai/Acre. However, where alachlor is used it still has the potential to contaminate ground water. The risk of potential contamination of vulnerable ground-water resources can be reduced through label restrictions that identify 1) use restrictions and 2) soil or geographic restrictions (for example, karst areas, highly-permeable soils). Because the detection of alachlor is related to irrigation, more efficient irrigation methods could be adapted to reduce pesticide leaching.

In order to determine the effectiveness of any measure in preventing further contamination of ground-water resources, ground-water monitoring studies would be needed. Otherwise, we have no way of evaluating the extent to which proposed mitigation measures are effective. EFED believes it is appropriate to maintain the recommendation for mitigation triggers for alachlor, tied to results of sampling being done in the acetochlor ARP ground water monitoring program or other monitoring programs. Monsanto could enter into negotiations with SRRD to set the details of such triggers, such as number of detections and concentration levels.

(ii) Surface water resources

As described above, EFED is not raising concerns for drinking water from surface water sources at this time because there is substantial evidence that the current MCL of 2 µg/L is not routinely exceeded. However, degradation of surface water quality is of concern especially for sensitive class 1 and 2 streams and for its potential to further decrease the quality of lower class streams. Suggested label precautionary language below would reduce the potential for incidents of contamination of surface water. The risk to aquatic organisms can probably be reduced significantly only by general reductions in use.

(iii) Nontarget species

Alachlor is expected to have some adverse effects on terrestrial plants, at least close to application sites. The greatest concern at present is for impacts on aquatic ecosystems, resulting from effects on aquatic plants, and perhaps occasionally from direct effects on aquatic animals. Substantial reduction in the risk to aquatic species and ecosystems can probably only be obtained by a widespread reduction in use.

Suggested Label Precaution Language

EFED believes the following label precaution language, based on standard labels, would be effective in reducing risk to nontarget species and water resources:

Manufacturing-use and end use-products related to hazard to nontarget species:

> "This chemical is toxic to terrestrial and aquatic plants, fish, and aquatic invertebrates."

Label precautions related to chronic toxicity to terrestrial animals is an unresolved issue, in absence of avian chronic studies. EFED believes that alachlor is likely to be toxic to birds on a chronic basis, but we generally only propose label precautions based on direct measurements. It may be desirable to have label precautions advising against exposure of birds during the breeding season.

Manufacturing-use products regulating releases to the environment:

> "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 to control surface water contamination by runoff, drift, or accidental spillage:

(a) For direct contamination of surface water:

> "For terrestrial uses. Do not apply 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 washwater or rinseate."

(b) For spray drift and runoff from application sites to surface water: EFED suggests that the standard label language and language for best management practices for aerial spray drift management be included for all aerial application end-products.

In addition, the following precautionary language is recommended:

> "Alachlor can contaminate surface water through spray drift. Under some conditions, alachlor may also have a high potential for runoff into surface water (primarily via dissolution in runoff water), for several weeks post-application. These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, areas over-laying extremely shallow ground water, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and areas over-laying tile drainage systems that drain to surface water."

The ground-water advisory language below better reflects the concern pertaining to ground-water contamination with alachlor and its degradates than the current language located on the alachlor label under "Environmental Hazards":

> "This chemical and/or its metabolites are known to leach through soil into ground water under certain conditions as a result of registered uses. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground-water contamination."

Toxicity to Nontarget Organisms For Granular Products

> "This pesticide is toxic to fish, aquatic invertebrates, and wildlife. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high-water mark. Runoff may be hazardous to aquatic organisms in neighboring areas. Cover or incorporate granules that are spilled during loading or are visible on soil surface in turn areas. Do not contaminate water when disposing of equipment washwater or rinsate."

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ENVIRONMENTAL RISK ASSESSMENT FOR ALACHLOR

Use Characterization

Alachlor is herbicide registered for use on the following crops:

succulent and dry beans;
field, pop, and sweet corn;
peanuts;
grain sorghum;
soybeans.

Most of Alachlor use, by acreage or pounds, is accounted for by corn and soybeans.

Alachlor is typically applied as a broadcast or band application, either preemergent or postemergent. The registrant has agreed to reduce the maximum application rate of alachlor from 6 to 4 lb a.i./A.

Alachlor is an acetanilide. Other acetanilide herbicides are acetochlor, propachlor, and metolachlor. Chloroacetamides (chlorinated acetanilides) are known to inhibit biosynthesis of fatty acids, lipids, protein, isoprenoids, flavonoids, and gibberellins.

Formulations include emulsifiable Concentrate, Granular, Flowable Concentrate, Microencapsulated, and Water Dispersible Granules. In various products alachlor is formulated with trifluralin, atrazine, glyphosate, imazaquin, or dicamba.

Risk to nontarget species may be reduced by watering in, as recommended on some labels. However, there are indications that irrigation may promote movement into ground water.

The information available to us indicates that alachlor can be applied aerially, and also by other procedures that can create aerial drift. Application Equipment indicated by BEAD are: center pivot irrigators; aircraft (fixed wing, helicopter); granule applicator; ground; pneumatic (compressed air) applicator; sprayer; spreader.

Magnitude of Use:

BEAD has supplied a table summarizing magnitude of use for the period 1993 to 1995, by crop. Information supplied by the registrant indicates that the total volume of use has dropped precipitously in recent years (reduction by somewhat more than 50% from 1984 to 1994).

Use in Corn and Soybean Areas

Corn is grown in almost every state in the continental U.S. Major corn-growing areas include the Midwest and Great Plains states (from Ohio west to Nebraska and from southern Minnesota/Wisconsin south to Illinois/Missouri), the Mississippi River Valley, and the East Coast (from southeastern Pennsylvania to North Carolina) (USDA National Agricultural Statistics Service, 1996 Harvested Acres by County). These regions include such wildlife-rich areas as the Prairie Pothole region, Sandhills Lake region of Nebraska, and coastal/estuarine regions of the Delmarva peninsula and North Carolina. Many of these areas are used by waterfowl and shorebirds as breeding, feeding, and migratory resting grounds. In addition, corn may be grown in the vicinity of freshwater and estuarine/marine aquatic habitats. This can lead to exposure of aquatic resources from the off-site movement of chemicals applied to cornfields near such habitats.

The corn-growing region includes localized areas which have a high potential vulnerability for contamination of shallow ground water with pesticides (Kellog et al. 1992). Such vulnerable areas include the eastern coastal plain from southern Georgia to New Jersey, eastern Nebraska, and southern portions of the Great Lakes region. While the majority of corn-growing areas are dominated by soils which have a moderate runoff potential and moderate infiltration and permeability (also referred to as Hydrologic Group B soils), localized regions are more susceptible to runoff (Kellog et al., 1992). Areas with significant percentages of soils with moderately high to high runoff potential (Group C and D soils) include the Gulf Coast region of Texas, the lower Mississippi River Valley, the Missouri River Valley in South Dakota, the extreme eastern coastal plain of Georgia, South Carolina, and North Carolina, and portions of the Ohio River Valley. These soils are more prone to runoff because of slow permeability (low saturated hydraulic conductivities) and/or a relatively shallow water table.

Use in Sorghum Areas

Major sorghum-growing areas in the U.S. are the central and southern Great Plains (from Nebraska south to Texas and from eastern Colorado to Missouri) and the Mississippi River Valley from southern Illinois to Louisiana (USDA National Agricultural Statistics Service, 1996 Harvested Acres by County). The number of acres planted to sorghum appears to be increasing in the coastal plains of the Carolinas and Georgia. While the geographic extent of the sorghum area is less than that of corn, it does include significant areas of wildlife habitat. It may also be found in the vicinity of estuarine/marine habitats, especially along the Gulf Coast region of Texas. Potential exposure of aquatic resources may occur from the off-site movement of chemicals applied to sorghum fields near such habitats.

Sorghum is more tolerant of dry conditions than corn and is typically grown in warmer climates which have a lower rainfall than the corn region. Overall, the major sorghum areas also have a lower potential vulnerability for contamination of shallow ground water, except in the southeastern U.S., where the acreage of sorghum is increasing (Kellog et al. 1992). Large areas of Texas and the Mississippi River Valley are dominated by the high runoff potential Hydrologic Group C and D soils. In such areas, the adjacent aquatic habitats may be vulnerable to off-site movement of chemicals from runoff.

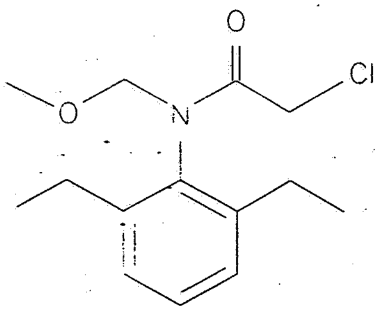
Use on peanuts areas

Peanuts are grown primarily in the southern Coastal Plain, from Virginia to Alabama and in the plains of central Texas and Oklahoma (USDA National Agricultural Statistics

Service, 1996 Harvested Acres by County). The Coastal Plain region includes significant areas used by waterfowl and shorebirds as breeding, feeding, and migratory resting grounds. Peanut-growing areas may occur in the vicinity of freshwater and estuarine/marine aquatic habitats. The Coastal Plain includes a large percentage of areas with a high potential vulnerability for contamination of shallow ground water with pesticides (Kellog et al. 1992).

Chemical Profile

Common name: Alachlor
Chemical structure:



Physical state: solid
Color: white or yellow
Melting point: 40-41°C
Molecular weight: 269.77
Specific gravity: 1.133
Solubility: water 240 ppm at 20°C
Soluble in ether, acetone, benzene, alcohol, and ethyl acetate
Vapor pressure: $2.2x10^{-5}$ mm Hg @ 24°C
Octanol/water partition coefficient: 434 (one study, MRID#00152209 reports partition coefficients of 33.0-37.1 in 20-120 ppm solutions)

Nomenclature for the parent Alachlor and its major degradation products:

Alachlor = 2-chloro-2',6'--diethyl-N-methoxymethylacetanilide

alachlor oxanilic acid = 2',6'-diethyl-N-methoxymethyloxanilic acid

alachlor sulfonic acid =2',6'-diethyl-N-methoxymethyl-2-sulfoacetanilide

alachlor sulfinylacetic acid = [N-methoxymethyl-N-(2,6-diethylphenyl)-2-amino-2-oxoethyl]sulfinylacetic acid

DM-oxanilic acid = 2',6'-diethyloxanilic acid

Alachlor is stable to abiotic processes (hydrolysis, photolysis in aqueous media, or photodegradation on soil). The major dissipation routes for the chemical appear to be microbially mediated degradation and leaching. Alachlor is degraded at moderate rates ($t_{½} \approx$ 2-3 weeks) in aerobic soils, with several degradates observed, including DM-oxanilic acid, alachlor ethane sulfonic acid (alachlor-ESA), alachlor oxanilic acid, and alachlor sulfinylacetic acid. Although EFED does not have valid K_d's for alachlor[1], the column leaching study for the parent indicates that it is very mobile and is not appreciably adsorbed to soils with low organic matter. A batch equilibrium study on alachlor-ESA shows that this degradate is very mobile. The findings in the field confirm the predicted fate from laboratory studies.

Alachlor dissipated at moderate rates in the field; the observed half-lives of 6 and 11 days are of the same order of magnitude of the half-lives observed in various aerobic soil metabolism studies (2-3 weeks). It appears that the persistence and mobility of the chemical may increase as it reaches deeper soil horizons which have lower organic matter content and decreased biological activity, thus increasing its potential to leach into groundwater.

a. *Environmental Fate Assessment*

Based on acceptable and supplemental studies, the following conclusions can be drawn:

i. Degradation and Metabolism

Alachlor is a soluble molecule (240 ppm in water at 20°C), with an octanol/water partition coefficient of 434, and a vapor pressure of 2.2×10^{-5} mm Hg.

Alachlor was stable to hydrolysis in buffered solutions at pH's 3, 6, and 9. It was also relatively stable in natural lake water. Alachlor does not show any absorption bands above 240 nm in the absorption spectrum; therefore, it is not expected to undergo photolysis in water or on soil.

In soils, under aerobic soil metabolism conditions, alachlor appears to degrade at a moderate rate. Results of three different studies (one acceptable and two supplemental) show that alachlor degrades with half-lives in the range of 6-21 days. The studies include use of different sites, different formulations, and different soil types. Several degradates were observed in the studies. The major degradates in the aerobic soil metabolism studies were DM-oxanilic acid (with a maximum of 17.0% of the applied), alachlor sulfonic acid (ESA; 24.9% of the applied), alachlor oxanilic acid (22.4% of the applied), and alachlor sulfinylacetic acid (16.2% of the applied). Of these major "water-soluble" degradates, alachlor sulfinylacetic acid was not observed in the valid aerobic soil metabolism study. However, it was observed in a supplemental study. All four degradates appear to be more

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[1] The registrant indicated that a K_{OC} of 124 has been reported by USDA/ARS in their Internet Web site. However, the scientific validity of this value cannot be determined from available information.

persistent than alachlor, since significant concentrations remained in the soils at the end of the aerobic soil metabolism studies.

CO_2 is the ultimate degradate; it comprised 16.17-30.00% of the applied after 175 days in a valid study. Unextracted residues comprised $\leq$20.76% of the applied at the same test interval.

ii. *Mobility*

Based upon both supplemental and acceptable studies, parent alachlor appears to be highly mobile in soils. In a column leaching study, in three of the soils with lower organic matter, alachlor was very mobile: silt, sand, and loamy sand soil (0.7-2.4% OM) columns, the leachates contained 40.9-96.9% of the applied radioactivity. In another soil with a higher organic matter content, the mobility was lower: silt loam soil (3.4% OM), the leachates had only $\leq$0.6% of the applied radioactivity; however, even though the water was added at a rate slower than the infiltration capacity, substantial downward movement was observed through the column, with a total of 53.5-57.7% of the applied radioactivity found in the soil segments from 9- to 18-cm.

Since all the major water soluble degradates of alachlor have carboxylic or sulfonic acid functional groups, which render a negative (anionic) character to the molecule under normal environmental conditions, it is expected that the degradates will be highly mobile in soils. This is supported by the available mobility data for the degradates of propachlor (propachlor sulfonic acid and propachlor oxanilic acid), which are structurally similar to the degradates of alachlor; the data for these degradates of propachlor has been used as surrogate data in lieu of the original alachlor metabolites. In addition, a batch equilibrium study on alachlor-ESA shows that this degradate is very weakly absorbed. Quantitative results could be obtained in only one of the soils (very mobile in Sable silty clay loam, Freundlich K_{ads} value was 0.45 and K_{OC} value was 15).

iii. *Bioaccumulation*

Alachlor is not expected to bioaccumulate significantly in fish, based on high solubility (240 ppm), and relatively low octanol/water partition coefficient (434).

iv. *Field Dissipation*

In a Terrestrial Field Dissipation study conducted in Chico, California, alachlor, at 4 lb. a.i./A, dissipated with a half-life of 11 days from loam/sandy clay loam soil planted to corn. This half-life is consistent with the ones observed in various aerobic soil metabolism studies. Most of the alachlor was found in the 0- to 18-inch soil layers, with occasional detections in the 18- to 24-, 24- to 36-, and 36- to 48-inch layers (the deepest layer sampled), indicating a large extent of leaching. The four major water-soluble metabolites of alachlor were also monitored in this study. The soil composition data in this study shows increasing percent of clay with soil depth (to a maximum of 65% clay in the 24- to 36-inch soil depth). This "clay pan" reduces the flow of water into deeper soils layers, decreasing the possibility of leaching of both parent alachlor and degradates.

In the Chico Terrestrial Field Dissipation study, the oxanilic acid, the sulfinylacetic acid, and the sulfonic acid derivatives were detected in the 0- to 6- and 6- to 12- inch soil depths at average concentrations of 0.010-0.045 ppm. Detections were observed through 36- to 48- soil depth for the oxanilic acid, 18- to 24-inch soil depth for the sulfinylacetic acid and sulfonic acid, and 6- to 12-inch soil depth for the DM-oxanilic acid. Generally, detections occurred through 44-90 days posttreatment in the subsoils. Once moved to the subsoils, these degradates appear to persist. Groundwater is not monitored in field dissipation studies, but there are confirmed detections of alachlor sulfonic acid in groundwater.

Alachlor, applied once at 4 lb a.i./A, dissipated with a registrant-calculated half-life of 6 days from the 0-6 inch soil depth of a bareground plot of sandy loam soil in Hickman, California. The field was bareground to simulate preemergent application to a crop. Alachlor remained mostly in the 0-6 inch soil depth. Detections averaging 0.018-0.046 ppm were reported in the 6-12 inch soil depth on days 0 and 1 after application.

In the Hickman, California Terrestrial Field Dissipation study the following degradates were detected: alachlor DM-oxanilic acid, which was detected in the 0-6 inch soil depth from day 1 through day 366 after treatment. The chemical was detected in the 6-12 inch soil depth only on day 182 after application (with an average value of 0.004 ppm). Alachlor oxanilic acid was detected in the 0-6 inch soil depth from day 0 through day 366 after application, in addition, at three test intervals, detections were reported in the 6-12 inch soil layer. The chemical was also detected in the 12-18 and 18-24 inch soil layers on day 182 after application. Alachlor sulfinylacetic acid was observed at low levels in the 0-6 inch soil layer from day 1 to 182 after application In addition, the chemical was detected in the 6-12 and 18-24 inch soil layers on day 182 after application, Alachlor sulfonic acid or alachlor-ESA was observed at low levels from day 0 through day 366 after application at average levels ranging from 0.003-0.010 ppm. Detections were also reported in the 6-12 inch soil depth on two test intervals. Furthermore, the chemical was detected in the 12-18 inch soil depth on day 182 after application, with an average value of 0.003 ppm

v. Volatility

Volatilization is not expected to be an important route of dissipation for alachlor. The chemical has relatively low vapor pressure (2.2×10^{-5} mm Hg). Furthermore, the amount of volatiles in the aerobic soil metabolism studies were negligible.

vi. Spray Drift

The labels indicate that alachlor may be applied aerially. No alachlor-specific spray drift studies were reviewed. The Spray Drift Task Force (SDTF), a consortium of pesticide registrants, has submitted to EPA a series of studies intended to characterize spray drift potential due to various factors, including application methods, equipment, meteorological conditions, crop geometry, and droplet characteristics. EPA is currently evaluating these studies, which include ground spray as well as aerial application methods. After its review of the studies, the Agency will determine whether a reassessment of the potential risks from the application of alachlor to nontarget organisms is warranted.

b. *Terrestrial Exposure Assessment*

Nongranular applications: The terrestrial exposure assessment is based on the methods of Hoerger and Kenaga (1972) as modified by Fletcher et al. (1994). Terrestrial estimated environmental concentrations (EECs) for nongranular formulations were derived from maximum application rates up to 6.0 lb ai/acre.

Table 1: Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1, 4, and 6 lb ai/A (Hoerger and Kenaga, 1972, as modified by Fletcher et al, 1994)

Food Items	*EEC (ppm) Max. Residue for 1, 4 and 6 lb ai/acre*			*EEC (ppm) Mean Residue for 1, 4 and 6 lb ai/acre*		
Short grass	240	960	1,440	85	340	510
Tall grass	110	440	660	36	144	216
Broadleaf plants and small insects	135	540	810	45	180	270
Fruits, pods, seeds, and large insects	15	60	75	7	28	42

Granular applications: EECs for broadcast granular applications are calculated on the basis of mass (in mg) per area (square foot), corrected for the fraction of the pesticide left on the surface. The maximum EEC for a broadcast granular formulation is 62.5 mg/ft^2 at the maximum 6.0 lb ai/acre application rate. For unincorporated broadcast applications, the entire fraction of the pesticide is assumed to remain on the surface. The label for granular formulation prescribes adjusting the desired application rate by the fraction:

band width (inches) / row spacing (inches)

c. *Water Resource Assessment*

i. *Ground Water Assessment*

Alachlor exhibits the properties associated with chemicals that are found in ground water. The chemical has a high solubility and mobility in soils. Once the chemical reaches deeper soil layers with lower organic matter content and lower microbial populations, it will persist. An independent study conducted for EPA indicates that alachlor half-lives at different depths in a sandy loam and a silt loam soil increased to about 250 to 600 days at a depth of 5 feet (Lavy et al., 1993). Alachlor has been found to leach in the field at soil depths of up to 36- to 48-inches (the deepest layer sampled). Considering the nature of the chemical (i.e., moderately persistent and very mobile in many soils), there is a strong possibility of movement to ground water, especially in vulnerable areas. This has been confirmed by a substantial number of detections reported in the "Pesticides in Ground Water Database," and in the National Alachlor Well Water Survey conducted by the Registrant, from which EPA determined that alachlor residues have had a significant impact on ground-water quality throughout the use area.

Several sources of information on monitoring/detections of alachlor and alachlor metabolites in ground water are reviewed in this document and presented in the Appendix C. That information confirms that alachlor and alachlor degradates will move into ground water. These monitoring data are summarized in Table 2.

Table 2. Summary of wells with detections of alachlor (parent).

Study[1]	Well type	Number of Wells (%)			
		Sampled	Alachlor Detected	Concentration <MCL	Concentration >MCL
USGS(1991-1994)	drinking	303	10 (3.3%)	9 (3.0%)	1 (0.3%)
ARP-GWMP	monitoring	173	27 (15.6%)	25 (14.5%)	2 (1.2%)
PGWDB	mixed, most drinking	25933	467 (1.8%)	368 (1.4%)	99 (0.4%)
NPS	drinking	1300	1 (<0.1%)	0 (0%)	1 (<0.1%)
NAWWS	drinking	1430	28 (2.0%)	26 (1.8%)	2 (0.1%)
Florida	drinking	310	46 (15%)		
North Carolina	drinking	171	15 (8.8%)	10 (5.9%)	5 (2.9%)

[1] PGWDB = Pesticides in Ground Water Database; NPS = National Pesticide Survey; NAWWS = National Alachlor Water Well Survey, USGS = U.S. Geological Survey Midcontinent Study, ARP-GWMP = Acetochlor Registration Partnership Ground-Water Monitoring Program.

Persistence of Alachlor in Ground Water

Ground-water monitoring studies have shown that alachlor contamination is common in use areas. Recent data suggests that alachlor can persist in the subsurface for years and that ground water contamination can be expected long after use has stopped. Maas *et al.* (1995) found evidence that low concentrations of alachlor in drinking water wells persisted over long periods, and contamination can move off-site via transport in ground water. In Florida, significant alachlor contamination still occurs years after all alachlor use was canceled in February 1991. Sixteen wells found to have alachlor at concentrations greater then 2.0 ppb prior to the ban have been sampled yearly since 1991. The mean alachlor concentrations in these wells have not changed over time (Simons and Fisher, 1997; R.E. Fisher, personal communication, 1998).

Alachlor Exposure from Drinking Ground Water

Results of several studies designed to assess the occurrence of alachlor in drinking water wells makes it possible to roughly estimate the number of people exposed to the compound by drinking contaminated ground water. Based on U.S. Census data the National Ground Water Association (NGWA) estimates that 53% of the American public relies on ground water for their drinking water. This includes about 282,000 public supply wells and approximately 15.1 million households using private wells. Based on estimates below, EFED believes a large number of people in the U.S. can expect to be exposed to alachlor in their drinking water. Hundreds of thousands of people living in households supplied by private wells will have alachlor and/or alachlor degradates in their drinking water as a result of labeled use of the compound. Large numbers of Americans can expect to have alachlor concentrations above the current Maximum Contamination Level (MCL) of 2.0 ppb in their drinking water as a result of labeled use of the compound[2].

The National Alachlor Well Water Survey (Holden and Graham, 1990; MRID 414000-01) was designed primarily to assess the occurrence of alachlor in rural wells in high alachlor use areas. The study estimated 6 million wells, serving 20 million households, occurred in the alachlor use areas, based on Monsanto's 1986 alachlor sales data. The majority of the wells were near agricultural areas, and 40% were within 300 feet of fields where alachlor target crops were grown. Alachlor was detected in 2.0 % (standard error of 0.25) of sampled wells at measurable concentrations. The survey found 0.18 % (standard error of 0.12) of the sampled wells had alachlor concentrations above 2.0 ppb (Table 2). No significant differences were seen in wells on farm and non-farm properties. Exposure estimates by Monsanto (assuming a nonlinear distribution for detections, which is reasonable for pollutant data with asymmetric distributions and a relatively low occurrence of events) suggest that more than 100,000 people in the study area had detectable levels of alachlor in their water supply, 35,000 would be exposed to concentrations of ≥ 0.2 ppb, and more then 3,000 people would have alachlor concentrations above 2.0 ppb (MIRD 414000-01). Weaknesses in the survey include: (a) the NAWWS use area underestimated the alachlor use area defined by Resources For the Future, (b) the study was conducted in a relatively dry year (1988) which would have minimized the potential for leaching, and (c) the estimates do not include small community wells that serve more than 15 households or more than 25 people, which may underestimate the total number of people exposed to alachlor in drinking water (Rappaport, ICF, 1991).

Two studies in North Carolina examined levels of alachlor in drinking water wells (Mass et al, 1995; Wade et al, 1997). NGWA estimates that North Carolina has 912,000 household wells and 20,000 public and community supply wells. In eastern North Carolina, 8.8% of drinking water wells sampled between 1989 and 1992 contained measurable alachlor concentrations and 2.9 % were above the current MCL of 2.0 ppb (Mass *et al,* 1995). This study also found that contamination is not always confined to wells in or close to fields to which alachlor was applied. Results of the eastern North Carolina study show a higher percentage of wells with alachlor contamination than that found in the NAWWS study. This study, conducted primarily within the coastal plain, may reflect potential exposure in an area in which the ground water is highly vulnerable to contamination from pesticides (as delineated by Kellogg *et al,* 1992).

Sampling in Florida found that 9.4 % of drinking water wells were contaminated with alachlor and 5.5 % had alachlor concentrations above 2.0 ppb (Simons and Fisher, 1997). Most of the well contamination at high levels may be a result of mixing and transfer operations or other point sources (R.E. Fisher, personal communication, 1998), and the owners have been provided with water treatment systems or an alternate supply. In

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[2] MCLs are established for public drinking water supplies and are not enforceable for private water supplies. A one-time detection above the MCL does not necessarily constitute a violation in public water systems or trigger requirements for mitigation. Such actions are based on average annual concentrations, which is a time-weighted average of all detections, including the exceedance value, for the year. Since drinking water violations reported by EPA's Office of Water are for public water supplies and are based on average annual concentrations, the frequency of such exceedances is likely to be less than the frequency of individual detections above the MCL reported here.

Florida, about 794,500 households are served by private wells; 16,000 are on public and community supply wells. Concerns about such exposure resulted in a ban of the use of alachlor in Florida. Since the 1991 ban, average alachlor concentrations in wells initially found to have levels above 2.0 ppb have not changed, and individual treatment systems are still required to provide safe drinking water to these households. More than five years after use was banned these wells still show contamination.

Despite the large amount of uncertainty associated with exposure estimates, they provide an estimate of the magnitude of people who can expect to have alachlor in their drinking water. Tens of millions of Americans rely on domestic wells for their drinking water and the majority of these are in rural areas. A few wells in any study showing significant levels of alachlor contamination or only a few percent of wells being contaminated suggests that a large number of people will be exposed.

There are additional concerns related to contamination of ground water used for drinking water supply. Alachlor appears to be persistent under aquifer biological and geochemical conditions. This means that alachlor can appear in ground water years after use and can migrate with ground water away from use areas. Alachlor contamination has resulted in loss of untreated ground water as a source of drinking water in Florida and other states. Years after alachlor was banned, the resource is still degraded.

ii. Surface Water Assessment

Alachlor can contaminate surface water at application via spray drift. Substantial fractions of applied alachlor could be available for runoff for several weeks post-application. The relatively low soil/water partitioning of alachlor indicates that most runoff will occur via dissolution in runoff water (as opposed to adsorption to eroding soil). The persistence of alachlor in surface waters with high microbiological activities should be somewhat limited by its susceptibility to biodegradation. Persistence will also be limited in waters with short hydrological residence times by flow out of the system. However, its resistance to abiotic hydrolysis and direct aqueous photolysis, coupled with its low volatilization potential should make alachlor more persistent in waters with low microbiological activities and long hydrological residence times.

Alachlor may also enter freshwater, estuaries, and coastal marine water in areas of interaction with ground water. Presence in fresh surface water of alachlor-ESA before application suggest input to rivers and streams from ground water.

There is an extensive body of information on levels of alachlor and alachlor degradates in surface water (Appendix D). Table 3 summarizes the major surface water studies:

Table 3: Summary major surface water sources with alachlor detections by study.

Study	Number of Sites	Maximum Peak (ug/l)	Maximum TWMC[1] (ug/l)
ARP - 1995-1996	175-179	4.0	0.36

Table 3: Summary major surface water sources with alachlor detections by study.

Study	Number of Sites	Maximum Peak (ug/l)	Maximum TWMC[1] (ug/l)
USGS - Midwestern Stream Recon. 1989	48	51.3	11.6
USGS Mississippi River Basin Study 1991-1992	8	3.6	0.43
State of Illinois 1986-1988	30	18	0.81
Monsanto Finished Surface Water Study 1986	30	9.5	1.1
Monsanto Finished Surface Water Study 1985	30	12	1.5
USGS Cedar River basin Study 1984	6	23	1.7
Ohio Tributaries to Lake Erie 1982-1985	8	76	3.3[2]
Lake Erie Basin Case Study 1983-1987	7	91.47	1.74

[1] TWMC: Time weighted mean concentrations, annual unless otherwise noted.

[2] Time weighted mean concentration calculated over a 4 month period of the study; April 15 to August 15

The monitoring results primarily reflect residue detections in lotic waters such as rivers and streams or large lentic bodies of water such as man-made reservoirs and lakes. Therefore the levels observed may have been affected by dilution, degradation, or adsorption to soil or sediment, relative to edge-of-field levels (values occurring close to sites of application immediately following runoff events). Edge-of-field levels may be better represented by modeling. (However, at this time only screening level modeling has been undertaken.) Also, the model scenarios represent small, static bodies of water. Reported peak concentrations are affected systematically by the intensity of sampling: with less frequent sampling there is higher probability of levels in the environment that substantially exceed the highest values detected.

Of the surface water monitoring data available, the USGS Midwestern Stream Reconnaissance Studies (1989, 1994, 1995) give what are probably the values closest to the most extreme edge-of-field levels. In that study peak exposures were 51.3 ug/L for 1989, 10.1 ug/L for 1994, and 19.9 ug/L for 1995. The 90th percentile values (upper 10th percentile values) were 12, 6.5, and 2.0 ug/L for the same years.

iii. Alachlor Degradates in Water

The major degradates of alachlor are DM-oxanilic acid, alachlor oxanilic acid, alachlor sulfinylacetic acid, and alachlor ethane sulfonic acid (alachlor-ESA). While uncertainty exists concerning the environmental or health effects of these breakdown products, available data suggests they are more persistent and mobile than parent alachlor. Limited monitoring data suggest that alachlor ESA is often found in ground water wells 5-10 times more frequently then the parent compound. Alachlor-ESA has been detected frequently in Midwestern reservoirs and streams at concentrations much greater than alachlor. High concentrations of ESA in flowing water even in early Spring before alachlor application may reflect discharges from ground water. The major degradates may be available for runoff longer than alachlor and will probably be transported primarily by dissolution in runoff water. They will probably readily partition into the water column and in addition to ESA, other degradates may also be more persistent in surface water than alachlor.

d. Aquatic Exposure Assessment

Preliminary aquatic EECs are estimated using GENEEC, a screening model that provides an upper-bound estimate of EECs on a high exposure site. The GENEEC program uses basic environmental fate values (adsorption to soil, degradation in soil before runoff and in water) and pesticide label information (rates, intervals, incorporation, method of application) to estimate the EECs in a one-hectare, two-meter deep pond following the treatment of a 10 hectare field. The runoff event occurs two days after the last application. The model accounts for direct deposition of spray drift onto the water body (assuming 5% of the application rate for aerial spray applications and 1% for ground spray applications).

Table 4: Evironmental fate parameters used to predict propachlor EECs.

Parameter	*Value*
water solubility (ppm):	242 ppm
Koc:	190
aerobic soil metabolism, t1/2:	21 days[1]
hydrolysis t1/2, pH 7:	Stable
aerobic aquatic metabolism, t1/2:	175 days
aqueous photolysis t1/2:	80 days

[1]The aerobic soil metabolism half-lives in three studies was 6-21 days. .

Table 5: Screening Level Aquatic EECs Generated by GENEEC, with LOC Exceedances.

Application Rate/Method/Incorporation	**EEC Estimates Over Time (ppb)**				**Species with LOC exceedance, (risk quotient)**
	Peak	**4 Da**	**21 Da**	**56 Da**	
1.0lb Granular/Ground/none	33	32.7	30.7	27.4	Aquatic Plant (21)
2.0lb Granular/Ground/none	66.3	65.5	61.5	58.9	Aquatic plant (41)
4.0lb Granular/Ground/none	133	131	123	110	Daphnid Chronic NOEC (1) Aquatic Plant (83)
6.0lb Granular/ground/none	199	196	184	164	Daphnid Chronic NOEC (2) Fish Chronic NOEC (1) Aquatic Plant (124)
1.25lb ai/groundspray/none	39	38	36	32	Aquatic Plant (24)
2.5lb ai/groundspray/none	78	77	72	65	Aquatic Plant (49)
3.0 lb ai/groundspray/none	94	93	87	78	Daphnid Chronic (1) Aquatic Plant (57)

Table 5: Screening Level Aquatic EECs Generated by GENEEC, with LOC Exceedances.

Application Rate/Method/Incorporation	EEC Estimates Over Time (ppb)				Species with LOC exceedance, (risk quotient)
	Peak	4 Da	21 Da	56 Da	
4.0lb ai/groundspray/none	125	124	116	104	Daphnid Chronic NOEC (1) Aquatic plant EC50 (76)
4.0 lb ai/groundspray/2.0 inch incorporation	64	63	59	53	Aquatic plant (40)
2.0 lb ai/A twice groundspray/no incorp./30 day interval	92	91	85	76	Daphnid Chronic NOEC (1) Aquatic Plant (57)

These EEC's are intended to be conservative for bodies of water adjacent to areas of application, primarily for use in ecological screening evaluations. Of the surface water monitoring data available (Appendix D), the USGS Midwestern Stream Reconnaissance Studies (1989, 1994, 1995) give what are probably the closest values to peak exposures occurring close to application sites soon after application. Peak exposures were 51.3 µg/L for 1989, 10.1 µg/L for 1994, and 19.9 µg/L for 1995. The 90th percentile values (upper 10th percentile values) were 12, 6.5, and 2.0 µg/L for the same years.

The Agency has reviewed an extensive body of information on levels of alachlor and alachlor degradates in surface water (discussed in more detail in Appendix D). This database for alachlor is substantially greater than that available for most pesticides. These monitoring results primarily reflect residue detections in lotic waters such as rivers and streams or large lentic bodies of water such as man-made reservoirs and lakes. As such they are good indications of what residue levels might be expected after residues have traveled farther down the watershed. These residue detections are influenced by a number of factors including dilution by the respective waterbody, time of monitoring, position of monitoring stations, and the number of measurement samples recorded over time (when averaging sample detection levels). Thus this information should be used as an indication of levels which might be expected after dilution, organic degradation, and soil or sediment adsorption factors have acted on the chemical for the period of time between application and actual sampling at respective monitoring stations. In many cases peak concentrations of alachlor occur during early to late spring months when rainfall events lead to higher than average runoff. Simple averages of measured concentrations are biased towards representing those time periods with more samples, a bias that can be eliminated by using time weighted mean concentrations (TWMC's).

An additional limitation of the monitoring information is the likelihood that some actual environmental concentrations will exceed the highest levels detected. The chance that a peak concentration will not be detected is expected to differ among monitoring studies, depending on the frequency of sampling and on the variability of environmental concentrations.

Tables 6 and 7 summarize two studies conducted by the US Geological Survey in 1991 and the State of Illinois in 1990. The studies are discussed in more detail in Appendix D.

Table 6: USGS Mississippi River Basin Survey, 1991-1992[1]

Location Sampled (24 Samples per location)	Concentration (µg/L)			LOC Exceedance-Organisms Effected
	Peak	Arithmetic average	Annual TWMC	
White River, Hazelton, In.	3.2	0.3	0.22	Aquatic Plants-(Peak only; based on EC_{50} (=1.64 ug/L)
Ohio River, Grain Chain, Il.	0.40	0.08	0.07	No
Miss. River, near Clinton, IA.	0.85	0.16	0.10	No
Illinois River, Valley City, Il	3.00	0.40	0.22	Aquatic Plants-(Peak only, based on EC_{50})
Platte River, Louisville, NE	3.60	0.43	0.22	Aquatic Plants-(Peak only, based on EC_{50})
Missouri River, Hermann, Mo.	0.92	0.19	0.12	No
Miss. River, near Thebes, Il.	0.86	0.27	0.23	No
Miss. River, Baton Rouge, LA.	0.46	0.12	0.09	No

[1] Based on bi-weekly samples May to August and weekly samples Sept. to Dec. 1 (Coupe et al. 1995).

Table 7: Illinois Surface Water Survey, 1986-1988[1]

Site Type	Range of over sites and years (ug/L)		LOC Exceedance Organism Effected
	Range of Peak values	Range of annual TWMC	
Illinois Rivers (21 Sites-18 Rivers)	0.02- 8.5	0.02-0.65	Aquatic Plants based on EC_{50}
Illinois Creeks (9 Creeks)	0.02-18.0	0.02-2.0	

[1] Based on samples from 30 sites representing different streams and rivers, 4-7 samples per yr at each site (Moyer and Cross, 1990).

In addition to surface water data reviewed by the Agency, the following data is reported by the Chesapeake Bay Fall Line Toxics Monitoring Program, representing the period from March 1992 to February 1993. Monitoring data is based on one station per river. This data has not been reviewed by the Agency. At this time it is viewed as supplementary information that tends to confirm concerns for adverse effects on aquatic organisms. Also, the study represents an East Coast tributary and thus provides a wider geographical scope for the monitoring data.

Table 8: Summary of Chesapeake Bay Fall Line Toxics Monitoring Program for Alachlor detections in Major Streams.

Location	Range detected µg/L	Mean µg/L	LOC Exceedances by Mean
Susquehanna River	<2.05-23.1	4.4	Aquatic Plants, based on EC_{50}
Potomac River	2.5-20.9	4.1	
James River	7.5-20.2	2.9	

Ecological Effects Hazard Assessment

Alachlor is slightly toxic to practically nontoxic to birds on an acute oral basis but chronic data are not available. The pesticide is considered slightly to practically nontoxic to terrestrial animals (based on tests on bobwhite quail, mallard duck, honeybee and rats). The chemical is considered moderately toxic to freshwater fish and invertebrates on an acute basis. Based on a single species tested, alachlor is highly toxic to aquatic plants. Based on two studies submitted for the sulfonic acid and oxanilic acid degradates, the major alachlor degradates are not very toxic to aquatic animals. Detailed summaries of the toxicity studies are provided Appendix B.

a. *Toxicity to Aquatic Animals*

Following is a summary of toxicity information for aquatic animals (fish and invertebrates).

Table 9: Summary of Alachlor Toxicity Data for Aquatic Animals (Fish and Invertebrates).

Species, No. of Studies / TGAI or EUP / formulation % / (A)cceptable or (S)upplemental Study	**Toxicity**	
Acute toxicity		
Bluegill and trout, 12 studies TGAI/EUP;43-100%; A/S	LC_{50} 1-8 ppm	moderately toxic
Daphnia/TGAI, 2 studies / TGAI/90-93% / A	LC_{50} 10-21 ppm	slight to moderate toxicity
Daphnia/EUP, 3 studies / EUP/42-49% / S	LC_{50} 22-33 ppm	
Daphnia/EUP, 1 study / EUP/43% / A	LC_{50} 8 ppm	
Midge, 2 studies / TGAI/EUP;45-93% / A	LC_{50} 3 ppm	
Sheepshead minnow, 1 study / TGAI / A	LC_{50} 3.9 ppm	moderately toxic
Eastern oyster, 1 study / TGAI / A	EC_{50} 1.6 ppm	
Mysid, 1 study / TGAI / A	LC_{50} 2.4 ppm	
Chronic toxicity		
Rainbow trout / 1 study / TGAI/100%/A	NOEC = 0.2 ppm LOEC = 0.4 ppm	highly toxic
Daphnia / 1 study / TGAI/95%/A	NOEC = 0.1 ppm LOEC = 0.2 ppm	highly toxic
Alachlor degradates: For rainbow trout and Daphnia, low **acute** toxicity of alachlor sulfonic acid (LC_{50} >104 ppm) and alachlor oxanilic acid (LC_{50} >95 ppm) (92% formulations)		

Data gaps:
- No chronic toxicity for alachlor degradates.
- No toxicity measurements for estuarine organisms (acute or chronic, parent or degradates).

Recommendation: require standard acute toxicity measurements for parent alachlor for estuarine fish and invertebrates.

EFED compared the toxicity values to Tier I (GENEEC) estimates of aquatic exposure and to concentrations observed in surface water monitoring. GENEEC calculations were performed for a range of use scenarios based on permitted combinations of application rate (1-6 lb ai/A), ground spray versus granular application, and incorporation. In addition to scenarios involving a single application, a scenario was evaluated with two 2 applications of 2 lb ai/A by ground spray without incorporation, separated by 30 days.

The most extreme EECs (lowest as well as highest) corresponded to granular application without incorporation: Time-zero EECs (representing concentration immediately following runoff) ranged from 33 ppb for 1 lb ai/A to 199 ppb for 6 lb ai/A; 56-day average EECs ranged from ranged from 27.4 ppb to 164 ppb for the same range of application rates. GENEEC values are intended to provide upper bounds for concentrations, to be used to indicate that a concern can be excluded or else that more refined (Tier II) modeling is required.

For freshwater animals (fish or invertebrates) *exposure estimates based on Tier I modeling (GENEEC) exceed concern levels only for chronic effects*, and only at application rates of *4-6 lb ai/A (invertebrates) or 6 lb ai/A (fish), without incorporation.* For estaurine/marine organisms (fish, shrimp and shellfish) exposure estimates based on Tier 1 modeling (GENEEC) do not exceed concern levels for acute effects. Alachlor concentration *levels observed in monitoring studies do not indicate a risk* for acute or chronic effects on aquatic animals. Thus, a chronic risk cannot be dismissed for small, shallow, relatively static bodies of water (such as farm ponds or small freshwater marshes) from unincorporated applications of alachlor at 4 lbs ai/A or above (invertebrates) or 6 lb ai/A (fish), but the information available suggests that impacts are not expected in larger water bodies such as rivers or large lakes. It is noted that the registrant has agreed to reduce the maximum application rate from 6 to 4 lb a.i./A, further reducing the potential to exceed the levels of concern.

b. Toxicity to Nontarget Plants and Aquatic Ecosystems

Effects on aquatic plants are expected to result in indirect effects on aquatic animals, e.g., by habitat modification or restricted food supply.

Based on the single species tested, alachlor is highly toxic to aquatic plants. An acceptable study using the freshwater green alga *Selenastrum capricornum* led to the following toxicity findings for effects on growth:

No observed effect level (NOEL) 0.35 ppb;
Low observed effect level (LOEL) 0.69 ppb;
50% growth reduction (EC_{50}) 1.64 ppb.

Tier I exposure modeling did not exclude concerns based on these results. The EC_{50} was exceeded substantially in the USGS reconnaissance studies in each year of three years, and occasionally exceeded in other monitoring studies. EFED believes substantial community level impacts can result from infrequent exceedance of toxic levels in aquatic ecosystems.

To completely fulfill the data requirements for aquatic plant testing, additional studies must be submitted for acute toxicity to an aquatic macrophyte, a marine diatom, a blue-green algae and a freshwater diatom. It is likely that testing of 4 more species will indicate that at least one is more sensitive than the single species tested already.

c. *Toxicity to Terrestrial and Semiaquatic Plants*

EFED is not raising special concerns for adverse effects of alachlor on terrestrial plants, relative to other herbicides with extensive use. Large scale use of a herbicide ordinarily poses some concern for terrestrial plants at least in the immediate vicinity of application sites. Plants more distant from application sites may be exposed to some level of alachlor because of aerial drift, seepage of contaminated ground water to the soil surface, channelized runoff from application sites to nearby low-lying areas, or irrigation with contaminated ground or surface water. For parent alachlor, evaluation for terrestrial plants indicates high risk with risk quotients of 1-5 assuming transport by drift and runoff.

EFED does not have information on toxicity of alachlor degradates to nontarget terrestrial plants. Situations where alachlor degradates might have a significant effect on terrestrial or semiaquatic plants include irrigation with contaminated ground or surface water and seepage of ground water to the soil surface.

d. *Toxicity to Terrestrial Animals*

Following is a summary of alachlor toxicity to terrestrial animals.

Table 10: Summary of Alachlor Toxicity Data for Terrestrial Animals.

Species / TGAI or EUP / formulation % / (A)cceptable or (S)upplemental	**Toxicity**	
Bobwhite Quail / TGAI/92% / A	LD_{50}=1500 mg/kg	slightly toxic
Bobwhite Quail, Mallard Duck / TGAI/92-95% / A	LC_{50}>5620 ppm	practically nontoxic
Honeybee/ 2 studies / TGAI/42-100%/A	LD_{50}>36 ug	slightly toxic
Rat [HED study/ MRID 00139383]	LD_{50}=930 mg/kg	slightly toxic

Information Gaps:
- Chronic avian toxicity for parent alachlor and degradates.
- Acute toxicity of degradates.

<u>Current recommendation:</u> Require studies of chronic toxicity for parent alachlor (bobwhite quail, mallard duck)

EFED does not find concerns based on *acute* toxicity. Regarding chronic effects, the Agency does not have studies of effects on *avian reproduction*. An acceptable avian reproduction study would have high value. In particular, alachlor is used extensively and tends to be used during parts of the year when birds will be breeding. Other acetanilides (acetochlor, metolachlor) have been shown to be toxic in avian reproduction studies reviewed by EFED.

The potential for chronic impacts will depend on exposure factors that include persistence in terrestrial environments (particular in exposure pathways of nontarget species) and number of applications. As for most pesticides we do not have the information that would be required for a detailed characterization of dissipation in the exposure pathways of terrestrial species. The persistence of the compound indicates that it may be available for a relatively long period of time on the application site.

Exposure to terrestrial species can be reduced by soil incorporation or by watering in the pesticide. However, there are indications that irrigation may promote movement into ground water.

Comparative Assessment With Other Acetanilides

a. Environmental Fate Characteristics

Alachlor, acetochlor and metolachlor are moderately persistent while propachlor appears to be the least persistent of all the acetanilides. However, the available aerobic soil metabolism values ($t_{1/2}$ and DT_{50}) for the four chemicals are within the same order of magnitude. All of the compounds are highly mobile.

A table summarizing the environmental fate characteristics of the four acetanilides appears in Appendix E. An inspection of the physico-chemical characteristics of these chemicals reveals that alachlor has the second lowest molecular weight. Alachlor has a high solubility in water, although it is lower than the solubility of acetochlor and metolachlor. All the compounds have relatively low octanol/water partition coefficients, low vapor pressures, low calculated Henry's Law constants, and relatively low bioaccumulation factors.

Further investigation of the environmental fate characteristics reveals that all four chemicals are relatively stable to hydrolysis and photolysis in water. Three of the compounds are stable to photolysis on soil while metolachlor has a half-life of 8 days. In general, it appears that the important routes of dissipation for these compounds are aerobic soil metabolism and leaching. The aerobic soil metabolism 50% dissipation rates range from 2.7 days for propachlor, to 2-3 weeks for alachlor, and 67 days for metolachlor. The available studies indicate that anaerobic soil metabolism is not an important route of degradation for the acetanilides.

The half-lives observed in the field are of the same order of magnitude of the half-lives of aerobic soil metabolism studies in all cases. Results of the field studies confirm aerobic soil metabolism as an important route of dissipation for the four compounds.

b. Ecotoxicity

The comparative analysis of the ecotoxicity data for propachlor, alachlor, acetochlor, and metolachlor is based on data taken from the OPP/EFED Pesticide Ecotoxicity Data Base-1997. Only those studies classified as Core data were used in the analysis. Study identification numbers are shown as either an MRID#, Accession No., or an EPA ID# (Fiche No.). Category terminology was taken directly from Brooks, et al. (1973).

Tables E-2 through E-8 in Appendix E show the ecological toxicity data available for birds, mammals, freshwater fish, estuarine fish, freshwater aquatic invertebrates, and estuarine invertebrates. The analysis suggests that this group of acetanilides are similar in toxicity. Propachlor appears to be more toxic to fish and aquatic invertebrates while acetochlor is more toxic to birds. However, no clear differences are evident.

i. Avian Species

On an acute oral basis, the toxicity data suggest that acetochlor is the most toxic of the four herbicides (49 mg/kg), followed in order by propachlor, alachlor and metolachlor. The avian subacute dietary data suggest that acetochlor is slightly more toxic (4171 ppm) than the other three herbicides. In general, both the acute and subacute avian toxicity data indicate that all four herbicides are practically non-toxic to slightly toxic to avian species on both an acute and subacute basis. These data suggest a low risk to most avian species from either acute or subacute exposure from the use of these four herbicides.

ii. Mammalian Species

No mammalian toxicity data are available for alachlor. Available toxicity data suggest that propachlor is practically nontoxic while acetochlor and metolachlor are moderately toxic to mammalian species.

iii. Fish Species

The 96-hour LC_{50} values generally indicate that propachlor is highly toxic while alachlor, acetochlor and metolachlor are moderately toxic to freshwater fish species. Available toxicity data for alachlor, acetochlor and metolachlor suggest that these herbicides are only moderately toxic to estuarine fish species.

iv. Aquatic Invertebrates

The freshwater aquatic invertebrate 48-hour LC_{50}/EC_{50} data suggest that propachlor is the most toxic (0.79 ppm) of the four herbicides, ranging from moderately to highly toxic to freshwater invertebrates. The 48-hour LC_{50} values generally indicate that alachlor, acetochlor and metolachlor are moderately to slightly toxic to freshwater invertebrate species. Available toxicity data for alachlor, acetochlor and metolachlor indicate that these herbicides are only moderately toxic to estuarine invertebrate species.

Environmental Risk Assessment

The Levels of Concern (LOC) are criteria used to indicate potential risk to nontarget organisms. The criteria indicate that a chemical, when used as directed, has the potential to cause undesirable effects on nontarget organisms. There are two general categories of LOC (acute and chronic) for each of two nontarget floral groups. In order to determine if an LOC has been exceeded, a risk quotient must be derived and compared to the LOC's. A risk quotient is calculated by dividing an appropriate exposure estimate, e.g., the estimated environmental concentration, (EEC) by an appropriate toxicity test effect level, e.g., the LC_{50}. The acute effect levels typically are:

EC_{25} (terrestrial plants),
EC_{50} (aquatic plants and invertebrates),
LC_{50} (fish and birds), and
LD_{50} (birds and mammals).

The chronic test results are the: No Observed Effect Level (NOEL) for avian and mammal reproduction studies, and either the NOEL for chronic aquatic studies , or the Maximum Allowable Toxicant Concentration (MATC), which is the geometric mean of the NOEL and the Low Observed Effect Level (LOEL), for chronic aquatic studies. The NOEL and LOEL are sometimes referred to as No/Low Observed Effect *Concentration* (NOEC or LOEC).

When the risk quotient exceeds the LOC for a particular category of organism, there is presumed to be risk to that particular category. Risk presumptions for particular categories of organisms are presented below along with the corresponding LOC's:

Table 11: Levels of Concern and Associated Risk Presumptions:

Criterion	**Presumption when Criterion Met**
Mammals and Birds	
Acute $RQ \geq 0.5$	High acute risk.
Acute $RQ \geq 0.2$	Risk that may be mitigated through restricted use.
Acute $RQ \geq 0.1$	Endangered species may be affected acutely.
Acute $RQ \geq 1$	Chronic risk, endangered species may be affected chronically.
Fish and Aquatic Invertebrates	
Acute $RQ \geq 0.5$	High acute risk
Acute $RQ \geq 0.1$	Risk that may be mitigated through restricted use.
Acute $RQ \geq 0.05$	Endangered species may be affected acutely.
Chronic $RQ \geq 1$	Chronic risk, endangered species may be affected chronically.
Plants	
$RQ \geq 1$	High risk.
$RQ \geq 1$	Endangered plants may be affected.

For plants, there are not separate criteria for restricted use or chronic effects

a. *Risk to Nontarget Terrestrial Animals*

Although available information does not indicate acute risk concerns for birds or mammals, an LC_{50} measurement for a small mammal would be required for a conclusive finding.

i. Birds

Alachlor emulsifiable concentrate at a maximum rate of 6 lbs a.i./A, would produce a maximum expected concentration of approximately 1440 ppm on range grasses. Alachlor is practically nontoxic to birds on a dietary basis: in the acute tests with two avian species, little or no mortality was observed at the highest measured concentration (5620 ppm). Therefore no exceedance of Agency levels of concern for acute dietary risk are expected.

The avian acute oral data (LD_{50} = 1499 mg/kg) can be used to evaluate avian exposure to granules. The potential hazard to birds from exposure to granules should be slight. Granules are deposited typically in bands 6 inches wide, with 32 inches between band centers. This implies that the pesticide is applied to an area of 8,163 square feet in every acre. At the maximum label rate (for granular uses) of 4.0 lb ai per acre, there will be 222 mg ai/sq.ft. for the area within bands. If 85% of the granules are incorporated (Erbach and Tollefson, 1983) the potential surface residue is 33 mg/sq.ft. This value does not indicate an acute toxicity concern for non-endangered species (LOC=0.5). Exposures exceeding 150 mg/sq ft would exceed the endangered species LOC of a tenth of the LD_{50}. *Without incorporation, exposure could approach this level of concern*[3].

Assessment of chronic effects to terrestrial vertebrates is based on results of reproduction studies. Properties and use conditions of alachlor indicate a need for such studies. To date the Agency has not received or reviewed data on possible reproductive or growth effects to birds from exposure to Alachlor. There is some certainty that the nesting and breeding seasons of many bird species will coincide with the usual preemergent application periods for Alachlor. The persistence of the compound indicates that it will be available for a relatively long period of time on the application site, with an aerobic soil half life of 2-3 weeks and longer half lives for abiotic processes (photolysis, hydrolysis).

ii. Mammals

Available information for mammals is inconclusive regarding concerns for acute risk. LD_{50} values for laboratory rats indicate slight acute toxicity. An LC_{50} measurement would be required to calculate a risk quotient for non-target mammals. It is common for mammals to be somewhat less sensitive than birds, and risk quotients calculated above for birds do not indicate a concern for acute effects.

Regarding the possibility of chronic effects on mammals, three-generation rat studies produced a reproductive NOEL of 10 mg/kg/day and an LOEC of 30 mg/kg/day (Shroeder, 1981). Renal toxicity was observed in F_2 males. The rat teratological study showed maternal and fetotoxic effects at dose levels of 400 mg/kg/day and an NOEC of 150 mg/kg/day (Rodwell, 1980). Based on the computations for mg ai/sq ft for a granular application, the LOEC for a 1 kg mammal could be contained within a square foot of surface area. Higher exposure is expected for surface application with no incorporation. Ingestion of this amount of active ingredient for the extended periods represented in these

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[3] The registrant has indicated that Lasso II is applied in 10 and 14-inch wide bands, reducing the level of exposure and attenuating the concern.

studies would, however, seem unlikely as the herbicide would dissipate downward or laterally once irrigation or rainfall events occurred. Irrigation is recommended within five days of planting to move the chemical to the root zone (in absence of rainfall).

b. Risk to Nontarget Aquatic Animals

i. Freshwater Animals

The following features of alachlor use are relevant to the determination of aquatic exposures: Alachlor is a pre-emergent herbicide and is usually applied only once. There are some postemergence uses that allow two applications. Irrigation is recommended within five days of planting to move the chemical to the root zone (in absence of rain).

Sufficient information is available to characterize the *toxicity* of alachlor to freshwater animals. Alachlor shows moderate acute toxicity to both coldwater fish and warmwater fish, based on measurement with TGAI or formulated EC 45. Alachlor TGAI and formulated products (42-45%EC) are slightly to moderately toxic to freshwater aquatic invertebrates on an acute basis.

Alachlor is highly toxic to freshwater fish and invertebrates chronically. Both LOEC values for growth and reproductive effects are below 400 ppb. NOEC's are below 190 ppb.

Alachlor is not expected to put freshwater fish or invertebrates at *acute* risk. *Screening level modeling results do not exclude the possibility of chronic effect threshold exceedence for fish and invertebrates through spray drift or runoff in areas close to application sites, particularly for smaller bodies of water with little inflow or outflow. Based on monitoring results, chronic thresholds in areas farther down the watershed from these smaller tributaries or ponds are not expected to exceed acute or chronic levels of concern for fish or invertebrates.* The EEC's for multiple applications have not been modeled for the higher application rates as Alachlor is generally (but not always) applied once per season at these higher rates.

ii. Estuarine and Marine Animals

Sufficient data are available to characterize alachlor as being only moderately toxic to saltwater fish (sheepshead minnow), saltwater mysid and shellfish (Eastern oyster).

iii. Bioaccumulation

Alachlor is not expected to bioaccumulate significantly in fish, based on high solubility (240 ppm), and relatively low octanol/water partition coefficient (434).

c. Risk to Nontarget Plants

Toxicity data for plants, though incomplete, are sufficient to characterize alachlor as highly toxic for both terrestrial and aquatic plants. Alachlor poses substantial risks to aquatic and terrestrial plants near use sites. Terrestrial plants may be exposed to alachlor via drift and runoff from areas of application, or via irrigation with contaminated ground water. Aquatic plants may be exposed via runoff or drift, or by discharge of contaminated ground water into surface water.

i. Aquatic Plants

Alachlor has an aquatic plant EC_{50} of 1.64 μg/l and NOEC of 0.35 µg/l, based on a green alga study. *The risk quotients based on screening models using this EC_{50} range from 21 to 124, values that substantially exceeds the level of concern (LOC=1). Based on monitoring results average detection levels often exceed levels of concern for aquatic plants.*

Measurements of alachlor in surface and ground water are available as described in Section C.2.c. The EC_{50} of 1.64 µg/l for aquatic plants approximately equals the alachlor MCL (2 µg/l); therefore the frequency of acute exposures exceeding the LOC for plants (LOC=1) approximately equals the frequency of exceeding the MCL.

Aquatic plants may be adversely affected by alachlor in ground water, in places where ground water discharges into surface water. Regarding ground water, the measured concentration of alachlor was higher than the MCL in 21% of wells (99 of 467 wells) that had detectable alachlor, as recorded in the Pesticides in Ground Water Database.

ii. Terrestrial Plants

For terrestrial plants, the RQ is the ratio of the EEC to the EC_{25}, and RQ values 1 or larger indicate high risk. Based on calculations that follow, RQ values are equal to 5 or larger, so *high risk is indicated.*

Typically alachlor is applied by ground equipment at rates of 4 lbs a.i./A. With 5% runoff the EEC is 0.2 lbs a.i./A. The EC_{25} for seedling emergence was 0.04 lbs a.i./A, based on a study that was found to be supplemental. The corresponding RQ is 5 (0.2/0.04). Alachlor is persistent, so additional applications would be additive, to some extent. The highest seasonal ground application rate is for Bronco (Reg.#524-341) applied at 5.94 lbs a.i./A. The corresponding RQ is 7.4.

iii. Semi-Aquatic Plants

Semi-aquatic plant species live for some part of a year in wet soil near freshwater wetlands or estuarine marshes. For these plants, the most appropriate toxicity measurements are those for terrestrial plants. Exposure scenarios are similar to those described previously for aquatic organisms.

Risk to semi-aquatic plants exceeds levels of concern. Risk is assessed using two different risk quotients, representing exposure by drift and runoff. Both are compared to an LOC of 1.

1. A risk quotient based on exposure to aerial *drift* of pesticide is as follows. The

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pesticide is applied aerially at 6 lbs a.i./A, and drifts to a plot with area equal to that of the application plot. A loading of 0.3 lbs a.i./A (=5% drift) is calculated as for aquatic organisms. The most applicable toxicity data is that for vegetative vigor of terrestrial plants, with EC_{25} measurements as low as 0.044 lbs a.i./A. The value of the risk quotient is 0.3/0.044=7.

2. A risk quotient based on exposure to *runoff* of water contaminated with pesticide is calculated as follows. If the pesticide is applied aerially at 6 lbs a.i./A to a 10-acre application plot and is transported to a 1-acre plot, a loading of 1.8 lbs a.i./A is calculated. The most applicable toxicity data is that for germination and growth of terrestrial plants, with EC_{25} measurements as low as 0.0067 lbs a.i./A. The value of the risk quotient is 269.

References Not Identified By an MRID Number

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Wade, H., C. Bailey, J. Padmore, K. Rudo, B. Williams and A. York, 1997. *The interagency study of the impact of pesticide use on ground water in North Carolina.* North Carolina Dept. of Ag. 2109 Blue Ridge Rd., Raleigh, NC. 112p

Web site references for the NAWWS and National Groundwater Association:

Acetochlor Registration Partnership - http://www.arpinfo.com/gwm.html

NGWA - http://www.h2o-ngwa.org/gwmarket/wells.html

Nomenclature for the parent alachlor and its major degradation products:

Alachlor = 2-chloro-2',6'--diethyl-N-methoxymethylacetanilide

alachlor oxanilic acid = 2',6'-diethyl-N-methoxymethyloxanilic acid

alachlor sulfonic acid =2',6'-diethyl-N-methoxymethyl-2-sulfoacetanilide

alachlor sulfinylacetic acid = [N-methoxymethyl-N-(2,6-diethylphenyl)-2-amino-2-oxoethyl]sulfinylacetic acid

DM-oxanilic acid = 2',6'-diethyloxanilic acid

(a) Degradation.

161-1 Hydrolysis. In an acceptable study, [^{14}C] Alachlor (carbonyl labeled) applied at 50 ppm was relatively stable in sterile commercial pH 3, 6, and 9 buffer solutions, natural lake water, and deionized water that were incubated in the dark at 25°C for 30 days. [^{14}C] Alachlor comprised 97.5-98.7% of the applied radioactivity in all test solutions, with no discernible pattern of decline. The degradate 2',6'-Diethyl-N-methoxymethyl acetanilide was ≤1.57% of the applied.

In nonsterile lake water, [^{14}C] alachlor, at 2 ppm, degraded very slowly when incubated at an unspecified temperature for 30 days. After 30 days of treatment, alachlor was 88.8% of the applied concentration in the test solution. Five nonvolatile compounds were identified, at ≤2.7% of the applied. (MRID# 00134327)

161-2 Photolysis in Water. This data requirement will be waived based on the UV absorption spectrum of alachlor in water. The current policy in the Environmental Fate and Ground Water Branch is to concur with waivers for this requirement when the electronic spectrum of the chemical does not show significant absorption between 290 and 800 nm, because photodegradation can only take place when there is an overlap between absorption regions of the spectrum of the chemical and the irradiation spectrum of the light source. Although the requirement is waived, a study submitted did indicate that the UV absorption spectrum of alachlor in water shows no absorption at wavelengths above 290 nm. (MRID 00023012)

161-3 Photodegradation on Soil. The Agency will require no additional data to support the Photodegradation on Soil data requirement at this time. Although the Agency does not have any information about the photolytic behavior of any of the major degradates of alachlor at this time, an acceptable study will not be required because the absorption spectrum of the chemical in water does not show significant absorption at wavelengths above 290 nm.

(b). Metabolism

162-1 Aerobic Soil Metabolism. Three different studies conducted on various soil types have shown similar degradation rates, ranging from 6 to 21 days. The degradation products were identified only in two of the studies, one of which is acceptable and the other is supplemental. Three of the four major degradates were observed in both studies. The compound

(N-methoxymethyl-N-(2,6-diethylphenyl)-2-amino-2-oxoethyl) sulfinylacetic acid,

which was up to 15.9% of the applied in one supplemental study (MRID# 00101531), was not observed in the acceptable study (MRID# 00134327). All major metabolites were monitored in the available Terrestrial Field Dissipation study.

In an acceptable study [^{14}C] Alachlor applied at 2 ppm degraded with estimated half-lives of 2-3 weeks in silt, loamy sand, and silt loam soils incubated in the dark at 25°C and 75% of field moisture capacity for 175 days. In the silt loam soil, alachlor was 87.7% or the applied at the initiation of the study, 47.4% at 21 days, and 1.6% at 175 days. In the loamy sand, alachlor was 98.5% of the applied at 0 days, 52.4% at 14 days, and 2.5% at 175 days. In the silt soil, alachlor was 99.0% of the applied at day 0, 40.4% at day 14, and 0.7% at 175 days.

Four degradates were detected, with significant concentrations (≥ 10% of the applied):

2',6'-diethyloxanilic acid or [(2,6-diethylphenyl)amino]-2-oxoacetic acid (DM-oxanilic acid), which was a "water soluble" metabolite that increased gradually to a maximum of 5.3% of the applied at 50 days posttreatment in the silt loam, it decreased to 3.9% at 175 days. It increased to a maximum of 15.8-17.0% of the applied at 175 days posttreatment (last test interval) in the loamy sand and silt soils;

2',6'-diethyl-N-methoxymethyloxanilic acid or [2-(2,6-diethylphenyl) methoxymethyl) amino]-2-oxoacetic acid (alachlor oxanilic acid), which was a "water soluble" metabolite, and was a maximum of 12.7-22.4% of the applied at 28-50 days posttreatment in all soil types and decreased to 2.9-13.4% of the applied at 175 days posttreatment;

2',6'-diethyl-N-methoxymethyl-2-sulfoacetanilide or [2-(2,6-diethylphenyl) (methoxymethyl)amino]-2-oxo-ethanesulfonic acid (alachlor sulfonic acid; ESA), which was a "water soluble" metabolite, which increased to a maximum of 24.9% of the applied at 50 days posttreatment in the silt loam, 16.9% of the applied at 175 days posttreatment in the loamy sand, and 16.0% of the applied at 21 days posttreatment in the silt soil. It decreased to 11.2-18.6% of the applied at 175 days posttreatment in the silt loam and silt soils.

2',6'-diethyl-2-hydroxy-N-methoxymethylacetanilide, which was the only major "methylene chloride soluble" degradate and increased to a maximum of 6.7-10.2%

of the applied at 7-21 days posttreatment and decreased thereafter to ≤1.1% of the applied at 175 days in all soil types.

Nine other degradates were also identified, at ≤10% of the applied. After 175 days incubation, $^{14}\mathrm{CO}_2$ was 16.17-30.00% of the applied. [^{14}C] volatiles were ≤1.15% of the applied, and unextracted [^{14}C] residues totaled 19.25-20.76% of the applied. (MRID# 00134327)

In a second study (found to be supplemental), [^{14}C] Alachlor (phenyl ring-labeled) applied at 2 ppm degraded with half-lives of 6-12 days in silt, loamy sand, and silt loam soils incubated in the dark at 25°C for 62 days. The soils were also treated with [^{14}C] alachlor encapsulated in a polyurea polymer. The rate of degradation is similar for the encapsulated [^{14}C] alachlor, with half-lives of 8-11 days.

Four major degradates were identified in the soil. These degradates were observed in all three soil types at 62 days; however, testing at various test intervals (monitoring through time) was performed only for the silt soil:

> 2',6'-diethyloxanilic acid or [(2,6-diethylphenyl)amino]-2-oxoacetic acid (DM-oxanilic acid), which comprised a maximum of 14.4% of the applied radioactivity in the silt soil at 62 days posttreatment. It comprised 2.9-7.3% of the applied at 62 days in the loamy sand and the silt loam;
>
> 2',6'-diethyl-N-methoxymethyloxanilic acid or [2-(2,6-diethylphenyl) methoxymethyl) amino]-2-oxoacetic acid (alachlor oxanilic acid), which comprised a maximum of 9.7-10.0% of the applied radioactivity in the silt soil at 20 days posttreatment. It decreased to ≤3.7% of the applied at 62 days in the loamy sand and the silt loam;
>
> (N-methoxymethyl-N-(2,6-diethylphenyl)-2-amino-2-oxoethyl) sulfinylacetic acid or [N-(2,6-diethylphenyl)-N-(methoxymethyl)-2-amino-2-oxo-ethyl] sulfinylacetic acid (alachlor sufinylacetic acid), which comprised 15.9-16.2% of the applied radioactivity in the silt loam soil at 62 days posttreatment. It was a maximum of 12.6-13.3% of the applied in the silt soil at 20 days posttreatment, decreasing to ≤9.7% at 62 days; and
>
> 2',6'-diethyl-N-methoxymethyl-2-sulfoacetanilide or [2-(2,6-diethylphenyl).(methoxymethyl)amino]-2-oxo-ethanesulfonic acid (alachlor sulfonic acid), which comprised a maximum of 6.5% of the applied radioactivity in the silt soil at 30 days posttreatment and ≤5.1% at 62 days. It was 2.7-4.1% of the applied in the loamy sand and silt loam at 62 days.

This study provides supplemental information about the rate of degradation of alachlor and the identity of alachlor degradates under aerobic conditions. This study is deficient because up to 22.3% of the applied radioactivity was not characterized. (MRID# 00101531)

In a third study (also supplemental) [^{14}C] Alachlor applied at 4 ppm degraded appreciably, with a half-life of <18 days in sandy loam, silt loam, and silty clay loam nonsterile soils incubated at $\leq$32°C in a greenhouse. [^{14}C] Alachlor was $\leq$0.5 ppm in all three soil types 72 days after treatment. The degradate 2-chloro-2',6'-diethylacetanilide was detected at all sampling intervals at $\leq$0.8 ppm, with no definite pattern of formation or decline.

This study was conducted in a greenhouse. It provides supplemental information about the aerobic soil metabolism of alachlor by identifying one alachlor degradate. The study, however, is deficient when evaluated according to current guidelines because it was conducted in the greenhouse and material balances could not be confirmed. (MRID# 00023014)

(c) Mobility/Leachability

163-1 Mobility, Leaching and Adsorption/Desorption. Based upon the studies available and the structural features of the chemicals, it appears that alachlor degradates, as well as parent alachlor, have a high potential to leach.

An acceptable study partially satisfies the requirement by providing information about the mobility of *unaged* alachlor. To satisfy the data requirement a supplemental Batch Equilibrium study was submitted for alachlor ESA, which is the major degradate observed in the aerobic soil metabolism studies.

[^{14}C] Alachlor (carbonyl labeled), at 3.5 lb a.i./A, was very mobile in 30 cm columns of silt, sand, and loamy sand soils that were leached with 20 inches of water. The leachate from the silt, sand, and loamy sand soil columns contained 40.9-96.9% of the applied radioactivity. This radioactivity was "mainly" alachlor. The following degradate was identified in these leachates, but not quantified:

2',6'-diethyl-N-methoxymethylacetanilide.

[^{14}C] Alachlor was mobile in columns of silt loam soil treated under similar conditions. The leachate from the silt loam soil contained 0.5-0.6% of the applied radioactivity. The radioactivity remaining throughout the soil columns increased from 1.9-5.4% of the applied in the 0- to 2-cm segment, to 10.9-12.9% in the 10- to 14-cm segments, and declined to 0.1% in the 28- to 30-cm segment. The following compounds were detected in the leachates at 5-23% *of the recovered* radioactivity:

2',6'-diethyl-N-methoxymethylacetanilide,
2-chloro-2',6'-diethylacetanilide, and
2',6'-diethyl-N-methoxymethyl-2-methylthioacetanilide.

The analysis of selected soil extracts of all four soils indicated that the radioactivity was "mainly" alachlor. There was no clear correlation between the mobility of alachlor and the soil composition; however, it appears that higher organic matter contents favor adsorption of the chemical to the soil. The following table summarizes the results:

Soil type	% sand	% silt	% clay	% OM	%CEC	% found in leachates
sand	86.0	11.0	1.8	0.7	5.1	86.7-96.9
silt	4.6	84.2	10.0	1.2	10.4	78.2-82.2
loamy sand	75.1	17.8	4.8	2.4	11.3	40.9-43.4
silt loam	2.4	68.0	25.3	3.4	24.6	0.5- 0.6

Although this study had been found acceptable and provides information about the mobility of parent alachlor, the following details are noted because they could have had an effect on the observed results: In the study, the columns were packed using a wooden dowel; it is not reported if the columns were saturated prior to leaching. In addition, it is reported that the water "was added at a rate slower than the infiltration capacity of the soil." These conditions could have affected the observed leaching behavior. The parent alachlor could have leached even more under saturated flow conditions which would be the maximum flow rates.(MRID# 00134327)

In a leaching study, [^{14}C] alachlor residues leached through the columns, with ≈96%, ≈51%, and 0% of the recovered having leached through a gravelly sand, sandy loam, and a silty clay loam soil columns, respectively. The soil columns measured 20 cm (8 inches, recommended 30 cm), and were leached with 10 inches of water (recommended 20 inches). This study was considered scientifically valid in the original reviews. However, the Agency now believes that these studies only provide supplemental information. In the study leaching and soil retention were reported based on ^{14}C rather than concentrations of alachlor and its degradates. The study indicates a high level of leaching in sand, sandy loam, and silty clay loam. (MRID# 00027139, 00027140)

Based on a supplemental Adsorption/Desorption experiments [^{14}C] alachlor, at 1-10 ppm, appears to have a high mobility in three soil types. The K_d values, calculated based on [^{14}C] instead of actual alachlor concentrations, decreased with a decrease in soil organic matter. The mean K_d values were 3.74 for a silty clay loam, 2.88 for sandy loam, and 0.80 for a gravelly sand.

In a supplemental column leaching study alachlor applied at 5 kg ai/A appeared to be very mobile in a Lakeland sand, with 59% of the applied alachlor recovered from the leachates of a 30 cm soil column, eluted with 8 inches (20 cm) of water. Alachlor was less mobile in other soils tested, with maximum leaching depths of 18 cm, 10 cm, and 4 cm in Collenbey sand, silt loam, and sandy clay loam columns, respectively. The level of leaching appeared to be related to the percent organic matter, with lower leaching of the soils associated with higher organic matter.

This study was considered scientifically valid. However, the study does not meet the Subdivision N Guidelines because the columns were eluted with only 8 inches of water.

(Subdivision N Guidelines recommends elution with 20 inches of water.) In addition, no attempts were made to measure possible degradates or total residues. Therefore, the Agency is concerned about the validity of the study since insufficient elution water was applied to demonstrate the mobility of alachlor in the soils. This study is now deemed supplemental and gives an indication of the level of leaching in sandy clay loam, silt loam, and sand. (MRID 00078301)

Based on supplemental column leaching studies, aged (30 days) *uncharacterized* [^{14}C] residues of alachlor were mobile in 30 cm columns with sandy loam soil, treated at 3.5 lb a.i./A, and leached with 20 inches of water. The radioactivity recovered in the leachate totaled 29.1-31.5% of the applied. Approximately 10 compounds were isolated from the leachates each at $\leq$0.7% of the applied radioactivity. The major component found in the soil samples was [^{14}C] alachlor.

This portion of the study (aged) is not acceptable because the soil was aged for 30 days, which may be a period of time considerably longer than one half-life. The aerobic soil metabolism studies show estimated half-lives between 2 and 3 weeks. After the aging period, and prior to leaching, the soil was not characterized; therefore, it is not possible to determine if sufficient parent compound remained at the time of leaching, and what was the ratio of the degradates formed. (MRID 00134327)

Mobility of alachlor degradates.

Mobility and Adsorption/Desorption of Alachlor-ESA Based on batch equilibrium studies, uniformly phenyl ring-labeled [^{14}C]-alachlor ESA (alachlor sulfonic acid, sodium salt), at approximately 6.0, 1.0, 0.2, and 0.04 μg/mL, was determined to be very mobile in Sable silty clay loam:calcium chloride solution slurries (1:5) that were equilibrated in the dark for 24 hours at approximately 25°C. Freundlich K_{ads} value was 0.45 and K_{OC} value was 15. Following one desorption step, Freundlich K_{des} value was 1.43. Material balance ranged from 95.8 to 110.9% of the applied for the definitive study.

Based on batch equilibrium studies, uniformly phenyl ring-labeled [^{14}C]-alachlor ESA, at approximately 6.0, 1.0, 0.2, and 0.04 μg/mL, was determined to be very mobile in Sarpy sandy loam, Spinks sandy loam, and Katy loam:calcium chloride solution slurries (1:5) that were equilibrated in the dark for 24 hours, at approximately 25°C. Accurate Freundlich K_{ads} values could not be calculated because levels of adsorbed [^{14}C]-alachlor ESA metabolite were very low. Adsorption values in these three soils were approximately 0% (MRID# 444053-01).

The study on alachlor-ESA does not fully fulfill the data requirement because Freundlich adsorption values could not be calculated in three of the soils. However, the study provides supplemental information about the mobility of alachlor-ESA, a major metabolite of alachlor. EFED believes that a new study would not provide new information about the mobility of alachlor-ESA other than say that this degradate is very mobile; therefore, no additional data on the mobility of alachlor-ESA is required at this time.

Registrants have submitted Adsorption/Desorption studies for two propachlor soil metabolites. Propachlor is structurally similar to alachlor. The registrant proposed to use this mobility data on propachlor degradates as surrogate data for alachlor degradates. Results obtained for the propachlor degradates are as follows:

Mobility and Adsorption/Desorption for Propachlor Oxanilic Acid. An acceptable study is available, can be used to partially satisfy the data requirement for the chemical propachlor. Based on batch equilibrium studies, propachlor oxanilic acid was determined to be very mobile in loamy sand, sandy loam, loam, and silty clay loam soil: solution slurries. Freundlich K_{ads} values ranged from 0.03 to 0.08. The following table summarizes results obtained in the study. (MRID 42485703)

	K_{ads}	K_{OC}	Des	K_{OC}
loamy sand	0.03	8	4.48	1120
sandy loam	0.04	2	15.86	886
loam	0.08	7	4.34	391
silty clay loam	0.06	10	20.91	3428

Mobility and Adsorption/Desorption for Propachlor Sulfonic Acid. An acceptable study is available, which can be used to partially satisfy the data requirement for propachlor. Based on batch equilibrium studies, propachlor sulfonic acid was determined to be very mobile in sand, sandy loam, loam, and silty clay loam soil:solution slurries. Freundlich K_{ads} values ranged from 0.03 to 0.07. The following table summarizes results obtained in the study. (MRID 42485704)

	K_{ads}	K_{OC}	Des	K_{OC}
sand	0.03	7	1.33	317
sandy loam	0.06	6	6.24	624
loam	0.05	5	1.73	156
silty clay loam	0.07	3	1.23	47

Mobility characteristics compared for alachlor and propachlor. An examination of the mobility characteristics of alachlor and propachlor show that both are very mobile. Generally, propachlor is more mobile than alachlor (except in the Ray silt). It is observed that %CEC and %OM are good predictors of alachlor mobility (higher mobility when %CEC is lower, and higher mobility when %OM is lower), while this trend is only general for propachlor. The Agency believes, however, that for both alachlor and propachlor degradates, the negative charges play an important role in predicting the mobility.

Mobility Characteristics for Alachlor

Soil type	% sand	% silt	% clay	% OM	% CEC	% found in leachates
sand	86.0	11.0	1.8	0.7	5.1	86.7-96.9
silt	4.6	84.2	10.0	1.2	10.4	78.2-82.2
loamy sand	75.1	17.8	4.8	2.4	11.3	40.9-43.4
silt loam	2.4	68.0	25.3	3.4	24.6	0.5-0.6

Mobility Characteristics for Propachlor

Soil type	% sand	% silt	% clay	% OM	% CEC	Ave. % found in leachates
Lintonia sand	86.0	11.0	1.8	0.7	5.1	83.1-95.9
Ray silt	4.6	84.2	10.0	1.2	10.4	40.6-71.4
Spinks loamy sand	75.1	17.8	4.8	2.4	11.3	71.0-84.0
Drummer silt loam	2.4	68.8	25.3	3.4	24.6	2.9-7.9

The Agency believes that the mobility requirements for alachlor metabolites have been partially satisfied with the submission of mobility data of the propachlor degradates: propachlor oxanilic acid and propachlor sulfonic acid. The Agency believes that these degradates show substantial structural similarity to alachlor degradates, therefore they can be used for a preliminary assessment of the mobility of alachlor degradates. The Agency believes that the available data confirms that all the four major degradates of alachlor are very mobile under normal environmental conditions.

(d) Volatility

163-2 and 163-3 Laboratory and Field Volatility. This data requirement was waived, based on the relatively low vapor pressure and levels of volatiles in the aerobic soil metabolism study.

Alachlor has a vapor pressure of 2.2x10^{-5} mm Hg @24°C (MRID 00152209). The Agency believes that this value is relatively low and that volatility may not be an important route of dissipation for alachlor. In addition, the acceptable Aerobic Soil Metabolism study

(MRID# 00134327) showed the presence of small amounts of [^{14}C] volatiles (≤1.15% of the applied after 175 days of incubation). In a supplemental aerobic soil metabolism study (MRID# 00101531) [^{14}C] volatiles were ≤4.84% of the applied after 40-62 days. This suggests that volatilization is not a significant route of dissipation for alachlor.

(e) Field Dissipation

164-1 Terrestrial Field Dissipation. Field dissipation has been evaluated at sites in Chico and Hickman, California. These studies have been reviewed and found to be acceptable. Both terrestrial field dissipation studies were conducted in California, despite the fact that alachlor is widely used throughout the United States. These two studies are not adequate to fully characterize the range of field conditions to which alachlor may be exposed. Despite this fact, EFED will not require an additional terrestrial field dissipation. The Division believes that a new study would not provide substantial new information.

The study conducted in Chico, California is acceptable and can be used to partially satisfy the Terrestrial Field Dissipation (164-1) data requirement.

Alachlor (Lasso 4-EC), applied once at 4 lb a.i./A, dissipated with an observed half-life of approximately 11 days from a plot of loam/sandy clay loam soil in Chico, California, that was planted to corn immediately after treatment. Alachlor was detected at a depth of 18- to 24-inches (at test intervals 7 and 14 days). In the 0- to 6-inch soil depth, alachlor averaged 0.781-0.798 ppm at 0-1 days posttreatment, 0.641 ppm at 7 days, and 0.350 ppm at 11 days. Two samples showed ≥0.124 ppm at 14 days, both in the 12- to 18- and 18- to 24-inch soil depths. In addition, five minor detections occurred at 36- to 48-inch soil depth at ≤0.016 ppm at 11-18 days. The rainfall plus irrigation totaled 6 inches through 18 days posttreatment.

The following degradates were detected in the soil:

> [2-(2,6-diethylphenyl)methoxymethyl)amino]-2-oxoacetic acid (alachlor oxanilic acid), which was detected through 44 days posttreatment in the 0- to 6- and 6- to 12-inch soil depths, at averages ≤0.047 ppm. There were 15 individual detections through 44 days in the 0- to 6-inch soil depth and 10 individual detections through 21 days in the 6- to 12-inch soil depth. There were also sporadic detections in the soil depths up to 36- to 48-inch at ≤0.023 ppm. These included 5 detections in the 12- to 18-inch soil depth (14-120 days), 2 detections in the 18- to 24-inch soil depth (18 and 180 days), and 2 detections in the 36- to 48-inch soil depth (44 days);
>
> [N-(2,6-diethylphenyl)-N-(methoxymethyl)-2-amino-2-oxo-ethyl] sulfinylacetic acid (alachlor sulfinylacetic acid), which was detected from 7 through 44 days posttreatment in the 0- to 6- and 6- to 12-inch soil depths, at averages ≤0.039 ppm. There were 13 individual detections through 44 days in the 0- to 6-inch soil depth and 11 individual detections through 44 days in the 6- to 12-inch soil depth. There were 5 sporadic detections in the soil depths up to 18- to 24-inch at ≤0.020 ppm at 14 and 18 days;

[2-(2,6-diethylphenyl)(methoxymethyl)amino]-2-oxo-ethanesulfonic acid (alachlor sulfonic acid; ESA), which was detected from 1 through 44 days posttreatment in the 0- to 6- and 6- to 12-inch soil depths, at averages ≤0.027 ppm. There were 14 individual detections through 44 days in the 0- to 6-inch soil depth, 10 individual detections through 90 days in the 6- to 12-inch soil depth; and 4 detections each in the 12- to 18- and the 18- to 24- soil depths (at ≤0.022 ppm) at 14-78 days. Two sporadic detections at ≤0.011 ppm were observed in the 24- to 36-inch soil depth, at 18, and 44 days.

[(2,6-diethylphenyl)amino]-2-oxoacetic acid (DM-oxanilic acid), with only sporadic detections at ≤0.061 ppm through 90 days after treatment, in the 0- to 6- and 6- to 12-inches depths. In addition, there was 1 detection each in the 12- to 18- and the 18- to 24-inch soil depths (90 and 44 days), and 2 detections in the 24- to 36-inch soil depth (14 and 78 days).

Three samples were tested per test intervals. The lowest limit at which the method was validated for each metabolite is 0.01 ppm. Detections below this level were reported as <0.01 ppm.

Examination of the soil composition data of the Chico plot shows an increasing percent of clay with soil depth (to a maximum of 65% clay in the 24- to 36-inch soil depth). This "clay pan" reduces the flow of water into deeper soil layers, decreasing the possibility of leaching of both parent alachlor and its degradates. It is possible that under conditions that would favor the flow of water into deeper soil layers, further leaching would have been detected.

The study conducted in Hickman, California is acceptable and can be used to partially satisfy the Terrestrial Field Dissipation data requirement.

Alachlor (Lasso® E.C.), applied once at 4 lb a.i./A, dissipated with a registrant-calculated half-life of 6.2 days from the 0-6 inch soil depth of a bareground plot of sandy loam soil in Hickman, California. The field was bareground to simulate preemergent application to a crop. In the 0-6 inch soil depth, alachlor averaged 1.363-1.458 ppm at 0-1 days posttreatment, 0.932 ppm on day 7 after application, and 0.220 ppm on day 21 after application. Alachlor remained mostly in the 0-6 inch soil depth. Detections averaging 0.018-0.046 ppm were reported in the 6-12 inch soil depth on days 0 and 1 after application.

The following degradates were detected in the soil:

[(2,6-diethylphenyl)amino]-2-oxoacetic acid (alachlor DM-oxanilic acid), which was detected in the 0-6 inch soil depth from day 1 through day 366 after treatment at average levels from 0.006-0.048 ppm (no clear pattern of formation or decline). The chemical was detected in the 6-12 inch soil depth only on day 182 after application, with an average value of 0.004 ppm.

[2-(2,6-diethylphenyl)methoxymethyl)amino]-2-oxoacetic acid (alachlor oxanilic acid), which was detected in the 0-6 inch soil depth from day 0 through day 366 after application at average levels from 0.005 to 0.058 ppm, with no clear pattern of formation and decline. At three test intervals, detections were reported in the 6-12 inch soil layer. On days 0, 125, and 182, the oxanilate levels were 0.004, 0.004, and 0.013 ppm, respectively. The chemical was also detected in the 12-18 and 18-24 inch soil layers on day 182 after application, with average values of 0.007, and 0.008, respectively.

[N-(2,6-diethylphenyl)-N-(methoxymethyl)-2-amino-2-oxo-ethyl] sulfinylacetic acid (alachlor sulfinylacetic acid), which was observed at low levels in the 0-6 inch soil layer from day 1 to 182 after application, at average levels ranging from 0.002 to 0.017 ppm. In addition, the chemical was detected in the 6-12 and 18-24 inch soil layers on day 182 after application, with average values of 0.004 ppm in both cases,

[2-(2,6-diethylphenyl)(methoxymethyl)amino]-2-oxo-ethanesulfonic acid (alachlor sulfonic acid or ESA), which was observed at low levels from day 0 through day 366 after application at average levels ranging from 0.003-0.010 ppm. Detections were also reported in the 6-12 inch soil depth on days 182 and 366 after application, with average values of 0.004 and 0.008 ppm, respectively. Furthermore, the chemical was detected in the 12-18 inch soil depth on day 182 after application, with an average value of 0.003 ppm

The study conducted at Madera, California was considered invalid since the alachlor concentrations found at all levels in the soils was ≤0.1 ppm. The application rate was 4 lb a.i./A. The concentrations were too low to assess the dissipation of alachlor. The study authors did not explain the low residue levels found. The registrant should try to provide the reason for the low recoveries observed in this study. (MRID 42528001, 42528002, 42528003, 42528004, 43774701)

(f) Bioaccumulation

165-4 Bioaccumulation in Fish. This data requirement was *waived.* Alachlor has a relatively high water solubility (240 ppm), and a low octanol/water partition coefficient of 434 (one study reports as low as 35). Chemicals with these physico/chemical properties are not expected to bioaccumulate substantially in fish. Therefore, the Agency will require no additional information on the Bioaccumulation in Fish (165-4) data requirement for alachlor at this time.

(g) Spray Drift

201-1 and 201-2 Spray Drift/Droplet Spectrum and Field Evaluation. Alachlor is highly toxic to nontarget plants. Since the chemical can be applied aerially, the data requirement was imposed in 1991. The results would be used to assess the extent of exposure to nontarget plants. This data requirement is *not satisfied.* It will be held in Reserve, pending the evaluation of the work of the industry's Spray Drift Task Force (SDTF). The registrants are members of the SDTF.

Appendix B: Detailed Ecological Toxicity Data

a. Toxicity to Terrestrial Animals

To evaluate the toxicity of a pesticide to birds, the following tests are required using technical grade material:

- An avian single-dose oral (LD_{50}) study on one species, preferably mallard or bobwhite quail;
- A subacute dietary (LC_{50}) study using one waterfowl species, preferably the mallard duck;
- A subacute dietary (LC_{50}) study using one upland game species, preferably bobwhite quail or ring-necked pheasant.

Tests on wild mammals may be required, depending on intended use pattern, environmental fate characteristics, and results of lower tier studies such as acute and subacute toxicity tests.

An acute contact LD_{50} for honey bees is required if the proposed use will result in exposure of honey bees.

(1) Birds, Acute and Subacute

The requirement for a measurement of acute oral toxicity to birds is fulfilled based on one acceptable study, which indicates *slight toxicity.* Results follow. (MRID 00079523)

Avian Acute Oral Toxicity

Species	% Test Material (TGAI)	LD_{50} (mg/kg)	Fulfills Guidelines
Bobwhite quail	92.3	1499	Yes

The requirement for a measurement of subacute dietary toxicity is fulfilled based on two acceptable studies, which indicate that the chemical is **practically nontoxic to birds.** Results follow: (MRID 43087101, 43087001)

Avian Subacute Dietary Toxicity

Species	% Test Material (TGAI)	LC_{50} (mg/l)	Fulfills Guidelines
Bobwhite Quail	95.4	>5620	Yes
Mallard Duck	92.3	>5620	Yes

(2) Birds, Chronic Toxicity

When birds are expected to be exposed to pesticides for long periods of time or exposed during the breeding and nesting season avian reproduction studies are sometimes required. Avian reproduction studies for Alachlor are required based on the following criteria as explained in FIFRA 158.145.

1. Birds are expected to be subjected to repeated or continued exposure to Alachlor and or it's degradates preceding or during breeding season. Alachlor is generally applied in early Spring months when birds are most actively breeding.

2. Alachlor and it's metabolites or degradates are stable in the environment to the extent that potentially chronically toxic amounts may be present in avian feed.

3. Reproductive effects have been seen in three-generation rat studies (Shroeder, 1981). In a rat teratological study maternal and fetotoxic effects were observed at 400 mg/kg/day (Rodwell, 1980).

4. Reproduction studies with acetochlor, a pesticide whose chemical structure is very similar to alachlor, have shown reproductive effects to mallard duck at 150 ppm and bobwhite quail at 750 ppm (MRID 43383101, 43383102, reviewed by the Agency in 1996). In a partially acceptable reproduction study conducted with metolachlor on mallard duck, eggs in 10, 100, and 1000 ppm test concentrations showed eggshell thinning (MRID 0162292 reviewed 1993).

(3) Mammals

Ecological effects data on toxicity data to mammals will not be required for alachlor at this time. Available toxicity data for laboratory rats indicate an LD_{50} of 930 mg/l. This data is a health effects data requirement. Mammalian LD_{50}'s are not used directly to determine whether LOC's are exceeded, but do provide some indication of level of toxicity. The available data indicates that alachlor is slightly toxic to small mammals.

(4) Insects

Honeybee acute contact studies conducted with technical ingredient and 42% formulation products have been reviewed. These studies indicated low toxicity toward honeybees, with LD50 levels greater than 36.2 ug ai/bee for the technical and greater than 100 ug ai/bee for the formulated product. (MRIDs 00074486 and 00028772)

Toxicity to Honeybees

%Test Material (TGAI)	LD_{50} (ug ai/bee)	Fulfills Guidelines
Technical	>36.2	Yes
42.2% Formulation	>100	Yes

b. Toxicity to Aquatic Animals

(1) Freshwater Fish

To evaluate toxicity of a pesticide to freshwater fish, LC_{50} measurements are required for two species, using technical grade active ingredient. One study should use a cold water species, preferably rainbow trout. The other should use a warm water species, preferably bluegill sunfish. Chronic toxicity testing is required for evaluation of possible effects to growth or reproduction of fish exposed to persistent pesticides. This requirement is fulfilled by Early Life-stage Testing of one species of freshwater fish.

The data requirement is fulfilled for alachlor based on studies submitted. Studies submitted indicate *moderate toxicity to warm- and cold- water fish.* LC_{50} values are displayed below. Precautionary toxicity statements are required on labels based on MRID 438626-01 which shows Alachlor to be *highly toxic on a chronic basis* to freshwater fish growth, reproduction and development. Acute toxicity of Alachlor and tested formulations is moderate. (MRID 00023615, 00023616, 00028549, 00028550, 00028551, 00028553, 00028554, 00028555, 00031524, 00031525, 40098001)

Acute Toxicity to Freshwater Fish

Species	% Test Mater. (TGAI)	LC_{50} (mg/l)	Fulfills Guidelines
Toxicity Based on Exposure to Technical Active Ingredient			
Bluegill Sunfish	90	2.8	Yes
	100	4.3	Yes
Rainbow Trout	90	1.8	Partially
	100	2.4	Yes
Toxicity Levels Based on Exposure to End-Use Product			
Bluegill Sunfish	43EC	3.2	Partially
	45	6.2	Partially
	42.4	7.9	Partially
Rainbow Trout	42.5	3.6	Partially
	45	3.7	Partially
	44	4.2	Partially
	43	1.4	Yes
	43	3.2	Yes

Chronic Toxicity To Freshwater Fish in mg ai/L

Species	% Test Material	NOEL	LOEC	Fulfills Requirement
Rainbow trout	Technical	0.187	0.388	Yes

(b) Toxicity to Freshwater Invertebrates

To evaluate acute toxicity to freshwater aquatic invertebrates, an EC_{50} measurement is required based on technical grade active ingredient, preferably using first instar *Daphnia magna*, or early-instar amphipods, stoneflies, mayflies, or midges. The requirement is fulfilled based on studies submitted. Results are displayed in the table below. The studies submitted indicate *moderate to slight acute toxicity* for this category, based on studies reviewed to date. (MRID 00028549, 00028555, 00031526, 40098001).

Toxicity to Freshwater Invertebrates

Species	% Test Material (TGAI)	EC_{50} (mg/l)	Fulfills Guidelines
Toxicity Based on Exposure to Technical Active Ingredient			
Water Flea *Daphnia magna*	90	10	Yes
	93	21	Yes
Midge	93	3.2	Yes
Toxicity Levels Based on Exposure to End-Use Product			
Water Flea *Daphnia magna*	49	33	Partially
	45	22	Partially
	42.4	27	Partially
	43	7.7	Yes
Midge	45	2.5	Yes

Chronic toxicity to freshwater invertebrates is determined by exposing one species of freshwater invertebrate, preferably *Daphnia magna*, to the pesticide for a full generation and observing effects on growth and reproduction. In 21 Day full lifecycle testing Alachlor was shown to be highly chronically toxic to growth and reproduction of freshwater invertebrates. Chronic LOEC and NOEC values are displayed in the following table. Based on the high chronic toxicity of this pesticide appropriate environmental warning labels are required. (MRID 437747-07)

Chronic Toxicity Based on Exposure to Technical Active Ingredient

Species	% ai Tested	LOEC mg ai/L	NOEC mg ai/L	Fulfills Requirement
Water Flea, *Daphnia magna*	94.6	0.23	0.11	Yes

(3) Acute Toxicity of Pesticide Metabolites to Freshwater Animals

Aquatic testing with metabolites of pesticide compounds is requested when metabolites are likely to be persistent in the aquatic habitats in amounts greater than or equal to the parent compound. Four studies have been submitted to aid in characterization of the acute toxicity of Alachlor sulfonic and oxanilic acids to freshwater invertebrate and fish species. The studies indicate that these *degradate compounds display low acute toxicity* to the tested species. The submitted studies are summarized in the table below. (MRID 437747-03, 437747-04, 437747-05, and 437747-06)

Acute Testing with Alachlor Metabolites

Species Tested	Degradate and % ai	LC50/EC50 mg ai/L	Fulfills Guidelines
Daphnia magna	Sulfonic acid, 91.5%	>104 mg/L	Yes
	Oxanilic acid, 92.4%	>95 mg/L	Yes
Rainbow trout	Sulfonic acid, 91.5%	>104 mg/L	Yes
	Oxanilic acid, 92.4%	>95 mg/L	Yes

(4) Estuarine and Marine Animals

The use pattern of alachlor includes applications to major crops that are sometimes grown in close proximity to estuarine and marine environments. Therefore, *testing of estuarine and marine organisms is required.*

The toxicity measurements required are a 96-hour LC$_{50}$ for an estuarine fish, a 96-hour LC$_{50}$ for shrimp or mysid, and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with an estuarine mollusc species. The data requirement is fulfilled for alachlor based on the studies submitted. LC50/EC50 values are shown below.

Acute Toxicity to Estaurine/Marine Species

Species	% Test Mater. (TGAI)	LC$_{50}$/EC$_{50}$ (mg/L)	Fulfills Guideline
Sheepshead minnow	93.8	LC50=3.9	Yes
Mysid	93.8	LC50=2.4	Yes
Eastern Oyster	93.8	EC50=1.6	Yes

A study submitted to the agency (Kirby-Smith, et.al.), indicates that, in general, there were no significant differences in diversity, numbers and/or biomass between those creeks and estuaries that received pesticidal run-off (farm creeks) and those that didn't (forested creeks). The data derived from this study is confounding because results did not compare with laboratory toxicity data and EEC estimates. During the course of this study there does not appear to be any significant chronic adverse effects in terms of species diversity, biomass, energy transfer or nutrient cycling, occurring in the system.

c. Toxicity to Plants

Data from studies submitted to the Agency, though incomplete, indicate *high toxicity to aquatic and terrestrial plants.*

(1) Terrestrial Plants

Studies were required to establish toxicity to nontarget terrestrial plants. Two studies were received. Of the ten species of terrestrial plants tested, seven had EC_{25} levels for vegetative vigor less than maximum permitted rates on present labels. Seedling emergence was also effected in most of the species tested. Based on the data provided, *alachlor is highly toxic to nontarget terrestrial plants.* (MRID 42468601, 42468701)

Toxicity to Terrestrial Plants

Measurement Endpoint	Most Sensitive Species Tested	NOEL (lbs a.i./A)	EC_{25}(lbs a.i./A)
Vegetative Vigor[a]			
Phytotoxicity	Ryegrass	0.019	undetermined
21-Day Survival	Onion	0.22	0.31
21-Day Height	Ryegrass	0.037	0.12
21-Day Weight	Ryegrass	0.037	0.044
Germination and Growth			
6-Day Seed Germination	Cabbage	0.67	undetermined
6-Day Seedling Emergence	Ryegrass	0.019	0.04
21-Day Survival	Onion	0.037	0.011
Phytotoxicity	Lettuce	0.0093	undetermined
Height	Ryegrass	0.0023	0.011
Weight	Ryegrass	0.0023	0.0067

[a] Based on a supplemental study with 94.6% active ingredient that fulfills guideline requirements.

[b] Based on a supplemental study with 94.2% active ingredient that fulfills guideline requirements.

(2) Aquatic Plants

Studies were required to establish toxicity to nontarget aquatic plants. The requirement is partially fulfilled by the single study submitted. However, to completely fulfill data requirements for aquatic plant testing additional studies must be submitted for acute toxicity to an aquatic macrophyte, a marine diatom, a blue-green algae and a freshwater diatom. Based upon the one study available, *alachlor is highly toxic to aquatic plants.* (MRID 42763801)

Toxicity to Aquatic Plants

Species Tested	%Test Material	Toxicity (µg/l)	Fulfills Guidelines
Freshwater Green alga *Selenastrum capricornutum*	98.6	NOEL=0.35 LOEL=0.69 EC_{50}=1.64 (growth effects)	Yes

Appendix C. Ground Water Monitoring Information for Alachlor

Ground-water monitoring data collected, since 1991, by the USGS and the Acetochlor Registration Partnership (ARP) have found alachlor parent in two to eight percent of ground-water wells sampled. Up to 1.5 percent of these wells were found to have alachlor residues above the MCL of 2.0 µg/L. These recent monitoring data are in agreement with earlier studies (e.g., those reported in Pesticides in Ground Water Data Base, Hoheisel et al., 1992). The maximum and minimum alachlor concentrations were 15.89 µg/L and 0.05 µg/L, respectively.

Monitoring data collected by the USGS (Kolpin and Goolsby, 1995; Kolpin et al., 1995; Kolpin et al., 1996) also indicates that in addition to alachlor, more than 40 percent of the wells sampled in Midcontinental US were contaminated with alachlor-ESA degradate and/or 16 percent were contaminated with the alachlor 2,6-diethylanaline degradate. There is no ground water monitoring data on the other two major degradates (alachlor oxanilic acid and sulfinylacetic acid). These results correspond with the fate data, which indicates that these alachlor degradates are more mobile and persistent than the parent compound.

These recent studies reflect that current alachlor use may still result in ground-water concentrations which exceed the LOCs for alachlor parent as detections have occurred which exceed the current MCL of 2.0 µg/L. Since a much greater proportion of ground water wells are impacted by alachlor degradates, if an MCL or cancer risk level is established for alachlor-ESA at the same level as alachlor parent, concern would be much greater than for the parent compound only.

Similar chemicals, acetochlor, metolachlor, and propachlor have also been found in ground water. Approximately, the same percentage of wells have been found to be contaminated by propachlor (1.2%) as alachlor (1.8%), although many fewer wells have been analyzed for propachlor. Although number of wells sampled for metolachlor and alachlor are similar, there are approximately twice as many wells with detections of alachlor (1.8%) residues then metolachlor (0.96%). Acetochlor, with a maximum of 2.17 µg/L, was detected in eight wells (4.6%) of 173 in the registrant's ground-water monitoring study.

BACKGROUND:

Detections of alachlor degradates in ground water are important because ground water may represent an important means of exposure. Four major degradates have been identified for alachlor: alachlor DM oxanilic acid, alachlor sulfinylacetic, alachlor sulfonic acid (ESA), and alachlor oxanilic acid. As noted above, the four degradates are more persistent than the parent compound. The Branch previously requested batch equilibrium studies on the degradates to assess their mobility. The registrant has proposed using adsorption data from two propachlor degradates as surrogate data for the alachlor degradates. The Branch has accepted this for two degradates, but will still require the determination of the mobility for the alachlor-ESA degradate.

CURRENT AND RECENT GROUND WATER MONITORING DATA

USGS Midcontinent Ground Water Monitoring Studies:

In 1991, the USGS sampled 303 wells from a reconnaissance well monitoring network in near-surface aquifers distributed across 12 Midwestern states (Kolpin et al., 1995). These wells were distributed geographically and hydrogeologically by state, aquifer class (unconsolidated vs bedrock), and relative depth. At least 25% of the land within a 3.2 km radius of the well was in corn or soybean production during the 1990 growing season. One hundred wells were resampled during 1992 by selecting wells using a stratified random design based upon State and aquifer class.

The USGS found that five of the six most frequently detected pesticide compounds detected in ground water of 12 Midwestern states were pesticide metabolites (Kolpin et al., 1995). Kolpin et al. (1996) also demonstrated that as the analytical reporting limits are decreased, there is an increase in the differences in frequencies of detections. Alachlor-ESA is reported almost 10 times more frequently than parent alachlor at the 0.05 µg/L level.

Alachlor was detected in 6 wells (2%) out of 303 wells in 1991 and 5 wells (5%) out of 100 wells in 1992 in near-surface aquifers in 12 Midwestern states (Kolpin et al., 1995). The alachlor reporting limits were 0.05 and 0.002 µg/L for 1991 and 1992, respectively. The degradate alachlor-ESA was the most frequently detected compound detected in 1992 found in 33 wells (45%) of 73 wells for which the degradates were analyzed, with a reporting limit of 0.10 µg/L. In the same study, metolachlor was detected in 12 wells (4%) out of 303 in 1991; and, 11 wells (11%) out of 100 in 1992, with the same reporting limits as stated for alachlor. None of the metolachlor detections exceeded existing drinking water standards.

Additional samples were collected in 1993 (110 wells) and 1994 (38 wells) from unconsolidated aquifers (Kolpin et al., 1996). Alachlor was detected in 10 wells (3.3%) out of 303 wells. Alachlor parent was found in 5.9% of the 153 wells for which metabolites were analyzed. The maximum alachlor concentration detected was 4.27 µg/L, with a reporting limit of 0.05 µg/L. The alachlor degradate ESA was found in 70 wells (45.3%) of 153 wells analyzed for degradates. The maximum concentration of ESA was 8.63 µg/L, with a 0.10 µg/L reporting limit. A second alachlor degradate, 2,6-diethylanaline, was also detected in 15 wells (16%) of 94 wells analyzed. The maximum concentration was 0.02 µg/L with a reporting limit of 0.003 µg/L.

Atrazine degradates deisopropylatrazine (10% of 303 well; maximum concentration of 1.17 µg/L) and deethylatrazine (22.8% of 303 wells; maximum concentration 2.20 µg/L) were also detected. Metolachlor was also detected at levels above 0.05 µg/L in 8 wells (2.7%) out of 300 (Goolsby et al., 1995).

Table C-1. Summary of wells with detections of alachlor-ESA.

Study	Number of Wells			Concentrations (µg/L)	
	Sampled	Detected	Percent Detected	Maximum Concentration	Reporting Limit
USGS 1992	73	33	45%	-	0.1
USGS 1993	153	70	45.3%	8.63	0.1
USGS 1994	38	25	65.8%	8.6	0.1
USGS-IOWA 1995	106	69	65.1%	14.78	0.1
Wisconsin 1993 vulnerable wells	293	206	70%	26.7 (ave. = 4.89)	1.0[1]

[1] Analyzed by immunoassay

Acetochlor Registration Partnership Ground Water Monitoring Program (ARP-GWMP):

As a requirement for the registration of acetochlor, the two acetochlor registrants are conducting a ground-water monitoring program in seven major use states. Analytes are parent (no degradates) alachlor, acetochlor, and atrazine, dimethenamid, and metolachlor (only the first three were reported). Ground-water samples are collected monthly from 175 wells located in corn producing areas. The annual report from the first year of monitoring (only for acetochlor, alachlor, and atrazine) has been submitted by the registrants which includes a computer disk with a number of EXCEL data files (DP Barcode D225973). The report covers the a 13-month period, beginning in December 1994 and ending December 1995. Only parent compounds were reported. The limits of detection and quantification for all analytes are 0.03 µg/L and 0.05 µg/L, respectively.

The text of the annual report indicates that alachlor was detected in 45 samples (2.6%) out of 1720 (27 of which were greater than 0.1 µg/L). Acetochlor residues were detected in 25 of 1720 samples (15 of which were greater than 0.1 µg/L) and atrazine was detected in 651 samples (427 were greater than 0.1 µg/L) out of 1720.

The computer disk contained EXCEL files with 13 months (December 1994 to December 1995) worth of data from 180 wells was also submitted by the ARP. [The numbers of wells and samples do not correspond exactly to the narrative (e.g., 175 well vs 180 wells, number of samples 1720 vs 2340 as values less than 0.05 µg/L are not differentiated from no data]. Results for the three pesticides are summarized in the table below. Fourteen of the wells had alachlor detects greater than limit of quantification (LOQ - 0.05 µg/L), six had detections of acetochlor above the LOQ, and 75 had atrazine detections above the LOQ. Twenty-seven wells had alachlor detections above the limit of detection (LOD) of 0.03 µg/L, 93 wells had detections of atrazine above the LOD, and eight wells has acetochlor levels above the LOD.

Approximately 36 percent of the alachlor detections exceeded the MCL (2.0 µg/L) and 54 percent exceeded a one-in-million cancer risk level of 0.4 µg/L. Approximately 75 percent of the detections exceeded 0.11 µg/L for alachlor, acetochlor and atrazine. These current studies should reflect the impact to ground water from the current alachlor use and demonstrates that LOCs are still exceeded for alachlor parent.

Two of the fourteen wells with alachlor detections had detections on more than one sampling date. One of these wells was located in Illinois. The first detection of alachlor for this well (May 1995) was also the greatest (13.05 µg/L) concentration. Alachlor concentrations in this well declined with time, reaching 0.42 µg/L by December 1995. The second well with multiple detections occurred in Kansas. The first detection (0.3 µg/L) was reported in March 1995. The highest detections for this well occurred in May 1995 (14.17 µg/L) and June (15.89 µg/L) and generally declined, reaching 3.64 µg/L by December 1995. According to the registrant, these detections in Kansas and Illinois are linked to surface runoff and ponding near the wellhead rather than leaching. New wells were installed, and follow up sampling indicates that the underlying aquifers are not contaminated with alachlor. Seven other wells also had alachlor detections in March 1995.

Table C-2. Detections and concentrations (in µg/L) of acetochlor, alachlor, and atrazine in study conducted by the registrants of acetochlor (DP Barcode D225973) and submitted as EXCEL data files.

Statistic	Acetochlor	Alachlor	Atrazine
Number of Samples with Detects ≥0.05 µg/L (% of samples)	18 (1.0)	30 (1.7)	539 (31.3)
Number of Wells (% of 173)	8 (4.6%)	14 (8.1%)	75 (43.4%)
Number of Samples[1]	1720	1720	1720
Mean	0.39	3.38	0.75
Standard Deviation	0.52	4.89	5.88
Minimum	0.06	0.05	0.05
1st Quartile	0.11	0.12	0.11
Median	0.25	0.73	0.24
3rd Quartile	0.38	5.06	0.56
Maximum	2.17	15.89	131.53[2]

[1] It was not possible to determine whether data identified as missing were no data or below detection limit.

[2] The next highest value for atrazine was 30.03 µg/L.

Alachlor, metolachlor and propachlor in the pesticides in ground water data base:

As previously noted (draft EFED RED, 1994), the Pesticides in Ground Water Data Base (PGWDB) (Hoheisel et al., 1992) reports that alachlor was detected in 25 states, in 467 wells of 25933 sampled (1.8%). Of the wells with detections 99 wells (0.4%) had concentrations above the MCL. The PGWDB (Hoheisel et al., 1992) reported propachlor detections in 33 (1.2%) wells [in five states] out of 2718 wells sampled in eleven states. The concentrations ranged from 0.02 to 3.5 µg/L, thus the maximum concentration exceeded the MCL of alachlor (2 µg/L), but not the Lifetime Health Advisory (HAL) for propachlor (90 µg/L) (Table 3).

The PGWDB (Hoheisel et al., 1992) also summarizes a number of studies which included metolachlor. Metolachlor has been analyzed for in 29 states and detected in 20 states. Detections occurred in 213 (1%) wells out of 22,255 wells sampled, with concentrations ranging from 0.02 to 157 µg/L. Three exceeded the lifetime Health Advisory (LHA) of 70 µg/L for metolachlor, but typically appear to less than 10 µg/L.

Table C-3. Summary or alachlor, metolachlor, and propachlor ground water monitoring data from the Pesticides in Ground Water Data Base (Hoheisel et al., 1992).

Detection Information	Alachlor	Metolachlor	Propachlor
	Number of Wells (Percent of Wells)		
MCL or HAL (µg/L)	2	70	90
≥ MCL	99 (0.38)	3 (0.01)	0 (0.00)
< MCL	368(1.42)	210(0.94)	33(1.21)
Total Detections	467(1.80)	213(0.96)	33(1.21)
Total Sampled	25993	22255	2718
Number States with detections	25	20	5
Number of States with monitoring	35	29	11
Range of concentrations (µg/L)	trace to 3000	0.001 to 157	0.02 to 3.5

National Pesticide Survey (NPS).

The EPA National Pesticide Survey (USEPA, 1990) was conducted to provide a statistical estimate of the frequency and concentration of pesticide contamination of drinking water wells in the United States. From April 1988 to February 1990, EPA collected water samples and well information from over 1300 community water systems and rural domestic drinking water wells. Based on these data, EPA estimated that alachlor contamination occurred at or above the detection limit in about 3,140 (0.03 percent) of rural domestic wells nationwide. The detection limit for alachlor was 0.5 µg/L which likely resulted in the lower frequency of detection reported for alachlor compared with other studies. Alachlor was not found in samples collected from community water supply wells. Also, degradates of alachlor were not analyzed in the NPS.

National Alachlor Well Water Survey (NAWWS).

From 1987 - 1990, at the request of the USEPA, Monsanto conducted the National Alachlor Well Water Survey (NAWWS), a large-scale retrospective monitoring study patterned after EPA's National Pesticide Survey of drinking water wells. This study was statistically designed to estimate the proportion of rural domestic wells in alachlor use areas with detectable concentrations of alachlor (Holden et al., 1990, 1992). Monsanto also chose to include atrazine, cyanazine, metolachlor, and simazine as analytes in the NAWWS. The limit of detection for most chemicals (including alachlor) was approximately 0.03 µg/L. No degradates of any of the pesticides, including the alachlor degradate ESA, were analyzed in this study.

Wells selected for the NAWWS study were located in the rural portion of 89 counties, in 26 states where alachlor was used in 1986. Wells were selected based on county-level sales information and vulnerability estimates (based on DRASTIC, Aller et al., 1987) in counties where corn, soybeans or peanuts were grown. A total of 1430 private rural wells were sampled. Alachlor was estimated to have been used within a half-mile of 58.8 percent of the wells during the last five years. Hydrogeologic characteristics of the aquifers sampled were not directly measured; however, the probability that a well was installed in a confined (less vulnerable) or unconfined (more vulnerable) aquifer was estimated by Monsanto. Nearly one-third of the wells sampled were estimated to tap surficial, "vulnerable" aquifers. Over one-half of the wells were located within 300 feet of surface-water sources (e.g. streams or ponds).

Alachlor detections were reported in nearly one percent of the wells sampled in the NAWWS (Holden et al., 1990, 1992). Based on the monitoring results (summarized in table below), alachlor was estimated to occur in 0.78 percent (46,800 wells) of the six million private, rural domestic wells in the alachlor use area. Wells in the study area are estimated to supply drinking water to approximately 20 million people. Alachlor was estimated to occur at levels exceeding the MCL of 2 µg/L in about 0.02 percent of private rural drinking water wells in the alachlor use area, or about 1,200 wells. Monsanto recently estimated (Wratten, 1995) that approximately 12,400 individuals will be exposed to alachlor at 0.4 µg/L, the former EPA upper bound estimate of the $1x10^{-6}$ cancer risk level established for alachlor).

Table C-4. Estimated percentage of wells with detections of alachlor from the National Alachlor Well Water Survey (NAWWS).

Concentration (µg/L)	Percentage of wells with alachlor[1]	estimated number of wells[2]	standard error (percent of wells)
>0.03	0.78	46,800	0.29
0.1	0.36	22,000	0.22
0.2	0.32	19,000	0.20
0.5	0.06	3,600	0.03
1.0	0.03	1,800	0.02
> 2.0	0.02	1,200	-

[1] from Holden et al., 1992.

[2] estimated by EPA, based on total rural domestic water wells in the alachlor use area from Holden et al., 1992 (6,000,000 wells).

USGS Ground water Study in IOWA (1995).

The USGS, University of Iowa Hygenic Laboratory, and the Iowa Department of Natural Resources have been involved in a joint program to monitor municipal wells in Iowa since 1982, known as the Iowa Ground Water Monitoring Program (IGWM). In the summer of 1995, the USGS sampled 106 municipal wells, representing the major aquifer systems in the state in order to determine the occurrence of selected herbicide compounds (Kolpin and Kalkhoff, 1996). All samples were analyzed for alachlor and alachlor-ESA, with a reporting limit of 0.05 µg/L for all analytes.

Alachlor was detected in 7.5 percent of wells in the network, with a maximum of 0.63 µg/L. Alachlor-ESA was the most frequently detected compound, found in 65.1 percent of wells, at a maximum concentration of 14.78 µg/L. Consistent with other studies, alachlor-ESA was detected almost 9-times as frequently as parent alachlor. Factors found to influence the frequency of detection of both parent and degradates were: well depth, water age, dissolved oxygen content, and aquifer type. Both parent and degradates are found much more frequently in shallow wells (defined as $\leq$50 meters deep), in post-1953 age water, and under reducing conditions. Alluvial and bedrock/karst aquifers had the most frequent incidence of pesticide detections in this study.

Wisconsin DATCP Alachlor Study.

Following the reports of alachlor-ESA in ground water in Ohio in 1993, Wisconsin's Department of Agriculture Trade and Consumer Protection (DATCP), with the assistance of Monsanto, began testing monitoring wells and private water supply wells for alachlor-ESA in the summer of 1993. Results indicated that alachlor-ESA was present in a large number of samples, and it was decided to include alachlor-ESA in a Wisconsin survey of private wells most at risk. Wells were selected in an area of high alachlor use from wells that had previous detections of triazine herbicides or high concentrations of nitrate. The program was designed to indicate whether or not a problem existed with alachlor or alachlor-ESA in wells most at risk. Alachlor was detected in 12 of the 293 samples (4 percent) at concentrations ranging from 0.21 - 6.91 µg/L. Alachlor-ESA was detected in 206 of 293 samples (70 percent) at concentrations ranging from 1.09 - 26.7 µg/L. In part because of these results, the State of Wisconsin established an interim health advisory (20 ppb) and is considering proceeding to establish an enforcement standard for ESA.

State of Florida Monitoring Program.

Prior to the ban on the use of alachlor in the State of Florida, Monsanto conducted a ground-water monitoring study for alachlor in conjunction with the Florida Department of Agriculture and Consumer Services (FDACS). The main focus of this study was the monitoring of alachlor in open hole bedrock wells in Jackson County, in northern Florida. After confirmed detections of alachlor were reported in 13 of 100 wells, the sampling was expanded to include 310 wells in 10 counties.

Alachlor was detected in 189 samples, from 46 (15 percent) of 310 wells during sampling from July 1989 to May 1990. Reported concentrations ranged from trace levels to 135 µg/L in a well in Levy county. This high concentration is above the child one-day health advisory for the chemical, which is 100 ppb. Concentrations in that particular well above the 100 ppb level were still detected after 18 months. This pattern (persistent high concentrations of alachlor) was observed in many wells with lesser concentrations above the MCL. The Florida Department of Agriculture and Consumer Services stated that although Jackson County is underlain by karst limestone, these conditions were not found throughout the 10 county area where alachlor was detected. The State of Florida does not consider the detections in this study to be the result of point-source contamination.

State of New York- Suffolk County.

From 1990 to 1992, the Suffolk County Department of Health Services (SCDHS) analyzed private wells near a plant nursery for alachlor residues. Alachlor was detected in 14 of the 63 wells, 11 of which had at least one detection equal to or greater than the 2.0 ppb MCL. The highest concentration detected was 49 µg/L. Subsequent sampling of 92 wells near plant nurseries resulted in a single detection of alachlor at 0.6 µg/L.

The SCDHS did not find any evidence to suspect point source contamination. In their response to the 1996 draft, the registrant indicated that they suspect that point source contamination may have occurred. It is indicated that subsequent monitoring has shown that levels in most wells are dropping below the MCL.

State of North Carolina

The University of North Carolina-Asheville Environmental Quality Institute (EQI) conducted a study from 1989 to 1992 to gather information on the spatial distribution of pesticides in rural water supply wells in eastern North Carolina (Maas, R.P. et al., 1995). Alachlor was one of eight chemicals investigated, with a method detection limit of 0.13 µg/L. Samples were collected from 171 sites, which corresponded to individual wells. Alachlor was detected at 8.8 percent of the 171 sites, with concentration that ranged from 0.23 to 68 µg/L. Five of the detections were above the 2.0 ppb MCL. Multiple samples were collected over approximately a year and a half. Results indicated that alachlor contamination was not a seasonal phenomenon, but persists over longer periods of time in eastern North Carolina. Two of three wells that were re-sampled maintained levels of alachlor above the MCL for over a year. The third had an initial detection at 0.3 µg/L, declined to below the detection limit a half year later, increasing again to above the MCL one year after the original sampling.

The EQI study concluded that the majority of detections of alachlor encountered in the study appeared to be the result of normal agricultural use. Only one of the wells was located near a pesticide mixing area (within 100 feet).

The study authors reported that alachlor detection was not significantly related to distance from pesticide mixing, storage and loading areas. This suggests that the observed groundwater contamination was not a result of point sources. The authors also found that alachlor was detected in wells more frequently further from cropped fields, and that the compound was detected in areas that had received no application for at least several years. This data was interpreted as showing that the detected alachlor came from a great distance from the well or from applications in the distant past. The authors concluded that well water contamination was not a seasonal phenomenon but persists over time.

The Interagency Study of the Impact of Pesticide Use on Groundwater in North Carolina conducted in 1991-1996 (Wade *et al.*, 1997). In phase I of this study 55 wells representing the state's major drinking water aquifers were sampled at least twice and analyzed for pesticides. No attempt was made to select these wells where pesticides were known to have been used. In phase II, 97 shallow monitoring wells were installed and sampled at least twice. Phase II wells were located in areas believed to represent the highest risk, and were adjacent to or down gradient from areas of pesticide application. When pesticides were detected in phase II wells additional sampling was done from nearby domestic supply wells. Forty-six domestic supply wells were sampled in this phase.

Alachlor was not detected in phase I or phase II wells. Alachlor was detected in two domestic supply wells near phase II wells that had other pesticides detected. One of the wells with alachlor was a "shallow bored well" located within an agricultural field and had been used to fill spray equipment. Two other domestic wells within 0.5 miles did not have detectable pesticides. The other well with alachlor detected was a "bored well of unknown depth" located 100 feet from corn field on an adjacent farm. Alachlor was detected in this well at two separate sampling events at 9.2 ppb and 5 ppb. Three other monitoring and domestic wells near this well did not have detectable alachlor.

Continued sampling following completion of the study by the North Carolina Department of Agriculture has not detected additional alachlor groundwater contamination. However, the alachlor degradation products, including ESA, have been detected in groundwater at concentrations ranging up to 22 ppb. (H. Wade, Personal communication, 1998)

OTHER CONSIDERATIONS

Since the degradation of alachlor appears to be much slower in aquifers than in the soil root zone and since alachlor-ESA is reported more frequently than alachlor in ground water, Kolpin et al. (1996) concluded that the degradation of alachlor occurs prior to being transported to the aquifer. They theorize that if alachlor degradation occurred after reaching the aquifer, the frequency of detections of alachlor and alachlor-ESA would be more similar. They also report that alachlor-ESA appears to be persistent in shallow aquifers, because 90 percent of the wells having alachlor-ESA concentrations exceeding 0.10 µg/L remained at that level during all subsequent samples (1-year time interval). If an MCL or cancer risk level is established for alachlor-ESA at the same level as alachlor parent and because of the much higher percentages of wells having degradate detections, the concern for the population being exposed to levels of alachlor exceeding levels of concern is much greater than for the parent compound only.

Irrigation appears to increase the probability of contaminating ground water. The frequency of herbicide detection (35%) with irrigation within a radius of 3.2 km was greater than the frequency of herbicide detections (19%) without irrigation (Kolpin and Goolsby, 1995). They also suggest that ground water recharge from streamflow may also be a source of herbicide contamination.

Appendix D. Surface Water Monitoring Information for Alachlor

Alachlor can contaminate surface water at application via spray drift. Substantial fractions of applied alachlor could be available for runoff for several weeks post-application . The relatively low soil/water partitioning of alachlor indicates that most of alachlor runoff will occur via dissolution in runoff water (as opposed to adsorption to eroding soil).

Acetochlor Registration Partnership Data for 1995-1996.

This is the most extensive data on alachlor concentrations in finish surface drinking water available to the Office of Pesticide Programs. Samples were collected at 179 different sites (drinking water utilities) in the following 12 states: DE, IL, IN, IA, KS, MD, MN, MO, NE, OH, PA, and WI. Samples were collected approximately once every two weeks from April through early September. Two to three additional samples were collected at most sites, one to two in the Fall and one in the Winter. Unfiltered samples were analyzed for total alachlor.

Additional detail is provided in a review and analysis of the data by R. David Jones (EFED memo dated May 24, 1996 to B. Montague) and in an electronic spreadsheet (summary statistics) by S. Abel. The analyses provide yearly summary statistics for peak, 96-hour time weighted mean concentrations (TWMC), and annual TWMC for 1995 (R. David Jones) and peak and annual TWMC for 1996 (S. Abel). Additionally, running peak and annual TWMC are provided for both years data.

Based on the reanalysis of data covering 1995 and 1996, the following table provides maximum and 90th percentile (upper 10th percentile) concentrations (peak and annual TWMC).

Table D-1. Summary of 1995 and 1996 Alachlor Monitoring by the ARP

Statistic	Calculation for a given site	Summary Across Sites	
		Maximum Value for any Site (µg/l)	Value Equaled/Exceeded on 10% of Sites (µg/l)
Peak Concentrations	Highest Value Observed 1995-1996, for any Site	4	0.63
Annual Time Weighted Mean	Weighted Mean for 1995-1996 for any Site (weight by time)	0.36	0.1

USGS 1989, 1994, and 1995 Midwestern Stream Reconnaissance Studies

Since the data submitted by the Acetochlor Registration Partnership was for samples collected at set intervals once every two weeks, it is probable that the data are generally substantially lower than peak alachlor concentrations associated with post-application runoff events. Such peak alachlor concentrations are probably more closely represented by post-application data collected by the USGS in reconnaissance studies conducted on numerous midwestern streams. The USGS (Goolsby/Thurman 1991; Goolsby 1995;

Goolsby 1996) conducted reconnaissance surveys of numerous midwestern streams in 1989, 1994, and 1995 to determine post-application, and in some cases pre-application and Fall concentrations of various herbicides including alachlor. Pre-application samples collected in 1989 and 1994 and Fall samples collected in 1989 had alachlor concentrations much less than 1 ug/L and generally below the detection limit of 0.05 ug/L.

Since post-application samples were generally collected during the first major runoff event after application, the concentrations in those samples should more closely represent peak alachlor concentrations. The maximum post-application alachlor concentrations for 1989, 1994, and 1995 were 51.3, 10.1, and 19.9 ug/L, respectively. The 90th percentile (upper 10th percentile) post-application alachlor concentrations for 1989, 1994, and 1995 were 12, 6.5, and 2.0 ug/L, respectively. The substantially lower concentrations in 1994/1995 than in 1989 may reflect reported decreases in alachlor use.

In 1989, a pre-application sample, a post-application sample, and a Fall sample were collected from 48 of the sites. The maximum and 90th percentile (upper 10th percentile) annual TWMCs were 11.6 and 3.4 ug/L, respectively. Annual TWMCs based on 4 quarterly samples (as specified to determine compliance with the Safe Drinking Water Act) probably would have been somewhat lower (but not more than 25% lower).

In 1994 and 1995, samples were analyzed for alachlor-ESA as well as alachlor. Alachlor-ESA concentrations are much higher than alachlor. That also appears to be true in early Spring even before alachlor application. EFED strongly recommends the accurate determination of the toxicity of alachlor-ESA so that a risk assessment can be performed for it.

USGS 1991-1992 Study of 8 River Locations Mississippi River Basin

The USGS (Coupe et.al. 1995) sampled 8 locations on rivers within the Mississippi Basin from April 1991 through March-September 1992 (depending on location) and analyzed the samples for numerous insecticides and herbicides including alachlor. Samples were collected twice per week from May 6 to July 15 1991, once per every two weeks from November 1991 to February 1992, and once per week at other times. The samples were filtered (0.7 u) and analyzed for dissolved alachlor. The maximum peak and 1991 annual time weighted mean concentrations over the 8 sites were 3.6 ug/L and 0.43 ug/L, respectively (both in the Platte River at Louisville NE).

Following the three sites with the highest 1991 alachlor concentration pre-application concentrations of less than 0.1 ppb in early Spring rapidly increase to several ppb during post-application runoff events in May and June, then rapidly declined to background levels by mid-late summer. The White River at Hazelton IN site was the only one of those three sites at which sampling was performed far enough into 1992 to give a second set of alachlor peaks (1992) in addition to the 1991 set. Alachlor concentrations in 1992 were lower than in 1991 at that site.

USGS 1992 Midwestern Reservoir Reconnaissance Study

The USGS (Goolsby etal 1993) sampled each of 76 midwestern reservoirs four times during 1992 and analyzed them for various herbicide degradates and herbicides including alachlor and ESA. Alachlor was detected above a detection limit of 0.05 ug/L in 36%, 48%, 26% and 16% of the samples collected in late April to mid-May, late June to early July, late August to early September and late October to early November, respectively. ESA was detected more frequently (72, 79, 77, and 64%) and at higher concentrations than alachlor. The highest alachlor and ESA concentrations were for samples collected in June or July of 1992. The maximum and 95th percentile alachlor concentrations for June-July over the 76 reservoirs appear to be between 5 and 10 ug/L. The maximum and 95th percentile ESA concentrations for June-July appear to be between 10 and 20 ug/L. After June-July, alachlor concentration appear to decrease more substantially then ESA concentrations.

Missouri River Public Water Supplies Association 1990 Study

The Missouri River Public Water Supplies Association (MRPWSA) sampled the raw water of 8 surface water supplies within the Missouri River Basin. Samples were collected daily May-July 1990. The maximum peak and May-July mean concentrations were 14.9 and 0.47 ug/L, respectively (both at Kansas City MO). However, the second highest peak and May-July mean concentrations were 2.9 and 0.29 ug/L, respectively. The annual mean concentrations should be greater than 25% of the May-July means.

State of Illinois 1986-1988 Study

The State of Illinois (Moyer and Cross 1990) collected 4-7 samples per year from each of 30 flowing surface water sites during 1986-1988 and analyzed the unfiltered samples for numerous pesticides including alachlor. The maximum alachlor peaks over the 30 sites were 5.6, 8.5, and 18 ug/L for 1986, 1987, and 1988, respectively. The maximum alachlor annual TWMCs over the 30 sites were 0.65, 0.76, and 2.0 ug/L for 1986, 1987, and 1988, respectively. The maximum three year TWMC over the 30 sites was 0.81 ug/L.

The State of Illinois (Taylor 1994) recently summarized pesticide data for surface water samples collected from 34 stations from 10/1/85 through 2/15/94. Thirty of the stations were the same ones discussed in the Moyer and Cross 1990 document, but the Taylor summary represents a update to February 1992. A total of 1278 samples were analyzed for alachlor at a detection limit of 0.05 ug/L. Apparently assuming non-detects were equal to the detection limit, Illinois reported maximum, 95th percentile, 90th percentile, and mean total (unfiltered sample) alachlor concentrations over the 34 sites and 9 years of 18 ug/L, 0.90 ug/L, 0.32 ug/L, and 0.065 ug/L, respectively.

Monsanto 1986 Finished Surface Water Supply Study:

In 1986, Monsanto sampled 30 finished surface water supply systems approximately weekly from April through August or September (Smith etal, 1987) and analyzed the samples for 5 herbicides including principally alachlor. The community water systems sampled represented 4 combinations of Lasso (alachlor) use and average soil susceptibility to runoff (high use/high runoff, low use/high runoff, high use/low runoff, low use/low runoff). The susceptibility to runoff was estimated from the weighted average of hydrological classifications (A, B, C, D) of soils within the drainage area. Of the 30 community water systems sampled, 13, 2, and 15 were classified as using sources which drain areas with high, intermediate, and low susceptibility to runoff, respectively. The maximum and 90th percentile (upper 10th percentile) peak alachlor concentrations over the 30 systems were 9.5 and approximately 6.0 ug/L, respectively. The maximum and 90th percentile (upper 10th percentile) alachlor annual TWMCs over the 30 systems were 1.1 and approximately 0.73 ug/L, respectively.

Monsanto 1985 Finished Surface Water Supply Study:

In 1985, Monsanto had sampled 30 finished surface water supply systems different from the ones sampled in 1986. They also sampled raw water. Samples were collected approximately weekly from April 1995 through August or September 1995 (Lauer etal, 1986) and analyzed only for alachlor. The community water systems sampled represented areas of high, medium and low alachlor use.

The maximum and 90th percentile (upper 10th percentile) peak alachlor concentrations in finished water over the 30 systems were 12 and approximately 4.2 ug/L, respectively. The maximum and 90th percentile (upper 10th percentile) alachlor annual TWMCs over the 30 systems were 1.5 and approximately 0.62 ug/L, respectively.

Due to the low soil/water partitioning of alachlor, the primary treatment processes employed by most surface water supply systems are not expected to be effective in removing it.

USGS 1984-1985 Study on the Cedar River Basin IA

The USGS (Squillace and Engberg 1988) collected samples at 6 locations within the Cedar River Basin (5 along the Cedar River and one along the Shell Rock River. Samples were collected approximately monthly from May 1984 through September 1985 at the Floyd and Cedar Falls sampling locations, and from May 1984 through November 1985 at the other 4 locations.

Two sets of samples were collected. One set was centrifuged for the determination of the dissolved concentrations of herbicides. "Total recoverable" herbicide concentrations consisting of both extractable adsorbed and dissolved herbicides were determined in the sample set not centrifuged.

The maximum peak and annual TWMC concentrations over the 12 site-years were 23 and 3.3 ug/L, respectively. The next highest peak and annual TWMCs were 21 and 1.9 ug/L, respectively. The maximum two year TWMC over the 6 sites was 1.7 ug/L.

Baker 1982-1985 Study on Ohio Tributaries to Lake Erie

Baker collected samples at various times including several times per week from mid-April to mid-August from 8 Ohio tributaries to Lake Erie during 1982-1985 and analyzed them for many pesticides including alachlor. Alachlor Peak and 4/15-8/15 TWMCs concentrations were reported.

The maximum and 90th percentile (upper 10th percentile) peak alachlor concentrations over the 30 site-years are 76 and 32 ug/L, respectively. The maximum and 90th percentile (upper 10th percentile) 4/15-8/15 TWMCs over the 24 site-years are 3.3 and 2.7 ug/L, respectively. Annual TWMCs should be greater than 33% of the 4/15-8/15 TWMCs.

Baker 1983-1987 Lake Erie Basin Case Study.

The Water Quality Laboratory at Heidelberg College, Ohio (Baker et al. 1991) sampled seven Ohio streams and rivers of the Lake Erie Basin for a number commonly used herbicides and insecticides, including alachlor. Samples were collected and analyzed at frequent intervals (daily) during the pesticide use period mid-April to mid-August, especially during runoff producing storm events, and twice per month during the remainder of each year's cycle. Samples were collected at existing USGS Gaging Stations. Alachlor was detected above the level of detection (0.1 ug/l) at all sampling stations in all years during the study. Alachlor peak and time weighed mean concentrations (TWMC) were reported.

The maximum peak concentration over the five-year study of 91.47 ug/l (n=410) occurred in the smallest basin, Lost Creek. The maximum TWMC over the study period of 1.74 ug/l (n=534) occurred in Honey Creek basin, the third smallest basin, but the second highest in agriculture intensity.

Study on the South River Estuary North Carolina

In a study of effects of pesticides on marine and estuarine aquatic biota from farmland runoff, alachlor was monitored in several headwater streams of the South River in the Pamlico Sound, North Carolina. Data collected during the conduct of this study provided valuable information on the concentrations of alachlor in estuarine waters from known pesticide applications.

Dissolved alachlor concentrations increased from background (residual) levels of approximately 0.019 ug/l to a maximum of 48 ug/l following pesticide applications and significant rainfall. Alachlor concentrations rapidly decreased to less than 1 ug/l following the termination of pesticide applications and after several runoff producing rain events had occurred. Eventually, concentrations returned to background level, although specific timing could not be determined from the submitted study.

Kirby-Smith 1987-1991 Study on the South River Estuary North Carolina

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Possible Concerns Over Alachlor and Alachlor-ESA in Surface Water:

According to available data, the potential risks to fish and aquatic invertebrates posed by alachlor in surface water are low. Potential risks to aquatic plants posed by alachlor are currently being assessed by EFED. The potential risks of ESA to fish, aquatic invertebrates and aquatic plants has not been well characterized.

In analyzing surface water concentration data, the EFED considers the frequency that annual averages exceed the drinking water MCL (for alachlor, 2 µg/l), and the frequency that peak concentrations exceed the MCL by a factor of 4 or more: Compliance with the Safe Drinking Water Act is based on comparison of the MCL to an arithmetic average of four quarterly measurements. Consideration of 4 times the MCL (4MCL) is of interest because if one or more of four measurements exceeds 4MCL, then the average of the measurements exceeds the MCL.

Most of our original concern over alachlor in drinking water was due to individual alachlor measurements frequently exceeding 4 times the MCL. The frequency of exceedances of 4MCL was greatest in the 1989 USGS reconnaissance study in which samples were collected during major runoff events following application, and in the study by Baker (1988), in which samples were apparently collected at least 3 times a week and not time composited. They were less frequent in the 1994 and 1995 USGS reconnaissance studies (which were also designed to capture peak concentrations) possibly due to decreases in alachlor use.

With the exception of 2 site-years in the 1984-1984 USGS study of the Cedar River Basin and one site-year in the 1986-1988 Illinois EPA study, none of the annual TWMCs for alachlor exceeded the MCL of 2 ug/L. This includes the 1985-1986 Monsanto studies of drinking water supplies and the recent 1995 Acetochlor Registration Partnership study of 175 sites over 12 states. In that study, the maximum annual TWMC was only 0.4 ug/L. Although the study used set sampling intervals that may often miss peak concentrations associated with runoff events, the once every two weeks sampling from April through September and the Fall and Winter samples (a total of 14/site) is much more than the 4 quarterly samples required under the SDWA. Again, the relatively low alachlor concentrations compared to some earlier studies may reflect substantial decreases in alachlor use.

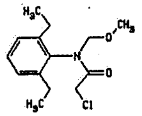
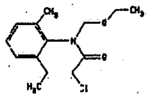
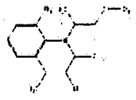
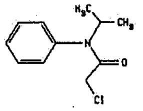
Appendix E: Comparative Assessment Tables For the Acetanilides Alachlor, Acetochlor, Metolachlor, and Propachlor

The following tables provide a comparison of environmental fate and ecological toxicity data for the acetanilides alachlor, acetochlor, metolachlor, and propachlor.

The environmental fate data for the four acetanilides come from a combination of data reported in the EFED Environmental Fate One-Liner Database and from recently-completed environmental fate assessments.

The comparative analysis of the ecotoxicity data for propachlor, alachlor, acetochlor, and metolachlor is based on data taken from the OPP/EFED Pesticide Ecotoxicity Data Base-1997. Only those studies classified as Core data were used in the analysis. Study identification numbers are shown as either an MRID#, Accession No., or an EPA ID# (Fiche No.). Category terminology was taken directly from Brooks, et al. (1973). Tables summarizing the toxicity characteristics of the four acetanilides appears in Appendix E.

Table E-1: Comparison of the Environmental Fate Characteristics of Alachlor, Acetochlor and Propachlor:

Characteristic	Alachlor	Acetochlor	Metolachlor	Propachlor
Chemical Structure				
Empirical Formula	$C_{14}H_{20}NO_2Cl$	$C_{14}H_{20}NO_2Cl$	$C_{15}H_{22}NO_2Cl$	$C_{11}H_{14}NOCl$
Molecular Weight	269.80	269.80	283.80	211.69
Vapor Pressure (mm Hg)	$2.2x10^{-5}$	$4.40x10^{-5}$	$1.30x10^{-5}$	$7.90x10^{-5}$
Log K_{OW}	2.64	3.0		2.30
Henry's Constant (atm m³/mol)	$3.2x10^{-8}$	$7.0x10^{-8}$	$9.16x10^{-9}$	$3.59x10^{-8}$
Solubility in water (ppm)	240	223	530	613
Hydrolysis	Stable at pH 3.0, 6.0, and 9.0	Stable at pH 5.0, 7.0, 9.0	Stable at pH 5.0, 7.0, 9.0	Stable at pH 5.0, 7.0, 9.0
Photolysis in Water	Not expected to be an important route of degradation, based on UV absorption spectrum	Stable	70 days	Stable
Photolysis on soil	Not expected to be an important route of degradation, based on UV absorption spectrum	Stable	8 days	Not an important route of degradation
Aerobic Soil Metabolism	2-3 weeks in three soil types	8-14 days one study reports 110 days	67 days	2.7 days
Anaerobic Soil Metabolism	Not available	230 days in sandy loam soil	81 days	146 days in a clay-loam sediment/lake water system

Characteristic	Alachlor	Acetochlor	Metolachlor	Propachlor
Mobility	Very mobile in loamy sand, silt and sand, mobile in silt loam in column leaching studies Estimated K_{OC}=190	K_d variable between 0.81-7.5	K_d between 0.08 and 4.81	Propachlor K_{ads}=0.45-1.39; K_{OC}=73-138, in loamy sand, sandy loam, loam, silty clay loam. Propachlor oxanilic acid K_{ads}=0.03-0.08, K_{OC}=391-3428. Propachlor sulfonic acid K_{ads}=0.03-0.07, K_{OC}=47-624
Terrestrial Field Dissipation	11 days in Chico, California	8-36 days at 5 sites in the United States	Supplemental studies show variability between 7 and 292 days	1.0-1.7 days in Janesville, Iowa; 5.0-5.8 in York, Nebraska; 2.3-2.8 in Uvalde, Texas
Bioaccumulation in Fish	Not expected to be important, based on K_{OW}. In a supplemental study BCF=5.8X in fillet, BCF=11X in whole, and BCF=15X in viscera	BCF=40X edible BCF=780X non-edible BCF=150X whole fish	BCF=15X edible BCF=69X whole fish	BCF=13X edible BCF=71X nonedible BCF=37X whole fish

The above table shows that alachlor, acetochlor, and propachlor are not only structurally related, but they also exhibit similar fate properties.

Table E-2: Comparison of avian acute oral LD50 data (mg/kg) for propachlor, acetochlor, alachlor and metolachlor.

Chemical	Avian LD50 (mg/kg)	Category	MRID/Acc#/ EPA ID#	Classification
Propachlor	88	Moderately toxic	00132907	Core
Alachlor	1499	Slightly toxic	245260	Core
	>2000	Slightly toxic	00160000	Core
	>2610	Slightly toxic	070839	Core
Acetochlor	49	Highly toxic	41963303	Core
	1567	Slightly toxic	Acc.# 99812	Core
	1788	Slightly toxic	41565129	Core
Metolachlor	4640	Slightly toxic	00015547	Core

* Technical Grade Material

Table E-3: Comparison of avian subacute dietary LC50 data (ppm) for propachlor, acetochlor, alachlor and metolachlor.

Chemical	Avian LC50	Category	ID #	Classification
Propachlor	>5000	Practically Non-toxic	00108087 00104335	Core
	>5423	Practically Non-toxic	LEWPRO3	Core
	>5620	Practically Non-toxic	00132908	Core
Alachlor	>5000	Practically Non-toxic	00093660	Core
	>5620	Practically Non-toxic	070839	Core
	>5620	Practically Non-toxic	070839	Core
Acetochlor	>4171	Slightly toxic	41565130	Core
	>4610	Slightly toxic	41565131	Core
	>5620	Practically Non-toxic	Acc.99812	Core
	>5620	Practically Non-toxic	Acc.99812	Core
Metolachlor	>10000	Practically Non-toxic	0016425	Core
	>10000	Practically Non-toxic	0016426	Core

*Technical Grade Material

Table E-4: Comparison of freshwater fish 96-hr LC50 data (ppm) for propachlor, acetochlor, alachlor and metolachlor.

Chemical	96-hr LC50*	Category	ID #	Classification
Propachlor	0.23	Highly toxic	40098001	Core
	0.17	Highly toxic	00041335	Core
Alachlor	1.0	Highly toxic	234628	Core
	5.6	Moderately toxic	234628	Core
	2.8	Moderately toxic	00023615	Core
	4.3	Moderately toxic	40094602	Core
	2.4	Moderately toxic	40094602	Core
Acetochlor	1.2	Moderately toxic	41963306	Core
	1.5	Moderately toxic	41565133	Core
	0.38	Highly toxic	41565132	Core
	1.6	Moderately toxic	415651332	Core
Metolachlor	3.9	Moderately toxic	0018722	Core
	4.9	Moderately toxic	0015534	Core
	8.0	Moderately toxic	40098001	Core
	10.0	Moderately toxic	00018723	Core

Table E-5: Comparison of aquatic invertebrate 48-hour LC50 data (ppm) for propachlor, acetochlor, alachlor and metolachlor.

Chemical	48-hr LC50*	Category	ID #	Classification
Propachlor	0.79	Highly toxic	40098001	Core
	7.8	Moderately toxic	00041336	Core
	6.9	Moderately toxic	40098001	Core
Alachlor	21.0	Slightly toxic	40098001	Core
	3.2	Moderately toxic	40098001	Core
Acetochlor	8.2	Moderately toxic	41565134	Core
	14.0	Slightly toxic	Acc. 99812	Core
Metolachlor	25.1	Slightly toxic	226955	Core
	23.5	Slightly toxic	40098001	Core
	3.8	Moderately toxic	40098001	Core

* Technical grade material

Table E-6: Comparison of estuarine fish 48-hour LC50 data (ppm) for propachlor, acetochlor, alachlor and metolachlor.

Chemical	48-hr LC50*	Category	ID #	Classification
Propachlor	No Data			
Alachlor	No Data			
Acetochlor	2.1	Moderately toxic	42713102	Core
	3.9	Moderately toxic	41565137	Core
Metolachlor	9.8	Moderately toxic	43487101	Core

Table E-7: Comparison of estuarine invertebrate 96-hour LC50/EC50 data (ppm) for propachlor, acetochlor, alachlor and metolachlor.

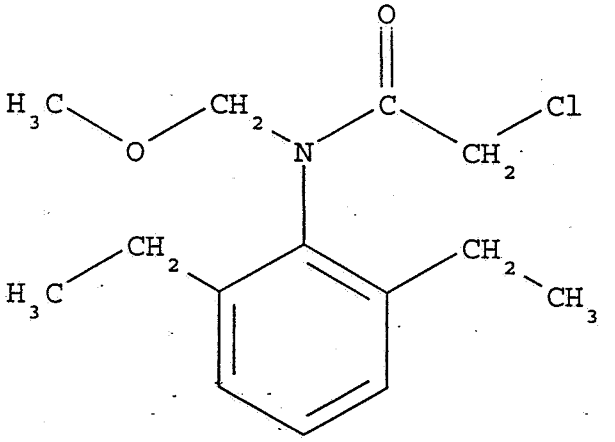
Chemical	48-hr LC50*	Category	ID #	Classification
Propachlor	No Data			
Alachlor	No Data			
Acetochlor	2.2	Moderately toxic	42713101	Core
	8.0	Moderately toxic	41565136	Core
	5.3	Moderately toxic	41565135	Core
	3.82	Moderately toxic	42713103	Core
Metolachlor	4.9	Moderately toxic	43487103	Core
	1.6	Moderately toxic	43487102	Core

Table E-8: Comparison of mammalian acute oral LD50 data (mg/kg) for propachlor, acetochlor, alachlor and metolachlor.

Chemical	96-hr LD50*	Category	ID #	Classification
Propachlor	1800			NA
Alachlor	No Data			
Acetochlor	2.2	Moderately toxic	42713101	Core
	8.0	Moderately toxic	41565136	Core
	5.3	Moderately toxic	41565135	Core
	3.82	Moderately toxic	42713103	Core
Metolachlor	4.9	Moderately toxic	43487103	Core
	1.6	Moderately toxic	43487102	Core

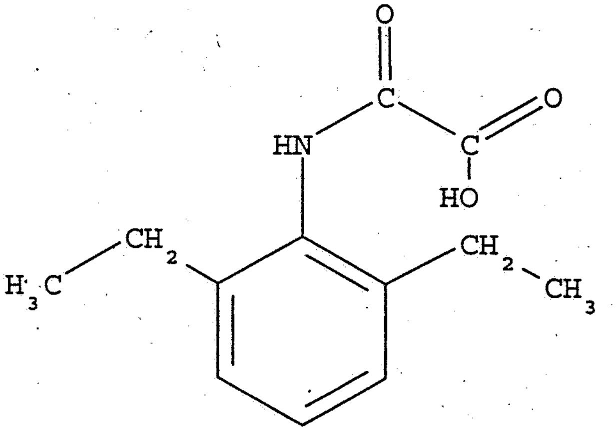
* Technical grade material

Appendix F: Alachlor and its Degradates

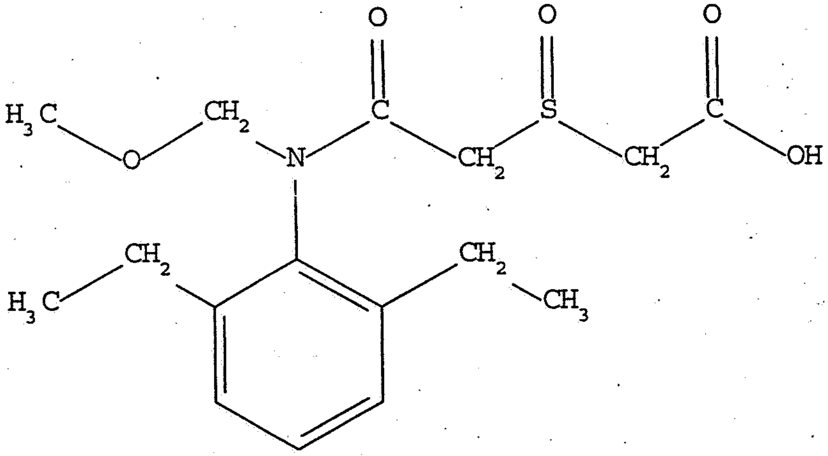


2-Chloro-2',6'-diethyl-N-methoxymethylacetanilide

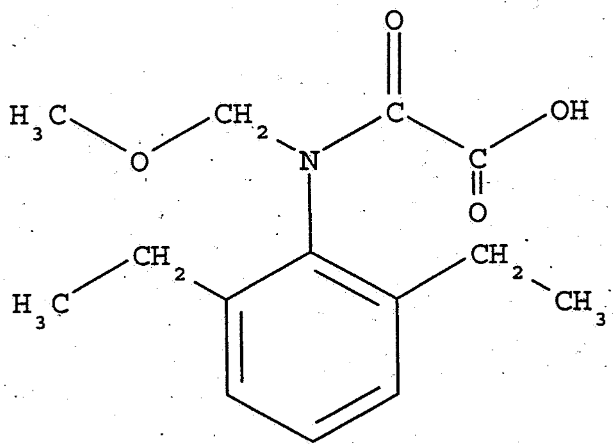
(Alachlor)



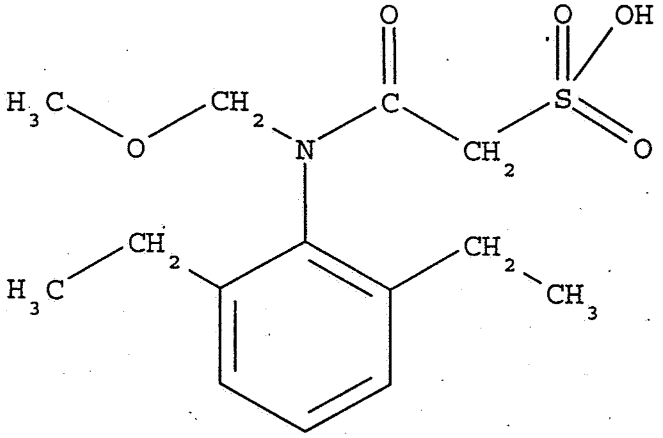
2',6'-Diethyloxanilic acid
(DM-Oxanilic acid)
(Compound III)



(N-Methoxymethyl-N-(2,6-diethylphenyl)-2-amino-2-oxoethyl)-sulfinylacetic acid
(Alachlor-sulfinylacetic acid)
(Compound VIII)



2',6'-Diethyl-N-methoxymethyloxanilic acid
(Alachlor oxanilic acid)
(Compound X)



2',6'-Diethyl-N-methoxymethyl-2-sulfoacetanilide
(Alachlor sulfonic acid)
(Compound XI)