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THRU: Henry Jacoby, Chief
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Attached, please find the EFGWB review of...

Reg./File # : 100-597

Common Name : Metolachlor

Product Name : Dual and Medal

Company Name : CIBA-GEIGY

Purpose : Review Large-Scale Retrospective Ground-Water Study

Type Product : Herbicide

Action Code : 660 EFGWB #(s): 90-0547 Total Review Time = 21 days

EFGWB Guideline/MRID/Status Summary Table: The review in this package contains...

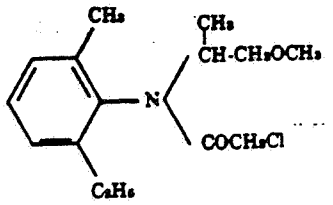
161-1		162-4		164-4		166-1	
161-2		163-1		164-5		166-2	
161-3		163-2		165-1		166-3	
161-4		163-3		165-2		167-1	
162-1		164-1		165-3		167-2	
162-2		164-2		165-4		201-1	
162-3		164-3		165-5		202-1	

Y = Acceptable (Study satisfied the Guideline)/Concur P = Partial (Study partially satisfied the Guideline, but additional information is still needed)
S = Supplemental (Study provided useful information, but Guideline was not satisfied) N = Unacceptable (Study was rejected)/Non-Concur

1. CHEMICAL:

Chemical name: 2-Chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide

Common name: Metolachlor
Trade names: Dual and Medal
Structure:



2. TEST MATERIAL:

Metolachlor

3. STUDY/ACTION TYPE

Review of large-scale retrospective ground-water monitoring study (Pesticide Assessment Guidelines-Subdivision N: Environmental Fate; Section 166-3).

4. STUDY IDENTIFICATION:

Title: A Large-Scale Retrospective Ground-Water Study for Metolachlor in Four States (Georgia, Illinois, Iowa, and Wisconsin)

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Date: 1/5/93

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Date: 1/5/93

TABLE 1: Comparison of Metolachlor Envoronmental Fate Data to EFGWB Leaching Criteria

CHARACTERISTIC	LEACHING CRITERIA	REPORTED VALUE
Water solubility	> 30 ppm	530 ppm
Henry's Law Constant	< 10^{-2} atm-m^3/mol	9.16E-9
Hydrolysis half-life	> 25 weeks	Stable
Photolysis half-life	> 1 week	>30 days (water) 8 days (soil)
Soil adsorption: K_d	< 5 (usually <1- 2)	1.6-1.9 (sand) 3.5 (silt loam) 11.3 (sandy loam)
Soil adsorption: K_{oc}	< 300 - 500	200
Aerobic soil metabolism half-life	> 2 - 3 weeks	17 weeks

shaded area indicates that chemical parameter exceeds trigger.

7. CONCLUSIONS:

EFGWB does not concur with CIBA-GEIGY's primary conclusion that "there appears to be no measurable field leaching of metolachlor to ground water-- even under conditions of high product use and high vulnerability." We further do not agree that all measurable detections of metolachlor appear to be associated exclusively with point source problems." We disagree that this report has proven that point sources pose the most significant risk of ground-water contamination. We further maintain that CIBA-GEIGY's decision to select monitoring wells with evident potential for point-source contamination is inconsistent with the study protocol submitted by the registrant and approved by EFGWB.

Results indicate that metolachlor has affected ground-water quality significantly in 3 of 4 areas studied, particularly in peanut areas of Georgia and potato areas in Wisconsin. According to CIBA-GEIGY's report, "the results of the study showed detection of metolachlor in 89 of 920 samples (10% of the samples collected) in 39 of 240 wells (16% of the wells selected) at the screening level of 0.1 ppb." No detections exceeded the Health Advisory Level for metolachlor of 100 ppb. The bulk of the detections (>60%) were at concentrations of 0.1-1.0 ppb. Roughly 7 % of the positive samples had metolachlor concentrations greater than 10% of the HAL (Table 1).

Based on an analysis of the information submitted, this report does not demonstrate that all metolachlor detections are due to point sources of contamination. Information pertaining to well characterization, aquifer characterization, and pesticide use history provided in the report is insufficient to allow a connection to be drawn between point sources and wells with detections, in all cases. Both point sources and normal field use appear to be responsible for the detections of metolachlor in this study.

The protocol for the study was approved by EPA, and sites were selected with input from the Agency. These "sites" were specific counties or multiple county areas. A well selection process was agreed upon with the Agency considering factors such as depth to the water table and proximity of a field with documented use of metolachlor. Wells located near obvious point sources of contamination were not to be selected for sampling.

Clearly, at least some percentage of the wells sampled were known to be at a high risk of contamination from point sources prior to sampling, in spite of the protocol. Since they were, it is inappropriate to conclude from this study that detections not anticipated to be associated with point sources were subsequently revealed to be so affected. This change in the study design by the Registrant makes the results of this study useful to characterize the potential impact on ground-water quality of

pesticide handling activities, and has been transmitted to EFED'S Pesticide Management and Disposal staff for their information.

While the Agency considers information on point source contamination to be very important, it was not the intent of this monitoring study to determine the impact of point sources of pesticides on ground-water quality. Metolachlor has the chemical properties of a "leacher" and residues have been found in ground water. Despite EPA approval of this protocol and selection of monitoring areas, the wells selected by CIBA-GEIGY, and the other deficiencies discussed in the Discussion section, do not allow us to determine the "means and extent of metolachlor potential to leach to contaminate ground water."

It is apparent that CIBA-GEIGY's claim that metolachlor will not leach to ground water as a result of normal agricultural use is not borne out by the results of this study. This claim is also inconsistent with monitoring information from the Pesticides in Ground Water Database (PGWD), which documents the detection of metolachlor above 10% of the Health Advisory Level (HAL) of 100 ppb in 8 states. The range of soil, hydrologic, and climatic conditions represented by these 8 different states makes it difficult to assess the conditions which constitute high-vulnerability scenarios for metolachlor. A prospective field *study is necessary to allow us to recommend meaningful mitigation measures. In the interim it would be justified to restrict the use of metolachlor on sandy soils where the water table is shallow.

It seems also from point-source contamination documented in this report that the existing ground-water label advisory has not been effective at preventing transport of metolachlor residues to ground water in agricultural areas. The registrant should be aware that metolachlor meets the triggers for classification as a restricted use compound based on environmental fate data and ground-water detections.

8. <u>RECOMMENDATIONS</u>:

(1) Because this study does not address non-point pesticide leaching in a systematic way, small-scale prospective ground-water monitoring studies are required to be conducted in several representative use-areas to determine the impact of metolachlor and degradates on ground-water quality from field application. These studies should include the determination of metolachlor and metabolites of concern in soil and water samples.

(2) The registrant should be aware that metolachlor meets the proposed triggers for classification as a restricted use compound based on ground-water concerns.

(3) The metolachlor label should be revised to restrict the use of metolachlor on sandy soils.

9. BACKGROUND:

Metolachlor is a widely used herbicide for weed control in corn and soybeans. Other uses include cotton, nonbearing citrus, nonbearing grapes, peanuts, pod crops, potatoes, safflowers, grain or forage sorghum, stone fruits, tree nuts, and woody ornamentals. Metolachlor is manufactured and marketed by CIBA-GEIGY Corp. under the trade names Dual and Medal. Metolachlor is also used in combination with atrazine under the trade name Bicep. Bicep is used to control weeds in corn, grain and forage sorghum.

Data from EFGWB's Pesticide Environmental Fate One Line Database indicate that metolachlor should be expected to leach to ground water, based on the screening criteria determined by EFGWB (Table 1). Metolachlor meets the criteria of a "leacher" for all of the parameters that have been measured for the chemical. The chemical's stability to hydrolysis, photolysis and aerobic soil metabolism indicate that metolachlor should be relatively persistent under normal agricultural conditions.

Data compiled by the EPA Office of Prevention, Pesticides and Toxic Substances (OPPTS) reveals that metolachlor has been detected in about 1% (213 of 22,255) of ground-water samples analyzed nationwide, in 20 of the 29 states that have performed this analysis. Concentrations above 10% of the 100 ppb Health Advisory Level (HAL) were found in 8 of these states. The highest concentration reported was 157 ppb, which was detected in a sample in Wisconsin ("Pesticides in Ground Water Database", USEPA/OPPTS; August, 1992).

In light of concerns about metolachlor's leaching potential, EFGWB required in the Metolachlor Reregistration Guidance Package that studies "be designed and conducted to determine the means and extent of metolachlor's potential to leach to ground water". CIBA-GEIGY's first protocol for the current study was submitted in December 1987, but was rejected due to disagreements concerning the criteria used in the selection of sites and wells. The protocol was revised to put more emphasis on the hydrologic vulnerability of counties chosen for the study. The final study sites selected jointly by EFGWB and CIBA-GEIGY were: McLean Co., Illinois; Floyd and Mitchell Counties, Iowa; the Dougherty Plains in Georgia; and the Central Sands Region of Wisconsin.

CIBA-GEIGY hired Roux Associates, Inc., Huntington, NY to conduct the field phase of the study, including the site selections. The analytical phase of the study was conducted by EN-CAS Laboratories, Winston-Salem, NC. The study was initiated in April

1988, and completed in October 1989.

10. DISCUSSION:

The purpose of this study was to evaluate the "means and extent of metolachlor to leach to ground water" in several vulnerable hydrologic settings. To this end, the registrant conducted site investigations at each location to ensure that the wells selected would be located such that they sample shallow ground water near fields with proven metolachlor use, according to the protocol approved by the EPA.

A. County Selection

CIBA-GEIGY submitted a protocol for a large-scale retrospective ground-water monitoring study for metolachlor in December 1987. The protocol described the selection of counties, strategy to locate wells, and sampling plans for the ground-water survey. EFGWB rejected the protocol because the proposed selection process was solely based on metolachlor sales data. With the guidance of EFGWB, the protocol was revised to better address the Agency's concerns about the study sites' hydrologic sensitivity through evaluation of county DRASTIC scores. The counties selected jointly by EFGWB and CIBA-GEIGY were: McLean, IL; Grundy, IA; Dougherty, GA; and the Central Sands Region of Wisconsin.

McLean County, Illinois was selected as one of the study areas based upon metolachlor sales data that show McLean County to be the highest metolachlor-use county in the United States. However, based on the DRASTIC score, its vulnerability to ground-water contamination was the lowest of the selected counties. Selection of counties in Georgia and Wisconsin was suggested by EFGWB because they were: (1) relatively vulnerable to ground-water contamination, and (2) located in peanut- and potato-growing areas, respectively. Peanuts and potatoes are minor-use crops for metolachlor.

Two of the counties agreed to had to be replaced due to the difficulties in locating an adequate number of acceptable wells in these counties. Grundy County was replaced by Floyd and Mitchell Counties in Iowa, which were chosen for their high metolachlor use rate. CIBA-GEIGY was unable to locate sufficient wells to fulfill protocol requirements in Dougherty County, Georgia. EFGWB granted permission to monitor in adjacent peanut-growing counties provided they were in the hydrogeologically sensitive Dougherty Plains.

B. Well Selection and Sampling

Criteria agreed to by EFGWB for the selection of wells are cited in the original study protocol and its amendments. Among these criteria were stipulations that:

- Well construction data be available;
- Selected wells be screened in the shallowest aquifer and as close to the water table as possible (wells less than 100 feet were preferred);
- Selected wells have a pumps that are operational, except in the case of USGS and other properly constructed monitoring and observation wells. Where available, these test wells would be given priority over other wells;
- The well be located within 300 feet of the application area. A well would not be greater than 500 feet unless it could be justified based on sound hydrogeologic data and use history;
- The fields have documented use of metolachlor within the previous two growing seasons;
- Every attempt be made to locate wells downgradient (with respect to ground-water flow) of metolachlor use areas;
- Wells with obvious point sources would be excluded.

Based on the site descriptions, which are discussed later, it is not convincing that CIBA-GEIGY followed this protocol when selecting monitoring wells. Well construction data was only provided anecdotally in the text. Fourteen wells were more than 500 feet from treated fields, without justification. Proof of previous metolachlor use was not provided, nor proof that wells selected were downgradient of the treated fields. Finally, CIBA-GEIGY did not exclude wells which, by their own admission, were located near obvious point sources. This will be discussed in more detail on a state-by state basis.

Sixty wells were selected in each of four states and sampled quarterly for a period of one year beginning in April 1988. Twenty-six wells were sampled less than four times due to problems such as equipment failure, adverse weather, or well destruction during the course of the study. Seven wells were sampled on more than four occasions to confirm the variation of the metolachlor detections in these wells or to provide Quality Assurance/Quality Control (QA/QC) samples.

Domestic wells were sampled at a point in the water supply system prior to any treatment, such as water softening or carbon

filtering. When possible, the sample was collected from a tap at or near the wellhead prior to entry into a pressure tank.

C: Results of Ground Water Sampling

Results of the analysis of metolachlor residues in the ground-water of the four study regions (Dougherty Plains, Georgia; McLean County, Illinois; Floyd & Mitchell Counties, Iowa; and the Central Sands Region of Wisconsin) are summarized in Table 2. The results of the study showed detections of metolachlor in 89 of 920 samples (10%) and 39 of 240 wells (16%) at the screening level of 0.1 ppb. The analyses cited were for the parent compound metolachlor only; no analyses were performed to determine the concentrations of metolachlor metabolites.

Georgia:

Metolachlor residues were detected in 42 of the 237 ground-water samples analyzed, at concentrations ranging from 0.11 to 88 ppb. Concentrations at or above 1.0 ppb were detected in 6 of the 60 wells sampled. The registrant attributes all of the detections above 1.0 ppb to "suspected or known point sources of metolachlor." In fact, the registrant claims that of the 13 wells with any detections, the detections in only 2 wells could not be attributed to point sources.

CIBA-GEIGY's attempt to attribute the detections of metolachlor in 11 of the 13 contaminated wells to point sources is inconsistent with their assertion that 51 of the 60 wells chosen met EPA's well selection criteria. CIBA-GEIGY states in their section on well selection that only two wells (GA-20 and 38) fail EPA selection criteria by being too near pesticide storage and disposal areas. However, CIBA-GEIGY later contradicts itself by claiming that 5 other wells were also contaminated because of nearby pesticide storage and/or disposal.

The argument that detections in 11 of 13 wells should not be considered since they were contaminated by point sources is inappropriate, because wells in this category were supposed to be disqualified by the study protocol. The well GA-43 site, for instance, had a "strong odor of pesticides at each sampling" event, and should never have been considered for the study. If CIBA-GEIGY was not aware of the "backsiphoning" that had occurred the previous year at well GA-39, nor the "spills" reported to have occurred three years previously near well GA-42, then the cooperator interviews done before the study began were completely inadequate.

However, it is not convincing from CIBA-GEIGY's description of the wells that 11 wells were contaminated by point sources, as claimed. The detections in well GA-20 can not be attributed to hypothetical mixing, backsiphoning, or breaks in the water line

to the spigot. The storage area blamed for detections in well GA-38 is located 100 feet downgradient of the well sampled. The third quarter detections in well GA-26 were considered as possibly the result of 6 different pesticide containers found during the third quarter within 100 feet of the well. It is doubtful that "mixing and disposal" of unnamed pesticides would contaminate an 85-foot deep well within the same quarter. Several of the other claims of point-source contamination are based on mixing or storage as far from the well as the treated field, and which are possibly downgradient.

Illinois:

Metolachlor residues were reported from two of the 60 wells chosen for sampling. Well IL-28 (30 feet in depth) contained residues of 0.27 ppb during the first sampling, however no residues were detected in samples at later dates. Well IL-44 (49 feet in depth) was found to have a single metolachlor detection of 0.58 ppb during the second sampling quarter. The average well depth sampled in McLean was 72 feet; the wells with detections were screened within the uppermost, unconsolidated glacial aquifer. Wells were located an average of 142 feet from a field having metolachlor application. CIBA-GEIGY did not provide any more detailed well construction information than this, but reported that ten of the wells exceeded EPA's well depth criteria of 100 feet.

The registrant reports that the area has generally good pesticide handling and management practices. Well construction and well conditions are generally reported as poor. Although most wells were reportedly covered by well houses, the registrant reported that approximately 40% of the wells were probably exposed to spray drift and were unprotected. The registrant did not find evidence of metolachlor or other pesticides stored near the McLean County wellheads. No further investigation was reported for the wells with no detections.

Iowa-Floyd and Mitchell Counties:

Metolachlor residues were detected in 21 of 230 samples (9.1%). These detections represented 10 wells (17%) and concentrations ranged from 0.10 to 3.1 ppb. Three of the wells had detections greater than 1 ppb, two of which had detections in three or more sampling rounds. The highest concentration detected was from well IA-30, which was located about 500 feet from a bulk ag-chemical distributor. Although the well is closer to treated fields than this facility, the bulk storage of metolachlor pesticides near the well should have eliminated it from consideration during the site investigation.

CIBA-GEIGY does not attribute any of the other detections directly to point source contamination, but does suggest that

well IA-16 was contaminated indirectly by direct runoff of pesticides into nearby sinkholes. Well IA-16 was is not screened in the uppermost quaternary glacial aquifer, but the underlying limestone bedrock aquifer. There are a reported 1,800 known sinkholes between the two counties, some of which have been used for disposal of used pesticide containers. The possibility that the contamination of IA-16 is typical of local bedrock wells is consistent with an 1983 Iowa State study of 20 domestic and farm supply wells in Floyd and Mitchell Counties. In this study, 65 % of the wells had detections of some pesticide at some point during the year.

Detailed descriptions are not provided, but well construction and conditions are reported as poor and many wells are unprotected near field sites. Of the 60 wells sampled in this area, 18 were more than 100 feet deep, exceeding EPA's criterion, and 2 wells were located greater than 500 feet from a field of metolachlor application. The average well depth was 102 feet, and the average distance from a field with metolachlor application was 218 feet.

Wisconsin:

The Central Sands area was chosen for its reputation of being particularly vulnerable to pesticide leaching, which has been substantiated by past studies. Thick deposits of glacial outwash sands are present over most of the area and depth to ground water is usually less than 30 feet. The 60 wells sampled in this area averaged 29 feet in depth and were located an average of 170 feet from a field with metolachlor application.

Metolachlor residues were detected in 24 of 221 samples (10.9%). The concentrations ranged from 0.13 to 4.3 ppb. Fourteen of the 60 wells (23%) contained detectable concentrations of metolachlor. The highest detection occurred in well WI-5 containing 4.3 ppb in the fourth quarter.

CIBA-GEIGY attempts to find point-source explanations for Wisconsin metolachlor detections in the same manner as with those in the other three regions. Most of these explanations involve pesticide storage sheds on-site which are further from the monitoring well than the treated field. A few others, such as WI-4, 18 and 20, were located so near to stored pesticides that they should never have been selected.

The difficulty in finding wells that fit the criteria set forth in the protocol extended beyond the difficulty in avoiding possible point sources. Twenty-three of the sampled wells were domestic wells reported to be of generally poor construction. Two domestic wells exceeded the 100 depth criteria, and six domestic wells exceed the 500 foot distance to a field with metolachlor application.

These obstacles to a straightforward interpretation of the analytical data emphasize the need for a prospective study for metolachlor. The placement of monitoring wells within a treated field would give unambiguous answers as to whether field leaching of metolachlor occurs under standard agricultural practices. The monthly sampling of these wells may provide a better understanding of metolachlor transport through the soil than the quarterly sampling in this retrospective study. EFGWB does not concur with CIBA-GEIGY's contention that one detection in four quarterly samples "may not be significant."

Table 2.

STATE	No. Wells	No. Samples	No. Samples with Conc (ppb) of: <0.1	0.1-1.0	1-10	>10-88	Wells >1 Detection	% Wells >1 Detection
GA	60	237	195	25	11	6	13	22
IL	60	232	230	2	0	0	2	3
IA	60	230	209	13	8	0	10	17
WI	60	221	197	18	6	0	14	23
Total	240	920	830*	58*	25	6	39*	16*
Distribution, %			90*	6*	3	1	16*	-

* These numbers may be incorrect due to the effects of lengthy holding time between GC and GC/MS analyses.

The residue levels in the samples with detections ranged from 0.1-88 ppb. None of the detections in this study exceed Lifetime Health Advisory (HA) of 100 ppb. Half of the samples with detections were found to have residues between 0.1-0.5 ppb.

D. Storage Stability Studies

Two storage stability studies were conducted to determine the stability of metolachlor in water during refrigerated storage. In the first study, deionized water was fortified with 2.5 ppb of metolachlor and aliquots were analyzed after zero, one, and four months of storage at 4°C. A storage stability study performed with deionized water is of limited use in estimating the storage

stability of metolachlor in ground-water samples, as it can not reflect site-specific matrix or biological effects.

In the second study, ground-water samples collected at the study sites were reanalyzed after 6, 7, and 9 months of refrigeration. The registrant claimed that metolachlor was stable under refrigerated storage conditions for a period of 9 months, although recoveries ranged from 71 to 145%.

Five of the 9 ground-water samples reanalyzed had previously had metolachlor detections ranging from 2 to 62 ppb. The other 4 samples had no detections previously, and were fortified at 2.5 ppb in the field. It would have been helpful to analyze the stability of metolachlor at lower concentrations, because approximately 90% of the samples collected were found below the detection limit (0.1 ppb), and 6% in the range of 0.1-0.5 ppb.

This information would have been useful in interpreting the results of GC\MS analysis used to confirm metolachlor detections. Samples with detections above 0.5 ppb were confirmed with few exceptions; this was not the case for sample detections below 0.5 ppb. A storage stability study that included samples with less than 0.5 ppb might have resolved whether the lower-concentration samples were more affected by the lengthy holding times between sample extraction and GC\MS analysis (21 to 326 days). If these samples were more sensitive to degradation in storage, it is possible that some positive detections were lost due to excessive holding times.

E. Correlation between Metolachlor and Nitrate

In an attempt to correlate the occurrence of metolachlor with nitrate in ground water, samples collected were also analyzed for nitrate. The protocol did not specify the type and number of QC samples for nitrate analysis and no storage stability study was performed. Samples were analyzed within 6 months of collection. Recovery and standard deviation were 115% and 15%, respectively. The screening level of the analytical method was established as 0.1 ppb.

With the exception of one well in Illinois (only one sample was collected in this well and no detections were found), nitrate was detected in all wells in four states. Nitrate levels ranged from 0.6-50 ppm in Georgia, 1-39 ppm in Iowa, <0.1-36 ppm in Illinois, and 0.2-86 ppm in Wisconsin. In general, there was no significant relationship between the reported detection of nitrates and metolachlor in the 240 wells sampled during this study.

F. Supplemental Well Sampling in Georgia

For those wells with high detection levels (>1 ppb) in the study area of Georgia, a supplemental sampling program was conducted in November 1988 in an attempt to support the contention that the detections represented localized point source contamination. Seven additional wells were sampled in the vicinity of wells GA-15, GA-20, GA-39, and GA-43. None of the supplemental wells contained a detectable level of metolachlor. Therefore, the registrant claimed that the contamination in the original wells was due to point sources.

EFGWB does not agree that the information from these supplemental wells is of any use in interpreting the contamination in the original monitoring wells. The approximate distance between these seven supplemental wells and the original wells ranges from 300-3,200 feet; the treated fields are much closer than this. The screened depth is not provided for all seven supplemental wells, but none of the wells are shown to be screened at the same depths as the wells to which they are compared. Furthermore, no indication is given as to whether these supplemental wells are nearer to a treated field, or whether they are hydraulically downgradient of a treated field or the wells to which they are compared.

CONCLUSIONS:

CIBA-GEIGY conducted a large-scale retrospective ground-water study for metolachlor in four areas of the U.S. with high metolachlor use and/or high vulnerability to contamination of ground water by pesticides. Approximately 20% of the wells sampled at the Georgia, Iowa, and Wisconsin sites contained metolachlor residues. The majority of the detections (60%) were at lower concentrations (0.1-1 ppb); roughly 7% of the positive samples exceeded 10% of the Lifetime Health Advisory Level. Only two wells in Illinois had a single metolachlor detection among 60 wells sampled quarterly for a year.

CIBA-GEIGY's efforts to link all reports of detections to point sources were unsuccessful, largely due to the anecdotal nature of the evidence. It is clear that some wells that were sampled were affected by point sources; these wells did not meet protocol selection criteria, and should not have been included in the study. The contamination of some wells by point sources underscores the need for better pesticide handling and disposal practices to ensure that ground-water is not contaminated as a result of these procedures. Although this study has not shown the impact of agricultural use of metolachlor on ground-water quality, CIBA-GEIGY has shown that there is a high probability of ground-water contamination when such practices are not followed. This information is very valuable and will be passed along to EFED's Disposal Group for their information. The registrant should be aware that metolachlor
meets the triggers for classification as a restricted use

compound based on ground-water concerns.

The purpose of this large scale retrospective study was to determine the means and extent of metolachlor leaching to ground-water from normal agricultural usage. Leaching of metolachlor to ground water does appear to have occurred at a number of sites. Normal agricultural practices cannot be determined from the study, since no use history was provided for the study fields, and CIBA-GEIGY raised numerous questions pertaining to storage, mixing, and disposal at these sites.

The objectives not met through the completion of this retrospective study would be better resolved by performing a small-scale prospective ground-water study. A small-scale study will allow the observation of the transport of a known application of metolachlor through the soil without fear of point source contamination. The installation of new monitoring wells of known depth will eliminate the present concerns with poorly constructed wells of unknown depth, and will allow better understanding of subsurface geology and direction of ground-water flow.