To: Jay Ellenberger  
Product Manager 12  
Registration Division (TS-767)

From: Carolyn K. Offutt  
Chief, Environmental Processes and Guidelines Section  
Exposure Assessment Branch, HED (TS-769)

Attached, please find the estimated environmental concentration review of:

Reg./File No.: 464-448, 464-523

Chemical: Chlorpyrifos

Type Product: Insecticide

Product Name: LORSBAN

Company Name: DOW

Submission Purposes: Runoff study review

ZBB Code: other

Action Code: 575

Date In: 13 July 1984

EFB#: 4459-4460

Date Completed: 11 Sept 1984

TAIS (Level II) Days

63 3.8

Deferrals To:

___ Ecological Effects Branch

___ Residue Chemistry Branch

___ Toxicology Branch
Chlorpyrifos

I. Introduction.
DOW performed a one-year runoff and water quality study in Kankakee County, Illinois, where chlorpyrifos was applied to corn in three different applications.

II. Chemical/Physical Characteristics.
Common Name: Chlorpyrifos
Chemical Name: O,O-diethyl-0-3,5,6-trichloro-2-pyridylphosphorothioate
Additional chemical/physical information may be found on the attached "One-liner".

III. Discussion.
DOW Chemical has submitted a one-year runoff and water quality study conducted in 1982 in Kankakee County, Illinois, where chlorpyrifos was applied to corn in three different applications. This study was performed in this field and pond because there had been a fish kill in the pond in 1981 and chlorpyrifos was suspected as the lethal agent. DOW used the information from the study to validate modeling efforts to predict field and pond pesticide dissipation.

In the DOW field study, the concentration in the whole pond due to drift from the third application was 18 to 55 ppt.

During the runoff events, the DOW study found that between 2 and 90 mg/ha of chlorpyrifos was transported from the pond watershed. DOW's modeling study using USDA's CREAMS (Chemical Runoff and Erosion from Agricultural Management Systems) runoff model predicted these runoff quantities quite well (see accompanying tables from DOW report).

The concentrations found in the pond in the DOW study ranged and were similarly predicted by a simplistic water quality model to be between 80 and 400 ppt depending upon the quantity of application and the period of time between application and the storm event.

IV. Conclusion.
This field study expresses the quantity of chlorpyrifos that can be transported from an agricultural field in Illinois into a nearby pond.
Chlorpyrifos - 2

The study with its accompanying laboratory studies are scientifically sound (with the exception of the permeability study) and fulfill the following Subdivision N tests:

§161-1 Hydrolysis study (temperature-dependent) - supplemental
§162-1 Aerobic soil metabolism studies - acceptable
§162-3 Anaerobic aquatic metabolism study - unacceptable
§163-1 Leaching and adsorption/desorption studies (batch study) - acceptable
§164-1 Field dissipation study for terrestrial uses - acceptable in part
§164-2 Field dissipation study for aquatic uses and aquatic impact uses - acceptable in part

Robert W. Holst, Ph.D.
Exposure Assessment Branch
Hazard Evaluation Division (TS-769C)
EXPOSURE ASSESSMENT BRANCH ONE LINER

EAB File No: 059101 TYPE PESTICIDE: Insecticide STRUCTURE

COMMON NAME: Chlorpyrifos
CHEMICAL NAME: O,O-diethyl-O-3,5,6-trichloro-2-pyridyl phosphorothioate

Formulation Types: 4E, 15G

Degradation Products:

CHEMICAL AND PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Mole. Wt.</th>
<th>Aqueous Solubility</th>
<th>Vapor Pressure</th>
<th>Kow</th>
<th>Henry's</th>
</tr>
</thead>
<tbody>
<tr>
<td>350.6</td>
<td>2.00 (ppm) 25(°)C</td>
<td>1.87E-5(torr) 25(°)</td>
<td>66000</td>
<td>4.21E-6(atm/mol/m³)</td>
</tr>
</tbody>
</table>

Soil Adsorption Coefficient

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>pH</th>
<th>O.C.</th>
<th>Kd</th>
<th>Kow</th>
<th>Koc</th>
</tr>
</thead>
<tbody>
<tr>
<td>fine sandy loam</td>
<td>7.5</td>
<td>1.3</td>
<td>112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fine sandy loam</td>
<td>7.5</td>
<td>2.8</td>
<td>247</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fine sandy loam</td>
<td>7.5</td>
<td>0.8</td>
<td>114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fine sandy loam</td>
<td>7.5</td>
<td>0.6</td>
<td>97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hydrolysis

<table>
<thead>
<tr>
<th>pH</th>
<th>Temp.</th>
<th>T1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>25</td>
<td>26400 hr</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>8400 hr</td>
</tr>
<tr>
<td>9</td>
<td>25</td>
<td>720 hr</td>
</tr>
</tbody>
</table>

Photolysis

<table>
<thead>
<tr>
<th>pH</th>
<th>T1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air:</td>
<td></td>
</tr>
<tr>
<td>Soil:</td>
<td></td>
</tr>
<tr>
<td>Water:</td>
<td>6-24 hr</td>
</tr>
</tbody>
</table>

Mobility Class

(1) Immobile
(2) Low
(3) Low to Mod.
(4) Moderate
(5) Mobile

Degradation - Laboratory Half-life

<table>
<thead>
<tr>
<th>Soil Aerobic:</th>
<th>T1/2</th>
<th>Soil Anaerobic:</th>
<th>T1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>fine sandy loam</td>
<td>18-53 dy</td>
<td>2 soils</td>
<td>39-51 dy</td>
</tr>
</tbody>
</table>
25% 1/3 bar moisture

Aquatic Aerobic:       Aquatic Anaerobic:
**EAB Chemical One-Liner**

**Chemical Chlorpyrifos**

### Degradation - Field Half-life

<table>
<thead>
<tr>
<th>Terrestrial [Crop Site]</th>
<th>corn fine sandy loam</th>
<th>T1/2</th>
<th>Forestry [Crop Site]</th>
<th>T1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18-53 dy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aquatic [Crop Site]</th>
<th>Other [Crop Site]</th>
</tr>
</thead>
</table>

### ENVIRONMENTAL EXPOSURE

- Found in Ground Water (Y/N)?
- Site(s) ___________________________ Level: ___________________________
- Reentry Interval Established?
- Rotational Crop Restrictions: __________________________________________

### Fish Bioaccumulation Factors

<table>
<thead>
<tr>
<th>Species</th>
<th>Tissue</th>
<th>Whole Fish</th>
<th>Duration (Half-life)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Edible</td>
<td>Viscera</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EXPOSURE ASSESSMENT:**

Degradation Summary (including degradation product names and structures):

- Not likely to leach due to high Kd.
- Likely to runoff but in quantities less than 1%.

**REFERENCES:** EAB Files

**One-Liner Writer:** R.W. Holst
Chemical: Chlorpyrifos  
Formulation: LORSBAN 4E Insecticide  

Citation: McCall, P.J., G.R. Oliver, and R.L. McKellar. 1984. Modeling the runoff potential and behavior of chlorpyrifos in a terrestrial - aquatic watershed. Submitted by DOW Chemical Co. (EPA Acc.# 253708)

Reviewer: Robert W. Holst, Ph.D., Staff Scientist, Exposure Assessment Branch, Hazard Evaluation Division (TS-769C), OPP. 29 August 1984.

Title: Runoff and Water Quality Study of Chlorpyrifos Applied to Corn in Illinois.

Materials and Methods: Two watersheds on a farm in Kankakee County, Illinois, were selected to be monitored for chlorpyrifos runoff in 1982. One watershed flowed into a small pond and, therefore, the pond was also monitored. This watershed of 2.65 acres drained in a 0.75 acre pond, while a second watershed of 0.64 acres drained into a ditch. The watersheds were delimited by metal and cement gutters. The soil was analyzed and found to be a fine sandy loam. The hydrologic parameters of each field were characterized. Daily weather data were collected for the period of the experiment (mid-May to mid-September). LORSBAN 4E was applied three times: 28 April, 4 lb a.i./A incorporated to 4 inches; 15 May and 15 June, 1.5 lb a.i./A each. Runoff and pond water and field soil and pond sediment samples were taken before the first application and at intervals through the remainder of the experimental period. Earthworms, corn, soybean, and off-target vegetation samples were also collected and analyzed.

Results: Plant and animal residues were reported as follows:

<table>
<thead>
<tr>
<th>Plant/Animal</th>
<th>Day of Application</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn foliage (within area of application)</td>
<td>30 days after</td>
<td>130-170 ppm</td>
</tr>
<tr>
<td></td>
<td>day of appl.</td>
<td>0.10-0.01 ppm</td>
</tr>
<tr>
<td>Soybean foliage (adjacent to field of application)</td>
<td>day of appl.</td>
<td>150 ppm</td>
</tr>
<tr>
<td></td>
<td>30 days after</td>
<td>0.10 ppm</td>
</tr>
<tr>
<td>Earthworms (within appl. area)</td>
<td>4 days after</td>
<td>1.2-6.6 ppm</td>
</tr>
<tr>
<td></td>
<td>30 days after</td>
<td>0.04-0.67 ppm</td>
</tr>
<tr>
<td>Blackberries (windward edge)</td>
<td>day of appl.</td>
<td>1-25 ppm</td>
</tr>
<tr>
<td></td>
<td>30 days after</td>
<td>0.02-3 ppm</td>
</tr>
<tr>
<td>Grass (outside appl. area)</td>
<td>day of appl.</td>
<td>0.13-45 ppm</td>
</tr>
<tr>
<td></td>
<td>30 days after</td>
<td>0.02-0.07 ppm</td>
</tr>
</tbody>
</table>

Chlorpyrifos in the runoff waters varied according to the physical characteristics of the fields. The pond watershed lost
Chlorpyrifos Runoff Study - 2

over 0.120 g/ha in the runoff sediment and 0.030 g/ha in the waters
while the second smaller watershed lost only 0.004 g/ha in the
sediments and 0.007 g/ha in the water runoff.

Chlorpyrifos in the pond waters was found to range from 300
pptr immediately after the 4 lb/A application to less than 10
pptr a month later. After the 1.5 lb/A surface applications,
the pond water concentrations did not generally exceed 150 pptr.
The pond sediments reached about 10 ppb just after the second
application but then declined to 2 ppb by the end of the experiment
in September.

DOW modeled the runoff of these watersheds and water quality
of the pond. USDA's CREAMS (Chemical Runoff and Erosion from
Agricultural Management Systems) runoff model and DOW's own
simpistic water quality model were used in the analysis. With
careful selection of the numerous input values for each model
(following the input parameters provided by USDA for CREAMS),
they were able to verify the modeling efforts using this extensive
field study. See the attached two tables comparing the actual
and predicted runoff values from the two watersheds and the two
figures comparing the actual and calculated pond water and pond
sediment concentrations of chlorpyrifos.

Conclusions: Chlorpyrifos will leave corn watersheds in
Illinois and can be transported to ponds a short distance from
the fields. The quantities of transport pesticide will vary
depending upon a variety of soil characteristics, crop management
practices, and application methodologies and are generally less
than 1%. The movement of a pesticide from the watershed to the
pond can be monitored and modeled.

Acceptability: This study was performed and reported in
accordance with the Subdivision N guidelines, §164-1 (Field
Dissipation Studies for Terrestrial Uses) and §164-2 (Field
Dissipation Studies for Aquatic Uses and Aquatic Impact Uses),
and the results are acceptable. Only part of the guidelines
requirements were met as only one geographical site was used.
Page _____ is not included in this copy.
Pages 6 through 12 are not included.

The material not included contains the following type of information:

____ Identity of product inert ingredients.  
____ Identity of product impurities.  
____ Description of the product manufacturing process.  
____ Description of quality control procedures.  
____ Identity of the source of product ingredients.  
____ Sales or other commercial/financial information.  
____ A draft product label.  
____ The product confidential statement of formula.  
____ Information about a pending registration action.  
____ FIFRA registration data.  
____ The document is a duplicate of page(s) _____.  
____ The document is not responsive to the request.

The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.
Chemical: Chlorpyrifos
Formulation: LORSBAN 4E Insecticide

Citation: McCall, P.J., G.R. Oliver, and R.L. McKellar. 1984. Modeling the runoff potential and behavior of chlorpyrifos in a terrestrial - aquatic watershed. Submitted by DOW Chemical Co. (EPA Acc.# 253708)

Reviewer: Padma Datta, Ph.D., Staff Scientist, Exposure Assessment Branch, Hazard Evaluation Division (TS-769C), OPP. 31 August 1984.

Title: Temperature-Dependent Hydrolysis of Chlorpyrifos in Illinois Farm Pond Waters.

Materials and Methods: 14C chlorpyrifos hydrolysis studies were conducted in pond water (pH 7.5) in 3 temperatures (15, 25, 35°C). The procedures used for incubation and radioactivity measurements follow the Subdivision N guidelines. H.P.L.C. systems used to obtain degradation products profile of chlorpyrifos follow those recommended in the Subdivision N guidelines. The pH-dependent hydrolysis studies were not reviewed as part of this assessment.

Results: The temperature-dependent hydrolysis data are given in the accompanying table found in the DOW Chemical report. The half-lives were calculated by the Agency to be 107, 53 and 17 days for temperatures of 15, 25, 35°C, respectively. This compares with 110, 50, and 16 days, respectively, as reported by DOW.

Conclusions: The half-lives are approximately 110, 50, and 16 days for temperatures of 15, 25, and 35°C, respectively, in pH 7.5 Illinois farm pond water.

Acceptability: This study was performed and reported in accordance with the Subdivision N guidelines. There are no requirements for a temperature-dependent hydrolysis study. This study is, therefore, supplemental data.
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___ Identity of product impurities.
___ Description of the product manufacturing process.
___ Description of quality control procedures.
___ Identity of the source of product ingredients.
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Citation: McCall, P.J., G.R. Oliver, and R.L. McKellar. 1984. Modeling the runoff potential and behavior of chlorpyrifos in a terrestrial - aquatic watershed. Submitted by DOW Chemical Co. (EPA Acc.# 253708)

Reviewer: Padma Datta, Ph.D., Staff Scientist, Exposure Assessment Branch, Hazard Evaluation Division (TS-769C), OPP. 31 August 1984.

Title: Degradation of Chlorpyrifos in Illinois Field Soils

Materials and Methods: Degradation rates were determined in Hoopeston, Guilford, Ada B, and Ada B2 soils (fine sandy loams) as a function of soil moisture (air dry, 25%, and 75% of 1/3 bar) and temperatures (25 and 35°C) as required by Subdivision N guidelines. The methods for radiolabeled chlorpyrifos and extraction, cleanup and quantitative measurements of 14C by combustion followed the Subdivision N guidelines. The H.P.L.C. conditions using a C18 uBondapak radial compression column and flow rate (1 ml/min) and procedures to obtain percent applied chlorpyrifos remaining in soils at certain time periods follow acceptable procedures. 14C chlorpyrifos of about 14.3 mci/mmole possesses sufficient radioactivity to detect at the 1 ppt level.

Results: The half-lives of chlorpyrifos were calculated using the data provided on the attached table found in the DOW Chemical report.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Moisture /%OC</th>
<th>Hoopeston (days)</th>
<th>Ada B (days)</th>
<th>Ada B2 (days)</th>
<th>Gilford (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Dry (25°C)</td>
<td>3.2</td>
<td>19.1</td>
<td>5.8</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>25% 1/3 bar (25°C)</td>
<td>37.2</td>
<td>53.7</td>
<td>29.0</td>
<td>18.7</td>
<td></td>
</tr>
<tr>
<td>75% 1/3 bar (25°C)</td>
<td>27.8</td>
<td>38.1</td>
<td>25.6</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>75% 1/3 bar (35°C)</td>
<td>0.4</td>
<td>20.0</td>
<td>10.4</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

The half-lives for the four soil types calculated by DOW are given in the accompanying table taken from the DOW Chemical report.

Conclusions: There is some discrepancy between the results as calculated, however, this is dependent upon the method of calculation. The results indicate half-lives of 0.6 to 19.1 days for air dry soil, 18 to 61 days for 25% 1/3 bar, and 12 to 38 days for 75% 1/3 bar depending upon soil type. The major pathway of degradation is by means of microbial processes as indicated by Q10s of 2 to 3 between the soils at 25 and 35°C.

Acceptability: This study was performed and reported in accordance with the Subdivision N guidelines, §162-1 (Aerobic Soil Metabolism), and the results are acceptable.
The material not included contains the following type of information:

___ Identity of product inert ingredients.
___ Identity of product impurities.
___ Description of the product manufacturing process.
___ Description of quality control procedures.
___ Identity of the source of product ingredients.
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Formulation: LORSBAN 4E Insecticide

Citation: McCall, P.J., G.R. Oliver, and R.L. McKellar. 1984. Modeling the runoff potential and behavior of chlorpyrifos in a terrestrial - aquatic watershed. Submitted by DOW Chemical Co. (EPA Acc.# 253708)

Reviewer: Padma Datta, Ph.D., Staff Scientist, Exposure Assessment Branch, Hazard Evaluation Division (TS-769C), OPP. 31 August 1984.

Title: Sorption of Chlorpyrifos in Illinois Field Soils

Materials and Methods: The sorption of chlorpyrifos to four soil types (all fine sandy loams) was estimated by the difference between that in solution and that amount added to the test tube. The laboratory procedures for measuring sorption chlorpyrifos using 14C material, including extraction, cleanup, and H.P.L. chromatography follow Subdivision N guidelines.

Results: The $K_d$ values were derived as noted in the accompanying table from the DOW Chemical report.

Conclusions: The results indicate that chlorpyrifos is strongly sorbed to these soils and is relatively immobile in soil and unavailable for leaching.

Acceptability: This study was performed and reported in accordance with the Subdivision N guidelines, §163-1 (Adsorption and Desorption), and the results are acceptable.
The material not included contains the following type of information:

____ Identity of product inert ingredients.
____ Identity of product impurities.
____ Description of the product manufacturing process.
____ Description of quality control procedures.
____ Identity of the source of product ingredients.
____ Sales or other commercial/financial information.
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Formulation: LORSBAN 4E Insecticide

Citation: McCall, P.J., G.R. Oliver, and R.L. McKellar. 1984. Modeling the runoff potential and behavior of chlorpyrifos in a terrestrial - aquatic watershed. Submitted by DOW Chemical Co. (EPA Acc.# 253708)

Reviewer: Padma Datta, Ph.D., Staff Scientist, Exposure Assessment Branch, Hazard Evaluation Division (TS-769C), OPP. 31 August 1984.

Title: Permeability (Column Leaching) of Chlorpyrifos in Illinois Field Soils

Materials and Methods: The permeability measurements were performed using undisturbed soil cores of 2 13/16-inches high by 3-inches diameter at a depth of 0 to 3 and 3 to 6 inches. The hydraulic conductivity determination was made in accordance with Subdivision N guidelines and by the method of Klute, A. 1979. In Methods of Soil Analysis, Part 1, ed. C.A. Black, Amer. Soc. Agron.

Results: No results were given other than a permeability or hydraulic conductivity value was mentioned in the USDA-SCS soil survey reports and used in the modeling of the runoff of this site.

Conclusions: No conclusions can be made from this study.

Acceptability: This study was performed but not reported in accordance with the Subdivision N guidelines, §163-1 (Leaching), and is, therefore, not acceptable. It may be upgraded with the submission of additional explanatory data. The §163-1 studies on mobility of chlorpyrifos through soils has been satisfied by the batch adsorption/desorption study.
Chemical: Chlorpyrifos
Formulation: LORSBAN 4E Insecticide

Citation: McCall, P.J., G.R. Oliver, and R.L. McKellar. 1984. Modeling the runoff potential and behavior of chlorpyrifos in a terrestrial - aquatic watershed. Submitted by DOW Chemical Co. (EPA Acc.# 253708)

Reviewer: Robert Holst, Ph.D., Staff Scientist, Exposure Assessment Branch, Hazard Evaluation Division (TS-769C), OPP. 31 August 1984.

Title: Anaerobic Aquatic Metabolism in Illinois Pond.

Materials and Methods: The methods used in this determination were not provided.

Results: The results were given in the appendix (Table XI) but not otherwise reported.

Conclusions: No conclusions can be made from this study.

Acceptability: This test is not scientifically sound and is unacceptable to fulfill the requirements of §161-3, Anaerobic Aquatic Metabolism, Subdivision N.