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OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

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Thru: Tom Bailey, Chief 10/13/98
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Subject: Reregistration Eligibility Document for Temephos
(D240786; Case No. 818974; Chemical No. 059001)

Attached to this memorandum is the EFED RED chapter for Temephos. EFED has reviewed available studies for Temephos and finds that the data is inadequate to fully describe the fate and effects properties of the chemical and to screen for concerns for effects on nontarget species. This transmittal memo summarizes EFED's findings and recommendations for mitigation and labeling.

1. Introductory Paragraph

Temephos is an organophosphate insecticide registered for the control of the aquatic insect larvæ, which is an outdoor, non-food use. There are no agricultural crop uses.

Temephos is manufactured by American Cyanamid company. They no longer wish to the market chemical as an insecticide, but have licensed Clarke Mosquito control company to register it.

Temephos is used for the control of the aquatic larvæ of mosquitoes, midges, gnats, punkies, and sandflies. Most of the data used in this RED was generated by American Cyanamid when they were the primary registrant. They held the registrations for the technical grade active ingredient (TGAI) (EPA Registration Number 241-220) and for four end-use products (241-174, -151, -150, and -132). In September 1997 these registrations were transferred to Clarke Mosquito Control Products, inc. (as 8329-56, -57, -58, -59, and -60 respectively). Clarke also holds four other Temephos end-use registrations (8329-15, -16, -17, and -30). There are two §24 registrations: NJ 940004 (which is the same as American Cyanamid's (241-132)) and NJ 940005 (241-150).

A. Kevin Magro, Clarke's Vice President for Regulatory Affairs, has told EPA that the only Temephos products being marketed are those of Clarke Mosquito Control. This has not been confirmed in writing nor has Clarke provided a "typical use scenario" for Temephos (*i.e.*, application rate, number and timing of applications, *etc.*) pests.

2. Use Characterization

Formulations include a granular and an emulsifiable concentrate. It is applied to water to kill the aquatic larvæ of certain pestiferous diptera, especially mosquitos, but gnat, pinkies, and sandflies as well. Sites and application rates are listed on labels as standing water, shallow ponds, lakes, woodland pools, tidal waters, marshes, swamps, waters high in organic content, highly polluted water, catch basins and similar areas where mosquitos may breed, margins of streams, and intertidal zones of sandy beaches.

3. Water Resources Assessment

Temephos [IS] applied directly to water. Exposure to Temephos and its degradation products is limited to aquatic environments where mosquito breeding occurs. Terrestrial exposure is expected to be minimal.

Temephos is a larvacide that is applied to shallow, stagnant, brackish and polluted waters. These waters are unsuitable as a source of drinking water. Temephos will not reach ground water that would be used for drinking water due to lack of hydraulic gradient and its relatively short half-life in natural waters. It was therefore decided jointly by the EFED and HED temephos teams that there are not FQPA drinking water concerns.

Temephos degrades relatively rapidly in natural water, therefore, the impact of two applications over a single application is not great.

4. Ecological Risk Characterization

Terrestrial animals

Because Temephos is only applied directly to water, it is not expected to have a direct impact upon terrestrial animals. EFED modeled the possibility of terrestrial animals (a duck)

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being exposed to Temephos via drinking water, but found that there was no cause for concern. Additionally, due to the tendencies for temephos to bioconcentrate, a piscivorous bird scenario was modeled to assess the risk to piscivores. This assessment was based on the comparison of the bioconcentration factor (BCF) and resulting residues in fish viscera to an avian subacute dietary $LC_{50.}$ It was concluded that residue levels are expected to be lower than the avian subacute dietary LC_{50}. This assessment indicates that only endangered species may be affected in the 15 cm pond depth scenario if the same presumptions for risks to non-piscivorous birds are applied.

There is no data on the effect of the chronic intake of food by waterfowl or upland gamebirds. In EFED's response to Cyanamid's low volume/minor use data waiver request, Maciorowski (1993) recommended avian reproduction testing, "information contained within the submission indicates that reproductive effects to waterfowl (mallard duck) may be expected at concentrations as low as 1 ppm (Fransen, et al., 1983). Nesting waterfowl are expected to be directly exposed to temephos from spraying operations. EEB is interested in reviewing this study as possible useable data for satisfaction of avian reproductive testing which is now required." An acceptable study has not been submitted.

Aquatic animals

Temephos is "Moderately to Very highly toxic" to aquatic (freshwater and estuarine/marine) vertebrates. It is "Highly toxic" to "Very highly toxic" to the aquatic vertebrates. The emulsifiable concentrate is much more toxic than the granular formulation in laboratory studies. Since, it is applied at much lower concentrations, they pose similar risks in the environment.

Chronic testing was reserved in the 1981 Registration Standard pending results of lower tier testing. EEB recommended for freshwater invertebrate life cycle chronic toxicity and fish early life stage chronic toxicity testing (Guideline 72-4) in the 1991 List A DCI Review. SRRD's 1993 letter required the studies to be submitted within one year. Acceptable studies have not been submitted.

Chronic studies were triggered because the labels allow repeated applications to water. LC_{50} values of less than 1 ppm have been demonstrated for both aquatic invertebrates and fish.

Temephos, when applied to shallow marshes, woodland pools, *etc.* (uses for which it is labeled), is expected to kill fish and their invertebrate prey. Chronic data are not available. In the absence of acceptable data, chronic risk assessments cannot be performed for aquatic invertebrate and fish.

Non-target plants

Seed germination/seedling emergence and vegetative vigor (Tier 1), and growth and reproduction of plants (Tier 1) were required in the 1981 RS. Seed germination/seedling emergence and vegetative vigor (Tier 1) was subsequently waived (Bushong, 1982). Aquatic plant growth (Guideline 122-2) was relisted as a requirement in EEB's 1991 List A Review. SRRD's 1993 letter required Tier 1 testing to be submitted 1 year from the date of receipt of the letter. A literature search which might reveal phytotoxicity to aquatic plants is currently being conducted by EFED. If such a search reveals a phytotoxic concern for aquatic plants, the aquatic plant data requirements will stand. If, however, aquatic plant phytotoxicity can not be demonstrated through this literature search, the aquatic plant testing requirements will be dropped. Acceptable aquatic studies have not been submitted to date. In the absence of aquatic plant data, the EEB is unable to perform an aquatic plant risk assessment.

Non-target insects

A honey-bee acute contact LD_{50} was not requested in the 1981 RS, but was listed as a data gap in EFED's 1991 List A DCI Review. Although the DCI was not issued, SRRD's 1993 letter required Tier 1 testing to be submitted 1 year from the date of receipt of the letter. An acceptable study has not been submitted.

5. Status of Data Requirements/Data Gaps

Acceptable studies have not been submitted for the following guidelines requirements:

70-3	Chronic Sediment Toxicity Tests for Freshwater and Marine/Estuarine Organisms
71-1(b)	Acute Avian Oral Quail or Duck/TEP
71-4(a)	Avian Reproductive/Quail
71-4(b)	Avian Reproductive/Duck
72-3(a)	Estuarine/Marine Toxicity Fish
72-3©	Estuarine/Marine Toxicity Shrimp
72-3(d)	Estuarine/Marine Toxicity Fish/TEP-EC
72-3(d)	Estuarine/Marine Toxicity Fish/TEP-G
72-3(e)	Estuarine/Marine Toxicity Mollusk/TEP-G
72-3(f)	Estuarine/Marine Toxicity Shrimp/ TEP-EC, Pink shrimp *Penaeus duorum*
72-3(f)	Estuarine/Marine Toxicity Shrimp/TEP-G
72-4(a)	Early Life Stage Fish
72-4(b)	Life Cycle Aquatic Invertebrate
72-5	Life Cycle Fish
122-2	Aquatic Plant Growth

Data Deficiencies and the Data Call-In:

EFED had requested a Data Call-In during 1991, but it was not officially issued. In 1993, SRRD sent a letter to American Cyanamid that required estuarine/marine testing (nine separate studies) to be submitted within one year. Acceptable studies have not been submitted.

Adequacy of Toxicity Data and Waivers:

SRRD's 11/17/93 letter contains an accurate depiction of the outstanding data requirement. EFED does not have sufficient data to complete an environmental risk assessment.

The registrants and users have argued that Temephos is needed because it is the least expensive and most efficacious pesticide to control larval mosquitos. They say Temephos is needed in developing countries, where its low price makes it very important.

EFED has recommended against data waivers (C. Bushong, 1982; Maciorowski, 1993). EFED has used EPA published data (MRID 40228401) to satisfy some testing requirements and has used data that was generated before 1982 by its own laboratory, though its policy is not to accept data that is that old.

Because of the reasons given for the waivers during the RED process, EFED will now agree to certain studies being waived.

Studies that may be waived for Temephos under certain conditions.

Guideline	Study Name	Reason
71-1(b)	Acute Avian Oral Quail or Duck/TEP	If the registrant concedes that Temephos is at least as toxic as is the TGAI, this study can only lead to the reproductive studies below.
72-3(a) 72-3©	Estuarine/Marine Toxicity Fish Estuarine/Marine Toxicity Shrimp	These two studies are on the TGAI. The studies on the end-use products will yield more useful information. If the registrant will do the TEP studies, the TGAI studies may be waived.
72-3(f) 72-3(f)	Estuarine/Marine Toxicity Shrimp/ TEP-EC Pink shrimp *Penaeus duorum* Estuarine/Marine Toxicity Shrimp/TEP-G	The Pink shrimp study was called "Supplemental- can be upgraded." If the registrant will upgrade it to "Core," the Mysid study can be waived. -OR- If an acceptable Mysid study is submitted, the Pink shrimp study need not be upgraded.
72-4(a)	Early Life Stage Fish	The fish Early Life Stage study is a preliminary study to the Fish Life Cycle study. If the registrant submits an acceptable life cycle study, the early life stage study can be waived.
122-2	Aquatic Plant Growth	This study was required because of the frequency of application of Temephos. If the rate of application is changed to twice per season and the pesticide is restricted to governmental PCOs, the concern about aquatic plants will lessen and this study may be waived. This requirement may also be waived if a phytotoxic literature search does not indicate phytotoxicity to aquatic plants. A search is currently underway by EFED.

6. Suggestions/Risk Mitigation Measures Proposed by EFED:

Many labels do not give a minimum interval between application or a maximum number of times per season or year that Temephos may be applied to water. The label should be modified to give exact minima and maxima.

Temephos is used primarily by POCs working for or contracted to governmental sorganizations. It should be restricted so that only these trained people should be allowed to use it.

Precautionary Labeling:

The following should be added to existing labeling.

End use products

"This product is toxic to birds and fish. Fish and other aquatic organisms in water treated with this product may be killed. You must consult your State Fish and Game Agency before applying this product to waters or wetlands. Do not contaminate water by cleaning of equipment or disposing of wastes. This product is toxic to bees and should not be applied when bees are actively visiting the treatment area."

"Do not apply this product to any body of water (lake, stream, *etc.*) that is used as drinking water by humans or that feeds any body of water that is used as drinking water by humans."

Manufacturing-use products

"This pesticide is toxic to birds, mammals, fish, and aquatic invertebrates. 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. For guidance, contact your State Water Board or Regional Office of the EPA."

7. Peer Reviewers

This chapter was peer-reviewed by Jim Felkel, Biologist and R. David Jones, Environmental Engineer.

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Environmental Risk Assessment

EFED does not have sufficient ecological toxicity data to complete an integrated environmental risk assessment. However, there is sufficient core environmental fate data to complete an environmental fate assessment for a low volume/minor use chemical. The core environmental fate data are: hydrolysis (161-1); direct photolysis in water (161-2); anaerobic aquatic metabolism (162-3); aerobic aquatic metabolism (162-4); mobility in soil/sediments (163-1) and bioaccumulation in fish (165-4). Therefore, the assessment which follows is an ecological risk assessment based on an inadequate data set for the production generating of a RED.

1. Use Characterization

Temephos is an organophosphate insecticide used for the control of aquatic larvæ of mosquitoes, midges, gnats, punkies, and sandflies. It is primarily applied to salt marshes and mangrove swamps. Primary use areas are coastal Lee County, Florida and coastal New Jersey. Mosquito breeding sites include swamps, shallow woodland pools, polluted waters and brackish coastal wetlands.

Most of the data used in this RED were generated by American Cyanamid when they were the primary registrant. They held the registrations for the technical grade active ingredient (TGAI) (EPA Registration Number 241-220) and for four end-use products (241-174, -151, -150, and -132). In September 1997 these registrations were transferred to Clarke Mosquito Control Products, Inc. (as 8329-56, -57, -58, -59, and -60 respectively). Clarke also holds four other Temephos end-use registrations (8329-15, -16, -17, and -30). There are two §24 registrations: NJ 940004 (which is the same as American Cyanamid's (241-132)) and NJ 940005 (241-150).

A. Kevin Magro, Clarke's Vice President for Regulatory Affairs, has told EPA that the only Temephos products being marketed are those of Clarke Mosquito Control. This has not been confirmed in writing nor has Clarke provided a "typical use scenario" for Temephos (*i.e.*, application rate, number and timing of applications, *etc.*).

Formulations include a granular and an emulsifiable concentrate. It is applied to water to kill the aquatic larvæ of certain pestiferous diptera, especially mosquitos, but gnats, pinkies, and sandflies as well. Sites and application rates are listed on labels as follows:

Standing water, shallow ponds, lakes, and woodland pools:

2 lb/A of 5% G (0.1 lb ai/A).
No interval given and Repeat as necessary.

2.5-5 lb/A of 2% G (0.05-0.10 lb ai/A). Repeat as necessary

0.5-1.5 fluid oz. of 45.1% (by weight) Emulsifiable Concentrate.
0.015-0.047 lb ai/A)
Repeat as necessary.

5-10 lb/A 1% G (0.05-0.1 lb ai/A). Repeat as necessary.

Tidal waters, marshes, swamps, and waters high in organic content:

4 lb/A 5% G (0.2 lb ai/A). No interval is given.

10 lb/A 2% G (0.2 lb ai/A). Repeat as necessary.

10-20 lb/A 1% G (0.1-0.2 lb ai/A).

10 lb/A 1% G (0.1 lb ai/A). No interval is given.

Highly-polluted water:

10 lbs/A 5% G (0.5 lb ai/A). No interval is given.

25 lb/A 2% G (0.5 lb ai/A). Repeat as necessary.

20-50 lb/A 1% G (0.2-0.5 lb ai/A). Repeat as necessary.

Catch basins and similar areas where mosquitos may breed:

5% G. Application rate is not specified. Repeat as necessary.

Standing water, shallow ponds, swamps, marshes, catch basins, and similar areas where mosquitos breed:

0.5-1.5 fluid oz. 4EC (0.015-0.047 lb ai/A). Repeat as necessary.

5-10 lb/A 1% G (0.05-0.1 lb ai/A). No interval is given.

2½-5 lb/A 2%G (0.05-1.0 lb ai/A). The Registration Division should have the registrant qualify the term on labels (*e.g.*, enclosed or semi-enclosed areas such as sewer manholes or storm drains).

Marshlands, margins of streams, intertidal zones of sandy beaches:

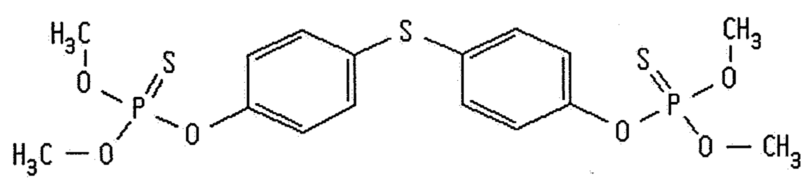
5-10 lb/A 2% G (0.1-0.2 lb ai/A). No interval is given.

2. Exposure Characterization

a. Chemical Profile

Common name: Temephos
Chemical name: Phosphorothioic acid,
O,O'-(thiodi-4,1-phenylene)bis(O,O'-dimethyl) phosphorothioate
Chemical Abstracts Service Number: 3383-96-8
Chemical Abstracts name: Phosphoric acid
O,O'-(thiodi,1,4-phenylene) O,O,O',O'-tetramethyl ester
Trade name: Abate®
Physical and chemical properties:
Molecular formula: $C_{16}H_{20}O_6P_2S_3$
Molecular weight: 446.46
Physical state: Crystalline Solid
Henry's Law Constant: 1.47 x 10^{-6} atm.m^3.mol^{-1}
Boiling point: Not applicable
Vapor pressure: 7.17 x 10^{-8} mmHg (torrs; 2.23 x 10^{-11} atm;
9.5 x 10^{-6} Pa) at 25°C
Melting point" 30.0 - 30.5° C
Solubility: 30 μg/l at 25°C
Kow= 80,900 (log Kow= 4.91)

Chemical Structure:



Temephos is composed of two dimethylphosphorothiate groups attached at the fourth carbon of two benzene rings linked by a sulfide bridge (-S-) at the *para*-position with respect to the phophorothioate groups.

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The sulfur in the sulfide linkage, S(-II), can oxidize to S(IV) and S(VI) to yield the sulfoxide and sulfone analog of Temephos, respectively. The sulfur in the phosphorothioate groups can be replaced by oxygens but usually elimination of one or both of the phosphorothioate groups are observed with or without replacement by oxygen. This results in free dimethyl phosphorothioate or dimethylphosphate ions and Temephos phenols. Temephos phenols, with or without oxidation of the sulfide linkage, have been identified in aquatic metabolism study (Temephos sulfone phenol and Temephos sulfide phenol).

The *n*-octanol/water partition coefficient, K_{ow} is 80,900 (log K_{ow}=4.91). This relatively high *n*-octanol/water partition coefficient indicates that Temephos is a hydrophobic compound and, thus, will have a tendency to remain at the water/air interface. Temephos has the potential to bioconcentrate.

The vapor pressure of Temephos is reported as 7.17 x 10^{-8} mmHg. The estimated Henry's Law constant is 1.47 x 10^{-6} atm.m^3.mol^{-1}, which suggests that Temephos may volatilize slowly from water, but volatilization may be more significant in shallow rivers and water bodies.

Temephos has an aquatic use pattern and is applied directly to water. Thus, exposure to Temephos and its degradation products is primarily associated with treated aquatic environments where mosquitos breed. Terrestrial exposure is expected to be minimal. Aquatic sites in which Temephos is used as a mosquito larvicide are presumably not suitable drinking water sources and, therefore, a drinking water assessment is not necessary. All labels of products containing Temephos must include a statement prohibiting treated water as sources of drinking water.

b. Environmental Fate Assessment

Direct photolysis and biodegradation in aqueous media are the major routes of transformation of Temephos, as indicated by half-lives of 15 days (photolysis), a primary half-life of 12.2 (0 to 29 days) and a secondary half-life of 27.2 days (30-121 days) under anaerobic conditions, and a half-life of 17.2 days under aerobic conditions. In contrast, under abiotic conditions Temephos is stable toward hydrolysis for at least 30 days.

Temephos sulfoxide was the only major degradate identified in pH 9 solutions in the hydrolysis study but at less than 10% of the applied radioactivity. This degradate and over twelve other photoproducts were found in irradiated water samples (pH 7), comprising a maximum of 11% Temephos sulfoxide and a total of 15% unidentified degradates (each at less that 10% of the applied radioactivity).

Aquatic metabolism studies showed that at day 0, a slightly higher amount of parent Temephos was associated with the sediment phase of anaerobically incubated samples than in aerobic incubations (59.9% and 51.9%, respectively). However, while Temephos in the sediment phase decreased with time in anaerobic samples, it increased to a maximum of *ca.* 73% in aerobic samples by day 2 compared to *ca.* 40% for anaerobic conditions. In both cases, the decrease of Temephos in the sediment parallels an increase in total degradation products partitioned into the water phase.

In water/sediment systems under aerobic conditions, Temephos mineralized to CO_2 (total of 4.6% of the applied radioactivity). No formation of CO_2 was observed under anaerobic conditions. Temephos sulfoxide was present under both aerobic and anaerobic conditions, but the amount found in sediment and water was higher under aerobic conditions. For example, up to 5.4% and 3.6% Temephos sulfoxide was present in aerobic sediment and water after 4 and 2 days incubation, respectively, when compared to a maximum of 3.4% in water after 205 days of anaerobic incubation. While Temephos sulfide phenol and Temephos sulfone phenol were observed under aerobic as well as under anaerobic conditions, they were primarily associated with the water phase under anaerobic conditions at sampling dates above 60 days. A higher concentration of oxidation products might be expected under aerobic conditions based solely on a higher concentration of dissolved oxygen, the presence of other dissolved redox couples and/or redox mineral surfaces in natural waters is more likely to control the redox behavior of a system such as Temephos/Temephos sulfoxide/Temephos sulfone.

Three unidentified degradates (A, B, and C) at greater that 10% of the applied were found in the water phase of anaerobically incubated Temephos, beyond 60-day sampling times. An unidentified metabolite in the sediment of aerobically incubated samples reached a maximum of 13.2% by day 30 but was below 3% in the water phase at all sampling times. Uncharacterized radioactivity in the aerobically incubated aqueous phase reached 17% after 30-days.

Data show that Temephos adsorbs strongly to soils. The Freundlich adsorption coefficients, $K_{ad,F}$, ranged from 73 to 541. Adsorption was dependent on the organic carbon content of the soil. In the experimental range of concentration, adsorption was observed to be non-linear, as indicated by the significant deviation of 1/n from 1. The correlation coefficients (r^2) were poor, ranging from 0.5 to 0.8. However, data also show that, under anaerobic conditions, Temephos generates degradation products that do not appear to bind as strongly to soils as parent Temephos. Under aerobic conditions, on the other hand, the amount of parent Temephos adsorbed to sediment steadily increased to a maximum after two days. Afterwards, the amount of Temephos adsorbed to sediments decreases with a concomitant increase of degradation products in the aqueous phase. No targeted mobility in soil data are available for the degradation products of Temephos.

Volatilization from soil is not likely to be a dissipation route for Temephos. However, based on the estimated Henry's Law constant, Temephos may volatilize from shallow rivers.

Temephos is a hydrophobic compound and concentrated in fish during the 28-day uptake phase of a flow-through study conducted with bluegill sunfish. The maximum daily bioconcentration factors were 970, 2300, and 3900 for fillet, whole fish and viscera, respectively, with corresponding maximum residues of 630, 1500, and 2500 ppb. During the 14-day depuration phase, 75, 75, and 78% of residues were eliminated from fillet, whole fish, and viscera respectively.

The calculated steady state bioconcentration factor (BCF), the rate of uptake (K_1), the rate of depuration (K_2), the time for one half-life depuration, and the time to reach 90% of steady state were 2300 (±270), 200 (±16), 0.086 (±0.0073), 8.0(±0.68) days, and 27±(2.3) days, respectively.

The major residue found in exposed fish was intact Temephos, which account for 630, 2500, and 1500 ppb in fillet, viscera and whole fish after 28-days. Temephos sulfoxide was the major metabolite. The maximum of Temephos sulfoxide was 12.6% in viscera after 28 days exposure. Metabolites in which one or both phosphorothioate groups cleaved from parent Temephos were less than 4%; none of them bearing an oxidized bridging sulfur (that is, they were not a sulfoxide or a sulfone).

Temephos is primarily applied to salt marshes and mangrove swamps. Seasonal variations in dissolved oxygen concentration, redox potential, pH, salinity, temperature, or tidal fluctuations are likely to influence the rate of degradation/dissipation of Temephos and the chemical nature of its degradation products. In these sites, the contribution of direct photolysis in water is likely to be reduced by vegetation, such as dense tree canopies, grasses, and high organic (tanins) in the water column.

Temephos has an aquatic use pattern and it is applied directly to water. Thus, exposure to Temephos and its degradation products is primarily associated with treated aquatic environments where mosquito breeding occurs . Terrestrial exposure is expected to be minimal. Aquatic sites in which Temephos is used as a mosquito larvicide are not suitable drinking water sources and, therefore, a drinking water assessment becomes unnecessary.

c. Environmental Fate and Transport

I. Degradation

Abiotic hydrolysis (§161-1): Abiotic hydrolysis is not a major degradative pathway for Temephos. Buffered solutions of ^{14}C-Temephos at pH 5, 7, and 9 at a concentration of 30 μg/l (ppb) and 25° C did not hydrolyze significantly over the 30-day duration of the study. However, there is evidence that there is a pH-related trend in the reported, extrapolated half-lives and pseudo first-order rate constants, with the half-lives decreasing with increasing pH. The reported half-lives and rate constants (in parentheses) are: pH 5, 1030 days ($k = 6.7 \times 10^{-4}$ day^{-1}); pH 7, 460 day ($k = 1.5 \times 10^{-3}$ days^{-1}); pH 9 86 days ($k = 8.1 \times 10^{-3}$ day^{-1}). However, there is a great uncertainty in these calculated half-lives because they are extrapolated well beyond the 30-day duration of the study. The only major degradate identified was the oxidation product Temephos sulfoxide at less than 10% and only at pH 9.

Direct photolysis in water (§161-2): Direct photolysis is an important degradation route for Temephos in water. The reported calculated half-life of ^{14}C-Temephos under 24 hours of continuous irradiation (xenon arc lamp) is 15 days ($k = 4.3 \times 10^{-2}$ days), for 30 μg/l (ppb) of Temephos in unbuffered solutions at pH 6.5 to 7.0 and 25° C. The major degradate identified was Temephos sulfoxide at 11% maximum from 3-days after beginning of exposure and throughout the 14-day duration of the study, in contrast to less than 4% in dark control solutions. There was a total of 12 unknowns in the irradiated samples, at a total of 15%. However, none of the individual components exceeded 10% of the applied.

Anaerobic aquatic metabolism (§162-3):

<u>Kinetics and Experimental Conditions: Radiolabeled (^{14}C-)</u>

Temephos applied at a concentration of 29.4 $\mu g/g$ to anaerobic water/sediment underwent degradation. The initial degradation/dissipation half-life was calculated as 12.2 days (first phase: 0 to 29 days) and the terminal, longer degradation/dissipation half-life of 27.2 days (30 to 121 days and beyond).

The 10-to-1 ratio water/sediment samples were incubated for five months under a nitrogen atmosphere prior to fortification. The temperature of the samples throughout the 373-days duration of the study was maintained between 23.3 and 26.7 degrees Celsius and were continuously purged with oxygen-filtered nitrogen. The water and sediment were collected from Lake Mendota, WI. The collected water had a pH of 8.0 and a dissolved oxygen concentration of 10 mg/l. The sand sediment (96% sand, 2% silt, and 2% clay) had a pH of 8, a cation exchange capacity of 7 meq/100g, and 0.3% organic matter. However, dissolved oxygen concentration, redox potential, and pH of the water phase were not measured prior to addition of Temephos nor monitored during the study. Test systems were fitted with traps to collect volatile products.

Transformation of Temephos under Anaerobic Aquatic Conditions

Mean total radioactivity recovered from the water/sediment systems ranged between 89 to 103 percent of the applied. In the aqueous phase, parent Temephos decreased from 59.9% at "day 0" (2 hours after application) to 7.9% by one week and below 1.6% after 90 days. In the sediment phase, Temephos decreased from 31.4% at "day 0" to 2.8% at day 90. Formation of CO_2 was not detected at any time during the course of the study.

In the aqueous phase, Temephos sulfoxide increased from 1.3% at "day 0," then decreased to below 1.0% but reached 3.4% after 205 days. Temephos sulfone increased from 0.9% at "day 0," reached a maximum of 3.3% by 7-days and remained below 1% throughout the duration of the study. In the sediment phase, these two degradates were detected at below 1% of the applied at all times.

The major identified degradates were Temephos sulfide phenol and Temephos sulfone phenol. None of these two degradates bear the organophosphate group. In the aqueous phase, Temephos sulfide phenol increased steadily from non-detected at "day 0" to a maximum of 13.8% after 373-days. In the sediment phase, this degradate was not detected until 29-days at 1.8% maximum and declined to non-detected afterwards. Temephos sulfone phenol increased steadily from 0.2% at "day 0" to 28.9% by day 61 and declined steadily to below 10% after 121 days. In the sediment phase, Temephos sulfide phenol was not present until 29 days after application of Temephos (maximum 1.7%), declining to 1% or less after 29 days. Temephos sulfone phenol was not detected until 7 days post-fortification (3.0%) and reached a maximum of 4.2% by day 15 but steady declined afterwards to 2.2% and 1.8% by days 90 and 121, respectively.

There is a major uncertainty in the identity of three degradation products labeled as "Metabolite A," "Metabolite B," and "Metabolite C." These degradation products partitioned predominantly to the aqueous phase and not to the sediment, where none of them were detected at concentrations greater than 1.1% of the applied at all times.

In the aqueous phase, the degradation product labeled as "Metabolite A" was detected first at 15 days after application at 8.9% but declined to 1.0% by day 121 and was not detected afterwards. "Metabolite B" was first detected at 1.9 by day 15. It steadily increased to 37.2% by day 373. "Metabolite C" was not detected at 0.9% until 29 days post-application. It increased steadily to a maximum of 13.4% by day 121. Beyond 121 days the concentration of this degradation product steadily declined to 5.4% by day 373.

The higher concentration of these unidentified degradates in the aqueous phase suggests that these degradates do not adsorb strongly to the sediment phase and that they may be associated with polar degradates. Polar degradates may form from oxidation of the sulfide linkage with or without oxidation the sulfur present in the organo-thiophosphate groups. Products containing the organothiophosphate groups can form by cleavage from parent Temephos with or without replacement their sulfur by oxygen and with or without oxidation of the sulfide linkage (*i.e.*, formation of a sulfoxide or a sulfone).

Aerobic aquatic metabolism (§162-4):

Kinetics and Experimental Conditions- Degradation/dissipation of ^{14}C

Temephos applied at a concentration of 31.7 μg/g to aerobic water/sediment followed first-order kinetics, with a half-life of 17.2 days. The water and sediment were collected from Lake Mendota, WI. The 10-to-1 ratio water/sediment samples were incubated in the dark at 25°C under air. A continuous flow of air was maintained throughout the duration of the study. The collected water had a pH of 8.0. The sand sediment (96% sand, 3% silt and 1% clay) had a pH of 7, a cation exchange capacity of 6 meq/100g, and 0.7% organic matter. However, dissolved oxygen concentration, redox potential, and pH of the water phase were not measured prior to addition of Temephos nor monitored during the study. Test systems were fitted with traps to collect volatile products. The duration of the study was 39 days.

Transformation of Temephos Under Aerobic Aquatic Conditions

Mean total radioactivity ranged from 91 to 101 percent of the applied. In the aqueous phase, Temephos decreased from 33.5% of the applied at day 0 to 0.3% at 30 days. In contrast, Temephos in the sediment phase increased from 51.9% at day 0 to a maximum of 72.9% at day 2, decreasing to 21.7% by day 30. Decrease of Temephos in the aqueous phase parallels partition to the sediment phase and increase in degradation.

Temephos sulfoxide, Temephos sulfide phenol, and Temephos sulfone phenol were identified in both the water and sediment phases. Temephos sulfoxide was found at a maximum of 5.4% in the sediment (day 4) and 3.6% in the water by day 2. The maximum Temephos sulfone phenol detected in the water phase was 6.3% (day 14) and 5.4% in the sediment (day 1). Temephos sulfide phenol in the sediment increased steadily, reaching a maximum 4.8% at day 30 but remained at 1.7% or below in the water phase at all sampling times shorter than 30 days.

An unknown metabolite ("Unknown 1") in the sediment reached a maximum of 13.2% on day 14. Uncharacterized degradates in the aqueous phase increased steadily to 17% by day

30 and are presumed to be highly polar, weakly adsorbing products. Volatile organic compounds and $^{14}CO_2$ reached 0.2% and 4.6%, respectively, by day 30.

d. Mobility

I. Mobility in Soil

Batch-equilibrium adsorption/desorption conducted with ^{14}C-Temephos in four different soils indicate that parent Temephos adsorbs strongly to soils as indicated by the Fruendlich adsorption coefficients $K_{ads,F,}$. Adsorption is dependent on the organic matter content of the soil. In the concentration range used in the study (5, 8, 11, and 26 ppb), adsorption was not linear as indicated by the deviation of 1/n from 1. The results of the study are summarized below:

Adsorption in soils

	Loamy Sand (Delaware)	Sandy Loam (Princeton)	Silt Loam (Nebraska)	Loam (Ontario)
pH	6.0	6.4	6.9	7.0
CEC	5.3	8.4	13.3	39.4
%OM	1.0	1.6	2.4	7.0
%Sand	77.6	55.6	24.0	38.0
%Silt	15.2	33.2	58.0	46.0
%Clay	7.2	11.2	18.0	16.0
$K_{ads,F.}$	7.3	130.0	244.	541.
1/n	0.58	0.62	0.72	0.78
K_{OC}	18,250	16,250	31,800	22,800

The correlation coefficients (r^2) were poor, ranging from 0.51 t 0.81. If outliers in the Fruendlich isotherms are considered, r^2 improves to 0.90 or higher.

Although a desorption study was conducted, the desorbed radioactivity was equal or below the background label to allow adequate calculations of Freundlich desorption coefficients.

No targeted mobility data are available on the major degradation products of Temephos but data from the aquatic metabolism studies suggest that oxidized, polar products of Temephos may be weakly adsorbed to sediments as these degradates tend to partition into the water phase.

ii. Volatility from soil and water

Temephos has a low tendency to volatilize from soil (vapor pressure 7.17 X 10-6 mmHg at 20°C). The estimated Henry's Law constant (1.47 X 10^{-6} atm.m^3.mol^{-1}) suggests that Temephos may volatilize slowly from water, but that volatilization of Temephos may be more significant in shallow rivers.

e. Bioaccumulation in Fish

A 28-day dynamic exposure of 120 acclimated fish to a concentration of ^{14}C-Temephos of 0.65 ± 0.12 μg/l indicated rapid uptake of radioactivity by the fish. Daily bioconcentration factors for fillet, whole fish, and viscera ranged from 63-970, 99-2300, and 150-3900, respectively. The uptake concentrations of ^{14}C-Temephos in tissues ranged from 50-630 ppb, 78-1500 ppb, and 120-2500 ppb for fillet, whole fish, and viscera, respectively. No mortality or abnormalities were observed in the Temephos-exposed fish.

The 14-depuration phase indicated 75, 75, and 78 percent depuration from fillet, whole fish and viscera, respectively and indicated a gradual decrease through the depuration phase. The ^{14}C-Temephos residues in the 28-day uptake phase dropped from 630 ppb to 160 ppb (fillet), 1500 ppb to 380 ppb (whole fish), and 2500 ppb to 560 ppb by the end of the 14-day depuration period.

The uptake rate constant (K_1), the depuration rate constant (K_2) the depuration half-life ($t_{1/2}$), the [steady state] bioconcentration factor (BCF), and the time to reach 90% of steady state were calculated using the non-linear BIOFAC kinetic modeling program. The standard deviation of each estimated parameter was use as a measure of variability. The results are summarized as follows:

$K_{1(uptake)}$= 200(±16);
$K_{2(depuration)}$= 0.086(±0.0073);
$t_{1/2(depuration)}$= 8(±0.68) days
$BCF_{steady\ state}$= 2300(±270)
Steady $state_{90\%}$= 27(±2.3)days

The metabolic fate of ^{14}C-Temephos in the fish was determined by characterizing the chemical nature of residues in fillet, whole fish, and viscera at 21 and 28 days exposure. The extracted residues (methanol:methylene chloride, 1:1 v/v; 95% extraction efficiency) were co-chromatographed (2-dimensional thin layer chromatography) with authentic standards of parent and suspected metabolites.

Parent Temephos was the major residue identified in fillet, whole fish, and viscera in 21 and 28 day samples. In fillet, whole fish and viscera Temephos was found at 490, 1700, and 1000 ppb, respectively in 21-day samples. In 28-day samples, 630, 2500, and 1500 ppb were respectively present in fillet, whole fish and viscera. The percent of applied Temephos found as intact Temephos was: (1) fillet, 79% at 21 days and 86% at 28 days; (2) whole fish, 73.6% at 21 and 28 days; viscera, 82% at 21 days and 59% at 28 days.

Temephos sulfoxide was the major metabolite. In terms of applied radioactivity, Temephos sulfoxide accounted for: (1) fillet, 5.1% at 21 days, and 4.5% at 28 days; whole fish, 6.8% at 21 and 28 days; viscera, 9.2% at 21 days and 12.8% at 28 days. Other minor hydrolytic and oxidative metabolites, each at equal or less than 4%, were also found. One of the metabolites, 4,4'-thiodiphenol, are the result of losing both phosphorothioate groups from the parent metabolite. The two other metabolites, phosphorothioic acid,O-*p*-(*p*- hydroxyohenylthio) phenyl, O,O'-dimethyl ester and phosphoric acid, O-*p*-(*p*-hydroxyphenylthio)phenyl dimethyl ester, contains only one organophosphate group; in the latter metabolite, the sulfur group in the phosphorothioate group was replaced by oxygen. All of these three metabolites preserve the sulfide linkage, that is, they are not a sulfoxide or a sulfone. Non-identified metabolites (2 to 9) were present at 4 to 13% and were mostly present in the viscera.

f. Water Resource Assessment Summary.

I. Modeling

Temephos is a mosquito larvacide that is applied to shallow, stagnant, brackish and polluted waters. These waters are unsuitable as a source of surface water/drinking water. Temephos would also not reach ground water that would be used for drinking water due to lack of hydraulic gradient and its relatively short half-life in natural waters. It was therefore decided jointly by the EFED and HED Temephos teams that there are no FQPA drinking water concerns. Therefore, only an aquatic exposure assessment is presented here.

Temephos as a mosquito larvacide was modeled using the Exposure Analysis Modeling System (EXAMS) version 2.97.5. The PRZM and GENEEC programs that are sometimes used in aquatic exposure assessments, were not used because they simulate runoff from a pesticide treated field that is not applicable to Temephos. The EXAMS program can be used to simulate direct application to water which is the case with Temephos.

Primary use areas are coastal Lee County, Florida and coastal New Jersey. Mosquito breeding sites include swamps, shallow woodland pools, polluted waters and brackish coastal wetlands. The EXAMS modeling setting chosen as a high exposure scenario is two shallow (15 and 30 centimeters deep) woodland pools. This scenario was chosen because it will not be influenced by stream flow that would remove Temephos from the site or by tidal action that would have a diluting effect on the concentrations. EXAMS input parameters are presented in appendix B.

Temephos is applied in one or two applications per year depending upon need (levels of breeding mosquitos). Modeling was completed for scenarios that simulate both one and two applications. For the two application scenarios, the modeled interval was varied so that the effect of residues from both applications could be assessed. Label application varies from site to site. The 0.5 pound of active ingredient per acre is the maximum permitted rate. Results are listed below.

Estimated Environmental Concentrations (EECs) For Aquatic Exposure

Site	Application Method	Application Rate (lbs ai/A)	# of Apps./ Interval Between Apps.	Initial (PEAK) EEC (ppb) 15 cm /30 cm	21-day average EEC (ppb) 15 cm /30 cm	56-day average EEC (ppb) 15 cm /30 cm	90-day average EEC (ppb) 15 cm/30 cm
DIRECT APPLICATION							
	aerial & ground	0.5	1 appl	48.8/24.4	3.0/1.5	1.4/0.7	1.0/0.5
			2 appl/7 days	50.4/25.2	5.6/2.8	2.8/1.4	2.0/1.0
			2 appl/15 days	50.0/25.0	5.2/2.6	2.6/1.3	1.8/0.9
			2 appl/90 days	48.4/24.4	5.0/2.5	1.4/0.7	1.0/0.5

ii. Discussion and conclusions

Because Temephos degrades relatively rapidly in natural water, the impact of two applications over a single application is not great. Maximum acute concentration expected for either one or two applications in a thirty centimeter deep pool is about 25 micrograms per liter (ppb).

3. Ecological Effects Toxicity Assessment

a. Toxicity to Terrestrial Animals

I. Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of Temephos to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). Results of this study are tabulated below. When a formulation is believed to affect the results, the study must be repeated with that formulated product. The studies for Temephos with an emulsifiable concentrate have not been submitted.

Avian Acute Oral Toxicity

Species	% ai	LD50 (mg/kg)	Toxicity Category	MRID No. Author/Year	Study Classification[1]
Northern bobwhite quail *(Colinus virginianus)*	94.7	27.4	Highly toxic	470167035 (157841) Fletcher, 1986	Core

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

Since the LD50 falls in the range of 10-50 mg/kg, Temephos is categorized as Highly toxic to avian species on an acute oral basis. The guideline 71-1a is fulfilled (MRID 470167035). The guideline 71-1b, Acute avian oral done with the emulsifiable concentrate formulation has not been addressed.

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

Avian Subacute Dietary Toxicity

Species	% ai	5-Day LC50 (ppm)[1]	Toxicity Category	MRID No. Author/Year	Study Classification
Bobwhite quail *(Colinus virginianus)*	86.9	92	Highly toxic	22923 Hill, 1975	Core
Mallard duck *(Anas platyrhynchos)*	86.9	894	Moderately toxic	22923 Hill, 1975	Core

[1] Test organisms observed an additional three days while on untreated feed.

Since the LC50 falls in the range of 50-500 ppm, Temephos is categorized as being Highly toxic to avian species on a subacute dietary basis. The guideline 71-2 is fulfilled (MRID 22923).

ii. Birds, Chronic

Avian reproduction studies using the TGAI are required for Temephos because birds will be subject to repeated exposure to the pesticide, especially preceding or during the breeding season. The preferred test species are mallard duck and bobwhite quail.

No acceptable reproductive studies have been submitted. The guideline (71-4) is not fulfilled.

iii. Mammals

Wild mammal studies are required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal studies. These toxicity values are reported below.

Mammalian Oral Acute Toxicity

Species	% ai	Toxicity Category	LD50 (mg/kg)	MRID
Laboratory rat *(Rattus norvegicus)*	86.9	Highly toxic	444	1902

An analysis of the results indicates that Temephos is categorized as being Highly toxic to small mammals on an acute oral basis.

iv. Insects

No acceptable studies have been reviewed. The requirement for a honey bee acute contact study has been waived, because its use will not result in honey bee exposure.

b. Toxicity to Freshwater Aquatic Animals

I. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of Temephos to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). When it is believed that the formulation will affect the results, a study for that formulation may be required. Results of these studies are tabulated below.

Freshwater Fish Acute Toxicity

Species/	% ai	96-hour LC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Rainbow trout *(Oncorhynchus mykiss)*	86.2	3.49	Moderately toxic	40098001 McCann, 1971	Core
	43%EC	0.158	Very highly toxic	1337 Kennedy, 1970	Core
Bluegill sunfish *(Lepomis macrochirus)*	86.2	21.8	Slightly toxic	40098001 McCann, 1971	Core
	43% EC	1.14	Slightly toxic	40098001 McCann, 1971	Core

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Since the LC_{50} of Temephos TGAI fall in the range of 1-100 ppm, it is categorized as being Slightly to Moderately toxic to freshwater fish on an acute basis. Since the LC50s of Temephos EC fall in the range of <0.1 to 10 ppm, it is categorized as being Very highly to Moderately toxic to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 40098001 and 1337).

ii. Freshwater Fish, Chronic

A freshwater fish early life-stage study using the TGAI is required for Temephos because the end-use product will be applied directly to water and the following conditions are met: (1) the pesticide's presence in water is likely to be continuous or recurrent regardless of toxicity, (2) an aquatic acute LC50 or EC50 is less than 1 mg/l, (3) the EEC in water is equal to or greater than 0.01 of any acute LC50 or EC50 value, and (4) the pesticide is persistent in water (*i.e.*, half-life greater than 4 days). The preferred study species is rainbow trout.

No acceptable studies have been reviewed. The guideline (72-4) is not fulfilled.

A freshwater fish life-cycle study using the TGAI is required for Temephos because the end-use product is intended to be applied directly to water. The preferred test species is the fathead minnow.

No acceptable studies have been reviewed. The guideline (72-5) is not fulfilled.

iii. Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity study using the TGAI is required to establish the toxicity of Temephos to aquatic invertebrates. The preferred test species is *Daphnia magna*. When the formulation is expected to affect the toxicity, studies with the formulated product may also be required. Results of these studies are tabulated below.

Freshwater Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai	48-hour LC50/ EC50 (ppm)	Toxicity Category	MRID No. Author/Year	Study Classification
Scud (*Gammarus lacustris*)	86.2	0.082	Very highly toxic	40098001 McCann, 1971	Core
Stone fly (*Pteronarcs* spp.)	86.2	0.01	Very highly toxic	40098001 McCann, 1971	Core
Waterflea *Daphnia magna*	43% EC Abate*	0.000011 NOEC = 0.00003	Very highly toxic	470177012 Forbis, 1986	Core
Waterflea (*Daphnia magna*)	5% G	0.00054	Very highly toxic	40098001 McCann, 1971	Core

Since the LC50 is <0.1 ppm in a TGAI study, Temephos is categorized as being very highly toxic to aquatic invertebrates on an acute basis. The guideline (72-2a) is fulfilled (MRID 40098001). Since the LC50 is <0.1 ppm in TEP (EC and G) studies, Temephos EC

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is categorized as being very highly toxic to aquatic invertebrates on an acute basis. The guideline (72-2b) is fulfilled (MRID 470177012).

iv. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle study using the TGAI is required for Temephos since the end-use product will be applied directly to water and : (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) any aquatic acute LC50 or EC50 is less than 1 mg/l, or, (3) the EEC in water is equal to or greater than 0.01 of any acute EC50 or LC50 value, or, (4) the pesticide is persistent in water (*i.e.*, half-life greater than 4 days). The preferred test species is *Daphnia magna*.

No acceptable studies have been reviewed. The guideline (72-4) is not fulfilled.

c. Toxicity to Estuarine and Marine Animals

I. Estuarine and Marine Fish, Acute

Acute toxicity studies with estuarine/marine fish using the TGAI are required for Temephos because the end-use product is intended for direct application to the marine/estuarine environment. The preferred test species is sheepshead minnow.

No acceptable studies have been reviewed. The guideline (72-3a) is not fulfilled.

ii. Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity study using the TGAI is required for Temephos because the end-use product will be applied directly to the estuarine/marine environment and: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) any aquatic acute LC50 or EC50 is less than 1 mg/l, or (3) the actual or estimated environmental concentration in water resulting from use is less than 0.01 of any acute LC50 or EC50 value and the pesticide is persistent in water (*i.e.*, half-life greater than 4 days). The preferred test species is sheepshead minnow.

No acceptable studies have been reviewed. The guideline (72-4) is not fulfilled.

An estuarine/marine fish life-cycle study using the TGAI is required for Temephos The preferred test species is sheepshead minnow.

No acceptable studies have been reviewed. The guideline (72-5) is not fulfilled.

iii. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI and the emulsifiable concentrate and the granular end use products are required for Temephos because the end-use product is intended for direct application to the marine/estuarine. The preferred test species are the mysid and eastern oyster.

Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% ai. Formulation	96-hour EC50 (ppm)	Toxicity Category	MRID Author/Year	Study Classification
Eastern oyster *(Crassostrea virginica)*	86.2 TGAI	0.22	Highly toxic	40228401 Mayer, 1986	Core
	43 EC	0.17	Highly toxic	40228401 Mayer, 1986	Core
Pink shrimp *(Penaeus duorum)*	[1]43 EC	0.0053	Very highly toxic	470231012, McCann, 1975	Supplemental

Since the EC50 for the Eastern oyster falls in the range of 0.1 - 1 ppm for the TGAI, Temephos TGAI is categorized as being highly toxic to Eastern oysters on an acute basis. The guideline 72-3b is fulfilled (MRID 40228401).

No acceptable studies have been submitted for toxicity to the Eastern oyster by the 5G formulation. The guideline 72-3e is not fulfilled.

No acceptable studies have been submitted for toxicity to the Mysid. The guidelines 72-3c and 72-3f have not been fulfilled.

iv. Estuarine and Marine Invertebrate, Chronic

An estuarine/marine invertebrate life-cycle toxicity study using the TGAI is required for Temephos because the end-use product will be applied directly to the estuarine/marine environment and: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) any aquatic acute LC50 or EC50 is less than 1 mg/l, (3) the EEC in water is equal to or greater than 0.01 of any acute LC50 or EC50 value, or, (4) the pesticide is persistent in water (*e.g.*, half-life greater than 4 days). The preferred test species is the mysid.

No acceptable studies have been reviewed. The guideline (72-4) is not fulfilled.

d. Toxicity to Sediment Dwelling Organisms

I. Freshwater and Marine, Acute

The aerobic aquatic metabolism study suggests that Temephos sediment concentrations increase from day zero to a maximum at day 2, but steadily decreases to 21% by day 30. Thus, there is uncertainty in the amount of Temephos associated with the soil phase beyond 30 days. However, the study indicates that Temephos transforms to the sediment phase with

[1]The results for this test was based on a 48-hour EC50.

partitions of transformed products to the water phase. Some chemical properties which might suggest that sediment toxicity testing be performed include the following.

Solubility ≤ 0.1 mg/L
K_{oc} ≥ 50,000
Persistence ≥ 10 days
K_d ≥ 1000
K_{ow} ≥ 1000

The solubility of Temephos is 0.030 mg/L and the K_{oc} is 16,250. The K_{ow} is 80,900. Because of the low solubility and relatively high K_{ow} and persistence potential of Temephos to partition in the sediment chronic sediment testing following the EPA test protocols (EPA/600R-96/XXX) for both freshwater and terrestrial organisms are required. Further justification for this test is cited in CFR 158.75 and under Subdivision E guideline 70-3.

e. Toxicity to Nontarget Plants

Currently, terrestrial and aquatic plant testing is not required for pesticides other than herbicides except on a case-by-case basis. Seed germination/seedling emergence and vegetative vigor (Tier 1), and growth and reproduction of plants (Tier 1) were required in the 1981 RS. Seed germination/seedling emergence and vegetative vigor (Tier 1) was subsequently waived (Bushong, 1982). Aquatic plant growth (Guideline 122-2) was relisted as a requirement in EEB's 1991 List A Review. SRRD's 1993 letter required Tier 1 testing to be submitted 1 year from the date of receipt of the letter. A literature search which might reveal phytotoxicity to aquatic plants is currently being conducted by EFED. If such a search reveals a phytotoxic concern for aquatic plants, the aquatic plant data requirements will stand. If, however, aquatic plant phytotoxicity can not be demonstrated through this literature search, the aquatic plant testing requirements will be dropped. Acceptable aquatic studies have not been submitted to date.

4. Ecological Risk Assessment

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

RQ = EXPOSURE/TOXICITY

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

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

Risk Presumptions for Aquatic Animals

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

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

a. Exposure and risk to nontarget terrestrial animals

Temephos is applied directly to water and is not expected to affect terrestrial animals. Therefore, LOCs have not been calculated for exclusively terrestrial animals.

I. Acute exposure and risk.

Some animals are primarily terrestrial but swim in and drink from water that may be sprayed with Temephos. The Mallard duck fits this category and EFED has data on Temephos' toxicity to it.

EPA's "Wildlife Exposure Factors Handbook" gives an equation to calculate the amount of water intake for a bird:

$$W.I. = 0.059 \times wt^{0.67} = 0.06 \text{ liters/day}$$

Where W.I. is the water intake, wt is the bird's weight in KG, and 0.059 and 0.67 are experimentally derived numbers. The average weight of a Mallard is 1.1 kg.

The Food Intake equation is:

$$F.I. = 0.0582 \times wt^{0.651} = 0.062 \text{ kg/day}$$

Where F.I. is the food intake, wt is the bird's weight in KG, and 0.0582 and 0.651 are experimentally derived numbers.

The dietary LC_{50} for a Mallard is 894 ppm, *i.e.*, 894 mg of Temephos per kilogram of food. If a Mallard eats 0.062 kg/day, it receives 55.4 mg of Temephos per day in an LC_{50}. The acute LD_{50} is 27.4 mg per kilogram of bird for Bobwhite quail (there is no acceptable Mallard LC_{50}), *i.e.*, 30.1 mg of Temephos per 1.1 kg bird. This value is below the level of concern.

The W.I. equation predicts that a Mallard will drink 0.06 liters of water per day. The highest "Peak Concentration" for application of Temephos is 50 ppb or 0.05 mg Temephos per liter of water. Therefore, a Mallard duck would be expected to take in 0.003 mg Temephos per day by drinking water. This expected intake is below the level of concern.

Another route of exposure for birds and mammals may be via the ingestion of aquatic organisms. Fish and other aquatic organisms may bioaccumulate pesticide residues from water, sediment, and/or their food. Some piscivores, like egrets, herons, kingfishers, pelicans, cormorants, water snakes, and turtles may swallow fish whole. Other piscivores species, like mink, river otter, osprey, bald eagle, gulls and terns may feed largely on the viscera which may have higher pesticide residue levels.

This risk assessment is limited to bioconcentration (i.e., residue uptake from water only), and does not address bioaccumulation of pesticide residues (i.e., residue uptake from diet and water exposures). In aquatic habitats, pesticides with certain properties are taken by organisms directly from water and sediments. Predatory species also take up pesticides in their diet. While the residues in food may increase residue levels higher than the amounts taken up from water, for most pesticides, aquatic organisms will obtain the largest portion of the pesticide residue directly from the water via absorption through the gills and skin. Since long-term, cumulative concentration of Temephos in an aquatic ecosystem does not allow assessment of residues potentially taken-up at levels that these organisms can be exposed. To assist aquatic bioaccumulation data are unavailable, the risks to piscivores are based on BCF values which may be an underestimation of risks to piscivorous species.

Gross estimates of the dietary exposures for piscivorous mammals and birds can be made by multiplying the average water concentration for the time it takes for a steady-state to be reach in bioconcentration test times the bioconcentration factor (BCF). Temephos BCF values used in this risk assessment are 970X for whole fish and 2300X for viscera. Aquatic bioaccumulation data from actual environmental concentrations (i.e. from monitoring data) are not available for Temephos. EXAMS generated concentrations were used to roughly estimate the uptake and bioconcentration in piscivorous mammals and birds. These residue levels in fish were estimated by multiplying the 21-day EEC from EXAMS generated concentrations times the BCF values for whole fish and viscera. Risks to piscivores can be estimated by comparing the estimated residue levels in fish to the subacute dietary LC_{50} and reproductive NOECs for mammals and birds. The resulting residue levels and resulting risk quotients are presented in the table below.

Risk Quotients for Piscivorus Birds Based On an Avian Subacute Dietary Bobwhite Quail LC_{50} of 92 ppm on the TGAI (86.2%) at a maximum rate of 0.5 lb ai/A for the granular formulation.

Site/Application Method/Rate in lbs ai/A (No. of Apps.)	LC50 (ppm) 86.2% ai	Residues (Fish Viscera) 21-day EEC (ppm) x BCF		Acute RQ (EEC/LC50)	
		15 cm	30 cm	15 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.5(1)	92	6.9	3.5	0:08	0:04
0.5(2) at 7 day intervals	92	12.9	6.5	0:14	0:07
0.5(2) at 15 day intervals	92	11.9	6.0	0:13	0:07
0.5(2) at 90 day intervals	92	11.5	5.8	0:13	0:06

Based on the above table, Temephos residue levels calculated from Bioconcentration Factors (BCF) in fish viscera, residue levels are expected to be lower than the avian subacute dietary LC_{50}. Although EFED has not established LOC criteria for presumption of risk to piscivorous birds, if the same presumptions for risks to non-piscvorous birds are applied, only endangered species may be affected in the 15 cm pond depth scenario.

ii. Reproductive risk to nontarget terrestrial animals

Birds are expected to be exposed Temephos during the breeding season. No studies on reproductive effects have been submitted for either the Mallard duck or the Bobwhite quail.

b. Exposure and Risk to Nontarget Freshwater Aquatic Animals

EFED uses environmental fate and transport computer models to calculate refined EECs. The Exposure Analysis Modeling System (EXAMS 2.97.5) simulates pesticide fate and transport in an aquatic environment (one hectare body of water, two meters deep). Since Temephos is directly applied as a mosquito larvacide to intermittent ponds and drainage ditches, it was concluded that the use of this exposure scenario with pond depths of 15 and 30 cm. The resulting EECs are presented under Section 2.f.

I. Risk quotients for freshwater Fish

Acute risk quotients are tabulated below based on pond depths of 15 and 30 cm for the 0.5 lb ai/A application rate for the granular formation, and 0.046875 lb ai/A for the EC formulation. Chronic data are unavailable for freshwater fish.

Risk Quotients for Freshwater Fish Based On a Rainbow trout LC50 of 3490 ppb (μg/l) on the TGAI (86.2%) at a maximum rate of 0.5 lb ai/A for the granular formulation.

Site/Application Method/Rate in lbs ai/A (No. of Apps.)	LC50 (ppb) 86.2% ai	EEC Initial/Peak (ppb)		Acute RQ (EEC/LC50)	
		15 cm	30 cm	15 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.5(1)	3490	48.8	24.4	0.01	0.01
0.5(2) at 7 day intervals	3490	50.4	25.2	0.01	0.01
0.5(2) at 15 day intervals	3490	50.0	25.0	0.01	0.01
0.5(2) at 90 day intervals	3490	48.8	24.4	0.01	0.01

Risk Quotients for Freshwater Fish Based On a Rainbow trout LC50 of 158 ppb (μg/l) on the EC Formulation (43% ai) at a maximum rate of 0.046875 lb ai/A.

Site/Application Method/ Rate in lbs ai/A (No. of Apps.)	LC50 (ppb) 43% ai	EEC Initial/Peak (ppb) cm		Acute RQ (EEC/LC)	
		15 cm	30 cm	15 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.046875 (1)	158	4.58	2.29	0.03	0.01
0.046875 (2) at 7 day intervals	158	4.73	2.36	0.03	0.01
0.046875 (2) at 15 day intervals	158	4.69	2.34	0.03	0.01
0.046875 (2) at 90 day intervals	158	4.58	2.29	0.03	0.01

An analysis of the results indicate that aquatic acute high risk, restricted use, and endangered species levels of concern are not exceeded for freshwater fish at a registered maximum application rates of 0.5 lb ai/A and 0.046875 lb ai/A.

ii. Risk Quotients for Freshwater Invertebrates

The acute risk quotients are tabulated below. Chronic data on freshwater aquatic invertebrates are not available.

Risk Quotients for Freshwater Invertebrates Based on a Stonefly *Pteronarcs* spp. EC50 of 10 ppb (μg/l) for the TGAI (86.2%) at a maximum rate of 0.5 lb ai/A for the granular formulation.

Site/Application Method/ Rate in lbs ai/A(No. of Apps.)	EC50 (ppb) 86.2% ai	EEC Initial/Peak (ppb)		Acute RQ (EEC/LC50)	
		15 cm	30 cm	5 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.5 (1)	10	48.8	24.4	4.88	2.44
0.5 (2) at 7 day intervals	10	50.4	25.2	5.04	2.52
0.5 (2) at 15 day intervals	10	50.0	25.0	5.00	2.50
0.5 (2) at 90 day intervals	10	48.8	24.4	4.88	2.44

Risk Quotients for Freshwater Invertebrates Based on a *Daphnia magna* EC50 of 0.011 ppb (μg/l) for the EC Formulation (43% ai) at a maximum rate of 0.046875 lb ai/A.

Site/Application Method/ Rate in lbs ai/A (No. of Apps.)	EC50 (ppb) 86.2% ai	EEC Initial/Peak (ppb)		Acute RQ (EEC/LC50)	
		15 cm	30 cm	15 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.046875 (1)	0.011	4.58	2.29	416:36	208:18
0.046875 (2) at 7 day intervals	0.011	4.73	2.36	430:00	214:55
0.046875 (2) at 15 day intervals	0.011	4.69	2.34	426:36	212:73
0.046875 (2) at 90 day intervals	0.011	4.58	2.29	416:36	208:18

An analysis of the results indicate that aquatic acute high risk, restricted use, and endangered species levels of concern are exceeded for freshwater invertebrates at a registered maximum application rate at 0.5 lb ai/A. All aquatic acute high risk, restricted use, and endangered species levels of concern are exceeded by many folds at the registered EC application rate of 0.046875 lb ai/A.

c. Exposure and Risk to Estuarine and Marine Animals

The acute risk quotients are tabulated below. Acute and chronic data are not available for marine/estuarine fish are not available. Chronic data on marine/estuarine invertebrates are not available.

Risk Quotients for Marine/Estuarine Invertebrates Based on a Mollusk EC50 of 220 ppb (μg/l) for the TGAI (86.2%) at a maximum rate of 0.5 lb ai/A for the granular formulation.

Site/Application Method/ Rate in lbs ai/A (No. of Apps.)	EC50 (ppb) 86.2% ai	EEC Initial/Peak (ppb)		Acute RQ (EEC/LC50)	
		15 cm	30 cm	15 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.5(1)	220	48.8	24.4	0.22	0.11
0.5(2) at 7 day intervals	220	50.4	25.2	0.23	0.11
0.5(2) at 15 day intervals	220	50.0	25.0	0.23	0.11
0.5(2) at 90 day intervals	220	48.8	24.4	0.22	0.11

Risk Quotients for Marine/Estuarine Invertebrates Based on a Pink Shrimp EC50 of 5.3 ppb (μg/l) for the EC Formulation (43% ai) at a maximum rate of 0.046875 lb Temephos/A.

Site/Application Method/ Rate in lbs ai/A (No. of Apps.)	EC50 (ppb) 86.2% ai	EEC Initial/Peak (ppb)		Acute RQ (EEC/LC50)	
		15 cm	30 cm	15 cm	30 cm
Intermittent Ponds/aerial & ground/ 0.046875 (1)	5.3	4.58	2.29	0:86	0:43
0.046875 (2) at 7 day intervals	5.3	4.73	2.36	0:89	0:45
0.046875 (2) at 15 day intervals	5.3	4.69	2.34	0:88	0:44
0.046875 (2) at 90 day intervals	5.3	4.58	2.29	0:86	0:43

An analysis of the results indicate that aquatic restricted use and endangered species levels of concern are exceeded for marine/estuarine invertebrates at a registered maximum application rate at 0.5 lb ai/A. Aquatic acute high risk, restricted use, and endangered species levels of concern are exceeded at 15 cm pond depths at the registered EC application rate of 0.046875 lb ai/A. Restricted use and endangered species levels of concern are exceeded at the 30 cm pond depth.

5. Endangered Species

The Agency has developed a program (the "Endangered Species Protection Program") to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that will eliminate the adverse impacts.

At present, the program is being implemented on an interim basis as described in a *Federal Register* notice (54 FR 27984-28008, July 3, 1989), and is providing information to pesticide users to help them protect these species on a voluntary basis. As currently planned, the final program will call for label modifications referring to required limitations on pesticide uses, typically as depicted in county-specific bulletins or by other site-specific mechanisms as specified by state partners. A final program, which may be altered from the interim program, will be described in a future *Federal Register* notice.

The Agency is not imposing label modifications at this time through the RED. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program.

6. Risk Characterization

a. Characterization of the Fate and Transport of Temephos to Drinking Water

Temephos is a mosquito larvacide that is applied to shallow, stagnant, brackish, and polluted waters that are unusable as a source of surface water/drinking water. It would not reach ground water that would be used for drinking water because of its lack of an hydraulic gradient and its very short half-life. Therefore OPP does not have FQPA drinking water concerns.

b. Characterization of Risk to Nontarget Species

Temephos is a mosquito larvacide that is applied to shallow, stagnant, brackish, and polluted waters. There are no indoor domestic or agricultural uses. The formulations include a granular, an emulsifiable concentrate, and an end use product with an inert of ground corn cobs that is applied to piles of old automobile tires.

I. Terrestrial

The only Incident Report (17 sandpipers killed during mosquito control operation) was from 1973. The formulation and the use pattern were not given. Malathion was used simultaneously and it could not be established which insecticide was responsible.

It is possible that a terrestrial animal, such as a wading bird, might be injured by Temephos in the water, but it seems unlikely. Mallards that drink water immediately after it has been sprayed with Temephos are not expected to be harmed. Based on Temephos residue levels calculated from Bioconcentration Factors (BCF) in fish viscera, residue levels are expected to be lower than the avian subacute dietary LC_{50}. Although EFED has not established LOC criteria for presumption of risk to piscivorous birds, if the same presumptions for risks to non-piscvorous birds are applied, only endangered species may be affected in the 15 cm pond depth scenario. It is not believed that Temephos poses a threat to terrestrial animals.

ii. Aquatic

Aquatic animals will not be exposed to Temephos from run-off from application to turf or agricultural crops, since these uses are no longer supported. Application of the pesticide to water for mosquito and midge larviciding is subject to interpretation in those uses that allow repeat treatment as needed. This insecticide is generally used by government mosquito control units or by POCs under contract to them. It is believed that, if Temephos is restricted to a limited number of repeat treatments and yearly cap, as well as use only by licensed pest control operators, potential risk to aquatic ecosystems can be minimized.

An analysis of the aquatic studies indicates that aquatic acute high risk, restricted use, and endangered species levels of concern are exceeded for freshwater fish and invertebrates at a registered maximum application rate of 0.5 lb ai/A. Chronic data are unavailable for freshwater fish or invertebrates.

An analysis of the estuarine/marine mollusk studies indicates that restricted use and endangered species levels of concern are exceeded for estuarine invertebrates at registered maximum application rates equal to or above 0.5 lb ai/A. Chronic data are not available for marine/estuarine mollusks are not available. Acute and chronic data are not available for marine/estuarine fish.

iii. Nontarget Plants

Currently, terrestrial and aquatic plant testing is not required for pesticides other than herbicides except on a case-by-case basis. Seed germination/seedling emergence and vegetative vigor (Tier 1), and growth and reproduction of plants (Tier 1) were required in the 1981 RS. Seed germination/seedling emergence and vegetative vigor (Tier 1) was subsequently waived (Bushong, 1982). Aquatic plant growth (Guideline 122-2) was relisted as a requirement in EEB's 1991 List A Review. SRRD's 1993 letter required Tier 1 testing to be submitted 1 year from the date of receipt of the letter. A literature search which might reveal phytotoxicity to aquatic plants is currently being conducted by EFED. If such a search reveals a phytotoxic concern for aquatic plants, the aquatic plant data requirements will stand. If, however, aquatic plant phytotoxicity can not be demonstrated through this literature search, the aquatic plant testing requirements will be dropped. Acceptable aquatic studies have not been submitted to date.

7. Appendices/Supporting documentation

APPENDIX A

Data requirements for Temephos

GUIDELINES	DATA REQUIREMENTS	FULFILLS REQUIREMENTS (Y/N/W/R[1]), % ai	STUDIES REVIEWED RESULTS (ppm or mg/l)	MRID, AUTHOR, & YEAR	STATUS
71-1(a)	Acute Avian Oral Quail	Yes, 94.7	LD_{50} =27.4 ht	470167035 (157841, 1357, 1354), Fletcher, 1986	Core
71-2(a)	Avian Dietary Quail	Yes, 86.9	"LC_{50}" + 92, ht	22923, Hill, 1975	Core
71-2(b)	Avian Dietary- Mallard	Yes, 86.9	"LC_{50}" = 894, mt	22923, Hill, 1975	Core
71-1(b)	Acute Avian Oral Quail or Duck/TEP	N			
71-4(a)	Avian Reproductive/Quail	N			
71-4(b)	Avian Reproductive/Duck	N			
72-1(a)	Fish Toxicity Bluegill	Yes, 86.2	LC_{50} = 21.8, st	40098001 (4602), McCann (USDA), 1971	Core
72-1(b)	Fish Toxicity Bluegill/TEP-G	Yes, 43% EC	LC_{50} = 1.14, ht	40098001, McCann (USDA), 1971	Core
72-1©	Fish Toxicity Rainbow Trout	Yes, 86.2	LC_{50} = 3.49, mt	40098001, McCann (USDA), 1971	Core
72-1(d)	Fish Toxicity Rainbow Trout/TEP	Yes, 43% EC	LC_{50} = 0.158 ppm, vht	1337, Kennedy, 1970	Core
72-2(a)	Invertebrate Toxicity- scud	Yes, 86.2	LC_{50} = 0.082, vht	40098001 (4602), McCann (USDA), 1971	Core
72-2(a)	Invertebrate Toxicity- Stonefly	Yes, 86.2	LC_{50} = 0.01, vht	40098001 (4602), McCann (USDA), 1971	Core
72-2(b)	Invertebrate Toxicity/TEP-EC Daphnid	Yes, Abate 4E	LC_{50} = 0.011 μg/l NOEC = 0.0032 μg/l, vht	470177012, (158327, 1534, 1357), Forbis, 1986	Core

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Data requirements for Temephos

		FULFILLS REQUIREMENTS	STUDIES REVIEWED		
72-2(b)	Invertebrate Toxicity/TEP-G Daphnid	Yes, 5G	LC_{50} = 0.54 μg/l, ht	(5002680, 4602), McCann (USDA), 1975	Suppleme ntal
72-3(a)	Estuarine/Marine Toxicity Fish	No			
72-3(b)	Estuarine/Marine Toxicity Mollusk	Yes, TGAI	LC_{50} = 0.22, ht	40228401	Core
72-3©	Estuarine/Marine Toxicity Shrimp	No			
72-3(d)	Estuarine/Marine Toxicity Fish/TEC-EC	No			
72-3(d)	Estuarine/Marine Toxicity Fish/TEP-G	No			
72-3(e)	Estuarine/Marine Toxicity Mollusk/TEP-EC	Yes	LC_{50} = 0.32, ht	40228401	Core
72-3(e)	Estuarine/Marine Toxicity Mollusk/TEP-G	No			
72-3(f)	Estuarine/Marine Toxicity Shrimp/ TEP-EC, Pink shrimp *Penaeus duorum*	No	LC_{50} = 5.3 ppb, NOEC = 0.6 ppb, vht	470231012, (161090, 1357)	Suppleme ntal, (can be upgraded)
72-3(f)	Estuarine/Marine Toxicity Shrimp/TEP-G	No			
72-4(a)	Early Life Stage Fish	No			
72-4(b)	Life Cycle Aquatic Invertebrate	No			
72-5	Life Cycle Fish	R			
72-6	Aquatic Organisms Accumulation	Y	Fillet, 79% at 21 days and 86% at 28 days; Whole fish, 73.6% at 21 and 28 days; Viscera, 82% at 21 days and 59% at 28 days.	165027 Fobis, 1986	Core
81-1	Mammalian (mouse, HED study)	Yes, TGAI	LD_{50} range, "770-130000"	1354, 1365, 1368, 5000974, pnt	Core

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Data requirements for Temephos

		FULFILLS REQUIREMENTS	STUDIES REVIEWED
122-2	Aquatic Plant Growth	No	
123-1(a)	Seed Germ/Seedling Emergency	W	
123-1(b)	Vegetative Vigor	W	
141-1	Honey Bee Acute Contact	No	We do have some old Bee studies, but they were dropped at Phase II (or whatever it was called.

Y = Data requirement fulfilled X = Not applicable
N = Data requirement *not* fulfilled, study required
R = Test reserved W = Waived
pnt = practically nontoxic, st = slightly toxic, mt = moderately toxic, ht = highly toxic, vht = very highly toxic

"Basic Six Required Tests"

APPENDIX B

EXAMS Input Chemical Variables

Name	Description	Value	Units	Source
HENRY	Henry's law rate		atm-$m^3$$mole^{-1}$	Registrant data
KBACW	Water col bact rate	1.68 e^{-3}	$(cfu/ml)^{-1}hr^{-1}$	Registrant data via EFED
KBACS	Benthic bact rate	2.73 e^{-3}	$(cfu/ml)^{-1}hr^{-1}$	Registrant data via EFED
KDP	Direct photol rate		$hour^{-1}$	Registrant data via EFED - based on 24 hours light
KBH	Base hydrol rate con	N/A	$mole^{-1}hour^{-1}$	Registrant data via EFED
KNH	Neutral hydrol rate	N/A	$hour^{-1}$	Registrant data via EFED
KAH	Acid hydrol rate con	N/A	$mole^{-1}hour^{-1}$	Registrant data via EFED
KOC	Partition coef.	16250	liter/kg-fOC	Registrant data via EFED
KOW	Octanol water part.	N/A	lit_{wat}/lit_{oct}	Registrant data via EFED
KPS	Sediment part. coef.	130	liter/kg	Registrant data via EFED
MWT	Molecular weight	426	grams/mole	Registrant data
QTBAS	Sediment bacteria temperature coef.	2	dimensionless	STANDARD
QTBAW	Water bact temp coef	2	dimensionless	STANDARD
SOL	Solubility	30	mg/liter	Registrant data; SOL is Max EEC
QUAINT	Quantum Yield	Measured	dimensionless	Use only with adsorp spectra
VAPR	Vapor pressure	e^{-8}	torr	Registrant data
PCTWA	Percent Water benthic	137	Percent	Georgia Pond

EXAMS Input Geometry Variables

Name	Description	Value	Units	Source
AREA	Segment area	10,000	$meter^2$	Standard
CHARL	Mixing length	0.175	meter	Georgia Pond
DEPTH	Segment thickness	2	meter	Standard
KOUNT	Number of segments	2	N/A	Standard
WIDTH	Segment width	63.61	meter	Standard
LENG	Segment length	157.2	meter	Standard
VOL	Segment volume	3,000	$meter^3$	Standard

EXAMS Input Environmental Variables.

Name	Description	Value	Units	Source
AEC	Anion exchange cap	1.0e-2	meq/100 gr	GEORGIA POND
ATURB	Atmospheric turb	2.0	kilometer	GEORGIA POND
BACPL	Plankton Population	1.0	cfu/ml	GEORGIA POND
BNBAC	Benthic bacteria	37	cfu/100 gr	GEORGIA POND
BNMAS	Benthic biomass	6.0e-3	gr/m^2	GEORGIA POND
BULKD	Bulk density	1.85	gr/cm^3	GEORGIA POND
CEC	Cation exchange cap	1.0e-2	meq/100 gr	GEORGIA POND
CLOUD	Mean monthly clouds	N/A	tenths of sky	GEORGIA POND
DFAC	Distribution factor	1.19	dimensionless	GEORGIA POND
DISO2	Disolved oxygen	5.0	mg/liter	GEORGIA POND
DOC	Dissolved org carb	5.0	mg/liter	GEORGIA POND
DSP	Dispersion coef.	3.0e-5	m^2/hour	GEORGIA POND
FROC	Frac. organic carbon	0.04	dimensionless	GEORGIA POND
OZONE	Mean monthly ozone	0.3	cm NTP	GEORGIA POND
PH	Log hydrogen ion con	7.0	pH units	GEORGIA POND
POH	Log hydroxid ion con	7.0	pOH units	GEORGIA POND
RAIN	Ave monthly rainfall	N/A	mm/month	GEORGIA POND
RHUM	Relative Humidity	N/A	% saturation	GEORGIA POND
SUSED	Suspended sediment	30	mg/liter	GEORGIA POND
TCEL	Temperature celsius	variable	C^o Max=30 C^o	Monthly average at site

Y = Data requirement fulfilled X = Not applicable
N = Data requirement *not* fulfilled, study required
R = Test reserved W = Waived
pnt = practically nontoxic, st = slightly toxic, mt = moderately toxic, ht = highly toxic, vht = very highly toxic

"Basic Six Required Tests"