ARKANSAS DEPARTMENT OF AGRICULTURE

1 Natural Resources Drive, Little Rock, AR 72205
agriculture.arkansas.gov
(501) 225-1598

Asa Hutchinson
Governor

Wes Ward
Secretary of Agriculture

June 1, 2022

Attn: Ruthanne Louden
Emergency Response Team
USEPA/ Office of Pesticide Programs
Document Processing Desk (EMEX)
Room S4900, One Potomac Yard
2777 S. Crystal Drive
Arlington, VA 22202

Dear Ms. Louden:

Please find enclosed the Section 18 Specific Exemption registration request from the Arkansas Department of Agriculture (ADA) for the use of Endigo ZC lambda-cyhalothrin and thiamethoxam, for control of rice stink bug (RSB), *Oebalus pugnax,* in rice in Arkansas. The ADA is requesting the use of lambda-cyhalothrin (CAS number 91465-08-6) and thiamethoxam (CAS number 153719-23-4), Endigo ZC (EPA Reg No. 100-1276). This is the second year the ADA has requested this use under a Specific Exemption.

Rice stink bug (RSB) is the major pest of heading rice in Arkansas. According to University of Arkansas, Extension Entomologists rice stink bug is a yearly pest of rice that begins infesting rice fields as rice begins to head. Yield loss can occur if feeding happens during the flowering and milk growth stages. Feeding will lead to quality losses or "pecky" rice. Heavy infestations of stink bug can cause damage exceeding 10% yield loss if is not controlled.

Adverse environmental conditions will play a major role in the quality of rice and impact yields this year, and the RSB density currently observed in wheat has the potential to decrease both drastically.

Arkansas wheat producers have reported a high number of rice stink bug populations in wheat this spring. Control methods are similar for rice stink bug control in wheat as they are in rice. Data shows an increase in lambda-cyhalothrin resistance in the current populations of RSB in Arkansas wheat/rice producing counties. With the lack of RSB control in wheat, rice producers are anticipating severe infestations of rice stink bug in all rice producing counties and need effective control options.

In most years, control of rice stink bug is achieved with the pyrethroids labeled for use in rice (lambda-cyhalothrin and zeta-cypermethrin). Currently, pyrethroids are providing between 20-60% control depending on the population. Extension entomologist have been receiving reports of pyrethroid failures and observing them in test plots due to little residual from pyrethroids.

Alternative products labeled for rice stink bug control, such as Malathion, Carbaryl, and Dinotefuran are in short supply. Extension entomologists have reported that both retailers and the manufacturer of dinotefuran confirmed that, due to production issues in the winter caused by the COVID-19 pandemic, supply is limited. Extension Entomologists reported that limited supply of malathion is available. Carbaryl is a good alternative, however many foreign ports are testing for carbaryl residue and have rejected multiple barges of rice

in the past three years for having low levels of carbaryl present. Carbaryl is not a recommended option for this reason.

The inability to effectively control the pest due to lack of effective insecticides will be a primary reason for additional yield losses and high control costs. Currently labeled insecticides are not effective or at least not available. The level of control achieved to this point has seldom exceeded 50% with even the most effective treatments and as often much poorer. This level of control is not sufficient to provide effective crop protection against the extremely high populations of rice stink bug that are present in many fields and will result in the need for growers to apply multiple, close interval applications at high rates. Such treatments are economically devastating to producers and will result in greatly increased amounts of pesticide being introduced into the environment.

The rationale for requesting an emergency exemption for the use of Endigo ZC based on the following: Rice Stink Bug populations are increasing in number and intensity throughout the area of the rice growing region; RSB is not effectively controlled with insecticides currently available; rice producers cannot afford the yield losses/quality losses and control costs associated with presently available insecticides; insecticide use would be drastically reduced if an effective insecticide was available; and Endigo ZC provides control of RSB and poses little or no threat to the environment.

The use period requested is from July 1 through October 15, 2022. It is estimated that 450,000 acres of rice will experience rice stink bug populations that require a treatment of Endigo ZC, with a portion of the acres requiring multiple applications. Endigo ZC will be applied aerially in all rice producing counties to treat up to 450,000 acres of rice. Endigo ZC will be applied at 4.5 ounces per acre to 6 ounces per acre with a maximum of 4 applications, not to exceed 18.5 ounces per acre per year. Preharvest interval is 21 days. Treated rice is anticipated to be harvested beginning August 20, 2022. A Section 18 tolerance has been established for Endigo ZC in rice.

If you have any further questions regarding this request or need any other supporting information, feel free to contact me.

Respectfully,

Scott Bray

Scott Bray
Director
Arkansas Department of Agriculture
Plant Industries Division

APPLICATION

FOR SECTION 18 EMERGENCY EXEMPTION

The following information is required for an emergency exemption request based on the revised United States Environmental Protection Agency (USEPA) Code of Federal Regulations, Title 40, Part 166 concerning Section 18 requests. Requests which are incomplete will be denied by the USEPA without review. In order to comply with these requirements, the information listed below must be provided. **Use additional pages if necessary.** Please note that the more complete the questionnaire, the better your chances are of obtaining the exemption.

[ ] Check box if this is a reissuance request. (Year _2022_)

TYPE OF EXEMPTION BEING REQUESTED (check one)

[X] SPECIFIC
[ ] QUARANTINE
[ ] PUBLIC HEALTH

DESCRIPTION OF PESTICIDE REQUESTED

Common Chemical Name
(Active Ingredient): _Lambda-cyhalothrin + Thiamethoxam_

Trade Name/Brand Name: _Endigo ZC_

U.S. EPA Reg. No.: _100-1276_

Formulation: __Aqeous Solution__

% Active Ingredient: _9.48% Lambda-cyhalothrin, 12.60% Thiamethoxam_ **%**

Manufacturer: _Syngenta_

CONTACT PERSON(S) AND QUALIFIED EXPERT(S)

APPLICANT:

Name: Scott Bray **Signature:** _____

Title: Director of Plant Industry Division **Date:** _____

Organization: Arkansas Department of Agriculture

Address: 1 Natural Resources Dr

Little Rock, AR, 72205

Telephone: (501) 225-1598 **FAX #:** _____

E-Mail: Scott.Bray@arkansas.gov

QUALIFIED EXPERT(S)

Name: Nick Bateman

Title: Extension Entomologist

Organization: University of Arkansas

Address: 2900 HWY 130 E

Stuttgart, AR, 72160

Telephone: (870) 456-8486

Name: Ben Thrash

Title: Extension Entomologist

Organization: University of Arkansas

Address: 2001 HWY 70 E

Lonoke, AR, 72086

Telephone: (501) 517-3853

Name: Glenn Studebaker

Title: Extension Entomologist

Organization: University of Arkansas

Address: PO Box 48
Keiser, AR 72351

Telephone: (501) 454-1922

DESCRIPTION OF PROPOSED USE

Sites to be Treated: (i.e. crops, structures, etc.)
Applications sites will be rice fields in Arkansas that are experiencing economic damage from rice stink bug feeding. Economic damage begins when greater than 5 rice stink bugs per 10 sweeps are observed during the first two weeks of heading, or 10 rice stink bugs per 10 sweeps during the second two weeks of heading. Damage will be accessed by monitoring four locations in the field to determine the abundance of rice stink bugs present and if an application of Endigo ZC is warranted.

Statewide or County Specific (list counties):
Arkansas, Ashley, Chicot, Clay, Conway, Craighead, Crittenden, Cross, Desha, Drew, Faulkner, Franklin, Greene, Independence, Jackson, Jefferson, Lawrence, Lee, Lincoln, Lonoke, Mississippi, Monroe, Perry, Phillips, Poinsett, Pope, Prairie, Pulaski, Randolph, St. Francis, White, Woodruff, Yell

Method of Application:
Aerial

Rate of Application (in terms of a.i. and product):
Lambda-cyhalothrin-0.0309 lb ai/a-0.0413
Thiamethoxam-0.0415 lb ai/a-0.0553 lb ai/a
4.5 oz/a-6 oz/a

Frequency/Timing of Application:
Applications will begin when threshold levels of rice stink bugs occur. Higher rates will be used for heavier infestations, or under conditions in which thorough coverage is more difficult.

Maximum Number of Applications:
3-4 depending on rate

Total Acreage (or other units) Planted and to be Treated:
During 2022, an estimated 1,100,000 acres of rice will be planted in Arkansas. We estimate that approximately 600,000 of these acres will be treated for rice stink bug (450,000 with Endigo ZC), with a portion of these acres requiring two applications.

Total Amount of Pesticide to be used (in terms of a.i. and product):
Lambda-cyhalothrin-9,281 lb ai-38,155 lb ai
Thiamethoxam-12,445 lb ai- 51,163 lb ai/a
10,547 gallons to 43,359 gallons

Use Season (period of time for which use of chemical is requested):

Date First Application Needed: **7**/1/2022
Date Last Application Needed: 10/15/2022

Restricted Entry Interval (REI):
24 hours

Preharvest Interval (PHI):
21 days

Earliest Harvest Date:
8/20/2022

Additional Restrictions, User Precautions and Requirements, Qualifications of Applicators, etc.:

EXPECTED RESIDUE LEVELS IN FOOD
(Residue data included as separate attachment)

Attached. A Section 18 tolerance has been established for Endigo ZC in rice

ALTERNATIVE METHODS OF CONTROL
(Efficacy data and/or other information included as a separate attachment)

Registered Alternative Pesticides:

Lambda-cyhalothrin
Zeta-cypermethrin
25-60% control was observed in 2021, and currently growers are experiencing similar levels this year in wheat

Malathion
Carbaryl
Dinotefuran
All of these products are in short supply

Alternative Control Practices:

EFFICACY OF USE PROPOSED UNDER SECTION 18
(Efficacy data and/or other information included as a separate attachment)

Table 1. Efficacy of selected insecticides for control of rice stink bug nymphs, 2015.

Treatment	7 days after application
Untreated	31 a
Warrior II 2.6 oz/a	11 b
Tenchu 9 oz/a	9 bc
Endigo ZC 5 oz/a	5 d
Endigo ZC 6 oz/a	6 cd
P-value	<0.05

Table 2. Efficacy of selected insecticides for control of rice stink bug nymphs 7 days after application, 2020.

	Location
Treatment	Stuttgart, AR
Untreated	16.2 a
Lambda Cy 3.65 oz/a	5.2 b
Mustang Maxx 4.5 oz/a	4.1 b
Cabaryl 32 oz/a	2.8 b
Malathion 32 oz/a	4.0 b
Tenchu 8 oz/a	2.5 b
Endigo ZC 5 oz/a	1.0 b
Endigo ZC 6 oz/a	0.8 b
P-value	<0.01

Table 3. Efficacy of selected insecticides for control of rice stink bug nymphs 7 days after application, 2021.

	Location	
Treatment	Althiemer, AR	Stuttgart, AR
Untreated	19.3 a	11.5 a
Lambda Cy 3.65 oz/a	7.5 b	5.2 b
Mustang Maxx 4.5 oz/a	6.3 bc	4.75 b
Cabaryl 32 oz/a	2.8 cd	0.75 c
Malathion 32 oz/a	1.0 d	0.0 c
Tenchu 8 oz/a	0.5 d	0.0 c
Endigo ZC 5 oz/a	0.0d	0.0 c
Endigo ZC 6 oz/a	0.0 d	0.0 c
P-value	<0.01	<0.01

Table 4. Percent mortality based on bioassay data comparing multiple rates of lambda-cyhalothrin to determine rice stink bug susceptibility.

	Year and Location		
Rate of Warrior II	Poinsett County-2019	Chicot County-2020	Crittenden County-2020
Untreated	0% c	8% d	18% b
0.25X (0.46 oz/a)	0% c	30% c	54% a
0.5X (0.91 oz/a)	4% c	40% bc	58% a
1X (1.82 oz/a)	32% b	51% ab	66% a
2X (3.6 oz/a)	56% b	54% a	68% a
4X (7.3 oz/a)	100% a	59% a	66% a
P-value	<0.01	<0.01	0.01

Table 5. RSB mortality for collections made in 2021 based on bioassay data comparing multiple rates of lambda-cyhalothrin.

	Month (number of populations)			
Rate of Warrior II	May (4)	June (5)	July (5)	August (4)
Untreated	0%	0%	0%	0%
0.25X (0.46 oz/a)	68%	49%	58%	40%
0.5X (0.91 oz/a)	76%	59%	68%	49%
1X (1.82 oz/a)	80%	60%	72%	60%
2X (3.6 oz/a)	82%	62%	74%	66%
4X (7.3 oz/a)	81%	68%	73%	68%
P-value	<0.01	<0.01	0.01	

Table 6. Field based assays with Warrior II for control of rice stink bug nymphs 3 days after application, 2021.

	Location			
	Wabbaseka, AR		Althiemer, AR	
	RSB/10 sweeps	% difference	RSB/10 sweeps	% difference
Untreated	9.6	26%	24.5	61%
Warrior II 1.82 oz/a	7.1		9.5	

Table 7. RSB mortality for collection made in May of 2022 based on bioassay data comparing multiple rates of lambda-cyhalothrin.

	Location					
Rate of Warrior II	Augusta, AR	Bradford, AR	Brinkley, AR	Crawfordsville, AR	Pine Bluff, AR	Pinetree, AR
Untreated	0% b	0% c	0% c	0% c	0% c	0 c
0.25X (0.46 oz/a)	64% ab	68% ab	58% ab	58% b	74 b	76 b
0.5X (0.91 oz/a)	76% a	56% b	66% a	66% ab	90 a	72 b
1X (1.82 oz/a)	78% a	70% a	70% a	72% a	94 a	86 ab
2X (3.6 oz/a)	72% a	70% a	68% a	72% a	96 a	86 ab
4X (7.3 oz/a)	78% a	74% a	70% a	76% a	94 a	92 a
P-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

COORDINATION WITH OTHER AFFECTED FEDERAL, STATE, and LOCAL AGENCIES

The appropriate state agencies are also being notified of this specific exemption request through routine notices which the Department of Agriculture distributes. Comments received after the submission of this request will be forwarded to the United States Environmental Protection Agency (USEPA).

NOTIFICATION OF REGISTRANT

A Letter of Authorization from the Registrant and copy of product label (included as separate attachment).

REPEAT USES (Interim Use Report)

The interim use report must address the following:

1. Amount of product used
2. Acreage treated
3. Number of permits issued
4. Estimate of effectiveness
5. Any adverse effects - Includes subjects such as: worker injuries, water contamination, effects on fish, wildlife, honeybees, domestic animals, and damage to non-target plants resulting from drift.

The above information will be submitted to the Arkansas Department of Agriculture by reports of application under the Section 18 exemption.

PROGRESS TOWARDS REGISTRATION

(Information from registrant concerning the current status)
(Not required for request of a Quarantine Exemption
(Check All That Apply)

[ ] NO APPLICATION FOR REGISTRATION OF THE USE IS UNDER REVIEW BY U.S. EPA.

[x] U.S. EPA IS REVIEWING AN APPLICATION FOR REGISTRATION OF THIS USE (TYPE OF REGISTRATION PRIA date for rice is January 2024.).

[ ] AN IR-4 PETITION FOR TOLERANCE IS BEING DEVELOPED OR IS UNDER REVIEW BY U.S. EPA PETITION # _____.

[ ] A PETITION FOR TOLERANCE HAS BEEN SUBMITTED TO U.S. EPA BY THE MANUFACTURER

PETITION # _____.

[ ] A PETITION FOR TOLERANCE OR AN APPLICATION FOR REGISTRATION HAS BEEN DENIED (INDICATE THE CIRCUMSTANCES _____).

IF THIS USE PATTERN WILL BE NEEDED FOR MORE THAN ONE SEASON, A PERMANENT TOLERANCE SHOULD BE PURSUED IMMEDIATELY. CONTACT THE MANUFACTURER OR THE IR-4 PROGRAM TO INITIATE THE ESTABLISHMENT OF A PERMANENT TOLERANCE.

NAME OF PEST

Scientific Name:
Oebalus pugnax

Common Name:
Rice Stink Bug

Rice stink bug is a major pest in Arkansas rice, feeding on developing rice kernels. Depending on the stage of kernel development, either yield loss (flowering and milk) or quality loss (soft dough and hard dough) can occur. Rice stink bugs typically have 5-6 generations per year with 3-4 generations occurring in rice.

DISCUSSION OF EVENTS OR CIRCUMSTANCES WHICH BROUGHT ABOUT THE EMERGENCY CONDITION

(Use separate attachment if necessary)

Rice stink bug, *Oebalus pugnax*, (RSB) is the major pest of heading rice in Arkansas. RSB is a yearly pest of rice in Arkansas, where we typically exceed threshold on 50% or more of our acres. RSB is a seed feeder, and begins infesting rice fields as rice begins to head. Yield loss can occur if feeding happens during the flowering and milk growth stages. Once rice kernels are in the soft and hard dough stages, RSB feeding will lead to quality losses, or "pecky" rice. If rice exceeds 2.5% 'peck' then growers can potentially get docked $20 or more per acre depending on the amount of peck and yield (bushels) per acre. It is common to see approximately 1 to 1.5% peck occur in a field without RSB present, but in heavy infestations of RSB the 'peck' level can exceed 10% if RSB is not controlled.

During the 2021 growing season we observed large numbers of RSB in most fields, with multiple fields needing to be treated two to three times. In most years, control of RSB is easily achieved with the pyrethroids labeled for use in rice (lambda-cyhalothrin and zeta-cypermethrin). During 2021, the average control with these products ranged between 20 and 60% control of RSB depending on the population. We saw this occur during 2019 and 2020, however it did not happen until late in the season (early September through October) and we have been conducting research on this issue the past 4 years (https://scholarworks.uark.edu/cgi/viewcontent.cgi?article=1162&context=aaesser pg 116, https://scholarworks.uark.edu/cgi/viewcontent.cgi?article=1199&context=aaesser pg. 117). During 2021, we started receiving reports of pyrethroid failures and observing them in test plots in mid-July, much earlier than observed in 2019 and 2020. What we consider a failure is when nymphs are present 4-7 days after application. This suggest that the eggs were laid when the application was made or the nymphs were already present when the application was made. It is common to see adults 7 days following an application. This is due to little to no residual from pyrethroids and new adults migrating into the field from wild hosts. Nymphs cannot migrate as adults do, so they are a better indicator of efficacy for a given product.

Starting in early April of 2022, we started receiving calls and observing extremely high number of RSB present in

wheat. RSB can be a pest of wheat, however usually the populations are not high enough to justify spraying. This year a majority of the wheat acres have been sprayed for RSB in Arkansas. The population currently in the state is much higher than we typically see this time of year. A similar regiem of products are labeled for RSB control in wheat as in rice. The reports we have received throughout the state from stakeholders and our assay data from the past month suggest that RSB resistance to lambda-cyhalothrin is greater this year compared to last. With increased populations and difficulty in control, our growers are in severe need of an effective control option in rice.

There are other products labeled for RSB control, such as Malathion, Carbaryl, and Dinotefuran, however these are in extremely short supply. We have reports from retailers that there will not be enough of these products to treat the amount of acres that will require treatment in Arkansas. This is due to production issues in the winter casued by COVID-19. There is some malathion available, but reports from distributors suggest it will be sold out by mid-July, similar for dinotefuran. Carbaryl is a good alternative, however many foreign ports are testing for carbaryl residue and have rejected multiple barges of rice in the past four years for having low levels of carbaryl present. We do not suggest our growers spray carbaryl for this reason.

Currently 90% of the estimated 1.1 million acres of rice has been planted in Arkansas. We have an extremely late crop this year due to adverse weather conditions during our normal planting window of April. This pushed a large percentage of the acreage to a May planting window. What we consistently see with RSB, is that late planted rice has higher populations of RSB than earlier planted. With the drastic increase in fertilizer prices and chemical prices, growers will need an adequate and cost effective control option. In general our rice crop is looking at a potential of 10% yield loss just due to planting date, regardless of insect pressure. With the addition of high RSB populations and a lack of control of RSB with currently available insecticides, growers could be looking at devastating yield losses.

Adverse environmental conditions will play a major role in the quality of rice and impact yields this year, and the RSB density currently observed in wheat has the potential to decrease both drastically. However, inability to effectively control the pest due to lack of effective insecticides will be a primary reason for additional yield losses and high control costs. Currently labeled insecticides are not effective or at least not available. The level of control achieved to this point has not been adequate and does not bode well for control in rice this year.

The rationale for requesting an emergency exemption is that we are expecting the RSB populations to be much higher than previous years and be much more difficult to control. Based on our experiences over the past 20 years, the later rice heads the higher the density of RSB observed. While there are other insecticides that would provide adequate control, they are either in short supply or not available at all, and we consider Endigo ZC to be a very environmentally friendly pesticide and very effective for control. It is also a product that our growers are familiar with and will have confidence in achieving adequate control.

Therefore, we are requesting an emergency exemption for the use of Endigo ZC based on the following: (1) RSB populations are increasing in number and intensity throughout the area of the rice growing region; (2) RSB is not effectively controlled with insecticides currently available; (3) rice producers cannot afford the yield losses/quality losses and control costs associated with presently available insecticides; (4) insecticide use would be drastically reduced if an effective insecticide was available; (5) Endigo ZC provides good control of RSB and poses little or no threat to the environment.

SIGNIFICANT ECONOMIC LOSS (SEL)
(Criteria for determining SEL)

Use of three-tier approach to determine if SEL has occurred or will occur. A SEL can be justified if:

A. Tier 1 - Yield loss of at least 20%

- Compare expected yield under pest emergency with non-emergency three-year average yield.
- Yield under pest emergency estimated using the most effective available alternative control (chemical or non-chemical).
- Average yield loss per acre for crop, not worse case scenario. Data from economic injury studies or comparative efficacy studies taken on yield. Industry field trials can be used.
- Efficacy data to support expected yield loss using available pest control alternatives.

Potential yield and quality losses from rice stink bugs

Treatment	Percent Control of Pest (efficacy)	Percent yield loss	Percent peck	Percent total lost (yield loss+dockage for peck)	Yield per acre	Change compared to 3 year avg yield
Warrior II	55	8	7	27	120	-45 bu
Mustang Maxx	55	8	7	27	120	-45 bu
Tenchu	90	2	2	0	165	0
Carbaryl	90	2	2	0	165	0
Malathion	90	2	2	0	165	0
Endigo ZC	95	0	2	0	165	0
Untreated	0	15	12	37	104	-61

Percent peck was coverted to USD/a then converted to bushels lost per acre.
If Tier 1 criteria not met, then Tier 2 criteria can be considered:

B. Tier 2 - Loss of at least 20% of gross revenue

- Compare gross revenue from crop grown under normal conditions versus gross revenue under emergency conditions when the best alternative chemical is used to control pest.
- Pest emergency crop revenue determined as crop average revenue, not the worse-case scenario.
- Supporting information - Yield loss from Tier 1 evaluation, **and**
- Baseline yield, Price (by end market), and losses to gross revenue due to quality (shift in grade or price reduction) and/or added production costs (e.g., sorting or repacking costs, additional pest control costs).
- Information from national or state Agricultural Statistics Services (NASS or SASS) reports, crop reports, market surveys, futures market, and university crop production costs analysis can be used.

Example Table for Documenting Tier 2 Gross Revenue Loss

Crop	Baseline- average yield without pest emergency	Pest Emergency- average yield with best alternative control	Difference Between Baseline & Emergency	Percent Change

		measure		
yield/acre	----	----	----	----
Price per unit	----	----	----	----
Gross revenue	----	----	----	----

If Tier 1 and Tier 2 criteria not met, then Tier 3 criteria can be considered:

C. Tier 3 - Loss of at least 50% of Net Operating Revenue:

- Compare the Net Operating Revenue expected with the pest emergency using the best control alternative and average loss for the crop to the non-emergency Net Operating Revenue.
- Net Operating Revenue = Gross Revenue -Variable Operating Costs.
- Variable Operating Costs - Includes annual purchased inputs: hired labor, fertilizer, fuel, pesticides, seed, other materials, etc.
  Does not include cost of or depreciation of machinery, land costs, taxes, other overhead.
- Information from grower surveys, university crop production costs analysis, etc. can be used.

Example Table for Documenting Tier 3 Percent Loss of Net Operating Revenue

Crop	Baseline- average yield without pest emergency	Pest Emergency- average yield with best control alternative	Difference Between Baseline & Emergency	Percent Change
Yield/acre	----	----	----	----
Price per unit	----	----	----	----
Gross Revenue	----	----	----	----
Costs ($/acre)	----	----	----	----
seed, fertilizer	----	----	----	----
other inputs	----	----	----	----
harvest costs	----	----	----	----
Total Operating Costs ($/acre)	----	----	----	----
Net Operating Revenue ($/acre)	----	----	----	----

FOOD QUALITY PROTECTION ACT OF 1996
(Use separate attachment if necessary)

To avoid unnecessary delays in processing your Section 18 request, the U.S. EPA recommends that you fully address the following questions:

1. Is there a possibility that the chemical may transfer to or be found in drinking water? Based on available information, the discussion should include, but not be limited to, information indicating if the pesticide is persistent and/or mobile, relevant product chemistry, and available modeling. Additionally, information concerning State drinking water monitoring programs should be provided (i.e. Does the State routinely monitor for the pesticide? Has it been detected? What are the detection limits? etc.).
• Thiamethoxam does have a surface and ground water advisory. The ADA routinely samples ground water and test for Pesticides of Interest. Thiamethoxam has not been a pesticide regularly detected.

2. Are there any residential uses of the chemical? If so, please provide information on these uses including, but not limited to, application sites, rates, and formulations used.
• Applications of Lamba-cyhalothrin and Thiamethoxam are labeled for agricultural use sites or for use by licensed pest control applicators.

3. Is there any information for this pesticide regarding a common mode of action with other pesticides?
• Group 3A and 4A Insecticides

4. When will the crop be harvested?
• Beginning Mid-September through October

DISCUSSION OF ANTICIPATED RISKS TO ENDANGERED OR THREATENED SPECIES, BENEFICIAL ORGANISMS, OR THE ENVIRONMENT

There are currently no Endangered Species Bulletins in effect for the use of lambda-cyhalothrin or thiamethoxam in the rice producing counties of Arkansas for the period of application under this exemption.

Thiamethoxam has been used as a broad spectrum insecticide in vegetable, soybean and cotton in Arkansas for years and has no know effects to endangered or threatened species.

Patricia (Pat) Dinnen
Regulatory Manager
State Registration/State Affairs

Syngenta Crop Protection, LLC
P.O. Box 18300
Greensboro, NC 27419-8300
www.syngenta.com

Tel. 336 632 2494
Fax: 336 632 2884
pat.dinnen@syngenta.com

May 18, 2022

Dr. Nick Bateman
Assistant Professor/Crop Entomologist
University of Arkansas
Department of Entomology and Plant Pathology
Fayetteville, Arkansas 72701

SUBJECT: Section 18 Emergency Exemption
Endigo® ZC (EPA Reg. No 100-1276)
For Control of Rice Stink Bug in Rice

Dear Dr. Bateman:

Syngenta Crop Protection, LLC supports the actions of the University of Arkansas and Arkansas Department of Agriculture in pursuing a crisis Section 18 Emergency Exemption for Endigo ZC, EPA Reg. No. 100-1276, for control of rice stink bug in rice.

Progress is being made toward a permanent tolerance and Section 3 registration. Submission for this use has been made to EPA but is pending due to the Interim Decision. The PRIA date for rice is January 5, 2024.

If you have questions or need anything further, please call me at 336-632-2494 or email me at pat.dinnen@syngenta.com.

Sincerely,

Pat Dinnen

Pat Dinnen
Regulatory Manager

Enclosures

RESTRICTED USE PESTICIDE
DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS
FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS, OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

syngenta

FIFRA

Section 18 Emergency Exemption

TO CONTROL RICE STINK BUG IN RICE IN THE STATE OF ARKANSAS

EFFECTIVE DATE: xxxxxx

Endigo® ZC
EPA Reg. No. 100-1276

KEEP OUT OF REACH OF CHILDREN.

FAILURE TO FOLLOW THE DIRECTIONS FOR USE AND PRECAUTIONS ON THIS LABEL MAY RESULT IN POOR INSECT CONTROL, CROP INJURY, OR ILLEGAL RESIDUES.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

Follow all applicable directions, restrictions, Worker Protection Standard requirements, and precautions on the EPA-registered Endigo ZC label (EPA Reg. No. 100-1276).

This label must be in the possession of the user at the time of application.

Any adverse effects resulting from the use of Endigo ZC under this exemption must be immediately reported to the Arkansas Department of Agriculture.

CROP USE DIRECTIONS

Crop	Pest	Rate of Endigo ZC per Acre per Application
Rice	Rice stink bug	4.5 – 6.0 fl oz

Use Restrictions:

- **Application Timing:** Apply as required by scouting, usually at intervals of 5 or more days. Base timing and frequency of applications upon insect populations reaching locally determined economic thresholds. Target applications for control before insects enter the stem.
- **Maximum Endigo ZC Allowed per Application:** Do not exceed a total of 6.0 fl. oz. of Endigo ZC per acre per application (0.055 lb ai of thiamethoxam and 0.04 lb ai of lambda-cyhalothrin).
- **Maximum Endigo ZC Allowed per Year**: Do not exceed a total of 18.5 fl. oz. of Endigo ZC per acre per year (0.170 lb ai of thiamethoxam and 0.12 lb ai of lambda-cyhalothrin). Do not apply more than 6.0 fl oz of Endigo ZC per acre within 21 to 27 days of harvest. Endigo ZC may be used in the same year thiamethoxam is used as an at-plant seed treatment.
- Up to four applications may be made by aerial application only.
- **Pre-Harvest Interval (PHI):** 21 days
- **Minimum interval between applications**: 5 days
- **Water Volume**: Apply by air equipment only using sufficient water volume to ensure thorough coverage of foliage. **Do not** use less than 2 GPA for aerial applications. **Do not** apply as an ultra-low volume (ULV) spray. Adding an emulsified crop oil (e.g., 1 pt. per acre) when lower aerial application volumes are used is recommended to help improve coverage, reduce evaporation, and improve efficacy.
- **Flood Water**: Do not release flood water within 7 days of an application.
- **Aquaculture:** Do not use treated rice fields for the aquaculture of edible fish and crustacea.

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Registrant:
Syngenta Crop Protection, LLC
PO Box 18300
Greensboro, NC 27419

Label Code: AR1276053CB0522

USA Rice

2101 Wilson Boulevard • Suite 610 • Arlington, VA 22201-3040 • (703) 236-2300 • FAX (703) 236-2301

July 11, 2022

To whom it may concern,

USA Rice is the global advocate for all segments of the U.S. rice industry with a mission to promote and protect the interests of farmers, millers, merchants, and allied businesses. The USA Rice Farmers, USA Rice Council, USA Rice Merchants' Association, and the USA Rice Millers' Association are members of USA Rice.

The U.S. has long grown high-quality rice that is shipped throughout the world to more than 120 countries. Similar to other crops, rice is often challenged by a number of diseases and pests. One of those pests are rice stink bugs, they present a major challenge for growers on an annual basis and typically reduce the quality of rice, and in turn, reduce the ability to sell the grain to foreign markets.

With the increasing resistance rice stink bug has shown to lambda-cyhalothrin (Warrior II), it is important that growers have alternative products to help manage this pest. There is a shortage of many products that are commonly used in agriculture to combat weeds, disease, and insects. Based on conversations with our stakeholders, there is major concern that products such as Tenchu and Malathion are in too short of supply to control this pest in rice.

U.S. rice quality is what drives its competitive edge domestically and internationally, and without alternative products there is already a high likelihood that the overall sales could suffer for rice produced this year.

Thank You,

Sincerely,

Peter Bachmann
Vice President, Policy & Government Affairs
USA Rice

Farmers Supply Association

General Office
16240 Highway 14E
Harrisburg, AR 72432
578-2468

Cherry Valley 588-3379
Hamlin 238-7895
Harrisburg 578-2468
Hickory Ridge 697-2288
Tuckerman 349-1317
Waldenburg 579-2203
Wynne 238-8501

July 11, 2022

To Whom It May Concern:

There is an overall shortage of chemicals used in agriculture in 2022. Common products that are normally accessible are in extremely short supply this year or are not available at all. While there is a major shortage in herbicides and fungicides, key insecticides used in crop protection are nearly sold out for the year, including Transform (sulfoxaflor) and Diamond (novaluron). Tenchu (dinotefuran) and Malathion are limited in the current distribution pipeline. Concern is being expressed by our clientele on the ability to control rice stink bug in 2022. We have first-hand experience of control failures with the commonly used pyrethroids in both 2020 and 2021. There will not be enough of either Tenchu or Malation to protect the acres that we service. Our growers need more options to help with this pest.

Thank you,

Randy Chlapecka

Randy Chlapecka
Lead Agronomist
Farmers Supply Association

LONOKE COUNTY CO-OP. INC.
P.O. Box 240 / 5406 Hwy. 70 East
Lonoke, AR. 72086

Phone: 870-552-7538 / 501-676-3139 / Fax 870-552-7048

To whom it may concern,

There is an overall shortage of chemicals used in agriculture in 2022. Common products that are normally accessible are in extremely short supply this year or in not available at all. While there is a major shortage in herbicides and fungicides, key insecticides used in crop protection are nearly sold out for the year, including Transform (sulfoxaflor) and Diamond (novaluron). Tenchu (dinotefuran) and Malathion are limited in the current distribution pipeline. We have received multiple phone calls from growers and consultants on options to manage rice stink bug in 2022. There will not be enough of either Tenchu or Malathion to protect the acres that we service. Our growers need more options to help with this pest.

Thank You,

Phillip R Murray

General Manager

Lonoke County Co-op

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

MEMORANDUM

Date: 31 August 2017

SUBJECT: **Thiamethoxam** Acute and Chronic Aggregate Dietary (Food and Drinking Water) Exposure and Risk Assessments for Registration Review

PC Code: 060109	DP Barcode: D441144
Decision No.: 528261	Registration No.: Multiple
Petition No.: NA	Regulatory Action: Registration Review
Risk Assessment Type: Dietary	Case No.: 7614
TXR No.: NA	CAS No.: 153719-23-4
MRID No.: NA	40 CFR: §180.565

FROM: Michael A. Doherty, Ph.D., Senior Chemist
Risk Assessment Branch II (RAB II)
Health Effects Division (HED, 7509P)

THROUGH: Jennifer Tyler, Chemist
Yvonne Barnes, Chemist
Dietary Exposure Science Advisory Council (DESAC)

TO: Margarita Collantes, M.S., Biologist
RAB II
HED

Thomas Harty, Chemical Review Manager
Neil Anderson, Branch Chief
Risk Management and Implementation Branch 1
Pesticide Re-Evaluation Division (7508P)

Executive Summary

Acute and chronic aggregate dietary (food and drinking water) exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and

Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA). The analyses were conducted in support of the registration review risk assessment. This memorandum was reviewed by two peer reviewers of the DESAC, per DESAC Standard Operating Procedure (SOP) 2016.1.

Acute Dietary Exposure Assessment

The acute dietary assessment is based on tolerance-level residues and assumes 100% crop treated. Residues in drinking water are based on high-end assumptions. Per the residues of concern for risk assessment (Herndon, D260224, 4 November 1999), residues in crops included thiamethoxam and its CGA-322704 metabolite (a.k.a., clothianidin; PC Code 044309). For drinking water, residues included only thiamethoxam and are based on high-end assumptions. On the basis of the screening-level inputs, the acute assessment is unrefined.

Acute dietary (food + drinking water) risk estimates range from 3 to 8% of the acute population-adjusted dose (aPAD) at the 95th percentile of exposure. The highest risk estimate is for children 1-2 years old. The risk estimates are not of concern.

Chronic Dietary Exposure Assessment

The chronic dietary assessment is based on average field trial residues and assumes 100% crop treated. Average residues from representative commodities were extrapolated to similar commodities per HED SOP 2000.1. Residues in drinking water are based on high-end assumptions. The chronic assessment is considered to be moderately refined.

Chronic dietary (food + drinking water) risk estimates range from 15 to 48% of the chronic population-adjusted dose (cPAD). The highest risk estimate is for children 1-2 years old. The risk estimates are not of concern..

Cancer Dietary Exposure Assessment

Thiamethoxam has been classified as “not likely to be carcinogenic to humans.” As such, cancer risk is not a concern for thiamethoxam.

I. Introduction

Dietary risk assessment incorporates both exposure and toxicity of a given pesticide. For acute and chronic assessments, the risk is expressed as a percentage of a maximum acceptable dose (i.e., the dose that HED has concluded will result in no unreasonable adverse health effects). This dose is referred to as the population-adjusted dose (PAD). The PAD is equivalent to the point of departure (POD, NOAEL, LOAEL, e.g.) divided by the required uncertainty or safety factors.

For acute and non-cancer chronic exposures, HED is concerned when estimated dietary risk exceeds 100% of the PAD. References that discuss the acute and chronic risk assessments in more detail are available on the EPA/pesticides web site: “Available Information on Assessing

Exposure from Pesticides, A User's Guide," 21-JUN-2000, web link: https://www.regulations.gov/document?D=EPA-HQ-OPP-2007-0780-0001; or see SOP 99.6 (20-AUG-1999).

The most recent dietary risk assessment for thiamethoxam was conducted by J. Cowins (D429717, 16 June 2016). As part of registration review, HED is assessing dietary risk based on the newest crop groupings (40 CFR 180.41), which have resulted in movements of commodities from one crop group to another. This assessment reflects the updated commodity listings for the crop groups; the level of refinement in both the acute and chronic assessments is the same as in the last assessment.

II. Residue Information

Tolerance listings for thiamethoxam are listed in 40 CFR 180.565. Residues of concern in crops and livestock, for both risk assessment and tolerance enforcement, are thiamethoxam and its CGA-322704 metabolite. CGA-322704 is also an insecticide, with the common name clothianidin (PC Code 044309). For drinking water, the only residue of concern is thiamethoxam.

The acute assessment is based on tolerance-level residues and the chronic assessment is based on average residues from crop field trials. These are the same levels of refinement as were used in the last dietary assessment for thiamethoxam, with the exception of commodities in Crop Group 4. For commodities that are included in Crop Group 4, the most recent assessment used tolerance-level residues for the chronic assessment. Average residues were as follows (MRIDs 44647907 and 44647908) and have been used in this assessment in accordance with HED SOP 2000.1:

Celery = 0.20 ppm,
Head lettuce without wrapper leaves = 0.031 ppm,
Leaf lettuce = 0.59 ppm,
Spinach = 0.81 ppm.

Current tolerance listings for thiamethoxam include Crop Groups/Subgroups 4, 5A, 5B, 8, 10, 11, 12, and 14. All of these crop groups have undergone revisions, and as part of registration review, the Health Effects Division is updating its assessments to reflect such crop group updates. Generally, crop group updates primarily reflect expansions to include additional commodities in the group (for example, inclusion of pistachio in the tree nut crop group). In the case of updates to Crop Groups 4 and 5, some commodities have moved to different crop groups. These changes are summarized in the table below.

Table 1. Summary of Crop Group Updates and Affected DEEM Commodity Listings

Current Crop Group Listing	Tolerance, ppm	New Crop or Crop Group Listing
Vegetable, leafy, except *Brassica*, Group 4	4.0	Leafy greens Subgroup 4-16A [DEEM entries: leafy amaranth, garland chrysanthemum, cilantro leaves, dandelion leaves, dillweed, endive, head lettuce, leaf

		lettuce, parsley leaves, radicchio, spinach, Swiss chard], Leafy petiole vegetable Subgroup 22B [DEEM entries: cardoon, celery, rhubarb], Celtuce, Florence fennel
Brassica, head and stem, Subgroup 5A	4.5	Vegetable, head and stem *Brassica* Group 5-16 [DEEM entries: broccoli, Brussels sprouts, cabbage, Chinese Napa cabbage, Chinese mustard cabbage, cauliflower], Kohlrabi
Brassica, leafy greens, Subgroup 5B	3.0	*Brassica* leafy greens Subgroup 4-16B [DEEM entries: arugula, Chinese broccoli, broccoli raab, Chinese bok choy cabbage, collards, garden cress, upland cress, kale, mustard greens, radish tops, rape greens, turnip greens, watercress]

DEEM default processing factors were used for any food forms without empirical processing data.

The USDA Pesticide Data program included thiamethoxam as a target analyte in catfish in 2008, 2009, and 2010 and residues in salmon in 2013 and 2014. Over the course of this period, there were no detectable residues of thiamethoxam or clothianidin in any of the 1479 samples of catfish or 647 samples of salmon. While there is no specific expectation of thiamethoxam or clothianidin residues in fish as a result of the compound's agricultural uses, there is a use in food handling establishments; therefore, fish have been included as a source of thiamethoxam exposure in these analyses.

III. Percent Crop Treated Information

These analyses assumed 100% crop treated for all commodities.

IV. Drinking Water Data

The estimated drinking water concentrations (EDWCs) in these dietary risk assessments were provided by EFED (D439308, C. Koper, 13 July 2017). The EDWCs were directly incorporated into the DEEM-FCID™ dietary assessments via entry into the food categories "water, direct, all sources" and "water, indirect, all sources." Clothianidin, a major metabolite of thiamethoxam in plants and livestock, is not a significant degradate of thiamethoxam in surface or groundwater sources of drinking water. As a result, clothianidin residues are not included in the EDWCs.

The surface water EDWCs are from modeled use on rice. The Pesticides in Flooded Applications Model (PFAM) was used and reflects a refinement relative to the last drinking water assessment (D363202, 7 April 2009). For ground water, EFED used the Pesticide in Water Calculator (PWC, v. 1.52). The results (Table 2) reflect high-end estimates of residues in drinking water. HED used

the maximum values, from ground water, of 63 ppb (0.063 ppm) in the acute assessment and 58 ppb (0.058 ppm) in the chronic assessment. In a summary of monitoring data for thiamethoxam, EFED noted that the maximum observed concentration in surface water, 4.37 ppb (0.00437 ppm), is of the same order of magnitude as the modeled estimates. For ground water, the maximum observed concentrations (2.11 ppb (0.00211 ppm) was an order of magnitude lower than the modeled estimates.

The drinking water models and their descriptions are available at the EPA internet site: Models for Pesticide Risk Assessment.

Table 2. Tier II Estimated Drinking Water Concentrations (EDWCs) resulting from applications of Thiamethoxam.

Drinking Water Source (model)	Use Scenario (modeled rate)	Acute EDWC (µg/L)	Chronic EDWC (µg/L)
Surface Water	Rice, seed (PFAM) (1 app. x 0.181 lbs a.i./A)	20	1.05
	Cranberry (PFAM) (1 app. x 0.188 lbs a.i./A)	16.8 [A]	3.83
	All other uses (PWC)	0.29-9.19	0.04-1.21
Ground Water (PWC)	Turf, Christmas tree plantations (foliar) (1 app. x 0.266 lbs a.i./A)	**63**	**58**

Recommended EDWC values in **bold** font.
[A] EDWCs were based on the 1-day average concentration release from winter flooded cranberry bogs.

V. DEEM-FCID Program and Consumption Information

Thiamethoxam acute and chronic dietary exposure assessments were conducted using the DEEM-FCID, Version 3.16, which incorporates 2003-2008 consumption data from USDA's NHANES/WWEIA. The data are based on the reported consumption of more than 20,000 individuals over two non-consecutive survey days. Foods "as consumed" (e.g., apple pie) are linked to EPA-defined food commodities (e.g., apples, peeled fruit - cooked; fresh or N/S; baked; or wheat flour - cooked; fresh or N/S, baked) using publicly available recipe translation files developed jointly by USDA/ARS and EPA. For chronic exposure assessment, consumption data are averaged for the entire U.S. population and within population subgroups. However, for acute exposure assessment, consumption data are retained as individual consumption events. Based on analysis of the 2003-2008 WWEIA consumption data, which took into account dietary patterns and survey respondents, HED concluded that it is most appropriate to report risk for the following population subgroups: the general U.S. population, all infants (<1 year old), children 1-2, children 3-5, children 6-12, youth 13-19, adults 20-49, females 13-49, and adults 50-99 years old.

For a chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food-commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake

estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

For an acute exposure assessment, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item can be multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user (i.e., only those who reported eating relevant commodities/food forms) and a per-capita (i.e., those who reported eating the relevant commodities as well as those who did not) basis. In accordance with HED policy, per capita exposure and risk are reported for analyses performed at all levels of refinement. However, for deterministic assessments, any significant differences in user vs. per capita exposure and risk are specifically identified and noted in the risk assessment.

VI. Toxicological Information

The points of departure (PODs) for dietary risk assessment are summarized in Table 3. For both acute and chronic scenarios, the inter- and intra-species uncertainty factors are 10X each and the FQPA Safety Factor has been reduced to 1X, resulting in an aPAD of 0.35 mg/kg/day and a cPAD of 0.012 mg/kg/day. Thiamethoxam has been classified as "not likely to be carcinogenic to humans."

Table 3. Summary of Toxicological Doses and Endpoints for use in Thiamethoxam Dietary Risk Assessments.

Exposure/ Scenario	Point of Departure	Uncertainty/ FQPA Safety Factors	Level of Concern for Risk Assessment	Study and Toxicological Effects
Acute Dietary All populations including infants and children	NOAEL = 34.5 mg/kg/day	UF_A= 10x UF_H= 10x FQPA SF=1	aRfD=0.35 mg/kg/day aPAD=0.35 mg/kg/day	**Rat Developmental Neurotoxicity study** LOAEL = 298.7 mg/kg/day based on decreased body weight, delayed sexual maturation in male pups, and reduced brain morphometric measurements.
Chronic Dietary All populations including infants and children	NOAEL= 1.2 mg/kg/day (MRID 46402904)	UF_A= 10x UF_H= 10x FQPA SF =1	cRfD=0.012 mg/kg/day cPAD=0.012 mg/kg/day	**2-Generation reproduction study** LOAEL = 1.8 mg/kg/day based on increased incidence and severity of tubular atrophy in testes of F_1 generation males. **2-Generation reproduction study** LOAEL = 156 (males), not determined (females) mg/kg/day based on sperm abnormalities and germ cell loss in F_1 males.
Cancer (oral, dermal, inhalation)	**"Not Likely to be Carcinogenic to Humans"** based on convincing evidence that a non-genotoxic mode of action for liver tumors was established in the mouse. Quantification of cancer risk is not required.			

Point of Departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no observed adverse effect level. LOAEL = lowest observed adverse effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). SF_{FQPA} = FQPA Safety Factor. PAD = population adjusted dose (a = acute, c = chronic). RfD = reference dose.

VII. Results/Discussion

Dietary (food + drinking water) risk estimates are below 100% of the acute and chronic PADs and, therefore, are not of concern (Table 4).

Table 4. Summary of Acute and Chronic Dietary Exposure and Risk Estimates for Thiamethoxam.

Population Subgroup	Acute (95th Percentile)		Chronic	
	Exposure, mg/kg/day	% aPAD	Exposure, mg/kg/day	% cPAD
General U.S. Population	0.014681	4	0.002490	21
All infants (< 1 year old)	0.018598	5	0.004793	40
Children 1-2 years old	**0.029494**	**8**	**0.005812**	**48**
Children 3-5 years old	0.024828	7	0.004420	37
Children 6-12 years old	0.014762	4	0.002758	23
Youth 13-19 years old	0.010615	3	0.001839	15
Adults 20-49 years old	0.013496	4	0.002221	18
Adults 50-99 years old	0.013554	4	0.002314	19
Females 13-49 years old	0.014177	4	0.002223	18

Bold entries are maximum exposure and risk estimates.

VIII. Characterization of Inputs/Outputs

The acute analysis is a screening-level assessment. The use of tolerance-level residues and the assumption of 100% crop treated is likely to result in overestimates of exposure and risk.

The chronic assessment incorporates average residues from field trials, which are designed to result in high-end residues. Generally, results from monitoring data, which reflect real-world use of pesticides and better approximate actual exposures to residues, are an order of magnitude or more lower than field-trial residues. Thus, this refinement, especially when coupled with the assumption of 100% crop treated is still likely to overestimate dietary exposures and risks for thiamethoxam.

Finally, HED notes that both the acute and chronic assessment are based on combined residues of thiamethoxam and clothianidin (CGA-322704). The toxicology databases for these compounds indicate that they have different modes of action and different adverse outcome pathways. As such, they should be assessed separately. Due to resource constraints making it difficult to derive separate residue estimates for thiamethoxam and clothianidin for all commodities, HED has not conducted separate assessments. This is a further conservatism in the exposure and risk estimates derived in these analyses.

IX. Conclusions

Based on the conservatisms in both the acute and chronic dietary assessments, HED is confident that the exposure and risk estimates in this assessment are overestimates, and that there are no risks of concern from food or drinking water sources.

X. List of Attachments

Attachment 1. Inputs for the acute dietary exposure analysis of thiamethoxam.
Attachment 2. Inputs for the chronic dietary exposure analysis of thiamethoxam.
Attachment 3. Summary of the acute dietary exposure and risk estimates for thiamethoxam.
Attachment 4. Summary of the chronic dietary exposure and risk estimates for thiamethoxam.

Attachment 1. Inputs for the acute dietary exposure analysis of thiamethoxam.

```
Filename: 060109 Thiamethoxam 2017 Acute Regroup.R08
Chemical: thiamethoxam
RfD(Chronic): .012 mg/kg bw/day  NOEL(Chronic): 0 mg/kg bw/day
RfD(Acute): .35 mg/kg bw/day  NOEL(Acute):  0 mg/kg bw/day
Date created/last modified: 08-29-2017/13:19:50       Program ver. 3.16, 03-08-d
Comment: Acute and Chronic RfDs = aPAD and cPAD
-------------------------------------------------------------------------------
   EPA     Crop                                   Def Res     Adj.Factors   Comment
   Code     Grp  Commodity Name                    (ppm)       #1    #2
---------- ---- ------------------------------  ----------  ------ ------  -------
0101050000 1AB  Beet, garden, roots               0.050000   1.000  1.000  D35744
            Full comment: D357449, recommended tol.
0101050001 1AB  Beet, garden, roots-babyfood      0.050000   1.000  1.000
0101052000 1A   Beet, sugar                       0.050000   1.000  1.000
0101052001 1A   Beet, sugar-babyfood              0.050000   1.000  1.000
0101053000 1A   Beet, sugar, molasses             0.050000   1.000  1.000
0101053001 1A   Beet, sugar, molasses-babyfood    0.050000   1.000  1.000
0101067000 1AB  Burdock                           0.050000   1.000  1.000
0101078000 1AB  Carrot                            0.050000   1.000  1.000
0101078001 1AB  Carrot-babyfood                   0.050000   1.000  1.000
0101079000 1AB  Carrot, juice                     0.050000   1.000  1.000
0101084000 1AB  Celeriac                          0.050000   1.000  1.000
0101100000 1AB  Chicory, roots                    0.050000   1.000  1.000
0101168000 1AB  Ginseng, dried                    0.050000   1.000  1.000
0101190000 1AB  Horseradish                       0.050000   1.000  1.000
0101250000 1AB  Parsley, turnip rooted            0.050000   1.000  1.000
0101251000 1AB  Parsnip                           0.050000   1.000  1.000
0101251001 1AB  Parsnip-babyfood                  0.050000   1.000  1.000
0101314000 1AB  Radish, roots                     0.050000   1.000  1.000
0101316000 1AB  Radish, Oriental, roots           0.050000   1.000  1.000
0101327000 1AB  Rutabaga                          0.050000   1.000  1.000
0101331000 1AB  Salsify, roots                    0.050000   1.000  1.000
0101388000 1AB  Turnip, roots                     0.050000   1.000  1.000
0103015000 1CD  Arrowroot, flour                  0.020000   1.000  1.000
0103015001 1CD  Arrowroot, flour-babyfood         0.020000   1.000  1.000
0103017000 1CD  Artichoke, Jerusalem              0.020000   1.000  1.000
0103082000 1CD  Cassava                           0.020000   1.000  1.000
0103082001 1CD  Cassava-babyfood                  0.020000   1.000  1.000
0103139000 1CD  Dasheen, corm                     0.020000   1.000  1.000
0103166000 1CD  Ginger                            0.020000   1.000  1.000
0103166001 1CD  Ginger-babyfood                   0.020000   1.000  1.000
0103167000 1CD  Ginger, dried                     0.020000   1.000  1.000
0103296000 1C   Potato, chips                     0.250000   1.200  1.000
0103297000 1C   Potato, dry (granules/ flakes)    0.250000   1.700  1.000
0103297001 1C   Potato, dry (granules/ flakes)-b  0.250000   1.700  1.000
0103298000 1C   Potato, flour                     0.250000   1.700  1.000
0103298001 1C   Potato, flour-babyfood            0.250000   1.700  1.000
0103299000 1C   Potato, tuber, w/peel             0.250000   1.000  1.000
0103299001 1C   Potato, tuber, w/peel-babyfood    0.250000   1.000  1.000
0103300000 1C   Potato, tuber, w/o peel           0.250000   1.000  1.000
0103300001 1C   Potato, tuber, w/o peel-babyfood  0.250000   1.000  1.000
0103366000 1CD  Sweet potato                      0.020000   1.000  1.000
0103366001 1CD  Sweet potato-babyfood             0.020000   1.000  1.000
0103371000 1CD  Tanier, corm                      0.020000   1.000  1.000
0103387000 1CD  Turmeric                          0.020000   1.000  1.000
0103406000 1CD  Yam, true                         0.020000   1.000  1.000
0103407000 1CD  Yam bean                          0.020000   1.000  1.000
0200315000 2    Radish, tops                      3.000000   1.000  1.000
0200317000 2    Radish, Oriental, tops            3.000000   1.000  1.000
0301237000 3A   Onion, bulb                       0.030000   1.000  1.000
0301237001 3A   Onion, bulb-babyfood              0.030000   1.000  1.000
0301238000 3A   Onion, bulb, dried                0.030000   9.000  1.000
0301238001 3A   Onion, bulb, dried-babyfood       0.030000   9.000  1.000
0401005000 4A   Amaranth, leafy                   4.000000   1.000  1.000
0401018000 4A   Arugula                           3.000000   1.000  1.000
0401104000 4A   Chrysanthemum, garland            4.000000   1.000  1.000
0401133000 4A   Cress, garden                     3.000000   1.000  1.000
0401134000 4A   Cress, upland                     3.000000   1.000  1.000
```

0401138000	4A	Dandelion, leaves	4.000000	1.000	1.000	
0401150000	4A	Endive	4.000000	1.000	1.000	
0401204000	4A	Lettuce, head	4.000000	1.000	1.000	
0401205000	4A	Lettuce, leaf	4.000000	1.000	1.000	
0401248000	4A	Parsley, leaves	4.000000	1.000	1.000	
0401313000	4A	Radicchio	4.000000	1.000	1.000	
0401355000	4A	Spinach	4.000000	1.000	1.000	
0401355001	4A	Spinach-babyfood	4.000000	1.000	1.000	
0402076000	4B	Cardoon	4.000000	1.000	1.000	
0402085000	4B	Celery	4.000000	1.000	1.000	
0402085001	4B	Celery-babyfood	4.000000	1.000	1.000	
0402086000	4B	Celery, juice	4.000000	1.000	1.000	
0402087000	4B	Celtuce	4.000000	1.000	1.000	
0402152000	4B	Fennel, Florence	4.000000	1.000	1.000	
0402322000	4B	Rhubarb	4.000000	1.000	1.000	
0402367000	4B	Swiss chard	4.000000	1.000	1.000	
0501061000	5A	Broccoli	4.500000	1.000	1.000	
0501061001	5A	Broccoli-babyfood	4.500000	1.000	1.000	
0501062000	5A	Broccoli, Chinese	3.000000	1.000	1.000	
0501064000	5A	Brussels sprouts	4.500000	1.000	1.000	
0501069000	5A	Cabbage	4.500000	1.000	1.000	
0501071000	5A	Cabbage, Chinese, napa	4.500000	1.000	1.000	
0501072000	5A	Cabbage, Chinese, mustard	4.500000	1.000	1.000	
0501083000	5A	Cauliflower	4.500000	1.000	1.000	
0501196000	5A	Kohlrabi	4.500000	1.000	1.000	
0502063000	5B	Broccoli raab	3.000000	1.000	1.000	
0502070000	5B	Cabbage, Chinese, bok choy	3.000000	1.000	1.000	
0502117000	5B	Collards	3.000000	1.000	1.000	
0502194000	5B	Kale	3.000000	1.000	1.000	
0502229000	5B	Mustard greens	3.000000	1.000	1.000	
0502318000	5B	Rape greens	3.000000	1.000	1.000	
0502389000	5B	Turnip, greens	3.000000	1.000	1.000	
0600347000	6	Soybean, seed	0.020000	1.000	1.000	
0600349000	6	Soybean, soy milk	0.020000	1.000	1.000	
0600349001	6	Soybean, soy milk-babyfood or in	0.020000	1.000	1.000	
0600350000	6	Soybean, oil	0.020000	1.000	1.000	
0600350001	6	Soybean, oil-babyfood	0.020000	1.000	1.000	
0601043000	6A	Bean, snap, succulent	0.020000	1.000	1.000	
0601043001	6A	Bean, snap, succulent-babyfood	0.020000	1.000	1.000	
0601257000	6A	Pea, edible podded, succulent	0.020000	1.000	1.000	
0602031000	6B	Bean, broad, succulent	0.020000	1.000	1.000	
0602033000	6B	Bean, cowpea, succulent	0.020000	1.000	1.000	
0602037000	6B	Bean, lima, succulent	0.020000	1.000	1.000	
0602255000	6B	Pea, succulent	0.020000	1.000	1.000	
0602255001	6B	Pea, succulent-babyfood	0.020000	1.000	1.000	
0602259000	6B	Pea, pigeon, succulent	0.020000	1.000	1.000	
0603030000	6C	Bean, black, seed	0.020000	1.000	1.000	
0603032000	6C	Bean, broad, seed	0.020000	1.000	1.000	
0603034000	6C	Bean, cowpea, seed	0.020000	1.000	1.000	
0603035000	6C	Bean, great northern, seed	0.020000	1.000	1.000	
0603036000	6C	Bean, kidney, seed	0.020000	1.000	1.000	
0603038000	6C	Bean, lima, seed	0.020000	1.000	1.000	
0603039000	6C	Bean, mung, seed	0.020000	1.000	1.000	
0603040000	6C	Bean, navy, seed	0.020000	1.000	1.000	
0603041000	6C	Bean, pink, seed	0.020000	1.000	1.000	
0603042000	6C	Bean, pinto, seed	0.020000	1.000	1.000	
0603098000	6C	Chickpea, seed	0.020000	1.000	1.000	
0603098001	6C	Chickpea, seed-babyfood	0.020000	1.000	1.000	
0603099000	6C	Chickpea, flour	0.020000	1.000	1.000	
0603182000	6C	Guar, seed	0.020000	1.000	1.000	
0603182001	6C	Guar, seed-babyfood	0.020000	1.000	1.000	
0603203000	6C	Lentil, seed	0.020000	1.000	1.000	
0603256000	6C	Pea, dry	0.020000	1.000	1.000	
0603256001	6C	Pea, dry-babyfood	0.020000	1.000	1.000	
0603258000	6C	Pea, pigeon, seed	0.020000	1.000	1.000	
0603348000	6C	Soybean, flour	0.020000	1.000	1.000	
0603348001	6C	Soybean, flour-babyfood	0.020000	1.000	1.000	
0801374000	8A	Tomatillo	0.250000	1.000	1.000	
0801375000	8A	Tomato	0.250000	1.000	1.000	
0801375001	8A	Tomato-babyfood	0.250000	1.000	1.000	
0801376000	8A	Tomato, paste	0.800000	1.000	1.000	Tol.

0801376001	8A	Tomato, paste-babyfood	0.800000	1.000	1.000	Tol.
0801377000	8A	Tomato, puree	0.250000	1.700	1.000	
0801377001	8A	Tomato, puree-babyfood	0.250000	1.700	1.000	
0801378000	8A	Tomato, dried	0.250000	14.300	1.000	
0801378001	8A	Tomato, dried-babyfood	0.250000	14.300	1.000	
0801379000	8A	Tomato, juice	0.250000	1.500	1.000	
0801380000	8A	Tomato, Tree	0.250000	1.000	1.000	
0802148000	8BC	Eggplant	0.250000	1.000	1.000	
0802234000	8BC	Okra	0.250000	1.000	1.000	
0802270000	8B	Pepper, bell	0.250000	1.000	1.000	
0802270001	8B	Pepper, bell-babyfood	0.250000	1.000	1.000	
0802271000	8B	Pepper, bell, dried	0.250000	1.000	1.000	
0802271001	8B	Pepper, bell, dried-babyfood	0.250000	1.000	1.000	
0802272000	8BC	Pepper, nonbell	0.250000	1.000	1.000	
0802272001	8BC	Pepper, nonbell-babyfood	0.250000	1.000	1.000	
0802273000	8BC	Pepper, nonbell, dried	0.250000	1.000	1.000	
0901075000	9A	Cantaloupe	0.200000	1.000	1.000	
0901187000	9A	Honeydew melon	0.200000	1.000	1.000	
0901399000	9A	Watermelon	0.200000	1.000	1.000	
0901400000	9A	Watermelon, juice	0.200000	1.000	1.000	
0902021000	9B	Balsam pear	0.200000	1.000	1.000	
0902088000	9B	Chayote, fruit	0.200000	1.000	1.000	
0902102000	9B	Chinese waxgourd	0.200000	1.000	1.000	
0902135000	9B	Cucumber	0.200000	1.000	1.000	
0902308000	9B	Pumpkin	0.200000	1.000	1.000	
0902309000	9B	Pumpkin, seed	0.200000	1.000	1.000	
0902356000	9B	Squash, summer	0.200000	1.000	1.000	
0902356001	9B	Squash, summer-babyfood	0.200000	1.000	1.000	
0902357000	9B	Squash, winter	0.200000	1.000	1.000	
0902357001	9B	Squash, winter-babyfood	0.200000	1.000	1.000	
1001106000	10A	Citron	0.400000	1.000	1.000	D34870
		Full comment: D348703				
1001107000	10A	Citrus hybrids	0.400000	1.000	1.000	
1001108000	10A	Citrus, oil	0.400000	0.600	1.000	D34927
		Full comment: D349272				
1001240000	10A	Orange	0.400000	1.000	1.000	
1001241000	10A	Orange, juice	0.400000	0.600	1.000	D34927
		Full comment: D349272				
1001241001	10A	Orange, juice-babyfood	0.400000	0.600	1.000	D34827
		Full comment: D348272				
1001242000	10A	Orange, peel	0.400000	1.000	1.000	
1001369000	10A	Tangerine	0.400000	1.000	1.000	
1001370000	10A	Tangerine, juice	0.400000	0.600	1.000	D34827
		Full comment: D348272				
1002197000	10B	Kumquat	0.400000	1.000	1.000	
1002199000	10B	Lemon	0.400000	1.000	1.000	
1002200000	10B	Lemon, juice	0.400000	0.600	1.000	D34827
		Full comment: D348272				
1002200001	10B	Lemon, juice-babyfood	0.400000	0.600	1.000	D34927
		Full comment: D349272				
1002201000	10B	Lemon, peel	0.400000	1.000	1.000	
1002206000	10B	Lime	0.400000	1.000	1.000	
1002207000	10B	Lime, juice	0.400000	0.600	1.000	D34827
		Full comment: D348272				
1002207001	10B	Lime, juice-babyfood	0.400000	0.600	1.000	D34927
		Full comment: D349272				
1003180000	10C	Grapefruit	0.400000	1.000	1.000	
1003181000	10C	Grapefruit, juice	0.400000	0.600	1.000	D34927
		Full comment: D349272				
1003307000	10C	Pummelo	0.400000	1.000	1.000	
1100007000	11	Apple, fruit with peel	0.200000	1.000	1.000	
1100008000	11	Apple, peeled fruit	0.200000	1.000	1.000	
1100008001	11	Apple, peeled fruit-babyfood	0.200000	1.000	1.000	
1100009000	11	Apple, dried	0.200000	8.000	1.000	
1100009001	11	Apple, dried-babyfood	0.200000	8.000	1.000	
1100010000	11	Apple, juice	0.200000	0.750	1.000	
1100010001	11	Apple, juice-babyfood	0.200000	0.750	1.000	
1100011000	11	Apple, sauce	0.200000	1.000	1.000	
1100011001	11	Apple, sauce-babyfood	0.200000	1.000	1.000	
1100129000	11	Crabapple	0.200000	1.000	1.000	
1100210000	11	Loquat	0.200000	1.000	1.000	

1100266000	11	Pear	0.200000	1.000	1.000	
1100266001	11	Pear-babyfood	0.200000	1.000	1.000	
1100267000	11	Pear, dried	0.200000	6.250	1.000	
1100268000	11	Pear, juice	0.200000	0.750	1.000	
1100268001	11	Pear, juice-babyfood	0.200000	1.000	1.000	
1100310000	11	Quince	0.200000	1.000	1.000	
1201090000	12A	Cherry	0.500000	1.000	1.000	
1201090001	12A	Cherry-babyfood	0.500000	1.000	1.000	
1201091000	12A	Cherry, juice	0.500000	1.500	1.000	
1201091001	12A	Cherry, juice-babyfood	0.500000	1.500	1.000	
1202012000	12B	Apricot	0.500000	1.000	1.000	
1202012001	12B	Apricot-babyfood	0.500000	1.000	1.000	
1202013000	12B	Apricot, dried	0.500000	6.000	1.000	
1202014000	12B	Apricot, juice	0.500000	1.000	1.000	
1202014001	12B	Apricot, juice-babyfood	0.500000	1.000	1.000	
1202230000	12B	Nectarine	0.500000	1.000	1.000	
1202260000	12B	Peach	0.500000	1.000	1.000	
1202260001	12B	Peach-babyfood	0.500000	1.000	1.000	
1202261000	12B	Peach, dried	0.500000	7.000	1.000	
1202261001	12B	Peach, dried-babyfood	0.500000	7.000	1.000	
1202262000	12B	Peach, juice	0.500000	1.000	1.000	
1202262001	12B	Peach, juice-babyfood	0.500000	1.000	1.000	
1203285000	12C	Plum	0.500000	1.000	1.000	
1203285001	12C	Plum-babyfood	0.500000	1.000	1.000	
1203286000	12C	Plum, prune, fresh	0.500000	1.000	1.000	
1203286001	12C	Plum, prune, fresh-babyfood	0.500000	1.000	1.000	
1203287000	12C	Plum, prune, dried	0.500000	5.000	1.000	
1203287001	12C	Plum, prune, dried-babyfood	0.500000	5.000	1.000	
1203288000	12C	Plum, prune, juice	0.500000	1.400	1.000	
1203288001	12C	Plum, prune, juice-babyfood	0.500000	1.400	1.000	
1301055000	13A	Blackberry	0.500000	1.000	1.000	
1301056000	13A	Blackberry, juice	0.500000	1.000	1.000	
1301056001	13A	Blackberry, juice-babyfood	0.500000	1.000	1.000	
1301058000	13A	Boysenberry	0.500000	1.000	1.000	
1301208000	13A	Loganberry	0.500000	1.000	1.000	
1301320000	13A	Raspberry	0.500000	1.000	1.000	
1301320001	13A	Raspberry-babyfood	0.500000	1.000	1.000	
1301321000	13A	Raspberry, juice	0.500000	1.000	1.000	
1301321001	13A	Raspberry, juice-babyfood	0.500000	1.000	1.000	
1302057000	13B	Blueberry	0.300000	1.000	1.000	
1302057001	13B	Blueberry-babyfood	0.300000	1.000	1.000	
1302136000	13B	Currant	0.200000	1.000	1.000	
1302137000	13B	Currant, dried	0.200000	1.000	1.000	
1302149000	13B	Elderberry	0.200000	1.000	1.000	
1302174000	13B	Gooseberry	0.200000	1.000	1.000	
1302191000	13B	Huckleberry	0.200000	1.000	1.000	
1304175000	13D	Grape	0.200000	1.000	1.000	
1304176000	13D	Grape, juice	0.200000	1.100	1.000	D28170
		Full comment: D281702				
1304176001	13D	Grape, juice-babyfood	0.200000	1.100	1.000	
1304179000	13D	Grape, wine and sherry	0.200000	1.000	1.000	
1307130000	13G	Cranberry	0.020000	1.000	1.000	
1307130001	13G	Cranberry-babyfood	0.020000	1.000	1.000	
1307131000	13G	Cranberry, dried	0.020000	1.000	1.000	
1307132000	13G	Cranberry, juice	0.020000	1.100	1.000	
1307132001	13G	Cranberry, juice-babyfood	0.020000	1.100	1.000	
1307359000	13G	Strawberry	0.300000	1.000	1.000	
1307359001	13G	Strawberry-babyfood	0.300000	1.000	1.000	
1307360000	13G	Strawberry, juice	0.300000	1.000	1.000	
1307360001	13G	Strawberry, juice-babyfood	0.300000	1.000	1.000	
1400003000	14	Almond	0.020000	1.000	1.000	
1400003001	14	Almond-babyfood	0.020000	1.000	1.000	
1400004000	14	Almond, oil	0.020000	1.000	1.000	
1400004001	14	Almond, oil-babyfood	0.020000	1.000	1.000	
1400059000	14	Brazil nut	0.020000	1.000	1.000	
1400068000	14	Butternut	0.020000	1.000	1.000	
1400081000	14	Cashew	0.020000	1.000	1.000	
1400092000	14	Chestnut	0.020000	1.000	1.000	
1400155000	14	Hazelnut	0.020000	1.000	1.000	
1400156000	14	Hazelnut, oil	0.020000	1.000	1.000	
1400185000	14	Hickory nut	0.020000	1.000	1.000	

1400213000	14	Macadamia nut	0.020000	1.000	1.000	
1400269000	14	Pecan	0.020000	1.000	1.000	
1400278000	14	Pine nut	0.020000	1.000	1.000	
1400282000	14	Pistachio	0.020000	1.000	1.000	
1400391000	14	Walnut	0.020000	1.000	1.000	
1500025000	15	Barley, pearled barley	0.400000	0.300	1.000	D28170
		Full comment: D281702				
1500025001	15	Barley, pearled barley-babyfood	0.400000	0.300	1.000	D28170
		Full comment: D281702				
1500026000	15	Barley, flour	0.400000	0.100	1.000	D28170
		Full comment: D281702				
1500026001	15	Barley, flour-babyfood	0.400000	0.100	1.000	D28170
		Full comment: D281702				
1500027000	15	Barley, bran	0.400000	0.300	1.000	D28170
		Full comment: D281702				
1500065000	15	Buckwheat	0.020000	1.000	1.000	
1500066000	15	Buckwheat, flour	0.020000	1.000	1.000	
1500120000	15	Corn, field, flour	0.020000	1.000	1.000	
1500120001	15	Corn, field, flour-babyfood	0.020000	1.000	1.000	
1500121000	15	Corn, field, meal	0.020000	1.000	1.000	
1500121001	15	Corn, field, meal-babyfood	0.020000	1.000	1.000	
1500122000	15	Corn, field, bran	0.020000	1.000	1.000	
1500123000	15	Corn, field, starch	0.020000	1.000	1.000	
1500123001	15	Corn, field, starch-babyfood	0.020000	1.000	1.000	
1500124000	15	Corn, field, syrup	0.020000	1.500	1.000	
1500124001	15	Corn, field, syrup-babyfood	0.020000	1.500	1.000	
1500125000	15	Corn, field, oil	0.020000	1.000	1.000	
1500125001	15	Corn, field, oil-babyfood	0.020000	1.000	1.000	
1500126000	15	Corn, pop	0.020000	1.000	1.000	
1500127000	15	Corn, sweet	0.020000	1.000	1.000	
1500127001	15	Corn, sweet-babyfood	0.020000	1.000	1.000	
1500226000	15	Millet, grain	0.020000	1.000	1.000	
1500231000	15	Oat, bran	0.020000	1.000	1.000	
1500232000	15	Oat, flour	0.020000	1.000	1.000	
1500232001	15	Oat, flour-babyfood	0.020000	1.000	1.000	
1500233000	15	Oat, groats/rolled oats	0.020000	1.000	1.000	
1500233001	15	Oat, groats/rolled oats-babyfood	0.020000	1.000	1.000	
1500323000	15	Rice, white	0.020000	0.900	1.000	
1500323001	15	Rice, white-babyfood	0.020000	0.900	1.000	
1500324000	15	Rice, brown	0.020000	1.000	1.000	
1500324001	15	Rice, brown-babyfood	0.020000	1.000	1.000	
1500325000	15	Rice, flour	0.020000	1.000	1.000	
1500325001	15	Rice, flour-babyfood	0.020000	1.000	1.000	
1500326000	15	Rice, bran	0.020000	0.900	1.000	D35744
		Full comment: D357449				
1500326001	15	Rice, bran-babyfood	0.020000	0.900	1.000	D35744
		Full comment: D357449				
1500328000	15	Rye, grain	0.020000	1.000	1.000	
1500329000	15	Rye, flour	0.020000	1.000	1.000	
1500344000	15	Sorghum, grain	0.020000	1.000	1.000	
1500345000	15	Sorghum, syrup	0.020000	1.000	1.000	
1500381000	15	Triticale, flour	0.020000	1.000	1.000	
1500381001	15	Triticale, flour-babyfood	0.020000	1.000	1.000	
1500401000	15	Wheat, grain	0.020000	1.000	1.000	
1500401001	15	Wheat, grain-babyfood	0.020000	1.000	1.000	
1500402000	15	Wheat, flour	0.020000	1.000	1.000	
1500402001	15	Wheat, flour-babyfood	0.020000	1.000	1.000	
1500403000	15	Wheat, germ	0.020000	1.000	1.000	
1500404000	15	Wheat, bran	0.020000	1.000	1.000	
1500405000	15	Wild rice	0.020000	1.000	1.000	
1901118000	19A	Cilantro, leaves	4.000000	1.000	1.000	
1901118001	19A	Cilantro, leaves-babyfood	4.000000	1.000	1.000	
1901144000	19A	Dillweed	4.000000	1.000	1.000	
2001163000	20A	Flax seed, oil	0.020000	1.000	1.000	
2001319000	20A	Rapeseed, oil	0.020000	1.000	1.000	
2001319001	20A	Rapeseed, oil-babyfood	0.020000	1.000	1.000	
2002330000	20B	Safflower, oil	0.020000	1.000	1.000	
2002330001	20B	Safflower, oil-babyfood	0.020000	1.000	1.000	
2002364000	20B	Sunflower, seed	0.020000	1.000	1.000	
2002365000	20B	Sunflower, oil	0.020000	1.000	1.000	
2002365001	20B	Sunflower, oil-babyfood	0.020000	1.000	1.000	

2003114001	20C	Coconut, oil-babyfood	0.020000	1.000	1.000	
2003128000	20C	Cottonseed, oil	0.100000	1.000	1.000	
2003128001	20C	Cottonseed, oil-babyfood	0.100000	1.000	1.000	
3100044000	31	Beef, meat	0.020000	1.000	1.000	
3100044001	31	Beef, meat-babyfood	0.020000	1.000	1.000	
3100045000	31	Beef, meat, dried	0.020000	1.920	1.000	
3100046000	31	Beef, meat byproducts	0.040000	1.000	1.000	
3100046001	31	Beef, meat byproducts-babyfood	0.040000	1.000	1.000	
3100048000	31	Beef, kidney	0.040000	1.000	1.000	
3100049000	31	Beef, liver	0.040000	1.000	1.000	
3100049001	31	Beef, liver-babyfood	0.040000	1.000	1.000	
3200169000	32	Goat, meat	0.020000	1.000	1.000	
3200170000	32	Goat, meat byproducts	0.040000	1.000	1.000	
3200172000	32	Goat, kidney	0.040000	1.000	1.000	
3200173000	32	Goat, liver	0.040000	1.000	1.000	
3300189000	33	Horse, meat	0.020000	1.000	1.000	
3400290000	34	Pork, meat	0.020000	1.000	1.000	
3400290001	34	Pork, meat-babyfood	0.020000	1.000	1.000	
3400292000	34	Pork, meat byproducts	0.020000	1.000	1.000	
3400292001	34	Pork, meat byproducts-babyfood	0.020000	1.000	1.000	
3400294000	34	Pork, kidney	0.020000	1.000	1.000	
3400295000	34	Pork, liver	0.020000	1.000	1.000	
3500339000	35	Sheep, meat	0.020000	1.000	1.000	
3500339001	35	Sheep, meat-babyfood	0.020000	1.000	1.000	
3500340000	35	Sheep, meat byproducts	0.040000	1.000	1.000	
3500342000	35	Sheep, kidney	0.040000	1.000	1.000	
3500343000	35	Sheep, liver	0.040000	1.000	1.000	
3600222000	36	Milk, fat	0.020000	1.000	1.000	
3600222001	36	Milk, fat-baby food/infant formu	0.020000	1.000	1.000	
3600223000	36	Milk, nonfat solids	0.020000	1.000	1.000	
3600223001	36	Milk, nonfat solids-baby food/in	0.020000	1.000	1.000	
3600224000	36	Milk, water	0.020000	1.000	1.000	
3600224001	36	Milk, water-babyfood/infant form	0.020000	1.000	1.000	
3600225001	36	Milk, sugar (lactose)-baby food/	0.020000	1.000	1.000	
3800221000	38	Meat, game	0.020000	1.000	1.000	
3900312000	39	Rabbit, meat	0.020000	1.000	1.000	
8601000000	86A	Water, direct, all sources	0.063000	1.000	1.000	
8602000000	86B	Water, indirect, all sources	0.063000	1.000	1.000	
9500016000	O	Artichoke, globe	0.450000	1.000	1.000	
9500020000	O	Avocado	0.400000	1.000	1.000	
9500023000	O	Banana	0.030000	1.000	1.000	
9500023001	O	Banana-babyfood	0.030000	1.000	1.000	
9500024000	O	Banana, dried	0.030000	1.000	1.000	
9500024001	O	Banana, dried-babyfood	0.030000	1.000	1.000	
9500074000	O	Canistel	0.400000	1.000	1.000	
9500089000	O	Cherimoya	0.110000	1.000	1.000	
9500111000	O	Coconut, meat	0.020000	1.000	1.000	
9500111001	O	Coconut, meat-babyfood	0.020000	1.000	1.000	
9500112000	O	Coconut, dried	0.020000	1.000	1.000	
9500113000	O	Coconut, milk	0.020000	1.000	1.000	
9500114000	O	Coconut, oil	0.020000	1.000	1.000	
9500115000	O	Coffee, roasted bean	0.200000	1.000	1.000	
9500116000	O	Coffee, instant	0.200000	1.000	1.000	
9500177000	O	Grape, leaves	0.200000	1.000	1.000	
9500178000	O	Grape, raisin	0.300000	1.000	1.000	
9500188000	O	Hop	0.100000	1.000	1.000	
9500215000	O	Mango	0.400000	1.000	1.000	
9500215001	O	Mango-babyfood	0.400000	1.000	1.000	
9500216000	O	Mango, dried	0.400000	1.000	1.000	
9500217000	O	Mango, juice	0.400000	1.000	1.000	
9500217001	O	Mango, juice-babyfood	0.400000	1.000	1.000	
9500245000	O	Papaya	0.400000	1.000	1.000	
9500245001	O	Papaya-babyfood	0.400000	1.000	1.000	
9500246000	O	Papaya, dried	0.400000	1.800	1.000	
9500247000	O	Papaya, juice	0.400000	1.500	1.000	
9500263000	O	Peanut	0.050000	1.000	1.000	
9500264000	O	Peanut, butter	0.050000	1.890	1.000	
9500265000	O	Peanut, oil	0.050000	0.310	1.000	D37636
		Full comment: D376367				
9500275000	O	Peppermint	1.500000	1.000	1.000	
9500276000	O	Peppermint, oil	1.500000	0.050	1.000	

9500283000	O	Plantain	0.030000	1.000	1.000	
9500284000	O	Plantain, dried	0.030000	1.000	1.000	
9500333000	O	Sapote, Mamey	0.400000	1.000	1.000	
9500352000	O	Spearmint	1.500000	1.000	1.000	
9500353000	O	Spearmint, oil	1.500000	0.050	1.000	D28170
		Full comment: D281702				
9500372000	O	Tea, dried	20.000000	1.000	1.000	
9500373000	O	Tea, instant	20.000000	1.000	1.000	
9500398000	O	Watercress	3.000000	1.000	1.000	

Attachment 2. Inputs for the chronic dietary exposure analysis of thiamethoxam.

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Filename: 060109 Thiamethoxam 2017 Chronic Regroup Avg.R08
Chemical: thiamethoxam
RfD(Chronic): .012 mg/kg bw/day  NOEL(Chronic): 0 mg/kg bw/day
RfD(Acute): .35 mg/kg bw/day  NOEL(Acute):  0 mg/kg bw/day
Date created/last modified: 06-26-2017/20:44:22       Program ver. 3.16, 03-08-d
Comment: Acute and Chronic RfDs = aPAD and cPAD
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EPA Code	Crop Grp	Commodity Name	Def Res (ppm)	Adj.Factors #1	#2	Comment
0101050000	1AB	Beet, garden, roots	0.050000	1.000	1.000	
0101050001	1AB	Beet, garden, roots-babyfood	0.050000	1.000	1.000	
0101052000	1A	Beet, sugar	0.050000	1.000	1.000	
0101052001	1A	Beet, sugar-babyfood	0.050000	1.000	1.000	
0101053000	1A	Beet, sugar, molasses	0.050000	1.000	1.000	
0101053001	1A	Beet, sugar, molasses-babyfood	0.050000	1.000	1.000	
0101067000	1AB	Burdock	0.050000	1.000	1.000	
0101078000	1AB	Carrot	0.050000	1.000	1.000	
0101078001	1AB	Carrot-babyfood	0.050000	1.000	1.000	
0101079000	1AB	Carrot, juice	0.050000	1.000	1.000	
0101084000	1AB	Celeriac	0.050000	1.000	1.000	
0101100000	1AB	Chicory, roots	0.050000	1.000	1.000	
0101168000	1AB	Ginseng, dried	0.050000	1.000	1.000	
0101190000	1AB	Horseradish	0.050000	1.000	1.000	
0101250000	1AB	Parsley, turnip rooted	0.050000	1.000	1.000	
0101251000	1AB	Parsnip	0.050000	1.000	1.000	
0101251001	1AB	Parsnip-babyfood	0.050000	1.000	1.000	
0101314000	1AB	Radish, roots	0.050000	1.000	1.000	
0101316000	1AB	Radish, Oriental, roots	0.050000	1.000	1.000	
0101327000	1AB	Rutabaga	0.050000	1.000	1.000	
0101331000	1AB	Salsify, roots	0.050000	1.000	1.000	
0101388000	1AB	Turnip, roots	0.050000	1.000	1.000	
0103015000	1CD	Arrowroot, flour	0.020000	1.000	1.000	
0103015001	1CD	Arrowroot, flour-babyfood	0.020000	1.000	1.000	
0103017000	1CD	Artichoke, Jerusalem	0.020000	1.000	1.000	
0103082000	1CD	Cassava	0.020000	1.000	1.000	
0103082001	1CD	Cassava-babyfood	0.020000	1.000	1.000	
0103139000	1CD	Dasheen, corm	0.020000	1.000	1.000	
0103166000	1CD	Ginger	0.020000	1.000	1.000	
0103166001	1CD	Ginger-babyfood	0.020000	1.000	1.000	
0103167000	1CD	Ginger, dried	0.020000	1.000	1.000	
0103296000	1C	Potato, chips	0.250000	1.200	1.000	
0103297000	1C	Potato, dry (granules/ flakes)	0.250000	1.700	1.000	
0103297001	1C	Potato, dry (granules/ flakes)-b	0.250000	1.700	1.000	
0103298000	1C	Potato, flour	0.250000	1.700	1.000	
0103298001	1C	Potato, flour-babyfood	0.250000	1.700	1.000	
0103299000	1C	Potato, tuber, w/peel	0.250000	1.000	1.000	
0103299001	1C	Potato, tuber, w/peel-babyfood	0.250000	1.000	1.000	
0103300000	1C	Potato, tuber, w/o peel	0.250000	1.000	1.000	
0103300001	1C	Potato, tuber, w/o peel-babyfood	0.250000	1.000	1.000	
0103366000	1CD	Sweet potato	0.020000	1.000	1.000	
0103366001	1CD	Sweet potato-babyfood	0.020000	1.000	1.000	
0103371000	1CD	Tanier, corm	0.020000	1.000	1.000	
0103387000	1CD	Turmeric	0.020000	1.000	1.000	
0103406000	1CD	Yam, true	0.020000	1.000	1.000	
0103407000	1CD	Yam bean	0.020000	1.000	1.000	
0200051000	2	Beet, garden, tops	0.010000	1.000	1.000	FHE
0200101000	2	Chicory, tops	0.010000	1.000	1.000	FHE
0200140000	2	Dasheen, leaves	0.010000	1.000	1.000	FHE
0200315000	2	Radish, tops	0.820000	1.000	1.000	FHE
0200317000	2	Radish, Oriental, tops	0.820000	1.000	1.000	FHE
0200332000	2	Salsify, tops	0.010000	1.000	1.000	FHE
0301165000	3A	Garlic, bulb	0.010000	1.000	1.000	FHE
0301165001	3A	Garlic, bulb-babyfood	0.010000	1.000	1.000	FHE
0301237000	3A	Onion, bulb	0.030000	1.000	1.000	
0301237001	3A	Onion, bulb-babyfood	0.030000	1.000	1.000	
0301238000	3A	Onion, bulb, dried	0.030000	9.000	1.000	
0301238001	3A	Onion, bulb, dried-babyfood	0.030000	9.000	1.000	

0301338000	3A	Shallot, bulb	0.010000	1.000	1.000	FHE
0302103000	3B	Chive, fresh leaves	0.010000	1.000	1.000	FHE
0302198000	3B	Leek	0.010000	1.000	1.000	FHE
0302239000	3B	Onion, green	0.010000	1.000	1.000	FHE
0302338500	3B	Shallot, fresh leaves	0.010000	1.000	1.000	FHE
0401005000	4A	Amaranth, leafy	0.810000	1.000	1.000	
0401018000	4A	Arugula	0.820000	1.000	1.000	
0401104000	4A	Chrysanthemum, garland	0.810000	1.000	1.000	
0401133000	4A	Cress, garden	0.820000	1.000	1.000	
0401134000	4A	Cress, upland	0.820000	1.000	1.000	
0401138000	4A	Dandelion, leaves	0.810000	1.000	1.000	
0401150000	4A	Endive	0.810000	1.000	1.000	
0401204000	4A	Lettuce, head	0.031000	1.000	1.000	
0401205000	4A	Lettuce, leaf	0.590000	1.000	1.000	
0401248000	4A	Parsley, leaves	0.810000	1.000	1.000	
0401313000	4A	Radicchio	0.031000	1.000	1.000	
0401355000	4A	Spinach	0.810000	1.000	1.000	
0401355001	4A	Spinach-babyfood	0.810000	1.000	1.000	
0402076000	4B	Cardoon	0.200000	1.000	1.000	
0402085000	4B	Celery	0.200000	1.000	1.000	
0402085001	4B	Celery-babyfood	0.200000	1.000	1.000	
0402086000	4B	Celery, juice	0.200000	1.000	1.000	
0402087000	4B	Celtuce	0.810000	1.000	1.000	
0402152000	4B	Fennel, Florence	0.810000	1.000	1.000	
0402322000	4B	Rhubarb	0.200000	1.000	1.000	
0402367000	4B	Swiss chard	0.810000	1.000	1.000	
0501061000	5A	Broccoli	0.980000	1.000	1.000	
0501061001	5A	Broccoli-babyfood	0.980000	1.000	1.000	
0501062000	5A	Broccoli, Chinese	0.820000	1.000	1.000	
0501064000	5A	Brussels sprouts	0.980000	1.000	1.000	
0501069000	5A	Cabbage	0.980000	1.000	1.000	
0501071000	5A	Cabbage, Chinese, napa	0.980000	1.000	1.000	
0501072000	5A	Cabbage, Chinese, mustard	0.980000	1.000	1.000	
0501083000	5A	Cauliflower	0.980000	1.000	1.000	
0501196000	5A	Kohlrabi	0.980000	1.000	1.000	
0502063000	5B	Broccoli raab	0.820000	1.000	1.000	
0502070000	5B	Cabbage, Chinese, bok choy	0.820000	1.000	1.000	
0502117000	5B	Collards	0.820000	1.000	1.000	
0502194000	5B	Kale	0.820000	1.000	1.000	
0502229000	5B	Mustard greens	0.820000	1.000	1.000	
0502318000	5B	Rape greens	0.820000	1.000	1.000	
0502389000	5B	Turnip, greens	0.820000	1.000	1.000	
0600347000	6	Soybean, seed	0.010000	1.000	1.000	
0600349000	6	Soybean, soy milk	0.010000	1.000	1.000	
0600349001	6	Soybean, soy milk-babyfood or in	0.010000	1.000	1.000	
0600350000	6	Soybean, oil	0.010000	1.000	1.000	
0600350001	6	Soybean, oil-babyfood	0.010000	1.000	1.000	
0601043000	6A	Bean, snap, succulent	0.010000	1.000	1.000	
0601043001	6A	Bean, snap, succulent-babyfood	0.010000	1.000	1.000	
0601257000	6A	Pea, edible podded, succulent	0.010000	1.000	1.000	
0601349500	6AB	Soybean, vegetable	0.010000	1.000	1.000	FHE
0602031000	6B	Bean, broad, succulent	0.010000	1.000	1.000	
0602033000	6B	Bean, cowpea, succulent	0.010000	1.000	1.000	
0602037000	6B	Bean, lima, succulent	0.010000	1.000	1.000	
0602255000	6B	Pea, succulent	0.010000	1.000	1.000	
0602255001	6B	Pea, succulent-babyfood	0.010000	1.000	1.000	
0602259000	6B	Pea, pigeon, succulent	0.010000	1.000	1.000	
0603030000	6C	Bean, black, seed	0.010000	1.000	1.000	
0603032000	6C	Bean, broad, seed	0.010000	1.000	1.000	
0603034000	6C	Bean, cowpea, seed	0.010000	1.000	1.000	
0603035000	6C	Bean, great northern, seed	0.010000	1.000	1.000	
0603036000	6C	Bean, kidney, seed	0.010000	1.000	1.000	
0603038000	6C	Bean, lima, seed	0.010000	1.000	1.000	
0603039000	6C	Bean, mung, seed	0.010000	1.000	1.000	
0603040000	6C	Bean, navy, seed	0.010000	1.000	1.000	
0603041000	6C	Bean, pink, seed	0.010000	1.000	1.000	
0603042000	6C	Bean, pinto, seed	0.010000	1.000	1.000	
0603098000	6C	Chickpea, seed	0.010000	1.000	1.000	
0603098001	6C	Chickpea, seed-babyfood	0.010000	1.000	1.000	
0603099000	6C	Chickpea, flour	0.010000	1.000	1.000	
0603182000	6C	Guar, seed	0.010000	1.000	1.000	

0603182001	6C	Guar, seed-babyfood	0.010000	1.000	1.000
0603203000	6C	Lentil, seed	0.010000	1.000	1.000
0603256000	6C	Pea, dry	0.010000	1.000	1.000
0603256001	6C	Pea, dry-babyfood	0.010000	1.000	1.000
0603258000	6C	Pea, pigeon, seed	0.010000	1.000	1.000
0603348000	6C	Soybean, flour	0.010000	1.000	1.000
0603348001	6C	Soybean, flour-babyfood	0.010000	1.000	1.000
0801374000	8A	Tomatillo	0.080000	1.000	1.000
0801375000	8A	Tomato	0.080000	1.000	1.000
0801375001	8A	Tomato-babyfood	0.080000	1.000	1.000
0801376000	8A	Tomato, paste	0.080000	3.800	1.000
0801376001	8A	Tomato, paste-babyfood	0.080000	3.800	1.000
0801377000	8A	Tomato, puree	0.080000	1.700	1.000
0801377001	8A	Tomato, puree-babyfood	0.080000	1.700	1.000
0801378000	8A	Tomato, dried	0.080000	14.300	1.000
0801378001	8A	Tomato, dried-babyfood	0.080000	14.300	1.000
0801379000	8A	Tomato, juice	0.080000	1.500	1.000
0801380000	8A	Tomato, Tree	0.080000	1.000	1.000
0802148000	8BC	Eggplant	0.080000	1.000	1.000
0802234000	8BC	Okra	0.080000	1.000	1.000
0802270000	8B	Pepper, bell	0.080000	1.000	1.000
0802270001	8B	Pepper, bell-babyfood	0.080000	1.000	1.000
0802271000	8B	Pepper, bell, dried	0.080000	1.000	1.000
0802271001	8B	Pepper, bell, dried-babyfood	0.080000	1.000	1.000
0802272000	8BC	Pepper, nonbell	0.080000	1.000	1.000
0802272001	8BC	Pepper, nonbell-babyfood	0.080000	1.000	1.000
0802273000	8BC	Pepper, nonbell, dried	0.080000	1.000	1.000
0901075000	9A	Cantaloupe	0.200000	1.000	1.000
0901187000	9A	Honeydew melon	0.200000	1.000	1.000
0901399000	9A	Watermelon	0.200000	1.000	1.000
0901400000	9A	Watermelon, juice	0.200000	1.000	1.000
0902021000	9B	Balsam pear	0.200000	1.000	1.000
0902088000	9B	Chayote, fruit	0.200000	1.000	1.000
0902102000	9B	Chinese waxgourd	0.200000	1.000	1.000
0902135000	9B	Cucumber	0.200000	1.000	1.000
0902308000	9B	Pumpkin	0.200000	1.000	1.000
0902309000	9B	Pumpkin, seed	0.200000	1.000	1.000
0902356000	9B	Squash, summer	0.200000	1.000	1.000
0902356001	9B	Squash, summer-babyfood	0.200000	1.000	1.000
0902357000	9B	Squash, winter	0.200000	1.000	1.000
0902357001	9B	Squash, winter-babyfood	0.200000	1.000	1.000
1001106000	10A	Citron	0.100000	1.000	1.000
1001107000	10A	Citrus hybrids	0.100000	1.000	1.000
1001108000	10A	Citrus, oil	0.100000	0.600	1.000
1001240000	10A	Orange	0.100000	1.000	1.000
1001241000	10A	Orange, juice	0.100000	0.600	1.000
1001241001	10A	Orange, juice-babyfood	0.100000	0.600	1.000
1001242000	10A	Orange, peel	0.100000	1.000	1.000
1001369000	10A	Tangerine	0.100000	1.000	1.000
1001370000	10A	Tangerine, juice	0.100000	0.600	1.000
1002197000	10B	Kumquat	0.100000	1.000	1.000
1002199000	10B	Lemon	0.090000	1.000	1.000
1002200000	10B	Lemon, juice	0.090000	0.600	1.000
1002200001	10B	Lemon, juice-babyfood	0.090000	0.600	1.000
1002201000	10B	Lemon, peel	0.090000	1.000	1.000
1002206000	10B	Lime	0.090000	1.000	1.000
1002207000	10B	Lime, juice	0.090000	0.600	1.000
1002207001	10B	Lime, juice-babyfood	0.090000	0.600	1.000
1003180000	10C	Grapefruit	0.070000	1.000	1.000
1003181000	10C	Grapefruit, juice	0.070000	0.600	1.000
1003307000	10C	Pummelo	0.070000	1.000	1.000
1100007000	11	Apple, fruit with peel	0.060000	1.000	1.000
1100008000	11	Apple, peeled fruit	0.060000	1.000	1.000
1100008001	11	Apple, peeled fruit-babyfood	0.060000	1.000	1.000
1100009000	11	Apple, dried	0.060000	8.000	1.000
1100009001	11	Apple, dried-babyfood	0.060000	8.000	1.000
1100010000	11	Apple, juice	0.060000	0.750	1.000
1100010001	11	Apple, juice-babyfood	0.060000	0.750	1.000
1100011000	11	Apple, sauce	0.060000	1.000	1.000
1100011001	11	Apple, sauce-babyfood	0.060000	1.000	1.000
1100129000	11	Crabapple	0.060000	1.000	1.000

1100173500	11	Goji berry	0.010000	1.000	1.000	FHE
1100210000	11	Loquat	0.060000	1.000	1.000	
1100266000	11	Pear	0.060000	1.000	1.000	
1100266001	11	Pear-babyfood	0.060000	1.000	1.000	
1100267000	11	Pear, dried	0.060000	6.250	1.000	
1100268000	11	Pear, juice	0.060000	0.750	1.000	
1100268001	11	Pear, juice-babyfood	0.060000	0.750	1.000	
1100310000	11	Quince	0.060000	1.000	1.000	
1201090000	12A	Cherry	0.210000	1.000	1.000	
1201090001	12A	Cherry-babyfood	0.210000	1.000	1.000	
1201091000	12A	Cherry, juice	0.210000	1.500	1.000	
1201091001	12A	Cherry, juice-babyfood	0.210000	1.500	1.000	
1202012000	12B	Apricot	0.070000	1.000	1.000	
1202012001	12B	Apricot-babyfood	0.070000	1.000	1.000	
1202013000	12B	Apricot, dried	0.070000	6.000	1.000	
1202014000	12B	Apricot, juice	0.070000	1.000	1.000	
1202014001	12B	Apricot, juice-babyfood	0.070000	1.000	1.000	
1202230000	12B	Nectarine	0.070000	1.000	1.000	
1202260000	12B	Peach	0.070000	1.000	1.000	
1202260001	12B	Peach-babyfood	0.070000	1.000	1.000	
1202261000	12B	Peach, dried	0.070000	7.000	1.000	
1202261001	12B	Peach, dried-babyfood	0.070000	7.000	1.000	
1202262000	12B	Peach, juice	0.070000	1.000	1.000	
1202262001	12B	Peach, juice-babyfood	0.070000	1.000	1.000	
1203285000	12C	Plum	0.071000	1.000	1.000	
1203285001	12C	Plum-babyfood	0.071000	1.000	1.000	
1203286000	12C	Plum, prune, fresh	0.071000	1.000	1.000	
1203286001	12C	Plum, prune, fresh-babyfood	0.071000	1.000	1.000	
1203287000	12C	Plum, prune, dried	0.071000	5.000	1.000	
1203287001	12C	Plum, prune, dried-babyfood	0.071000	5.000	1.000	
1203288000	12C	Plum, prune, juice	0.071000	1.400	1.000	
1203288001	12C	Plum, prune, juice-babyfood	0.071000	1.400	1.000	
1301055000	13A	Blackberry	0.120000	1.000	1.000	
1301056000	13A	Blackberry, juice	0.120000	1.000	1.000	
1301056001	13A	Blackberry, juice-babyfood	0.120000	1.000	1.000	
1301058000	13A	Boysenberry	0.120000	1.000	1.000	
1301208000	13A	Loganberry	0.120000	1.000	1.000	
1301320000	13A	Raspberry	0.120000	1.000	1.000	
1301320001	13A	Raspberry-babyfood	0.120000	1.000	1.000	
1301321000	13A	Raspberry, juice	0.120000	1.000	1.000	
1301321001	13A	Raspberry, juice-babyfood	0.120000	1.000	1.000	
1302057000	13B	Blueberry	0.300000	1.000	1.000	
1302057001	13B	Blueberry-babyfood	0.300000	1.000	1.000	
1302136000	13B	Currant	0.200000	1.000	1.000	
1302137000	13B	Currant, dried	0.200000	1.000	1.000	
1302149000	13B	Elderberry	0.200000	1.000	1.000	
1302174000	13B	Gooseberry	0.200000	1.000	1.000	
1302191000	13B	Huckleberry	0.200000	1.000	1.000	
1303227000	13C	Mulberry	0.010000	1.000	1.000	FHE
1304175000	13D	Grape	0.060000	1.000	1.000	
1304176000	13D	Grape, juice	0.060000	1.100	1.000	
1304176001	13D	Grape, juice-babyfood	0.060000	1.100	1.000	
1304179000	13D	Grape, wine and sherry	0.060000	1.000	1.000	
1304195000	13D	Kiwifruit, fuzzy	0.010000	1.000	1.000	FHE
1307130000	13G	Cranberry	0.020000	1.000	1.000	
1307130001	13G	Cranberry-babyfood	0.020000	1.000	1.000	
1307131000	13G	Cranberry, dried	0.020000	1.000	1.000	
1307132000	13G	Cranberry, juice	0.020000	1.100	1.000	
1307132001	13G	Cranberry, juice-babyfood	0.020000	1.100	1.000	
1307359000	13G	Strawberry	0.300000	1.000	1.000	
1307359001	13G	Strawberry-babyfood	0.300000	1.000	1.000	
1307360000	13G	Strawberry, juice	0.300000	1.000	1.000	
1307360001	13G	Strawberry, juice-babyfood	0.300000	1.000	1.000	
1400003000	14	Almond	0.010000	1.000	1.000	
1400003001	14	Almond-babyfood	0.010000	1.000	1.000	
1400004000	14	Almond, oil	0.010000	1.000	1.000	
1400004001	14	Almond, oil-babyfood	0.010000	1.000	1.000	
1400059000	14	Brazil nut	0.010000	1.000	1.000	
1400068000	14	Butternut	0.010000	1.000	1.000	
1400081000	14	Cashew	0.010000	1.000	1.000	
1400092000	14	Chestnut	0.010000	1.000	1.000	

1400155000	14	Hazelnut	0.010000	1.000	1.000	
1400156000	14	Hazelnut, oil	0.010000	1.000	1.000	
1400185000	14	Hickory nut	0.010000	1.000	1.000	
1400213000	14	Macadamia nut	0.010000	1.000	1.000	
1400269000	14	Pecan	0.010000	1.000	1.000	
1400278000	14	Pine nut	0.010000	1.000	1.000	
1400282000	14	Pistachio	0.010000	1.000	1.000	
1400391000	14	Walnut	0.010000	1.000	1.000	
1500025000	15	Barley, pearled barley	0.086000	0.300	1.000	
1500025001	15	Barley, pearled barley-babyfood	0.086000	0.300	1.000	
1500026000	15	Barley, flour	0.086000	0.100	1.000	
1500026001	15	Barley, flour-babyfood	0.086000	0.100	1.000	
1500027000	15	Barley, bran	0.086000	0.300	1.000	
1500065000	15	Buckwheat	0.020000	1.000	1.000	
1500066000	15	Buckwheat, flour	0.020000	1.000	1.000	
1500120000	15	Corn, field, flour	0.020000	1.000	1.000	
1500120001	15	Corn, field, flour-babyfood	0.020000	1.000	1.000	
1500121000	15	Corn, field, meal	0.020000	1.000	1.000	
1500121001	15	Corn, field, meal-babyfood	0.020000	1.000	1.000	
1500122000	15	Corn, field, bran	0.020000	1.000	1.000	
1500123000	15	Corn, field, starch	0.020000	1.000	1.000	
1500123001	15	Corn, field, starch-babyfood	0.020000	1.000	1.000	
1500124000	15	Corn, field, syrup	0.020000	1.500	1.000	
1500124001	15	Corn, field, syrup-babyfood	0.020000	1.500	1.000	
1500125000	15	Corn, field, oil	0.020000	1.000	1.000	
1500125001	15	Corn, field, oil-babyfood	0.020000	1.000	1.000	
1500126000	15	Corn, pop	0.020000	1.000	1.000	
1500127000	15	Corn, sweet	0.020000	1.000	1.000	
1500127001	15	Corn, sweet-babyfood	0.020000	1.000	1.000	
1500226000	15	Millet, grain	0.020000	1.000	1.000	
1500231000	15	Oat, bran	0.020000	1.000	1.000	
1500232000	15	Oat, flour	0.020000	1.000	1.000	
1500232001	15	Oat, flour-babyfood	0.020000	1.000	1.000	
1500233000	15	Oat, groats/rolled oats	0.020000	1.000	1.000	
1500233001	15	Oat, groats/rolled oats-babyfood	0.020000	1.000	1.000	
1500323000	15	Rice, white	0.010000	0.900	1.000	
1500323001	15	Rice, white-babyfood	0.010000	0.900	1.000	
1500324000	15	Rice, brown	0.010000	1.000	1.000	
1500324001	15	Rice, brown-babyfood	0.010000	1.000	1.000	
1500325000	15	Rice, flour	0.010000	1.000	1.000	
1500325001	15	Rice, flour-babyfood	0.010000	1.000	1.000	
1500326000	15	Rice, bran	0.010000	0.900	1.000	
1500326001	15	Rice, bran-babyfood	0.010000	0.900	1.000	
1500328000	15	Rye, grain	0.020000	1.000	1.000	
1500329000	15	Rye, flour	0.020000	1.000	1.000	
1500344000	15	Sorghum, grain	0.020000	1.000	1.000	
1500345000	15	Sorghum, syrup	0.020000	1.000	1.000	
1500381000	15	Triticale, flour	0.020000	1.000	1.000	
1500381001	15	Triticale, flour-babyfood	0.020000	1.000	1.000	
1500401000	15	Wheat, grain	0.020000	1.000	1.000	
1500401001	15	Wheat, grain-babyfood	0.020000	1.000	1.000	
1500402000	15	Wheat, flour	0.020000	1.000	1.000	
1500402001	15	Wheat, flour-babyfood	0.020000	1.000	1.000	
1500403000	15	Wheat, germ	0.020000	1.000	1.000	
1500404000	15	Wheat, bran	0.020000	1.000	1.000	
1500405000	15	Wild rice	0.020000	1.000	1.000	
1800002000	18	Alfalfa, seed	0.010000	1.000	1.000	FHE
1901028000	19A	Basil, fresh leaves	0.010000	1.000	1.000	FHE
1901028001	19A	Basil, fresh leaves-babyfood	0.010000	1.000	1.000	FHE
1901029000	19A	Basil, dried leaves	0.010000	1.000	1.000	FHE
1901029001	19A	Basil, dried leaves-babyfood	0.010000	1.000	1.000	FHE
1901102500	19A	Chive, dried leaves	0.010000	1.000	1.000	FHE
1901118000	19A	Cilantro, leaves	0.810000	1.000	1.000	
1901118001	19A	Cilantro, leaves-babyfood	0.810000	1.000	1.000	
1901144000	19A	Dillweed	0.810000	1.000	1.000	
1901184000	19A	Herbs, other	0.010000	1.000	1.000	FHE
1901184001	19A	Herbs, other-babyfood	0.010000	1.000	1.000	FHE
1901202000	19A	Lemongrass	0.010000	1.000	1.000	FHE
1901220000	19A	Marjoram	0.010000	1.000	1.000	FHE
1901220001	19A	Marjoram-babyfood	0.010000	1.000	1.000	FHE
1901249000	19A	Parsley, dried leaves	0.010000	1.000	1.000	FHE

1901249001	19A	Parsley, dried leaves-babyfood	0.010000	1.000	1.000	FHE
1901334000	19A	Savory	0.010000	1.000	1.000	FHE
1902105000	19B	Cinnamon	0.010000	1.000	1.000	FHE
1902105001	19B	Cinnamon-babyfood	0.010000	1.000	1.000	FHE
1902119000	19B	Coriander, seed	0.010000	1.000	1.000	FHE
1902119001	19B	Coriander, seed-babyfood	0.010000	1.000	1.000	FHE
1902143000	19B	Dill, seed	0.010000	1.000	1.000	FHE
1902274000	19B	Pepper, black and white	0.010000	1.000	1.000	FHE
1902274001	19B	Pepper, black and white-babyfood	0.010000	1.000	1.000	FHE
1902354000	19B	Spices, other	0.010000	1.000	1.000	FHE
1902354001	19B	Spices, other-babyfood	0.010000	1.000	1.000	FHE
2001163000	20A	Flax seed, oil	0.020000	1.000	1.000	
2001319000	20A	Rapeseed, oil	0.020000	1.000	1.000	
2001319001	20A	Rapeseed, oil-babyfood	0.020000	1.000	1.000	
2001336000	20A	Sesame, seed	0.010000	1.000	1.000	FHE
2001336001	20A	Sesame, seed-babyfood	0.010000	1.000	1.000	FHE
2001337000	20A	Sesame, oil	0.010000	1.000	1.000	FHE
2001337001	20A	Sesame, oil-babyfood	0.010000	1.000	1.000	FHE
2002330000	20B	Safflower, oil	0.020000	1.000	1.000	
2002330001	20B	Safflower, oil-babyfood	0.020000	1.000	1.000	
2002364000	20B	Sunflower, seed	0.020000	1.000	1.000	
2002365000	20B	Sunflower, oil	0.020000	1.000	1.000	
2002365001	20B	Sunflower, oil-babyfood	0.020000	1.000	1.000	
2003114001	20C	Coconut, oil-babyfood	0.010000	1.000	1.000	
2003128000	20C	Cottonseed, oil	0.100000	1.000	1.000	
2003128001	20C	Cottonseed, oil-babyfood	0.100000	1.000	1.000	
2100228000	21	Mushroom	0.010000	1.000	1.000	FHE
3100044000	31	Beef, meat	0.020000	1.000	1.000	
3100044001	31	Beef, meat-babyfood	0.020000	1.000	1.000	
3100045000	31	Beef, meat, dried	0.020000	1.920	1.000	
3100046000	31	Beef, meat byproducts	0.040000	1.000	1.000	
3100046001	31	Beef, meat byproducts-babyfood	0.040000	1.000	1.000	
3100047000	31	Beef, fat	0.010000	1.000	1.000	FHE
3100047001	31	Beef, fat-babyfood	0.010000	1.000	1.000	FHE
3100048000	31	Beef, kidney	0.040000	1.000	1.000	
3100049000	31	Beef, liver	0.040000	1.000	1.000	
3100049001	31	Beef, liver-babyfood	0.040000	1.000	1.000	
3200169000	32	Goat, meat	0.020000	1.000	1.000	
3200170000	32	Goat, meat byproducts	0.040000	1.000	1.000	
3200171000	32	Goat, fat	0.010000	1.000	1.000	FHE
3200172000	32	Goat, kidney	0.040000	1.000	1.000	
3200173000	32	Goat, liver	0.040000	1.000	1.000	
3300189000	33	Horse, meat	0.020000	1.000	1.000	
3400290000	34	Pork, meat	0.020000	1.000	1.000	
3400290001	34	Pork, meat-babyfood	0.020000	1.000	1.000	
3400291000	34	Pork, skin	0.010000	1.000	1.000	FHE
3400292000	34	Pork, meat byproducts	0.020000	1.000	1.000	
3400292001	34	Pork, meat byproducts-babyfood	0.020000	1.000	1.000	
3400293000	34	Pork, fat	0.010000	1.000	1.000	FHE
3400293001	34	Pork, fat-babyfood	0.010000	1.000	1.000	FHE
3400294000	34	Pork, kidney	0.020000	1.000	1.000	
3400295000	34	Pork, liver	0.020000	1.000	1.000	
3500339000	35	Sheep, meat	0.020000	1.000	1.000	
3500339001	35	Sheep, meat-babyfood	0.020000	1.000	1.000	
3500340000	35	Sheep, meat byproducts	0.040000	1.000	1.000	
3500341000	35	Sheep, fat	0.010000	1.000	1.000	FHE
3500341001	35	Sheep, fat-babyfood	0.010000	1.000	1.000	FHE
3500342000	35	Sheep, kidney	0.040000	1.000	1.000	
3500343000	35	Sheep, liver	0.040000	1.000	1.000	
3600222000	36	Milk, fat	0.020000	1.000	1.000	
3600222001	36	Milk, fat-baby food/infant formu	0.020000	1.000	1.000	
3600223000	36	Milk, nonfat solids	0.020000	1.000	1.000	
3600223001	36	Milk, nonfat solids-baby food/in	0.020000	1.000	1.000	
3600224000	36	Milk, water	0.020000	1.000	1.000	
3600224001	36	Milk, water-babyfood/infant form	0.020000	1.000	1.000	
3600225001	36	Milk, sugar (lactose)-baby food/	0.020000	1.000	1.000	
3800221000	38	Meat, game	0.020000	1.000	1.000	
3900312000	39	Rabbit, meat	0.020000	1.000	1.000	
4000093000	40	Chicken, meat	0.010000	1.000	1.000	FHE
4000093001	40	Chicken, meat-babyfood	0.010000	1.000	1.000	FHE
4000094000	40	Chicken, liver	0.010000	1.000	1.000	FHE

4000095000	40	Chicken, meat byproducts	0.010000	1.000	1.000	FHE
4000095001	40	Chicken, meat byproducts-babyfoo	0.010000	1.000	1.000	FHE
4000096000	40	Chicken, fat	0.010000	1.000	1.000	FHE
4000096001	40	Chicken, fat-babyfood	0.010000	1.000	1.000	FHE
4000097000	40	Chicken, skin	0.010000	1.000	1.000	FHE
4000097001	40	Chicken, skin-babyfood	0.010000	1.000	1.000	FHE
5000382000	50	Turkey, meat	0.010000	1.000	1.000	FHE
5000382001	50	Turkey, meat-babyfood	0.010000	1.000	1.000	FHE
5000383000	50	Turkey, liver	0.010000	1.000	1.000	FHE
5000383001	50	Turkey, liver-babyfood	0.010000	1.000	1.000	FHE
5000384000	50	Turkey, meat byproducts	0.010000	1.000	1.000	FHE
5000384001	50	Turkey, meat byproducts-babyfood	0.010000	1.000	1.000	FHE
5000385000	50	Turkey, fat	0.010000	1.000	1.000	FHE
5000385001	50	Turkey, fat-babyfood	0.010000	1.000	1.000	FHE
5000386000	50	Turkey, skin	0.010000	1.000	1.000	FHE
5000386001	50	Turkey, skin-babyfood	0.010000	1.000	1.000	FHE
6000301000	60	Poultry, other, meat	0.010000	1.000	1.000	FHE
6000302000	60	Poultry, other, liver	0.010000	1.000	1.000	FHE
6000303000	60	Poultry, other, meat byproducts	0.010000	1.000	1.000	FHE
6000304000	60	Poultry, other, fat	0.010000	1.000	1.000	FHE
6000305000	60	Poultry, other, skin	0.010000	1.000	1.000	FHE
7000145000	70	Egg, whole	0.010000	1.000	1.000	FHE
7000145001	70	Egg, whole-babyfood	0.010000	1.000	1.000	FHE
7000146000	70	Egg, white	0.010000	1.000	1.000	FHE
7000146001	70	Egg, white (solids)-babyfood	0.010000	1.000	1.000	FHE
7000147000	70	Egg, yolk	0.010000	1.000	1.000	FHE
7000147001	70	Egg, yolk-babyfood	0.010000	1.000	1.000	FHE
8000157000	80	Fish-freshwater finfish	0.010000	1.000	1.000	FHE
8000158000	80	Fish-freshwater finfish, farm ra	0.010000	1.000	1.000	FHE
8000159000	80	Fish-saltwater finfish, tuna	0.010000	1.000	1.000	FHE
8000160000	80	Fish-saltwater finfish, other	0.010000	1.000	1.000	FHE
8000161000	80	Fish-shellfish, crustacean	0.010000	1.000	1.000	FHE
8000162000	80	Fish-shellfish, mollusc	0.010000	1.000	1.000	FHE
8601000000	86A	Water, direct, all sources	0.058000	1.000	1.000	
8602000000	86B	Water, indirect, all sources	0.058000	1.000	1.000	
9500001000	O	Acerola	0.010000	1.000	1.000	FHE
9500001500	O	Agave	0.010000	1.000	1.000	FHE
9500006000	O	Amaranth, grain	0.010000	1.000	1.000	FHE
9500016000	O	Artichoke, globe	0.190000	1.000	1.000	
9500019000	O	Asparagus	0.010000	1.000	1.000	FHE
9500019500	O	Atemoya	0.010000	1.000	1.000	FHE
9500020000	O	Avocado	0.110000	1.000	1.000	
9500022000	O	Bamboo, shoots	0.010000	1.000	1.000	FHE
9500023000	O	Banana	0.030000	1.000	1.000	
9500023001	O	Banana-babyfood	0.030000	1.000	1.000	
9500024000	O	Banana, dried	0.030000	1.000	1.000	
9500024001	O	Banana, dried-babyfood	0.030000	1.000	1.000	
9500054000	O	Belgium endive	0.010000	1.000	1.000	FHE
9500060000	O	Breadfruit	0.010000	1.000	1.000	FHE
9500073000	O	Cactus	0.010000	1.000	1.000	FHE
9500074000	O	Canistel	0.400000	1.000	1.000	
9500077000	O	Carob	0.010000	1.000	1.000	FHE
9500089000	O	Cherimoya	0.010000	1.000	1.000	FHE
9500109000	O	Cocoa bean, chocolate	0.010000	1.000	1.000	FHE
9500110000	O	Cocoa bean, powder	0.010000	1.000	1.000	FHE
9500111000	O	Coconut, meat	0.010000	1.000	1.000	
9500111001	O	Coconut, meat-babyfood	0.010000	1.000	1.000	
9500112000	O	Coconut, dried	0.010000	1.000	1.000	
9500113000	O	Coconut, milk	0.010000	1.000	1.000	
9500114000	O	Coconut, oil	0.010000	1.000	1.000	
9500115000	O	Coffee, roasted bean	0.200000	1.000	1.000	
9500116000	O	Coffee, instant	0.200000	1.000	1.000	
9500141000	O	Date	0.010000	1.000	1.000	FHE
9500151000	O	Feijoa	0.010000	1.000	1.000	FHE
9500153000	O	Fig	0.010000	1.000	1.000	FHE
9500154000	O	Fig, dried	0.010000	1.000	1.000	FHE
9500177000	O	Grape, leaves	0.200000	1.000	1.000	
9500178000	O	Grape, raisin	0.060000	2.300	1.000	
9500183000	O	Guava	0.010000	1.000	1.000	FHE
9500183001	O	Guava-babyfood	0.010000	1.000	1.000	FHE
9500186000	O	Honey	0.010000	1.000	1.000	FHE

9500186001	O	Honey-babyfood	0.010000	1.000	1.000	FHE
9500188000	O	Hop	0.100000	1.000	1.000	
9500193000	O	Jackfruit	0.010000	1.000	1.000	FHE
9500209000	O	Longan	0.010000	1.000	1.000	FHE
9500211000	O	Lychee	0.010000	1.000	1.000	FHE
9500212000	O	Lychee, dried	0.010000	1.000	1.000	FHE
9500214000	O	Mamey apple	0.010000	1.000	1.000	FHE
9500215000	O	Mango	0.110000	1.000	1.000	
9500215001	O	Mango-babyfood	0.110000	1.000	1.000	
9500216000	O	Mango, dried	0.110000	1.000	1.000	
9500217000	O	Mango, juice	0.110000	1.000	1.000	
9500217001	O	Mango, juice-babyfood	0.110000	1.000	1.000	
9500218000	O	Maple, sugar	0.010000	1.000	1.000	FHE
9500219000	O	Maple syrup	0.010000	1.000	1.000	FHE
9500235000	O	Olive	0.010000	1.000	1.000	FHE
9500236000	O	Olive, oil	0.010000	1.000	1.000	FHE
9500243000	O	Palm heart, leaves	0.010000	1.000	1.000	FHE
9500244000	O	Palm, oil	0.010000	1.000	1.000	FHE
9500244001	O	Palm, oil-babyfood	0.010000	1.000	1.000	FHE
9500245000	O	Papaya	0.110000	1.000	1.000	
9500245001	O	Papaya-babyfood	0.110000	1.000	1.000	
9500246000	O	Papaya, dried	0.110000	1.800	1.000	
9500247000	O	Papaya, juice	0.110000	1.500	1.000	
9500252000	O	Passionfruit	0.010000	1.000	1.000	FHE
9500252001	O	Passionfruit-babyfood	0.010000	1.000	1.000	FHE
9500253000	O	Passionfruit, juice	0.010000	1.000	1.000	FHE
9500253001	O	Passionfruit, juice-babyfood	0.010000	1.000	1.000	FHE
9500254000	O	Pawpaw	0.010000	1.000	1.000	FHE
9500263000	O	Peanut	0.050000	1.000	1.000	
9500264000	O	Peanut, butter	0.050000	1.890	1.000	
9500265000	O	Peanut, oil	0.050000	0.310	1.000	
9500275000	O	Peppermint	1.500000	1.000	1.000	
9500276000	O	Peppermint, oil	1.500000	0.050	1.000	
9500277000	O	Persimmon	0.010000	1.000	1.000	FHE
9500279000	O	Pineapple	0.010000	1.000	1.000	FHE
9500279001	O	Pineapple-babyfood	0.010000	1.000	1.000	FHE
9500280000	O	Pineapple, dried	0.010000	1.000	1.000	FHE
9500281000	O	Pineapple, juice	0.010000	1.000	1.000	FHE
9500281001	O	Pineapple, juice-babyfood	0.010000	1.000	1.000	FHE
9500283000	O	Plantain	0.030000	1.000	1.000	
9500284000	O	Plantain, dried	0.030000	1.000	1.000	
9500289000	O	Pomegranate	0.010000	1.000	1.000	FHE
9500306000	O	Psyllium, seed	0.010000	1.000	1.000	FHE
9500311000	O	Quinoa, grain	0.010000	1.000	1.000	FHE
9500333000	O	Sapote, Mamey	0.400000	1.000	1.000	
9500335000	O	Seaweed	0.010000	1.000	1.000	FHE
9500335001	O	Seaweed-babyfood	0.010000	1.000	1.000	FHE
9500346000	O	Soursop	0.010000	1.000	1.000	FHE
9500351000	O	Spanish lime	0.010000	1.000	1.000	FHE
9500352000	O	Spearmint	1.500000	1.000	1.000	
9500353000	O	Spearmint, oil	1.500000	0.050	1.000	
9500358000	O	Starfruit	0.010000	1.000	1.000	FHE
9500361000	O	Sugar apple	0.010000	1.000	1.000	FHE
9500362000	O	Sugarcane, sugar	0.010000	1.000	1.000	FHE
9500362001	O	Sugarcane, sugar-babyfood	0.010000	1.000	1.000	FHE
9500363000	O	Sugarcane, molasses	0.010000	1.000	1.000	FHE
9500363001	O	Sugarcane, molasses-babyfood	0.010000	1.000	1.000	FHE
9500368000	O	Tamarind	0.010000	1.000	1.000	FHE
9500372000	O	Tea, dried	20.000000	1.000	1.000	
9500373000	O	Tea, instant	20.000000	1.000	1.000	
9500373500	O	Teff, flour	0.010000	1.000	1.000	FHE
9500390000	O	Vinegar	0.010000	1.000	1.000	FHE
9500397000	O	Water chestnut	0.010000	1.000	1.000	FHE
9500398000	O	Watercress	0.810000	1.000	1.000	

Attachment 3. Summary of the acute dietary exposure and risk estimates for thiamethoxam.

```
US EPA                                                        Ver. 3.18, 03-08-d
DEEM-FCID ACUTE Analysis for THIAMETHOXAM                 NHANES 2003-2008 2-Day
Residue file: 060109 Thiamethoxam 2017 Acute Regroup.R08
Adjustment factor #2 NOT used.
Analysis Date: 08-29-2017/13:22:18    Residue file dated: 08-29-2017/13:19:50
RAC/FF intake summed over 24 hours
Run Comment: "Acute and Chronic RfDs = aPAD and cPAD"
===============================================================================

Summary calculations--per capita:

                    95th Percentile      99th Percentile     99.9th Percentile
                    Exposure   % aRfD    Exposure   % aRfD    Exposure   % aRfD
                   ---------- --------  ---------- --------  ---------- --------
Total US Population:
                     0.014681     4.19    0.024687     7.05    0.045586    13.02
All Infants:
                     0.018598     5.31    0.028221     8.06    0.071030    20.29
Children 1-2:
                     0.029494     8.43    0.053574    15.31    0.089500    25.57
Children 3-5:
                     0.024828     7.09    0.042909    12.26    0.086799    24.80
Children 6-12:
                     0.014762     4.22    0.026709     7.63    0.045565    13.02
Youth 13-19:
                     0.010615     3.03    0.018004     5.14    0.033244     9.50
Adults 20-49:
                     0.013496     3.86    0.021555     6.16    0.040685    11.62
Adults 50-99:
                     0.013554     3.87    0.021048     6.01    0.032219     9.21
Female 13-49:
                     0.014177     4.05    0.022852     6.53    0.040957    11.70
```

Attachment 4. Summary of the chronic dietary exposure and risk estimates for thiamethoxam.

```
US EPA                                                          Ver. 3.16, 03-08-d
DEEM-FCID Chronic analysis for THIAMETHOXAM                NHANES 2003-2008 2-day
Residue file name: 060109 Thiamethoxam 2017 Chronic Regroup Avg.R08
                                                  Adjustment factor #2 NOT used.
Analysis Date 06-26-2017/20:50:23     Residue file dated: 06-26-2017/20:44:22
Reference dose (RfD, Chronic) = .012 mg/kg bw/day
===============================================================================
                     Total exposure by population subgroup
-------------------------------------------------------------------------------
```

Population Subgroup	Total Exposure mg/kg body wt/day	Total Exposure Percent of Rfd
Total US Population	0.002490	20.8%
Hispanic	0.002448	20.4%
Non-Hisp-White	0.002525	21.0%
Non-Hisp-Black	0.002155	18.0%
Non-Hisp-Other	0.002936	24.5%
Nursing Infants	0.002138	17.8%
Non-Nursing Infants	0.005979	49.8%
Female 13+ PREG	0.002266	18.9%
Children 1-6	0.004808	40.1%
Children 7-12	0.002578	21.5%
Male 13-19	0.001826	15.2%
Female 13-19/NP	0.001853	15.4%
Male 20+	0.002140	17.8%
Female 20+/NP	0.002368	19.7%
Seniors 55+	0.002294	19.1%
All Infants	0.004793	39.9%
Female 13-50	0.002226	18.5%
Children 1-2	0.005812	48.4%
Children 3-5	0.004420	36.8%
Children 6-12	0.002758	23.0%
Youth 13-19	0.001839	15.3%
Adults 20-49	0.002221	18.5%
Adults 50-99	0.002314	19.3%
Female 13-49	0.002223	18.5%

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 060109
DP Barcode: 439307

MEMORANDUM

DATE: November 29, 2017

SUBJECT: **Thiamethoxam** – Transmittal of the Preliminary Aquatic and Non-Pollinator Terrestrial Risk Assessment to Support Registration Review

TO: Thomas Harty, Chemical Review Manager
Ricardo Jones, Team Leader
Neil Anderson, Branch Chief
Risk Management and Implementation Branch I
Pesticide Re-evaluation Division (7508 P)

FROM: Ryan Mroz, Biologist
Christopher Koper, Chemist
Kristina Garber, Senior Science Advisor
Environmental Risk Branch 1
Environmental Fate and Effects Division (7507 P)

Digitally signed by RYAN MROZ Date: 2017.11.29 08:57:31 -05'00'

DN: cn=Christopher M. Koper, o=USEPA, ou=OCSPP/OPP/EFED/ERB1, email=koper.christopher@epa.gov, c=US Date: 2017.11.29 09:05:57 -05'00'

KRISTINA GARBER Digitally signed by KRISTINA GARBER Date: 2017.11.29 11:11:48 -05'00'

THRU: Sujatha Sankula, Branch Chief
Greg Orrick, Risk Assessment Process Leader
Environmental Risk Branch 1
Environmental Fate and Effects Division (7507 P)

Sankula, Sujatha Digitally signed by Sankula, Sujatha Date: 2017.11.29 11:45:29 -05'00'

2017.11.29 13:11:55 -05'00'

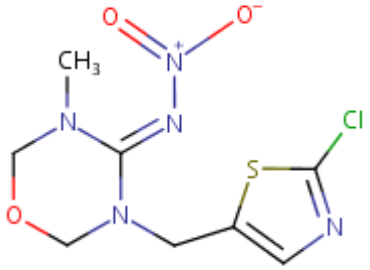
This memo transmits the Preliminary Aquatic and Non-Pollinator Terrestrial Risk Assessment to support the Registration Review of Thiamethoxam. This assessment reflects information currently available to the Environmental Protection Agency for assessing the risks of thiamethoxam agricultural and non-agricultural uses to aquatic taxa and non-pollinator terrestrial taxa.

A separate document for assessing risk of clothianidin and thiamethoxam to bees was previously completed (1/5/2017, DP Barcode 437097) and is available in the public docket EPA-HQ-OPP-2011-0865-0173 at www. regulations.gov.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND
POLLUTION PREVENTION

Preliminary Risk Assessment to Support the Registration Review of Thiamethoxam



Thiamethoxam
IUPAC: 3-(2-Chloro-thiazolyl-5-ylmethyl)-5-methyl-[1,3,5]oxadiazinan-4-ylidene-N-nitroamine
PC code: 060109
CAS: 153719-23-4

November 29, 2017

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Executive Summary

Overview

The purpose of this assessment is to determine potential risks from use of thiamethoxam to aquatic organisms, terrestrial vertebrates (*e.g.*, birds and mammals), and plants. Risks to bees from thiamethoxam agricultural uses were previously evaluated in 2017 (USEPA 2017; DP 437079). An upcoming updated bee risk assessment is scheduled for 2018 encompassing additional data, non-agricultural uses, and public comments. Thiamethoxam is a neonicotinoid insecticide, which acts on the insect nicotinic acetylcholine receptors (nAChRs) of the central nervous system via competitive modulation. The mode of action of thiamethoxam on non-target taxa (*e.g*., birds, plants) is unknown. Thiamethoxam is in the N-nitroguanidine group of neonicotinoids (IRAC subclass 4A)[1] along with imidacloprid, clothianidin and dinotefuran. Target pests include the chewing and sucking pests such as aphids, whiteflies, thrips, leafhoppers, scales, and leaf miners.

There are currently 80 registered Section 3 end-use products for thiamethoxam. Registered uses include a wide array of agricultural crops, including (but not limited to): root and tuber vegetables, leafy vegetables, brassica, cucurbits, fruiting vegetables, cereal grains, citrus fruit, pome fruit, stone fruit, berries, tree nuts, beans and other legumes, herbs, oilseed crops (*e.g.,* canola, cotton), and tobacco. Thiamethoxam is also registered for several non-agricultural uses, including ornamentals (Christmas trees), turf as well as perimeter/spot treatments.

Applications may be made via a variety of methods including aerial and ground foliar sprays, soil treatment (*e.g.*, drench), chemigation (*e.g.*, soil incorporation or foliar), and as a seed treatment. Maximum single foliar application rates for thiamethoxam range from 0.047-0.266 lb a.i./A. According to the most recent usage reports provided by the Biological and Economic Analysis Division (BEAD) on February 10, 2016 the majority of thiamethoxam used on agricultural crops is applied to soybeans (300,000 lbs/year on seeds), corn (300,000 lbs/year on seeds) and cotton (160,000 lbs/year on seeds and plants). It should be noted that usage data did not account for applications of thiamethoxam to non-agricultural uses.

In this risk assessment aquatic and terrestrial exposure modeling was not conducted for all registered crops/use sites. Rather, the crops/uses modeled were based on several lines of reasoning including: 1) agricultural crops which based on previous risk assessments presented a potential risk to honey bees (*i.e*., citrus, cotton, cucurbits; USEPA 2017a); 2) representation of major uses for thiamethoxam based on available usage information (*i.e*., seed treatments); 3) bracket a low and high-end range of estimated environmental concentrations (EECs) (*i.e*., rice, grapes); 4) representation of non-agricultural registered uses which account for some of the highest application rates (*i.e*., turf, ornamentals); and 5) grouping uses with similar application rates and scenarios (particularly for the terrestrial exposure component).

For aquatic modeling of foliar and soil applications, the crops modeled are designed to represent the various crop groups (*i.e.*, potatoes represent root and tuber vegetables, tree fruit and nuts represent pome fruit, stone fruit, and tree nuts, turf and ornamental represent non-agricultural uses, forestry represents ornamental shade trees, etc.). Additionally, for seed treatments, sugar beets were modeled

[1] http://www.irac-online.org/modes-of-action/

to represent vegetables, wheat to represent all cereal grains, cotton to represent oilseed crops, and the remainder to represent the individual crops for which they are named. While the application rates may not exactly match for the surrogate crop and what they were designed to represent, they were selected to approximate high-end exposures.

Risk Conclusions Summary

The primary risk concerns to aquatic taxa identified in this assessment involve chronic exposures to freshwater aquatic invertebrates (insects in particular). Risks are identified across a variety of use patterns, applying to foliar and soil treatments and to seed treatment on rice. There are also risk concerns for acute exposures to freshwater aquatic invertebrates from use on treated rice seed. Chronic risk concerns for aquatic insects result from exceedances of effect levels on larval survival. Effect levels are also exceeded frequently (10-29 years over a 30-year period) for foliar treatments, suggesting yearly variations (*e.g*., weather) do not change risk potential. Thiamethoxam concentrations measured in ambient monitoring programs are on the same magnitude as EECs, and also exceed chronic insect toxicity endpoints, supporting the risk conclusions that that environmentally relevant concentrations of thiamethoxam could be sufficient to result in growth impacts to aquatic insects.

The primary risk concerns to terrestrial taxa identified in this assessment involve risks to organisms foraging on thiamethoxam treated seed. Overall, acute risks to non-listed birds and mammals from foliar and soil treatments appear to be low, although a few acute LOC exceedances for listed species and from these use patterns are noted. Dietary intake of thiamethoxam treated seeds result in the highest acute and chronic LOC exceedances from the terrestrial risk assessment to birds and mammals. Larger seeds with lower application rates (*e.g.* soybean seeds) result in lower potential for risks to both birds and mammals than smaller seeds with higher per seed application rates (*e.g.* sugar beet seeds).

Potential risks to fish (surrogates for aquatic-phase amphibians) and terrestrial and aquatic plants are anticipated to be low.

The range of risk quotients (RQs) for each taxon is provided in **Table 1,** along with additional lines of evidence.

Environmental Fate and Exposure Summary

Thiamethoxam's primary transport routes from treated sites to non-target areas include spray drift (for foliar applications) and runoff (for all application methods). Thiamethoxam is mobile to moderately mobile in soil (Koc values range 33-178 L/kg-oc) and is soluble (4100 mg/L at 25°C) in water. Volatilization is not considered a major dissipation route based on the vapor pressure (4.95 x 10^{-11} mm Hg) and Henry's Law Constant (4.63 x 10^{-15} atm m^3/mol). The n-octanol-water partition coefficient (log Kow = -0.13) for thiamethoxam indicates a low potential for bioaccumulation. In terrestrial habitats, thiamethoxam is persistent, with half-lives on the orders of months (soil photolysis: 2.7-3.2 months; aerobic soil metabolism: 1.1-15.5 months). In aquatic habitats, thiamethoxam is less persistent, with aerobic aquatic metabolism half-lives on the order of weeks (2.3-5.0). In clear or basic water bodies, thiamethoxam may break down more quickly (aqueous photolysis half-lives 3.4-3.9 d; hydrolysis half-lives at pH 9 = 4.2-8.4 d).

Aquatic exposure concentrations were derived considering applications of thiamethoxam alone and did not consider degradation products. Thiamethoxam degrades into clothianidin (PC: 044309), a separate

active ingredient (a.i.) in the neonicotinoid class of chemicals which is subject to its own risk assessment. Assessing risks from exposure of both chemicals was considered; however due to the parent persistence and minimal impact on modeled concentrations (increase of 10^{-2}ppb) and subsequent risk estimations when considering both chemicals clothianidin was not further considered. Additional major degradates of thiamethoxam were also not considered due to a combination of lack of expected toxicity or, like clothianidin, minimal expected impacts on estimated exposure concentrations.

Ecological Effects Summary

On an acute exposure basis, thiamethoxam is very highly toxic (*i.e.*, LC50<100 µg a.i./L) to aquatic invertebrates. Tested insect species (class Insecta) are more sensitive on an acute exposure basis compared to tested species in other classes (*e.g.*, daphnids and mysid shrimp). By comparison, fish and aquatic plants are several orders of magnitude less sensitive following acute exposure, with LC50 and EC50 values >100,000 and >90,000 µg a.i./L, respectively. On a chronic exposure basis, a decrease in survival was observed in aquatic insects exposed to 2.23 µg a.i./L, resulting in a NOAEC of 0.74. As with acute exposure, daphnids and mysid shrimp are orders of magnitude less sensitive when exposed to thiamethoxam on a chronic exposure basis. In the most sensitive fish chronic study, 5% decreased length was observed at 4100 µg a.i./L (NOAEC = 1.7).

In terrestrial organisms, thiamethoxam is characterized as slightly toxic to birds on an acute oral exposure basis (LC_{50} = 576 mg/kg-bw/day) and practically non-toxic on a subacute dietary exposure basis (LC_{50} > 5200 mg/kg-diet). Weight loss was seen in a chronic avian reproductive study in parental males at 900 mg/kg-diet (NOAEC 300 mg/kg-diet). The most sensitive avian species is the mallard duck for both acute and chronic exposures. With respect to mammals, thiamethoxam is considered slightly toxic (LD_{50} = 1563 mg/kg-bw) on an acute oral basis, and in a chronic exposure reproduction test reduced weight gain was seen in offspring at 158 mg/kg-bw/day (NOAEL 61 mg/kg-bw/day). Generally minimal effects are seen in plant studies; however, some effects on plant height was observed in dicots: oilseed cucumber) IC_{25} and NOAEC 0.28 lb a.i./A and 0.061 lb a.i./A while cucumber IC_{25} and NOAEC values were 0.028 lb a.i./A and <0.017.

Data Gaps/Uncertainties

There are no major gaps related to the environmental fate or toxicity databases. No acceptable data have been submitted to fulfill the requirement for acute oral toxicity data for a passerine species; however, sufficient avian toxicity data are available to complete the risk assessment.

For risks to terrestrial organisms consuming treated seeds, there are several uncertainties with respect to dietary consumption of seeds; notably seeds are available, palatable, consumed as 100% of the diet. These factors can impact risk concerns for foraging birds and mammals; however, due to low estimated numbers of ingested seeds (*e.g.*, corn, cotton, sugarbeet) required to reach levels of concern (LOCs), there are still potential risks to terrestrial animals from consuming treated seeds. Additional consideration is given to seed size where some seeds are considered too large for certain passerine size classes to consume (corn, soybean, and cotton seeds).

All environmental fate data requirements have been fulfilled. This ecological risk assessment was based on maximum labeled application rates and use patterns. To the extent that actual application rates in the field are less than the labeled maximums, actual exposures would be lower. The first application of thiamethoxam was assumed to occur on the 15th day of the wettest month during the typical

application period for thiamethoxam. Depending on the precipitation during other times of the year when thiamethoxam could be applied, EECs could be higher or lower. The EECs for rice were developed using the Pesticide Flooded Application model (PFAM) and reflect exposure concentrations in the paddy. While these levels could potentially occur in a rice paddy and in waterbodies just outside of a release, they are not reflective of waterbodies where complete mixing and dilution have occurred.
While monitoring data for thiamethoxam indicated lower levels in surface water than those modelled, the monitoring data may not have been targeted specifically in thiamethoxam use areas or during times of known thiamethoxam use, and as such may not reflect potential peak thiamethoxam concentrations that may occur in surface waters when runoff events occur shortly after application. Adding to this uncertainty, the reporting limits for some of the data has varied over the years or was not reported, so it is uncertain if reported non-detects are instances when thiamethoxam is absent in the waterbody.

Table 1. Summary of Risk Concerns to Taxonomic Groups from Thiamethoxam.

Taxa	Exposure Duration	RQ range	RQ Exceeding the LOC?	Additional Information (i.e. Data gaps/ Refinements/ Lines of evidence)
FW Invertebrates	Acute	PWC: 0.01-0.17; Rice: 0.12-1.9	Yes (rice seed); No (all other uses)	No RQs exceed the non-listed species LOC except use on rice seed, while some RQs for foliar, soil and seed treatment uses exceed listed species LOC for invertebrates in water column.
	Chronic	PWC: 0.01-5.1; Rice seed: 5.1-48	Yes	RQs for all modeled foliar and soil uses, except cranberries, exceed the LOC (for both non-listed and listed species) for invertebrates. For seed treatment, only RQs for rice exceed the LOC. RQs are based on insect toxicity data as the most sensitive taxa. The most sensitive toxicological endpoint for insects was reduced survival of larvae. In addition to RQs, other lines of evidence support the risk concerns for aquatic invertebrates. First, EECs for several foliar and soil uses exceed the LOAEC for chronic effects (decreased larval survival). Second, concern levels (NOEC) were exceeded for multiple years of the 30-year simulation for foliar applications to cotton. Third, monitoring data exceed chronic LOAEC value. Risks are not necessarily indicated for all aquatic invertebrates. Non-insect (*e.g.*, waterflea, mysid shrimp) tested species are orders of magnitude less sensitive (such that risk is not indicated). When considering the risk profile for thiamethoxam on the basis of usage, the majority of pounds applied per year is as seed treatments on soybeans, corn and cotton and foliar or soil treatments to cotton. RQs for seed treatment uses on corn, cotton and soybean are below LOCs, indicating low risk for these uses. RQs for foliar applications to cotton are above LOC. It should be noted that because of the seed planting depth>2 cm for corn, EECs and resulting RQs were 0 because seeds were under the assumed run-off zone.
SW Invertebrates	Acute	<0.01	No	None
	Chronic	<0.01	No	None
FW Fish	Acute	<0.01	No	None
	Chronic	<0.01	No	None
SW Fish	Acute	<0.01	No	None
	Chronic	<0.01	No	None
	Acute	Foliar/Soil: <0.47	No	No RQs exceeded the non-listed LOC for foliar/soil uses

Taxa	Exposure Duration	RQ range	RQ Exceeding the LOC?	Additional Information (i.e. Data gaps/ Refinements/ Lines of evidence)
Birds, terrestrial amphibians and reptiles[1]		Seed: 0.06-29.6	Yes	Corn is considered too large for small/med and cotton for small sized passerine consumption; therefore, low risk of passerine dietary exposure. Risk concerns to non-listed species include small/med non-Passeriformes birds for modeled corn and cotton uses, med passerines consuming cotton, and all size classes of birds consuming sugarbeet seeds (or small vegetable seeds). The number of seeds that need to be consumed to reach the non-listed acute LOC for small to large birds: Corn (2-15); Cotton (8-50); Sugar beet (4-368). There are no non-listed exceedances for use on soybean and this seed is also considered too large for passerine consumption.
	Chronic	Foliar/Soil:<0.19	No	None
		Seed: 1.7-117	Yes	Risk concerns are noted for all size classes of birds from all seed treatment uses. Exceptions are noted for small/med passerines potentially consuming corn and soybean seeds and small passerines consuming cotton seeds as these seeds are considered too large to consume by these birds.
Mammals[1]	Acute	Foliar/Soil: <0.02	No	None
		Seed: <0.01-2.16	Yes	Acute risk concerns for all size classes uses on small treated vegetable seeds (modeled sugarbeet uses).
	Chronic	Foliar/Soil:<0.46	No	None
		Seed: 0.36-55.33	Yes	RQs exceed the chronic LOC for all mammalian size classes consuming treated seeds except soybean (no exceedances).
Aquatic plants (vascular)	N/A	<0.01	No	None
Aquatic plants (non-vascular)	N/A	<0.01	No	None
Terrestrial plants (monocots)	N/A	NC	No	EC_{25} is non-definitive (>); RQs are below the LOC based on a more conservative NOAEC value.
Terrestrial plants (dicots)		<0.1-4.83	Yes	Two different studies with cucumber produced EC_{25} values of >0.265 and 0.028 (resulting in RQ of 4.8). Risks are unlikely when considering the EC_{25} value of > 0.265 lb a.i./A (results in RQ <0.1) and when considering minimal plant effects seen in these studies.

[1] RQs and risk conclusions are based on a dietary exposure route.
RQ=risk quotient; N/A=not applicable; NC=not calculated; FW = Freshwater; SW = Saltwater;
Chronic risk LOC = 1.0 for terrestrial animals; Acute risk LOC for non-listed terrestrial species = 0.5; Acute risk LOC for non-listed aquatic animals = 0.5; Aquatic and terrestrial plant risk LOC = 1.0.

1. Problem Formulation

The problem formulation serves as the first step of a risk assessment and it provides the foundation for the entire ecological risk assessment. In addition to identifying the risk assessment scope and objectives, the problem formulation includes three major components: (1) assessment and measurement endpoints that reflect management goals and the ecosystem they represent, (2) conceptual models that describe key relationships between a stressor (*i.e.*, pesticide) and assessment endpoint or between several stressors and assessment endpoints, and (3) an analysis plan that summarizes the key sources of data and methods to be used in the risk assessment (USEPA 1998).

1.1. Registration Review Background

As articulated by the Agency's Registration Review Schedule, the nitroguanidine-substituted neonicotinoid insecticides (imidacloprid, clothianidin, thiamethoxam, dinotefuran) are currently undergoing Registration Review[2]. The first installment of the Registration Review process for thiamethoxam was the publication of the Problem Formulation and Preliminary Work Plan documents in 2011, (USEPA 2011a, 2011b). These documents summarized the available data on ecological effects and environmental fate of thiamethoxam, identified key data gaps, and set forth a schedule for obtaining these data and completing the ecological risk assessment. Following its receipt and response to public comments, the Agency published a Final Work Plan in 2012 (USEPA 2012). In 2013, a Generic Data Call-In (GDCI) was issued (USEPA 2013) that required registrants to submit certain types of environmental fate and effects data in preparation for the forthcoming Preliminary Ecological Risk Assessment document. In January 2017, EPA completed a risk assessment focused on the risks of thiamethoxam to bees applied to agricultural sites (USEPA 2017). An updated bee risk assessment is anticipated to be published in 2018 to include additional data received, non-agricultural uses, and incorporating any relevant comments received (e.g., during the public comment period).

1.2. Nature of the Chemicals Stressor and Scope of Assessment

The focus of this Preliminary Ecological Risk Assessment is on the risk of registered agricultural and non-agricultural thiamethoxam uses to aquatic organisms, specifically fish, invertebrates and plants, as well as for birds, mammals and terrestrial and wetland plants. This assessment utilizes an approach producing quantitative assessments from several representative crop use patterns to bridge or cover risk conclusions to the aforementioned taxon groups for all registered uses. Both the aquatic and terrestrial exposure and effects assessments will model similar use patterns to be protective of all uses based on crop usage data, application type, and application rates. Further characterization is added where necessary if the use patterns modeled are expected to be over or under protective.

1.2.1. Overview of Pesticide Usage

Thiamethoxam may be applied to crops via a variety of methods including aerial and ground foliar sprays, soil treatment (*e.g.*, drench), chemigation (*e.g.*, soil incorporation or foliar), and as a seed treatment. Thiamethoxam is used on a wide array of agricultural crops, including (but not limited to): root and tuber vegetables, leafy vegetables, brassica, cucurbits, fruiting vegetables, cereal grains, citrus fruit, pome fruit, stone fruit, berries, tree nuts, beans and other legumes, herbs, oilseed crops (*e.g.,* canola, cotton), and tobacco. There are also a wide variety of non-agricultural uses of thiamethoxam,

[2] Thiamethoxam docket can be found at: https://www.regulations.gov/docket?D=EPA-HQ-OPP-2011-0581

including turf, lawns and ornamentals[3]. There are currently 80 registered Section 3 end-use products for thiamethoxam and 3 technical/manufacturing product labels. For agricultural uses, the maximum single application rates allowed for thiamethoxam are 0.09 lb a.i./A (pounds of active ingredient per acre) for foliar application and 0.266 lb a.i./A for soil applications. Seed treatment applications are variable based on seed size and seeding rate, but these are such that the maximum amount of a.i/A should not exceed 0.266 lb a.i./A. The turf and non-agricultural uses on ornamentals application rates are in line with application rates for agricultural uses, not exceeding 0.266 lb a.i./A. A detailed summary of registered agricultural and non-agricultural uses of thiamethoxam to be included in this assessment is provided in Section 2.1.1 and this is adapted from the details in the stand alone problem formulation document (USEPA 2011a).

1.2.2. Pesticide Type, Class and Mode of Action

Thiamethoxam (IUPAC name: (3-(2-Chloro-thiazolyl-5-ylmethyl)-5-methyl- [1,3,5]oxadiazinan-4-ylidene-N-nitroamine)) is a systemic, neonicotinoid insecticide which acts on the insect nicotinic acetylcholine receptors (nAChRs) of the central nervous system via competitive modulation (IRAC 2015). Thiamethoxam is in the N-nitroguanidine group of neonicotinoids (IRAC subclass 4A) along with imidacloprid, clothianidin, and dinotefuran.[4] The mode of action on target insects (terrestrial and aquatic) involves out-competing the neurotransmitter, acetylcholine for available binding sites on the nAChRs (Zhang *et al*. 2008). At low concentrations, neonicotinoids cause excessive nervous stimulation and at higher concentrations, insect paralysis and death will occur (Tomizawa and Casida 2005). Thiamethoxam is systemic; as such, it kills feeding insects via ingestion or direct contact routes of exposure. Target pests include the chewing and sucking pests such as aphids, whiteflies, thrips, leafhoppers, scales, and leaf miners.

1.2.3. Overview of Physicochemical, Fate, and Transport Properties

Section 2.1.3 provides a detailed discussion of the physicochemical, fate, and transport properties of thiamethoxam. Briefly, thiamethoxam is a water soluble chemical with low vapor pressure and Henry's Law Constants. These properties suggest that the chemical will be readily soluble for movement with water and that it is unlikely to volatilize to a meaningful degree. The organic carbon partition coefficient (Koc) values indicate thiamethoxam is mobile to moderately mobile in soil. In addition, the organic carbon: water partitioning coefficient (K_{ow}) for thiamethoxam is low which suggests it is unlikely to bioaccumulate in living tissues. The major routes transporting thiamethoxam from treatment sites to off-site habitats include runoff and spray drift.

The dominant transformation process for thiamethoxam is photolysis (days in water; months in soil). Aerobic soil transformation is slow (half-life values are on the order of months to more than a year) and therefore, thiamethoxam is expected to persist in the soil system. Photodegradation may occur on soil surfaces following soil application and on wet foliage in the case of foliar application; photolysis on dry soil appears to be slower. In plants, thiamethoxam may be taken up via the roots or across plant stems and leaves. Thiamethoxam is considered xylem mobile, with dominant uptake routes following the

[3] Other non-agricultural uses include indoor and outdoor uses that were either baits, spot treatments, void treatments, crack or crevice treatments, perimeter treatments, or wood protection treatment by pressure. Wood protection products are evaluated in EFED's registration review ecological risk assessment; these antimicrobial uses will be evaluated by the Antimicrobial Division

[4] http://www.irac-online.org/

transpiration stream (i.e., no downward transport from leaves to roots). Although xylem mobile, numerous field studies have demonstrated thiamethoxam applied via foliar, soil or seed treatment methods can result in residues in pollen and nectar of blooming plants indicating it is phloem mobile as well, and available data suggest that thiamethoxam is metabolized within plants to form clothianidin.

1.3. Ecological Receptors

The receptor is the biological entity that is exposed to the stressor (US EPA, 1998). As indicated previously, this assessment focuses on all ecological taxa, excluding terrestrial invertebrates. Accordingly, aquatic receptors potentially at risk include (but are not limited to): invertebrates (*e.g.*, aquatic insects, mollusks, crustaceans, and worms) as well as fish, amphibians, and vascular/non-vascular plants. While terrestrial receptors include birds, mammals, and plants. Birds are also used as surrogates for terrestrial-phase amphibians and reptiles. Bees were assessed in a separate document (USEPA 2017a).

Consistent with the process described in the Overview Document (US EPA, 2004), this risk assessment uses the surrogate species approach in its evaluation of thiamethoxam. Toxicological data generated from surrogate test species, that are intended to be representative of broad taxonomic groups, are used to extrapolate to potential effects on a variety of species (receptors) among these taxonomic groupings.

Acute and chronic toxicity data from studies submitted by pesticide registrants along with data from the available open literature are used to evaluate potential direct effects of thiamethoxam to the aquatic and terrestrial receptors identified in this section. The open literature studies are identified through EPA's ECOTOX database (http://cfpub.epa.gov/ecotox/), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife.

1.4. Ecosystems Potentially at Risk

The ecosystems at potential risk from thiamethoxam are extensive in scope due to the wide geographic distribution of potential thiamethoxam application sites. Aquatic ecosystems potentially at risk include water bodies adjacent to (or downstream from) the treatment area and might include: static water bodies such as ponds, lakes, and wetland areas, impounded water bodies such as reservoirs or flowing waterways such as streams and rivers. For uses in coastal areas, aquatic habitat also includes marine ecosystems, including estuaries and salt marshes. Terrestrial ecosystems potentially at risk could include the treated area and immediately adjacent areas that may receive drift or runoff. Areas adjacent to the treated area could include cultivated fields, fencerows and hedgerows, meadows, fallow fields or grasslands, woodlands, riparian habitats and other uncultivated areas.

1.5. Assessment Endpoints

Assessment endpoints represent the actual environmental value that is to be protected, defined by an ecological entity (species, community, or other entity) and its attribute or characteristics (US EPA, 1998). For thiamethoxam, the ecological entities may include the following: aquatic animals (freshwater and estuarine/marine fish and invertebrates) and terrestrial animals (birds and mammals). The attributes for each of these entities may include growth, reproduction, and survival and are discussed further in Sections 2.7 and 3 (Ecological Effects Characterization).

1.6. Conceptual Model

For a pesticide to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a pesticide moves in the environment from a source to an ecological receptor. For an ecological pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure. A conceptual model is used in this risk assessment to provide a written and visual description of the predicted relationships between thiamethoxam, potential routes of exposure, and the predicted effects for the assessment endpoint. A conceptual model consists of two major components: risk hypotheses and a conceptual diagram (US EPA, 1998).

1.6.1. Potential Exposure Routes

Based on the preliminary iterative process of examining fate and effects data, the conceptual model from the 2011 problem formulation for the risk hypothesis model for foliar spray, soil, and seed treatment application is referenced (USEPA 2011a) and identifies: (1) likely stressors/exposure pathways and (2) organisms that are most relevant and applicable to this assessment. Primary exposure routes for aquatic organisms include spray drift and runoff of thiamethoxam into nearby bodies of water. Once in the water, the primary exposure route to aquatic organisms is direct uptake across respiratory membranes. For terrestrial animals, the major route of exposure is via diet, such as through consumption of plant leaves or insects, which contain thiamethoxam residues as a result of direct application and/or spray drift. However, exposure from inhalation of spray droplets and from ingestion of contaminated drinking water is also considered. The potential for thiamethoxam to bioaccumulate in living tissues is determined to be low based on its log K_{OW}.

1.6.2. Risk Hypothesis

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.*, changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (EPA 1998). The ensuing risk assessment will evaluate whether or not the specific risk hypotheses are supported. For foliar, soil, and seed treatment applications of thiamethoxam, the following ecological risk hypothesis is being employed for this risk assessment:

> *Based on the environmental fate, specifically the solubility, mobility, and persistence of thiamethoxam as well as its broad range of registered uses and application methods, there is a potential that aquatic and terrestrial organisms will be exposed when thiamethoxam is used in accordance with the label. Consequently, considering the MOA and toxicity of thiamethoxam, the registered uses have the potential to cause adverse effects upon the survival, growth, and reproduction of non-target aquatic and terrestrial organisms.*

1.7. Analysis Plan

The analysis plan provides a rationale for selecting and omitting risk hypotheses in the risk assessment. As with any risk assessment process, the analysis plan also articulates data gaps, the methods used to evaluate existing and anticipated data, and the assumptions that will be made where data may be missing. The analysis plan also identifies the specific measures of exposure (*e.g.*, estimated

environmental concentrations; EECs) and effect (*e.g.*, median lethal dose for 50% of the organisms tested; LD_{50}) which will be used to develop risk quotients.

1.7.1. Methods of Conducting Ecological Risk Assessment

The primary method used to assess risk in this preliminary assessment is the risk quotient (RQ) and follows closely methods outlined in the EPA Overview Document (USEPA, 2004). The RQ is the risk value for this preliminary assessment and is the result of comparing measures of exposure to measures of effect. A commonly used measure of exposure is the estimated exposure concentration (EEC) and commonly used measures of effect include toxicity values such as the median lethal dose to 50% of the organisms tested (LD_{50}), medial lethal concentration to 50% of tested organisms (LC_{50}), the no observed adverse effect level (NOAEL)[5], and the no observed adverse effect concentration (NOAEC). The resulting ratio of the point estimate of exposure and the point estimate of toxicity, *i.e.*, the RQ, is then compared to a specified level of concern (LOC), which represents a threshold for concern; if the RQ exceeds the LOC, risks concerns are triggered. Risk presumptions, along with the corresponding RQs, equations, and LOCs are summarized in **Section 4**. Generation of robust RQs is dependent on the quality of data from both fate and toxicological studies. The adequacy of the submitted data was evaluated relative to Agency guidelines.

1.7.2. Measures of Exposure

Measures of exposure are estimates for a receptor that can be determined by modeling or monitoring data. Measures of exposure for thiamethoxam are obtained from both modeling and available monitoring data.

Estimated environmental concentrations (EECs) in aquatic habitats were generated using EFED's standard tools, the Pesticide in Water Calculator (PWC) graphical user interface (GUI) which integrates the Pesticide Root Zone Model (PRZM5) and the Variable Volume Water Model (VVWM) and the Pesticide Flooded Application Method (PFAM; Version 2) model for rice and cranberry applications to estimate aquatic exposure concentrations[6]. PWC estimates pesticide movement and transformation on an agricultural field and in the receiving surface water body (*i.e.*, EPA standard pond), for terrestrial use sites and PFAM was developed specifically to estimate exposure for pesticides used in flooded agriculture such as rice paddies. PFAM was also used to estimate exposure for a periodic flooded cranberry bog and wet-harvest of cranberry.

Terrestrial wildlife is potentially exposed to thiamethoxam via consumption of residues on food items. For spray applications, the T-REX model (Terrestrial Residue EXposure model; v. 1.5.2; June 6, 2013b) is used to predict dietary exposure to thiamethoxam residues on foliar surfaces and insects using the Kenaga nomogram as modified by Fletcher (Hoerger and Kenaga 1972, Fletcher *et al*. 1994). In this assessment, a default foliar dissipation half-life of 35 days is used for terrestrial modeling purposes since suitable foliar dissipation data specific to thiamethoxam are not available. For soil treatments the LD_{50}/ft^2 methodology using default assumptions about incorporation (0%) as well as residues on arthropod dietary times in T-REX are used to estimate exposure from treated soil. For seed treatments, T-REX is also used to assess exposures and associated risks to granivore birds and mammals. In areas

[5] A NOAEL refers to a dose-based toxicity endpoint whereas a NOAEC refers to a concentration based endpoint.
[6] www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment

where risks are identified, refinements are made based on EFED's interim guidance on assessing risks through seed treatments. The model used to derive EECs and RQs relevant to terrestrial and wetland plants is TerrPlant (v.1.2.2; 10/29/2009). The AgDRIFT spray drift model (v2.1.1) is used to assess exposures of organisms to thiamethoxam deposited by spray drift onto areas adjacent to the treated field/orchard.

1.7.3. Measures of Effect

Measures of ecological effects are obtained from a suite of registrant-submitted guideline studies conducted with a limited number of surrogate species. The test species are not intended to be representative of the most sensitive species but rather were selected based on their ability to thrive under laboratory conditions. Measures of effect are based on deleterious changes in an organism as a result of chemical exposure. Functionally, measures of effect typically used in risk assessments include changes in survival, reproduction, or growth as determined from standard laboratory toxicity tests. The focus on these effects for quantitative risk assessment is due to their clear relationship to higher-order ecological systems such as populations, communities, and ecosystems. Monitoring data such as adverse effect incident reports may also be used to provide supporting lines of evidence for the risk characterization.

In addition, effects other than survival, reproduction, and growth may be considered, though rarely are they used quantitatively to estimate risks since, in many cases, the relationship between these effects and higher-order processes is undefined. Commonly used laboratory-derived toxicity values include estimates of acute mortality (*e.g.*, LD_{50}, LC_{50}) and estimates of effects due to longer term, chronic exposures (*e.g.*, NOAEC, NOAEL). The latter can reflect changes seen in mortality, reproduction, or growth. In general, for a given assessment endpoint the lowest (*i.e.*, most sensitive) relevant measure of effect is used in calculating the RQ. Assessment endpoints and their respective measures of effect are listed in **Table 2.**

Table 2. Summary of Assessment and Measurement Endpoints used in this assessment

Assessment Endpoint	Measures of Exposure	Measures of Effect
1. Survival and reproduction of individuals and communities of freshwater fish[2] and invertebrates.	1-d EEC (acute), 21-d & 60-d surface water EEC (chronic)[1]	1a. Most sensitive freshwater fish acute LC_{50}. 1b. Most sensitive freshwater fish early life stage chronic NOAEC and LOAEC. 1c. Most sensitive freshwater invertebrate acute EC_{50}/LC_{50}. 1d. Most sensitive freshwater invertebrate chronic reproduction NOAEC and LOAEC.
2. Survival and reproduction of individuals and communities of estuarine/marine fish and invertebrates.	1-d EEC (acute), 21-d & 60-d surface water EEC (chronic)[1]	2a. Most sensitive estuarine/marine fish acute LC_{50}. 2b. Most sensitive estuarine/marine fish early life stage chronic NOAEC and LOAEC. 2c. Most sensitive estuarine/marine invertebrate acute EC_{50}/LC_{50}. 2d. Most sensitive estuarine/marine invertebrate chronic reproduction NOAEC and LOAEC.

Assessment Endpoint	Measures of Exposure	Measures of Effect
3. Growth of aquatic plants	1-d EEC[1]	3a. Most sensitive non-vascular plant EC_{50} 3b. NOAEC or EC_{05} associated with species tested in 3a. 3c. Most sensitive vascular plant EC_{50} 3d. NOAEC or EC_{05} associated with species tested in 3c.
4. Survival and reproduction of individuals and communities of birds[3] and mammals.	Peak EEC	4a. Most sensitive avian acute LD_{50} (dose-based). 4b. Most sensitive avian acute LC_{50} (dietary-based). 4c. Most sensitive avian chronic reproduction NOAEC and LOAEC. 4d. Most sensitive mammalian LD_{50}. 4e. Most sensitive mammalian (rat) chronic reproduction NOAEC/NOAEL and LOAEC/LOAEL.
5. Growth of terrestrial and wetland plants	Peak runoff + drift EEC	5a. Most sensitive dicot plant EC_{50} from seedling emergence test 5b. NOAEC or EC_{05} associated with species tested in 5a. 5c. Most sensitive monocot plant EC_{50} from seedling emergence test 5d. NOAEC or EC_{05} associated with species tested in 5c.
6. Growth of terrestrial and wetland plants	Drift EEC	6a. Most sensitive dicot plant EC_{50} from seedling emergence or vegetative vigor test 6b. NOAEC or EC_{05} associated with species tested in 6a. 6c. Most sensitive monocot plant EC_{50} from seedling emergence or vegetative vigor test 6d. NOAEC or EC_{05} associated with species tested in 6c.

LD_{50} = Lethal dose to 50% of the test population; NOAEC = No-observed-adverse-effect level; LOAEC = Lowest-observed-adverse-effect level; LC_{50} = Lethal concentration to 50% of the test population; EC_{50} = Effect concentration to 50% of the test population.
[1] Based on a 1-in-10-year return frequency.
[2] In the absence of data, freshwater fish may be used as surrogates for aquatic-phase amphibians in accordance with EFED risk assessment guidance.
[3] In the absence of data, birds may be used as surrogates for terrestrial-phase amphibians and reptiles in accordance with EFED risk assessment guidance.

1.7.4. Stressors of Toxicological Concern

As will be discussed in Section 2.1.3, thiamethoxam may degrade into various compounds through multiple pathways. One of thiamethoxam's degradation products is clothianidin (PC code 044309; also referred to as CGA-322704), which is also a registered neonicotinoid insecticide. In the majority of the available fate studies, clothianidin is formed as a minor degradate (<10% of the applied dose); however, it was identified as a major degradate (>10% of applied residue) in four of eight aerobic soil metabolism

studies (18.9%,23.7%, 29.4%, 36.8%), one of two anaerobic soil metabolism studies (17.3%) as well as one of seven field dissipation studies (13.2%).

To evaluate how clothianidin formation may affect aquatic exposure concentrations, a total residue (thiamethoxam + clothianidin) approach was modeled based on the aerobic soil metabolism input parameter (only) as anaerobic soil metabolism and field dissipation studies do not contribute to model inputs. This changed the parent (thiamethoxam) only aerobic soil metabolism model half-life input (236 days) to stable. Comparison of the thiamethoxam versus the total residue model runs showed that the largest increase in acute aquatic exposure was 0.12 ppb which does not change the current risk estimations and conclusions based on a thiamethoxam only modeled exposure. Furthermore, clothianidin is currently being assessed at rates higher than what would be expected from clothianidin formation through thiamethoxam degradation (0.10 lb a.i/A)[7] , therefore, EECs used for this risk assessment are for parent thiamethoxam only.

Several other compounds were also identified as major degradate in most of the available fate studies including: CGA-353042, CGA-335190, NOA-404617 and NOA-407475. When considering degradates of potential toxicological concern, it is assumed that the toxicity associated with thiamethoxam is attributed to the presence of the N-nitro group.[8] Of the major degradates, only NOA-404617 maintains the N-nitro group, so, CGA-353042, CGA-335190, and NOA-407475 are assumed to be less toxic than the parent. The metabolite NOA-404617 was formed through hydrolysis under alkaline conditions (pH 9) (which is not accounted for in aquatic modeling) and in one aerobic aquatic metabolism study (where the half-life of thiamethoxam is already on the order of months). When the aerobic aquatic metabolism half-life is assumed to be stable, aquatic exposure 1-d, 21-d and 60-d EECs increase by as much as a factor of 2.8, 3.2 and 4.6 respectively, indicating little influence on EECs. Therefore, NOA-404617 was not included quantitatively in the EECs.

While both chemicals show a similar toxicity to fish, clothianidin shows greater toxicity to aquatic invertebrates than the parent thiamethoxam and similar toxicity to terrestrial organisms **(USEPA 2017b)**. However, all neonicotinoid insecticides are expected to exhibit a high toxicity to aquatic invertebrates, particularly insect larvae, in part due to the mode of action. Clothianidin was not formed in available aerobic aquatic metabolism studies and was formed at less than 3.8% in an anaerobic aquatic metabolism study. Due to low formation in the aquatic environment and already expected high toxicity to aquatic insects (parent), risk conclusions are not expected to significantly be changed by considering toxicity of both the parent thiamethoxam and clothianidin. Consequently, for aquatic organisms the parent thiamethoxam is considered the stressor of concern in this assessment.

As discussed in the bee risk assessment conducted for thiamethoxam and clothianidin (USEPA 2017), both thiamethoxam and clothianidin have been observed in plant tissues following applications of thiamethoxam via foliar, soil, and seed treatments. For terrestrial vertebrate risk assessments, the stressor of concern is thiamethoxam alone because 1) exposure is assessed based on peak applications of thiamethoxam (highly influenced by the day of application and less influenced by degradation), 2) a default foliar dissipation half-life of 35 d is used, and 3) thiamethoxam and clothianidin exhibit similar

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[7] Highest estimated application rate for clothianidin in this assessment: = highest thiamethoxam application rate (0.266 lb a.i/A) x maximum clothianidin formation (0.368) = 0.10 lb a.i/A

[8] The Metabolism Assessment
Review Committee (MARC) suggested that the toxicity associated with thiamethoxam was due to the presence of the N-nitro group (USEPA, 1999).

toxicity to birds, mammals, and plants. Both chemicals are systemic (i.e. translocated into plant materials from seed, soil, or foliar application) and there is an acknowledged uncertainty with respect to exposure of foraging birds and mammals to both thiamethoxam and clothianidin in treated plant materials; however, risk conclusions are not expected to be significantly altered for terrestrial organisms.

2. Exposure Assessment

2.1. Use Characterization

Exposure assessment for the registered uses of thiamethoxam begins with a detailed characterization of its labeled uses and current data on its usage across all crops (**Section 2.1**). Information regarding the fate and transport of thiamethoxam and its transformation products is also evaluated (**Section 2.1.3**). The labeled uses combined with environmental fate parameters serve as key inputs to the aquatic exposure modeling (**Section 2.2**). In addition to modeled concentrations, available data on concentrations of thiamethoxam measured in surface waters of the U.S. is also considered and evaluated (**Section 2.3**).

2.1.1. Thiamethoxam Labeled Use

Thiamethoxam may be applied to crops via a variety of methods including aerial and ground foliar sprays, soil treatment (*e.g.*, drench), chemigation (*e.g.*, soil incorporation or foliar), and as a seed treatment. Thiamethoxam is used on a wide array of agricultural crops, including (but not limited to): root and tuber vegetables, leafy vegetables, brassica, cucurbits, fruiting vegetables, cereal grains, citrus fruit, pome fruit, stone fruit, berries, tree nuts, beans and other legumes, herbs, oilseed crops (*e.g.,* canola, cotton), and tobacco. Additionally, there are non-agricultural uses including application to turf, ornamentals, and other spot/perimeter treatments[9]. There are currently 80 registered Section 3 end-use products for thiamethoxam.

Maximum single foliar and soil application rates allowed for thiamethoxam range from 0.05 to 0.265 lb a.i./A (pounds of active ingredient per acre) for most crops (**Table 3 and Table 4**). Thiamethoxam is also registered for use as a seed treatment on many crops (**Table 5**). In general, for the seed treatments, labels indicate that regardless of application method [e.g., application/seeding rate], to not apply more than 0.265 lb a.i./A/year. Where the table indicates "all registered uses" this language is intended to include the set or subset of actual registered crops within a crop group. It does not mean that all crops are registered for thiamethoxam within that crop group. The maximum application rates for non-agricultural uses is 0.265 lb a.i./A.

Table 3. Maximum rates for foliar applications of thiamethoxam

[9] Airports/landing fields, animal housing premises (indoor/outdoor), commercial/institutional industrial premises/equipment, commercial storages/warehouses premises, commercial transportation facilities, household/domestic dwellings, poultry feedlots, ships and boats, wood pressure treatment to forest products, wood protection treatment to buildings/products. Applications include both indoor and outdoor uses that were either baits, spot treatments, void treatments, crack or crevice treatments, perimeter treatments.

Use	Thiamethoxam			
	Max Single app rate (lb a.i./A)	# of apps	App. interval (d)	Method
AGRICULTURAL				
Crop Group 1 – Root and Tuber Vegetables				
Root and tuber vegetables, Crop Group 1 – Except listed below	0.05	2	7	a, g
Crop Subgroup 1A. Tuberous and corm vegetables subgroup: Sugar beet	0.05	2	7	a, g
Crop Subgroup 1b. Tuberous and corm vegetables subgroup (except sugar beet): Except listed below	0.063	2	7	a, g
Radish	0.063	1	N/A	a, g
Crop Subgroup 1C. Tuberous and corm vegetables subgroup: Potato	0.05	2	7	a, c, g
Crop Group 4 – Leafy Vegetables (Except brassica Vegetables)				
All registered uses	0.088	2	7	a, g
Crop Group 5 – Brassica (Cole) Leafy Vegetables				
All registered uses	0.088	2	7	a, g
Crop Group 6 - Legume Vegetables (Succulent or Dried)				
Soybeans	0.063	2	7	a, g
Crop Group 8 – *Fruiting Vegetables (Except Cucurbits)*				
All registered uses	0.088	2	7	a, g
Crop Group 9 – Cucurbit Vegetables				
All registered uses	0.088	2	5	a, g
Crop Group 11 – Pome Fruits				
All registered uses – Except listed below	0.086	3	10	g
Apple	0.071 (pre bloom)	3	10	g
Crop Group 12 – Stone Fruits				
All registered uses	0.088	2	10	g
Crop Group 13-07 – Berry and Small Fruit				
Crop Subgroup 13-07A. Caneberry Subgroup.	0.047	2	7	a, g
Crop Subgroup 13-07B. Bushberry Subgroup.	0.063	2	7	a, g
Crop Subgroup 13-07G. Low growing berries	0.063	3	10	g
Crop Subgroup 13-07H. Low growing berry subgroup, except strawberry. Cranberry	0.063	2	7	c, g
Crop Subgroup 13-07D. Small fruit vine climbing subgroup. and	0.055	2	14	a, g

Use	Thiamethoxam			
	Max Single app rate (lb a.i./A)	# of apps	App. interval (d)	Method
Crop Subgroup 13-07E. Small fruit vine climbing subgroup, except grape. Vine fruits				
Crop Subgroup 13-07F. Small fruit vine climbing subgroup except fuzzy kiwifruit. Grapes	0.056	2	14	a, g
Crop Group 14 – Tree nuts				
All registered uses	0.063	2	7	a, g
Crop Group 15 – Cereal Grains				
Barley	0.063	2	7	a, g
Crop Group 19 – Herbs and Spices				
Mint	0.063	3	14	a, g
Crop Group 20 – Oilseed				
Cotton	0.063	2	5	a, g
Crop Group 23 – Tropical and Subtropical Fruit, Edible Peel Group				
All registered uses	0.063	3	7	a, g
Crop Group 24 – Tropical and Subtropical Fruit, Inedible Peel Group				
All registered uses	0.063	3	7	a, g
Other Crops				
Artichoke	0.047	2	7	a, g
Tobacco	0.05	2	3	a, g
NON-AGRICULTURAL				
Turf	0.266	(1)	NS	g
Ornamentals	0.266	(1)	7	g

NS = Not Specified; NA = not applicable; g= ground; a= aerial; c=chemigation; () = assumed based on max labeled rate

Table 4. Maximum application rates for soil applications of thiamethoxam

Use	Thiamethoxam		
	Single app rate (lb a.i./A	# of apps	App. interval (d)
Crop Group 1 – Root and Tuber Vegetables			
All registered uses – Except listed below	0.18	1	--
Radish	0.1	1	--
Crop subgroup 1-C. Tuberous and corm vegetables	0.13	1	--
Crop Group 4 - Leafy Vegetables (Except Brassica Vegetables)			
All registered uses	0.17	1	--
Crop Subgroup 5-B - Brassica Leafy Greens Subgroup			
All registered uses	0.1	1	--
Crop Subgroup 8-10 – Fruiting Vegetables			

Use	Thiamethoxam		
	Single app rate (lb a.i./A	# of apps	App. interval (d)
All registered uses	0.17	1	--
Crop Group 9 - Cucurbit Vegetables			
All registered uses	0.17	1	--
Crop Group 10 – Citrus			
Citrus (FL)	0.17	1	--
Crop Group 13-07 – Berry and Small Fruit			
All registered uses -except listed below	0.19 (0.16)	1	--
Crop Subgroup 13-07G. Low growing berries (except cranberry) Strawberry			
Crop Subgroup 13-07F. Small fruit vine climbing subgroup except fuzzy kiwifruit. Grapes	0.27 (0.2)	1	--
NON-AGRICULTURAL			
Turf	0.266	(1)	NS
Ornamentals	0.266	(1)	7

NS = not specified; () = assumed based on max labeled rate

Table 5. Seed treatment uses and corresponding application rates registered for thiamethoxam.

Use	Thiamethoxam	
	lb a.i./seed	lb a.i./lb seed
Crop Group 1 – Root and Tuber Vegetables		
Carrot	1.1E-07	NA
Potato	NA	6.2E-05
Sugar Beet	1.6E-06	NA
Crop Group 3 – Bulb Vegetables		
Onion (including scallions, leeks and spring)	4.4E-07	NA
Crop Group 4 – Leafy Vegetables (Except brassica Vegetables)		
Leafy vegetables (Except Brassica), Crop Group 4	2.7E-06	NA
Amaranth, Chinese	2.7E-06	NA
Lettuce	1.3E-07	NA
Spinach	2.7E-07	NA
Corn salad	2.7E-06	NA
Crop Group 5 – Brassica (Cole) Leafy Vegetables		
Brassica leafy vegetables, Crop Group 5	2.2E-07	NA
Crop Group 6- Legume vegetables		

Use	Thiamethoxam	
	lb a.i./seed	lb a.i./lb seed
Legume vegetables, Crop Group 6	NA	5.0E-04
Beans	NA	5.0E-04
Soybeans	NA	7.5E-04
Lentils	NA	5.0E-04
Peas	NA	2.5E-04
Crop Group 9 - Cucurbit vegetables		
Cucurbit vegetables, Crop Group 9	1.7E-06	NA
Crop Group 15 – Cereal Grains		
Cereal grains	NA	5.2E-04
Barley	NA	5.2E-04
Buckwheat	NA	5.2E-04
Corn (unspecified)	2.8E-06	NA
Corn (field)	1.3E-06	9.9E-04
Corn (pop)	1.3E-06	2.2E-03
Corn (sweet)	1.3E-06	1.8E-03
Millet	NA	5.2E-04
Oat	NA	5.2E-04
Rice	7.0E-08	NA
Rye	NA	5.2E-04
Sorghum	NA	3.0E-03
Teosinte	NA	5.2E-04
Triticale	NA	5.2E-04
Wheat	NA	5.2E-04
Crop Group 20 - Oilseed		
Entire Group – Except listed below	NA	4.0E-03
Canola	NA	4.0E-03
Cotton	8.3E-07	NA
Sunflower	5.5E-07	NA
Crop Group 18 – Non-grass Animal Feeds (Forage Fodder, Straw and Hay)		
Alfalfa	1.1E-06	NA
Other Crops		
Peanuts	6.4E-07	4.5E-04

NA = not applicable

2.1.2. Thiamethoxam Usage

According to the most recent usage report provided by the Biological and Economic Analysis Division (BEAD) (thiamethoxam Screening Level Usage Analysis (SLUA) dated 2/10/16), the majority (approximately 80%) of thiamethoxam used on agricultural crops is applied to soybeans (300,000 lbs/year on seeds), corn (300,000 lbs/year on seeds) and cotton (160,000 lbs/year on seeds and plants). For corn, an estimated annual average of 25% total crop is treated with thiamethoxam (maximum of 45% for thiamethoxam in any given year). Current thiamethoxam end-use product labels restrict use on corn to seed treatment only. Summaries of the estimated annual usage of thiamethoxam as a seed

treatment and foliar/soil treatments are in **Tables 6 and 7**. When considering the SLUA data for this chemical, the majority of the mass applied per year is via seed treatment. Based on the estimated usage on corn (average percent crop treated in combination with acres planted), this represents an annual average of 24 million acres treated with thiamethoxam. For soybeans and again based on average percent crop treated, an estimated 13 million acres are treated with thiamethoxam (**Table 8**). Data are generally not available to inform usage of pesticides on non-agricultural applications (e.g., ornamentals, turf).

Table 6. Estimated annual usage of thiamethoxam applied via seed treatment (source: SLUAs) – Reporting Time 2005-2014

Crop	Lbs a.i. applied per year	PCT (annual average)	PCT (annual max)
Corn	300,000	25	45
Cotton	100,000	30	45
Potatoes	20,000	15	20
Sorghum	20,000	20	25
Soybeans	300,000	15	25
Sugar beets	2,000	5	10
Wheat	50,000	5	15
Total	792,000	NA	NA

NA = not applicable
PCT = percent crop treated

Table 7. Estimated annual usage of thiamethoxam applied via foliar or soil applications (source: SLUAs) – Reporting Time 2005-2014.

Crop	Lbs a.i. applied per year	PCT (annual average)	PCT (annual max)
Alfalfa	<500	<1	<2.5
Almonds	NA	NA	NA
Apples	2,000	5	20
Artichokes	<500	30	40
Beans, green	<500	<2.5	<2.5
Blueberries	<500	<2.5	<2.5
Broccoli	1,000	10	20
Brussels sprouts	<500	5	15
Cabbage	<500	5	20
Cantaloupes	NA	NA	NA
Caneberries	<500	15	25
Cantaloupes	1,000	5	25
Carrots	<500	5	10
Cauliflower	<500	5	20
Celery	1,000	20	50
Cherries	1,000	10	25
Chicory	<500	5	10
Cotton	60,000	10	15
Cucumbers	<500	5	10
Figs	NA	NA	NA
Dry Beans/Peas	<500	<1	<2.5
Grapefruit	2,000	25	65

Grapes	1,000	<2.5	5
Lemons	<500	5	10
Lettuce	2,000	10	35
Oranges	10,000	15	25
Peaches	1,000	5	15
Pears	1,000	20	35
Pecans	<500	<2.5	5
Peppers	1,000	15	35
Pistachios	<500	<1	<2.5
Plums/Prunes	<500	<2.5	<2.5
Pomegranates	NA	NA	NA
Potatoes	20,000	15	30
Pumpkins	<500	<2.5	10
Soybeans	10,000	<1	<2.5
Spinach	<500	5	10
Squash	<500	5	10
Strawberries	1,000	20	40
Tangerines	<500	5	10
Tobacco	<500	<2.5	5
Tomatoes	6000	10	20
Walnuts	NA	NA	NA
Watermelons	<500	5	10
Wheat	<500	<1	<2.5
Total	121,000-132,500	NA	NA

NA = not applicable

PCT = percent crop treated

Table 8. Estimated amount of acres treated with thiamethoxam via seed treatments (from 2016)

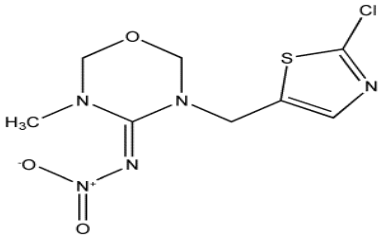
Crop	Millions of acres planted in 2016 (1)	Millions of acres treated (based on average PCT)	Millions of acres treated (based on max PCT)
Corn	94.1	24	42
Cotton	10	3.0	4.5
Potatoes	1.0	0.15	0.20
Sorghum	7.2	1.4	1.8
Soybeans	83.7	13	21
Sugar beets	1.1	0.06	0.11
Wheat	50.8	2.54	7.62

[1] http://www.usda.gov/nass/PUBS/TODAYRPT/acrg0616.pdf

2.1.3. Physical, Chemical, Fate and Transport Properties for Thiamethoxam

General physical, chemical and environmental fate properties of thiamethoxam, obtained from lab and field studies, are summarized in **Table 9**. Thiamethoxam is soluble (4100 mg/L) in water. The vapor pressure (4.95×10^{-11} mm Hg) and Henry's Law Constant (4.65×10^{-15} atm m^3/mol) indicate that the compound is relatively non-volatile under field conditions. The compound does not dissociate within the range of pH 2 to 12. The n-octanol water partition coefficient (log K_{ow} = -0.13) for thiamethoxam indicates a low potential for bioaccumulation.

Table 9: Nature of the Chemical Stressor Thiamethoxam

Parameter	Value	MRID
Common name	Thiamethoxam	44703304
CAS number	153719-23-4	44703304
Chemical name (IUPAC)	3-(2-Chloro-thiazolyl-5-ylmethyl)-5-methyl-[1,3,5]oxadiazinan-4-ylidene-N-nitroamine	44703304
Chemical Class Chemical Category	Neonicotinoid Insecticide	44703304
Empirical formula	$C_8H_{10}ClN_5O_3S$	44703304
Structure		44703304
Molecular mass (g/mol)	291.7	44703304
Water Solubility (25°C)	4100 mg/L	44703305
Vapor Pressure (25°C)	4.95×10^{-11} mm Hg	44703305
Henry's Law Constant	4.63×10^{-15}atm m^3/mol	Calculated[1]
Octanol/water partition coefficient (Log K_{ow})	-0.13 at 25°C	44703305
Hydrolysis ($t_{1/2}$)	572 and 643 days at pH 7 (stable) 4.2 and 8.4 days at pH 9	44703416 44703417
Direct Aqueous Photolysis ($t_{1/2}$; d)	3.36 3.90	44715024 44715025
Soil Photolysis ($t_{1/2}$; d)	80 97	44715027 44715028
Aerobic Soil Metabolism ($t_{1/2}$; d)	294 353 101 60.1 174 272 188 268 464 110 136 73.6 143 34.3	44703419 44703501 44703418 49589503 49589504 49589505 49589506 49589506 49589506 49589506 49589506 49589507 49589507 49589507
Anaerobic Soil Metabolism ($t_{1/2}$; d)	81.3 76.2 77.7 45.6 118	49829901 49829902 49829902 49829902 49829902
Aerobic Aquatic Metabolism ($t_{1/2}$; d)	16.3 16.2 35.1	44715032 44715032 49589509

Parameter	Value	MRID
Anaerobic Aquatic Metabolism ($t_{1/2}$; d)	28.6 25.3 20.7	44715029 44715030 49589508
Soil Partition Coefficient (K_{oc}; L/kg-oc)	77.2 for Sandy Clay Loam 53.1 for Loam 176.7 for Sandy Loam 43.0 for Sand 38.3 for Loam 33.1 for Silty Clay Loam	44703502 44703503 45640401 45084901
Terrestrial Field Dissipation ($t_{1/2}$; d)	72-111 (seed treatment) 13 (broadcast application) 70.7 (broadcast application) 100.4 (furrow application) 1.05 to 78.8 (turf)	44703505 44727506 44948902 45086202 44948903
Aquatic Field Dissipation ($t_{1/2}$; d)	11.6 to 17.2 (paddy water) 13.6 to 26.7 (paddy soil)	47558101 47558102 47558103
[1] = Henry's Law (atm-m^3/mole) = (VAPR/760)/(SOL/MWT), where VAPR is vapor pressure in torr, MWT is molecular weight in g/mol, and SOL is the solubility in water in mg/L.		

Degradation

In terrestrial environments, thiamethoxam is expected to be persistent, with half-lives on the order of months to years. Thiamethoxam persists from months to years in various aerobic soils with (14) half-lives ranging from 34.3 to 464 days (90th percentile half-life = 236 days; half-life > 100 days in 11 of 14 studies) from (8) aerobic soil metabolism studies. Thiamethoxam persists for months with (5) anaerobic soil half-lives ranging from 45.6 to 118 days (90th percentile half-life = 97 days) from two anaerobic soil metabolism studies. Photodegradation in soil is not expected to be a substantial route of dissipation, as half-lives range from 80 to 97 days in irradiated soil.

Thiamethoxam is less persistent in aquatic environments, with half-lives on the order of weeks. In aerobic aquatic metabolism studies, thiamethoxam degraded with half-lives ranging from 16.2 to 35.1 days in water sediment systems. Thiamethoxam showed similar persistence in anaerobic aquatic environments with half-lives ranging 20.7 to 28.6 days. In clear, alkaline waters, thiamethoxam is expected to be less persistent, as photodegradation in water (3.4-3.9 d) and alkaline-catalyzed hydrolysis (4.2-8.4 d) half-lives are on the order of days.

Major degradates are compounds that form at greater than 10% of the applied in at least one fate study. Major and minor (<10%) degradates including unextracted residues that have been identified in the thiamethoxam laboratory and field studies are listed in **Table 10** and their names, structures and percent formation are provided in **Appendix A**.

Soil Sorption and Mobility

Batch equilibrium studies indicate that thiamethoxam is mobile to moderately mobile in soils according to the FAO mobility classification (FAO, 2014). The adsorption, K_{oc} ranged from 33.1-176.7 L kg_{oc}. The study results indicate correlation between thiamethoxam adsorption to soil and percent organic carbon. No correlation is found between thiamethoxam adsorption and percent clay. The desorption K_{oc} values

were higher than the adsorption K_{oc} values, indicating that once adsorbed to soil, thiamethoxam would be less likely to be mobile in soil. Aged leaching studies also suggest that thiamethoxam becomes less mobile after aging. This data supports unextracted residues (**Table 10**) will most likely bind to soil and sediment. Given these lines of evidence in addition to the fact that exhaustive extraction techniques were utilized to extract thiamethoxam, unextracted residues were not included when calculating half-lives to assess aquatic exposure in this assessment.

Field Dissipation

Several field dissipation studies were conducted in the United States and Canada. Field dissipation half-lives for thiamethoxam following broadcast applications ranged from 13-70.7 days. A field dissipation half-life of 100 days was determined for an in-furrow application where an application rate that was 4.2 times greater than the broadcast rate was used. In studies conducted in 1997 in California, Florida, and Michigan, quantifiable thiamethoxam residues were detected at a maximum depth of 6-12 inches following broadcast applications. In a study conducted in 1998 in California, quantifiable thiamethoxam residues were detected at a 12-18 inches in turf plots and 18-24 inches in bare plots. In studies conducted in 1998 in California and New Jersey, quantifiable residues were detected at 6-12 inches in turf plots and 12-18 inches in bare plots. In a study that was conducted at four sites in Canada with thiamethoxam formulated as Helix seed treatment, thiamethoxam had half-lives that ranged from 72 to 111 days. A major transformation product in the field was clothianidin (CGA-322704) forming at 13.2%.

Two aquatic field dissipation studies of thiamethoxam under field conditions were conducted in Arkansas and Louisiana. These studies investigated the dissipation of thiamethoxam in a paddy water column (aquatic phase) and paddy soil when thiamethoxam was applied as a seed treatment. In Arkansas, thiamethoxam dissipated in both phases with a calculated dissipation half-life of 11.6 days in paddy water and 26.7 days in paddy soil. No major degradates were detected in the paddy soil or water column. In Louisiana, thiamethoxam dissipated in both phases a calculated dissipation half-life of 17.2 days in paddy water and 13.6 days in paddy soil. Major degradates CGA-355190 (10%) and CGA-353042 (10.2%) were observed in the water column.

Field dissipation half-lives are similar to or within an order of magnitude of degradation half-lives conducted in the laboratory.

Table 10. Degradates [Major (M) and Minor (m)] at Maximum Percent Formation[1] Identified in Laboratory and Field Studies

Degradate	*Hydrolysis*	*Photolysis (aqueous)*	*Photolysis (soil)*	*Aerobic Soil*	*Anaerobic Soil*	*Aerobic Aquatic*	*Anaerobic Aquatic*	*TFD*	*AFD*
CGA-265307	--	--	--	5.1	0.3	--	--	--	--
CGA-282149	--	--	3.17	6.8	--	--	--	--	--
CGA-309335	9.10	--	--	0.3	--	--	--	--	--
CGA-322704	--	--	2.44	**36.8**	**17.3**	--	< 3.8	**13.2**	8.8
CGA-353042	--	**60.7**	--	--	--	--	--	--	**10.2**
CGA-353968	--	--	1.13	3.8	--	9.8	< 3.8	--	--
CGA-355190	**59.5**	--	2.22	**23.7**	**21.5**	**78.9**	**31.3**	**30**	**10.0**
NOA-404617	**35.2**	--	--	--	7.6	**36.0**	7.7	--	
NOA-407475	--	--	--	--	**14.2**	**52.0**	**69.1**	--	9.1
NOA-459602	--	--	--	--	4.0	--	--	--	--
SYN501406	--	--	--	--	2.6	--	--	--	--
UER	--	--	--	**21.4**	**14.2**	**59.1**	**51.2**	--	--
CO_2	--	--	--	**44.2**	**41.5**	**33.3**	2.6	--	--

[1]Maximum percent formation from all available fate studies. Percent formation varies by individual study.
CGA-322704 is the active ingredient clothianidin.
TFD = Terrestrial Field Dissipation; AFD = Aquatic Field Dissipation; UER = Unextracted Residues

2.2. Aquatic Exposure Modeling

In this assessment, aquatic exposure modeling is not conducted for each individual registered crops/use site. Rather, the crops/uses modeled were selected to represent bracket exposures, with selected uses based on several lines of evidence, including: 1) agricultural crops, which based on previous risk assessments, presented a potential risk to honey bees (*i.e.*, citrus, cotton, cucurbits; USEPA 2017); 2) agricultural crops which, based on usage information, represent a majority use for thiamethoxam (*i.e.*, seed treatments); 3) uses intended to bracket a low and high-end range of EECs; and, 4) represent non-agricultural registered uses which account for some of the highest application rates (*i.e.*, turf, ornamentals, Christmas tree plantations).

Measures of exposure to aquatic organisms are pesticide concentrations in surface water. EECs are derived using the Pesticide in Water Calculator (PWC v 1.52), which couples the Pesticide Root Zone Model (PRZM v5.02, May 12, 2006a) and the Variable Volume Water Model (VVWM v.1.02.1) based on thiamethoxam use on crops, typically at maximum label use rates. The EECs used in risk assessment are simulated 1-in-10 year return frequency daily averages (acute assessments) and mean concentrations over a specified duration (21-d for invertebrates and 60-d for fish; chronic assessments) generated at the modeled site.

For aquatic exposure modeling, pesticide application information (scenarios, application rates and dates, etc.) were developed with consultation with the Biological and Economic Analysis Division (BEAD). For seed treatments, it is conservatively assumed that 100% of the chemical on the treated seed is available for environmental fate processes beyond its interaction with the plant. Planting (application) depths were consistent with those specified in the imidacloprid preliminary ecological risk assessment (USEPA, 2016b) and applications were modeled to occur 10 days prior to emergence, simulating planting. Depending on the crop, as well as regional agricultural practices, planting depth may be less than or greater than what is typically employed. Incorporation depth has

a significant impact on aquatic EECs, with deeper seeds resulting in lower EECs. Typical seeding depths were selected for use in PWC simulations for seed treatment uses. In PWC, for extraction of the chemicals from the soil into runoff, runoff flow is assumed to be constrained to a subsurface depth of 2 cm. As a result, if the seeding depth is greater than 2 cm (*i.e*. corn and wheat), the chemical is not extracted/available for runoff (*i.e.*, there is no dissolved pesticide in the runoff). The aquatic EECs for seed treatment generated in this assessment may under- or over-estimate concentrations typically seen in waterbodies receiving runoff from fields with treated seeds based on the actual planting depth of certain seeds.

PFAM was used to derive EECs for thiamethoxam use on rice seed and cranberry. The PFAM model simulates application of the pesticide to a wet or dry field and degradation in soil and/or water. If the pesticide is applied to dry soil, water may then be introduced into the field and movement of the pesticide may occur from soil into the water. After flooding, water may be held in a holding system, recirculated to other areas of the production facility, or released to adjacent waterbodies (canals, rivers, streams, lakes, or bays) external to the rice or cranberry fields. The cranberry bog water estimates are post-application residues in untreated flood water introduced into the treated cranberry field.

Release water EECs were calculated based on 30-years of simulated results based on flooding events (*e.g.,* winter flooding and flooding during harvest for cranberry scenario). Also, the PWC tool was utilized for dry harvest cranberry exposure using the OR berry scenario. The PWC and PFAM input parameters are shown in **Table 11** and **Table 12**, respectively with the resulting EECs in **Table 13**. Representative PWC and PFAM outputs are presented in **Appendix C**.

Table 11. Chemical-Specific PWC Model Input Parameters for Thiamethoxam

Input Parameter:	Value:	Comment:	Source:
Scenario(s):	All Registered Crops	pesticide application information (scenarios, application rates and dates, etc.) were developed with consultation with BEAD.	Crop Scenarios See TMX batch file TMX batch file
Maximum Single Application Rate: lbs a.i./A (kg a.i./ha)	varies (see batch file)	registered rates	registered labels
Applications per Year	varies from 1 to 3	label directions. Some labels specify rates per season. If crops are rotated with those on which thiamethoxam is used, yearly rates may be higher.	registered labels
Application Interval (days)	varies from 5, 7, 10 days depending on crop (see batch file)	intervals were selected to reflect labeled application patterns.	registered labels

Input Parameter:	Value:	Comment:	Source:
Date of Initial Application (scenario/day/month)	See batch file	Application dates for foliar and soil treatments were selected based on the wettest month for the meteorological file specified in scenario during the potential use period. The 15th of the month was randomly selected as the first application date. Application dates for seed treatments reflect planting 10 days before the emergence date specified in the scenario.	Crop Scenarios
Application Method	Aerial Ground Seed Treatment	label directions	registered labels
Seed Treatment Application Depth (cm)	Cotton = 1.27 Corn = 3.81 Soybean = 1.91 Sugarbeet = 1.27 Wheat = 2.54	Thiamethoxam seeding (application) depths were consistent with the imidacloprid preliminary ecological risk assessment.	USEPA, 2016b
Spray Drift Fraction	0.125 (aerial) 0.062 (ground) 0 (seed treatment)	label directions	Spray drift guidance (USEPA, 2013b)
Application Efficiency	0.95 (aerial) 0.99 (ground) 1.0 (seed treatment)	Generally aerial application scenarios generate higher drift exposure as compared to ground and chemigation scenarios	Input parameter guidance (USEPA, 2009)
Molecular Mass (g/mol)	291.7	product chemistry data	MRID 44703304
Vapor Pressure at 25°C (torr)	4.95×10^{-11}	product chemistry data	MRID 44703305
Solubility in Water at 25°C (mg/L)	4100	product chemistry data	MRID 44703305
Organic Carbon Partition Coefficient (K_{OC}) (L/kg_{OC})	70.23	represents the average K_{OC}	MRID 44703502
Aerobic Soil Metabolism Half-life (days) 20°C	236	represents the 90th %-tile confidence bound on the mean half-life of 14 values.	MRID 44703418 MRID 44703419 MRID 44703501 MRID 49589503 MRID 49589504 MRID 49589505 MRID 49589506 MRID 49589507
Aerobic Aquatic Metabolism Half-life (days) 20°C	34.4	represents the 90th %-tile confidence bound on the mean half-life of 3 values	MRID 44715032 MRID 49589509

Input Parameter:	Value:	Comment:	Source:
Anaerobic Aquatic Metabolism Half-life (days) 20°C	29.19	represents the 90th %-tile confidence bound on the mean half-life of 3 values	MRID 44715029 MRID 44715030 MRID 49589508
Hydrolysis Half-lives (days)	0 (pH 7)	Considered stable [a]	MRID 44703417
Aqueous Photolysis Half-life (days) at 40° Latitude	4.46	represents the 90th %-tile confidence bound on the mean half-life of 2 values	MRID 44715032
[a] estimated half-lives of (572 and 643 days) are beyond the duration of 30-d study, thus considered stable.			

Table 12. Chemical-Specific PFAM Model Input Parameters for Thiamethoxam

Input Parameter:	Value:	Comment:	Source:
Crop Cranberry Rice (seed)	Scenario MA Cranberry Winter Flood OR Cranberry No Flood OR Cranberry Winter Flood WI Cranberry Winter Flood MS Winter CA WInter	Interim standard scenarios for cranberry Rice scenarios selected based upon dry seeded (pre-flood timing) application	Crop Scenarios
Maximum Single Application Rate: lbs a.i./A (kg a.i./ha)	Cranberry 0.063 (0.071) 0.188 (0.211) Rice (seed) MS 0.048 (0.054) CA 0.062 (0.070)	registered rates	registered labels
Applications per Year	1 (soil) to 2 (foliar) (cranberry) 1 (rice seed)	label directions	registered labels
Application Interval (days)	Not applicable (soil) 7 (foliar)	intervals were selected to reflect labeled application patterns.	registered labels
Date of Initial Application (scenario/day/month)	6-15, 6-22 (cranberry) Rice (seed) MS 4-24 CA 5-13	Application dates for foliar and soil treatments were selected based on the wettest month for the meteorological file specified in scenario during the potential use period. The 15th of the month was randomly selected as the first application date. Application dates for seed treatments reflect planting 10 days before the emergence date specified in the scenario.	Crop Scenarios
Application Method	Ground	label directions	registered labels

Input Parameter:	Value:	Comment:	Source:
Drift Factor	No drift component for ERA	See guidance document	PFAM Model Input Guidance, (USEPA, 2016)[10]
Application Efficiency	Not applicable	See guidance document	PFAM Model Input Guidance, (USEPA, 2016)[3]
PFAM turn over/day	Not applicable for cranberry	---	---
Heat of Henry (J/mol)	45,727	5500 (from HenryWin for thiamethoxam) x 8.314 (constant)	HenryWin v3.20
Molecular Mass (g/mol)	291.7	product chemistry data	MRID 44703304
Vapor Pressure at 25°C (torr)	4.95×10^{-11}	product chemistry data	MRID 44703305
Solubility in Water at 25°C (mg/L)	4100	product chemistry data	MRID 44703305
Organic Carbon Partition Coefficient (K_{OC}) (L/kg_{OC})	70.23	represents the average K_{OC}	MRID 44703502
Aerobic Soil Metabolism Half-life (days) 20°C	236	represents the 90th %-tile confidence bound on the mean half-life of 14 values.	MRID 44703418 MRID 44703419 MRID 44703501 MRID 49589503 MRID 49589504 MRID 49589505 MRID 49589506 MRID 49589507
Aerobic Aquatic Metabolism Half-life (days) 20°C	34.4	represents the 90th %-tile confidence bound on the mean half-life of 3 values	MRID 44715032 MRID 49589509
Anaerobic Aquatic Metabolism Half-life (days) 20°C	29.19	represents the 90th %-tile confidence bound on the mean half-life of 3 values	MRID 44715029 MRID 44715030 MRID 49589508
Hydrolysis Half-lives (days)	0 (pH 7)	Considered stable [a]	MRID 44703417
Aqueous Photolysis Half-life (days) at 40° Latitude	4.46	represents the 90th %-tile confidence bound on the mean half-life of 2 values	MRID 44715032
[a] estimated half-lives of (572 and 643 days) are beyond the duration of 30-d study, thus considered stable.			

[10] https://www.epa.gov/sites/production/files/2016-10/documents/pfam-input-parameter-guidance.pdf

Table 13: Thiamethoxam Aquatic Modeling Inputs and Aquatic Exposure Concentrations (EECs)

Use	PWC Scenarios[1]	Application Rate (lbs a.i/A)	Application Date(s)[2]	Application Method[3]	1 in 10 Year			
					Peak (µg/L)	1-day (µg/L)	21-day (µg/L)	60-day (µg/L)
Foliar Application								
Cotton	MS cotton	0.063, 0.063	6/15, 6/20	Aerial	3.06	3.01	2.49	1.56
				Ground	2.90	2.85	2.29	1.43
	CA cotton		6/15, 6/20	Aerial	1.06	1.05	0.82	0.53
				Ground	0.66	0.66	0.52	0.33
Potato	FL potato	0.05, 0.05	2/15, 2/22	Aerial	2.66	2.64	2.30	1.72
				Ground	2.44	2.43	2.11	1.57
	ID potato		6/15, 6/22	Aerial	0.73	0.73	0.64	0.47
				Ground	0.41	0.41	0.36	0.27
Cucurbits/fruiting vegetables/low growing berries/leafy vegetable	FL cucumber	0.086, 0.086	10/15, 10/22	Aerial	5.47	5.38	4.02	2.63
				Ground	5.12	5.03	3.76	2.59
	CA lettuce		2/15, 2/22	Aerial	2.97	2.95	2.58	2.04
				Ground	2.49	2.48	2.19	1.75
Grapes	Not modeled; bounded by potato and cucurbits/fruiting vegs/low growing/leafy veggies				--	--	--	--
Cranberry	OR Berry (terrestrial)	0.063, 0.063	6/15, 6/22	Ground	0.53	0.52	0.45	0.33
	PFAM (highest EECs from 3 scenarios)			Ground	11.4	11.4	11.4	10.9
Tree fruit and nuts	OrchardBSS	0.086, 0.086, 0.086	5/15, 5/25, 6/4	Aerial	4.86	4.80	4.14	2.88
				Ground	4.50	4.45	3.85	2.60
	CA almonds	0.063, 0.063	6/15, 6/22	Aerial	0.90	0.89	0.73	0.53
				Ground	0.50	0.49	0.42	0.31
Ornamental	TN nursery	0.266	7/15	Ground	2.82	2.77	2.16	1.33
	CA nursery		3/15	Ground	1.11	1.10	0.95	0.72
Turf	FL turf	0.266	6/15	Ground	1.47	1.44	1.14	0.75

Use	PWC Scenarios[1]	Application Rate (lbs a.i/A)	Application Date(s)[2]	Application Method[3]	1 in 10 Year			
					Peak (µg/L)	1-day (µg/L)	21-day (µg/L)	60-day (µg/L)
	CA turf		1/15	Ground	3.82	3.80	3.39	2.72
Forestry	OR Xmas tree	0.266	12/15	Aerial	3.08	3.06	2.78	2.32
	NC apples		5/15	Aerial	5.87	5.82	5.02	3.76
Soil Application								
Citrus	FL citrus	0.175	5/15	Ground	3.27	3.22	2.70	1.74
Potato	Not modeled; bounded by radish and grapes				--	--	--	--
Cucurbits/fruiting vegetables/low growing berries/leafy vegetable	FL cucumber	0.170	10/15	Ground	4.01	3.94	2.95	2.18
	CA lettuce		2/15	Ground	3.82	3.79	3.34	2.60
Radish	FL Carrot	0.10	01/15	Ground	2.30	2.28	1.91	1.42
	CA Onion		02/15	Ground	0.35	0.35	0.31	0.25
Grape	NY grapes	0.27	6/15	Ground	2.10	2.08	1.71	1.20
	CA wine grapes		5/15	Ground	0.95	0.94	0.82	0.63
Cranberry	OR Berry (terrestrial)	0.188	6/15	Ground	0.74	0.74	0.65	0.50
	PFAM (highest EECs from 3 scenarios)			Ground	16.8	16.8	16.7	16.0
Tree fruit & nuts	Not a use				--	--	--	--
Ornamental	TN nursery	0.266	7/15	Ground	2.77	2.72	2.17	1.32
	CA nursery		3/15	Ground	1.06	1.05	0.91	0.69
Turf	FL turf	0.266	6/15	Ground	1.19	1.17	0.91	0.59
	CA turf		1/15	Ground	3.09	3.08	2.75	2.19
Forestry	OR Xmas tree	0.266	12/15	Ground	1.99	1.98	1.77	1.44
	CA forestry		5/15	Ground	3.69	3.65	3.13	2.18
Seed Treatment[4]								
Cotton	MS cotton	0.044	5/15	Incorporated 1.27 cm	0.51	0.51	0.42	0.26
	CA cotton	0.071[5]	4/21		0.09	0.08	0.07	0.05

Use	PWC Scenarios[1]	Application Rate (lbs a.i/A)	Application Date(s)[2]	Application Method[3]	1 in 10 Year			
					Peak (µg/L)	1-day (µg/L)	21-day (µg/L)	60-day (µg/L)
Corn	MS corn	0.097	5/15	Incorporated 3.81 cm	0.00	0.00	0.00	0.00
	CA corn	0.113[6]	3/22		0.00	0.00	0.00	0.00
Soybean	MS soybean	0.053	5/7	Incorporated 1.91 cm	0.03	0.03	0.02	0.02
	CA corn	0.083[7]	3/22		0.01	0.01	0.01	0.01
Sugarbeet	MN sugar beet	0.064	5/6	Incorporated 1.27 cm	0.28	0.27	0.25	0.19
	CA sugar beet	0.167[8]	1/22		0.54	0.54	0.50	0.41
Wheat	TX wheat	0.047	10/6	Incorporated 2.54 cm	0.00	0.00	0.00	0.00
	CA wheat	0.081[9]	11/15		0.00	0.00	0.00	0.00
Rice (PFAM)	MS Rice	0.048	4/24	Incorporation not applicable	4.14	4.13	3.81	2.78
	CA Rice	0.062[10]	5/13		68.9	66.4	35.5	16.2

1. Additional scenarios are available for other parts of the country for this use. Scenarios are selected to represent a high-end runoff scenario (first scenario) and a low-end runoff, drift driven scenario (second scenario). Scenarios are meant to represent the east coast and west coast, with EECs for scenarios for mid-western states lying somewhere in between the two.
2. Application dates (month/day) for foliar and soil treatments selected based on the wettest month for the meteorological file specified in scenario during the potential use period. The 15th of the month was randomly selected as the first application date. Application dates for seed treatments reflect planting 10 days before the emergence date specified in the scenario. EFED will be modeling one crop cycle per year for all crops.
3. Spray drift fractions – 0.125 (aerial), 0.062 (ground), 0 (incorporated).
4. Application assumed to occur 10 days prior to emergence date in PWC scenario.
5. 8.3 x 10^{-7} lb a.i/seed x 52,500 seed/A (from LA) and 85,000 seed/A in CA.
6. 2.8 x 10^{-6} lb a.i/seed x 59,739 seed/A. MI (actually MO): 26,400-34,500 seeds/acre; CA (max across states): 40,250 seeds/acre
7. 3.3 x 10^{-7} lb a.i/seed (Cruiser 5FS). MI (MO): 150,000-160,000 seeds/acre; CA (max across states): 250,000 seed/acre.
8. 1.6 x 10^{-6} lb a.i/seed x 40,000 seed/acre (MN) and 104,544 seed/A (CA)
9. 5.2 x 10^{-4} lb a.i/lb seed x 90 lb seed/A (TX) and 156 lb seed/A (CA)
10. 5.2 x 10^{-4} lb a.i/lb seed x 92 lb seed/acre (drill seeding; MS) and 120 lb seed/acre (water seeding; CA

2.3. Aquatic Exposure Monitoring Data

Monitoring data for thiamethoxam (**Table 14**) are available from the United States Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program Data Warehouse[11], searched on June 22, 2017. Access to the NAWQA monitoring data is now through the Water Quality Portal (WQP) website, which integrates public available water quality data from the USGS National Water Information System (NWIS), the EPA STOrage and RETrieval (STORET) Data Warehouse, and the USDA ARS Sustaining the Earth's Watersheds Agricultural Research Database System (STEWARDS). Thiamethoxam was detected in 216 of 2498 (8.7%) of surface water samples across 24 states; the reported maximum concentration (4.37 µg/L) was detected in California. This particular sample was a routine surface water sample was collected on September 28, 2016 by the USGS California Water Science Center and analyzed by LC/MS/MS. The detected concentrations of available monitoring data are within the same order of magnitude of the modeled surface water exposure estimates. Thiamethoxam was detected in 82 of 1935 (4.2%) ground water samples all of which were detections from Minnesota; the reported maximum concentration was 2.11µg/L. The detected concentration of monitoring data is an order of magnitude lower than the modeled ground water exposure estimates. However, the study design of NAWQA is not targeted to account for all thiamethoxam use areas; timing of application and other factors which may more accurately represent spatially and temporally dependent variables influencing runoff vulnerability.

Monitoring data for surface water and ground water from the California Department of Pesticide Regulation (CDPR)[12] was searched on June 22, 2017. Thiamethoxam was detected in 26 of 507 (5.1%) surface water samples across California; the reported maximum concentration was 4.37µg/L. The detected concentration of monitoring data is within the same order of magnitude compared to the modeled surface water exposure estimates. For ground water, thiamethoxam was detected in 27 wells in 2015 and 64 wells in 2016, but all samples were below the reporting limit of 0.05 µg/L.

Table 14. Monitoring Data Summary for Thiamethoxam in Groundwater and Surface Water

Monitoring Program	Water Type	Detects	Samples	Detection Frequency (%)	LOD (µg/L)	Maximum Concentration (µg/L)
NAWQA[a]	Surface Water	216	2498	8.7	0.02	4.37
	Ground Water	82	1935	4.2	0.02	2.11
CDPR[a]	Surface Water	26	507	5.1	0.02	4.37
	GW 2015	27	27	100	0.05	< 0.05
	GW 2016	64	64	100	0.05	< 0.05

[a]Data downloaded from the Water Quality Portal on June 22, 2017. Data sources are combined so there is the potential for duplicative data, which could skew interpretation.

The following open literature information was available about neonicotinoids (thiamethoxam) presence in surface waters. Detected thiamethoxam concentrations vary and are typically within an order of magnitude of the estimated environmental concentrations modeled in this assessment.

[12] http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm

Hladik *et al* (2014) investigated an area of intense corn and soybean production in the Midwestern United States to evaluate neonicotinoid presence in surface water. Study authors reported high agricultural use of neonicotinoids via both seed treatments and other forms of application occur in this region. Water samples were collected from nine stream sites (eight in Iowa and one in Nebraska, basin areas spanning 521 to 836,000 km^2) during the 2013 growing season (3/9/2013 to 11/1/2013). Reported clothianidin concentrations ranged from non-detect to 257 ng/L, with a median value of 8.2 ng/L (n=79, number of non-detects = 20). Thiamethoxam concentrations ranged from non-detect to 185 ng/L, with a median value < 2 ng/L (n=79, number of non-detects = 42). Dinotefuran was not detected in any of the 79 samples. The level of detection was 2 ng/L. Clothianidin and thiamethoxam were detected at all nine sites sampled. Study authors reported temporal patterns in concentrations associated with rainfall events during crop planting, suggesting seed treatments as the likely source of the neonicotinoids.

According to **Raina-Fulton, R. (2016)**, neonicotinoids have been detected in 63% of the 48 streams sampled across the United States with clothianidin having a detection frequency of 24% (maximum 66 ng/L), thiamethoxam having a detection frequency of 21% (maximum 190 ng/L), and dinotefuran having a detection frequency of 13% (maximum 130 ng/L)[13]. Clothianidin and thiamethoxam concentrations in surface water were positively correlated with land use in cultivated crops and imidacloprid was positively correlated with urban area within the water basin. Precipitation was identified as an important driver for neonicotinoid transport in the environment following periods of use[15]. In maize producing counties of southwestern Ontario in Canada, 100% of 76 samples collected had clothianidin and 98.7% had thiamethoxam with mean concentrations of clothianidin and thiamethoxam at 2,280 and 1,130 ng/L, respectively (maximum 43,600 and 16,500 ng/L, respectively)[14]. The highest concentrations in field occurred in a puddle with total concentration of neonicotinoid insecticides (clothianidin and thiamethoxam) of 44,380 ng/L as compared to outside the treated seed field in puddle, ditch and drain concentrations at 17,830, 12,250, and 6,210 ng/L[16]. Total concentration of neonicotinoids were 4.6 and 5.9 times higher in week 1-3 and 4-5 after planting with treated corn seed as compared to 1-2 weeks before planting and returned to similar concentrations of neonicotinoids to before planting by week 6-7[16]. In water from Canadian prairie wetlands of central Saskatchewan (located within a region of high neonicotinoid seed treatment use for wheat and canola) the highest detection frequency (62%) and highest concentrations of neonicotinoids (maximum 3,110 ng/L, mean 76.8 ng/L) occurred in summer with clothianidin greater than thiamethoxam[15]. Other areas with soil-applied neonicotinoids (thiamethoxam, clothianidin and imidacloprid) for potato production have detected thiamethoxam and clothianidin at 210 to 3,340 ng/L (average 620 ng/L) and 260-3,340 ng/L (average 790 ng/L) in ground water with the highest frequency of detection for thiamethoxam (during 2008-2012) suggesting high leaching potential[16]. In addition, cycling of contaminated ground water due to use of high capacity irrigation wells occurred.

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[13] *Hladik ML, Koplin DW*. First national-scale reconnaissance of neonicotinoid insecticides in streams across the USA. Environ. Chem. 2016; 13: 12-20

[14] *Schaafsma A, Limay-Rios V, Baute T, Smith J, Xue Y, et al*. Neonicotinoid insecticide residues in surface water and soil associated with commercial maize (corn) fields in southwestern Ontario. PLoS One. 2015; 10: e0118139.

[15] *Main AR, Michel NL, Headley JV, Peru KM, Morrissey CA, et al*. Ecological and Landscape Drivers of Neonicotinoid Insecticide Detections and Concentrations in Canada's Prairie Wetlands. Environ Sci Technol. 2015; 49: 8367-8376.

[16] *Huseth AS, Groves RL*. Environmental fate of soil applied neonicotinoid insecticides in an irrigated potato agroecosystem. PLoS One. 2014; 9: e97081.

Struger *et al* (2017) conducted a wide scale investigation of neonicotinoid insecticides used across the range of agricultural activities from fifteen surface water sites in southern Ontario. The fifteen sites consisted of nine streams near agricultural areas (drainage area <100 km^2), and six larger streams/rivers (drainage area >100 km^2). The stream sites reflected a range of agricultural activities including row crops, fruits and vegetables, orchards and grapes, greenhouses, ornamental nurseries, and turf. The sites also included an urban stream (Indian Creek) and a reference stream (Spring Creek) located adjacent to a national park removed from agricultural activities. All neonicotinoid insecticide concentrations in samples from Spring Creek were below the method detection limits (1.76 ng/L for clothianidin and 1.39 ng/L for thiamethoxam). Seventeen precipitation samples in total were collected between May and October 2013 at Bear Creek in southern Ontario. Bi-monthly integrated precipitation samples were collected using a MIC-B-wet-only automated precipitation sampler. Concentrations for clothianidin and thiamethoxam are presented in **Table 15**. Clothianidin concentrations ranged from non-detect to 399 ng/L in surface water, while thiamethoxam ranged from non-detect to 1340 ng/L. Neonicotinoids were rarely detected in precipitation at Bear Creek in 2013; most detections were during the period of 14-31 May 2013. Concentrations in precipitation of thiamethoxam and clothianidin on May 14th, 2013 were 114 ng/L and 120 ng/L, respectively. The study authors speculated that the detections may have been the result of drift of dust generated during application on row crops, or planting of treated seeds during the spring planting period, as the Bear Creek site is in proximity to the Lebo Drain and Sturgeon Creek stations, both of which are characterized by greater than 60% row crop agriculture. Using statistical analysis, study authors investigated the correlation of individual compounds with land use and assessed the relationship between neonicotinoid occurrence and hydrologic parameters in calibrated water courses. Of the five neonicotinoids studied, clothianidin and thiamethoxam exhibited detection rates above 90% at over half the sites sampled over a three-year period (2012-2014). For some watersheds, study authors found correlations between the occurrence of neonicotinoids and precipitation and/or stream discharge. Some watersheds exhibited seasonal maxima in concentrations of neonicotinoids in spring and fall, particularly for those areas where row crop agriculture is predominant; these seasonal patterns were absent in some areas characterized by a broad range of agricultural activities.

Table 15. Summary statistics for neonicotinoids measured in southwestern Ontario surface waters[1]

Site	N	N (non-detect)	Median (ng/L)	Mean (ng/L)	Stdev	Detection Frequency (%)	Maximum (ng/L)
Clothianidin							
Twenty Mile Creek	36	0	22.1	31.6	27.6	100.0%	133
Two Mile Creek	42	28	<1.76	13.8	63.3	33.3%	399
Four Mile Creek	41	6	4.01	13.3	32.9	85.4%	177
Big Creek	14	8	<1.76	4.19	8.67	42.9%	32.7
West Holland River	13	1	6.7	7.78	5.44	92.3%	19.1
Indian Creek	35	27	<1.76	2.65	1.75	22.9%	9.07
Innisfil Creek	26	2	4.83	7.28	8.11	92.3%	42.8
Lebo Drain	27	0	31.4	41.8	27.3	100.0%	125
Nissouri Creek	12	0	11.6	22.8	27.6	100.0%	104
Nottawasaga River	26	5	7.28	11.1	11.2	80.8%	50.7

Spring Creek	18	18	<1.76	-	-	0.0%	<1.76
Sturgeon Creek	39	8	3.81	5.17	5.05	79.5%	27.7
Sydenham River	42	0	18	28.7	32	100.0%	182
Thames River	30	0	11.7	17.5	16	100.0%	61.1
Prudhomme Creek	39	2	7.66	22.3	32.6	94.9%	132
Thiamethoxam							
Twenty Mile Creek	36	0	50.4	172	266	100.0%	1340
Two Mile Creek	42	26	<1.39	5.79	6.75	38.1%	25.1
Four Mile Creek	41	15	4.01	17.8	30	63.4%	123
Big Creek	14	8	<1.39	4.69	11.2	42.9%	41.5
West Holland River	13	0	16.3	21.2	22.3	100.0%	79.4
Indian Creek	35	25	<1.39	7.11	31.5	28.6%	181
Innisfil Creek	26	0	9.06	20.1	32.9	100.0%	137
Lebo Drain	27	0	101	137	125	100.0%	546
Nissouri Creek	12	4	2.02	4.28	4.8	66.7%	17.7
Nottawasaga River	26	0	12.9	23.5	24.9	100.0%	84.4
Spring Creek	18	18	<1.39	-	-	0.0%	<1.39
Sturgeon Creek	39	1	8.42	12.5	10.8	97.4%	47.8
Sydenham River	42	1	10.6	58.6	142	97.6%	743
Thames River	30	0	11.1	24.9	31.2	100.0%	126
Prudhomme Creek	39	11	3.16	15.3	37	71.8%	143

[1.] Mean, Median, and Standard Deviation (Stdev) were estimated using the Kaplan-Meier method for censored datasets (Helsel 2012).

In 2017, **Miles *et. al.*** conducted field surveys to determine neonicotinoid concentrations in soil and water samples from multiple sites in Tippecanoe Co., Indiana. Study authors tested for acetamiprid, clothianidin, imidacloprid, and thiamethoxam in soil and water. The four sampled locations had an associated stream or ditch that served as a location for our water samples. One site was selected because it contained wetland areas that would allow assessment of neonicotinoid concentrations in lentic water bodies. Sampling was performed at each site two weeks prior to planting and weekly from two through eight weeks post-planting. Only water sampling was conducted at two of the sites. Thiamethoxam was not detected any of the soil samples (n = 32). Thiamethoxam was detected in 98% of water samples (n = 48). The mean thiamethoxam concentration across all sites and sample periods was 302,000 ng/L, with a maximum concentration of 2,568,000 ng/L obtained from a water (stream) sample from the Martell Forest location. In general, concentrations tended to peak 5 to 7 weeks post planting. Clothianidin was detected in 81% of the soil samples (n = 32). The mean clothianidin concentration in soils across all sites and sampling periods was 24,200 ng/kg, with a maximum concentration of across all sites and sample periods of 176,000 ng/kg. Peak concentrations tended to occur 4 weeks post planting. Clothianidin was detected in 96% of water samples (n = 48). The mean clothianidin concentration across all sites and sample periods was 100 ng/L, with a maximum concentration of 670 ng/L.

Since 2003, the **Washington State Departments of Agriculture and Ecology** has been conducting a multi-year monitoring program to characterize pesticide concentrations in selected salmon-bearing streams during the typical pesticide application season (March – September) in Washington. In 2014 monitoring was conducted in seven Water Resource Inventory Areas (WRIAs), five agricultural and two urban basins, for a total of 15 sample sites. Sampling was conducted weekly at most monitoring locations for 27 consecutive weeks, beginning the second week in March and continuing through to the second week in September. Surface water samples were collected by hand-compositing grab samples from quarter-point transects across each stream. In situations where streamflow was vertically integrated, a one-liter transfer container was used to dip and pour water from the stream into sample containers. Additionally, several conventional water quality parameters were measured: pH, conductivity, continuous temperature data (collected at 30-minute intervals), dissolved oxygen, and streamflow. Laboratory surrogate recovery, laboratory blanks, laboratory control samples (LCS), and laboratory control sample duplicates (LCSD) were analyzed as the laboratory component of QA/QC. Field blanks, field replicates, matrix spikes (MS), and matrix spike duplicates (MSD) integrated field and laboratory components. Sixteen percent of the field samples analyzed in 2014 were QA samples. In 2014, the program began to monitor for clothianidin (lower practical quantitation limit of 50 ng/L). None of the samples collected in 2014 contained detectable levels of clothianidin. Thiamethoxam was detected at 7 sampling sites in 4 WRIAs at concentrations ranging from 6 to 53 ng/L (n=405, detects=41). Dinotefuran was detected at 3 sampling sites in 2 WRIAs at concentrations ranging from 9 to 4480 ng/L (n=405, detects=49).

From 2012-2013**, Main *et. al.*** evaluated the potential impact to ecologically significant wetlands in Canada's major Prairie crop growing region to seed treatments of neonicotinoids. Study authors modelled the spatial distribution of neonicotinoid use across central Saskatchewan in combination with temporal assessments of water and sediment concentrations in wetlands to measure four active ingredients (clothianidin, thiamethoxam, imidacloprid and acetamiprid). From 2009 to 2012, neonicotinoid use increased from 7.7 million hectares to nearly 11 million hectares (44% of Prairie cropland) and from 150,000 kg to 216,000 kg of active ingredients. The dominant seed treatments by mass and area were thiamethoxam followed by clothianidin. Areas of high neonicotinoid use were identified as high density canola or soybean production. Water sampled four times (spring, summer, fall 2012 and spring 2013) from 136 wetlands across four rural municipalities in Saskatchewan similarly revealed clothianidin and thiamethoxam in the majority of samples. A summary of the results is provided in **Table 16**. In spring 2012 prior to seeding, 36% of wetlands contained at least one neonicotinoid. Detections increased to 62% in summer 2012, declined to 16% in fall, and increased to 91% the following spring 2013 after ice-off. Peak concentrations were recorded during summer 2012 for both thiamethoxam (1490 ng/L, LOQ=1.8 ng/L) and clothianidin (3110 ng/L, LOQ=1.2 ng/L). Sediment samples collected during the same period rarely (6%) contained neonicotinoid concentrations (≤ 20 ng/L). Wetlands situated in barley, canola and oat fields consistently contained higher mean concentrations of neonicotinoids than in grasslands, but no individual crop singularly influenced overall detections or concentrations. Study authors concluded that frequently detected neonicotinoid concentrations in Prairie wetlands suggested high persistence and transport into wetlands.

In 2015 **Morrissey *et. al.*** conducted a review to synthesize the current state of knowledge on the reported concentrations of neonicotinoids in surface waters from 29 studies in 9 countries world-wide. Neonicotinoids were detected in most surface waters sampled, including puddled water, irrigation channels, streams, rivers, and wetlands in proximity to, or receiving runoff from, agricultural cropland. Strong evidence exists that water-borne neonicotinoid exposures are frequent, long-term and at levels

(geometric means = 130 ng/L (averages) and 630 ng/L (maxima)) which commonly exceed several existing water quality guidelines. Thiamethoxam was assessed in eleven studies, seven of which were conducted in the United States or Canada with dates ranging from 2005 to 2013. Reported detection limits ranged from 0.63 to 100 ng/L. Mean detected concentrations across the studies ranged from 2.65 to 7,700 ng/L, while maximum detected concentrations across the studies ranged from 1.1 to 225,000 ng/L. Reported detections ranging from 3-100% of the samples collected. In one study thiamethoxam was detected in ground water in Wisconsin at a maximum concentration of 8,930 ng/L and a mean concentration of 1,590 ng/L. A summary of the results is provided in **Table 17**. The highest concentrations in surface water resulted from sampling of playa wetlands in Texas.

Table 16. Neonicotinoid concentrations in Canadian prairie wetlands

Season	Crop	Wetlands (n)	Detection (%)	Total Neonic. (ng/L)		Thiamethoxam (ng/L)		Clothianidin (ng/L)	
				Mean	Max	Mean	Max	Mean	Max
Spring, 2012 (pre-seed)	Barley	28	29	5.8	41.1	ND	ND	3.9	39.4
	Canola	54	52	20.7	184	2.5	19.1	16.3	144
	Oats	15	47	5.8	21.7	1.3	7	3.6	20
	Peas	0	NS	NS	NS	NS	NS	NS	NS
	Wheat	24	25	8.3	52.7	4.3	32.4	3.1	20.2
	Grassland	15	7	1.1	7.9	ND	ND	1.1	7.9
	Overall	136	36	8.3	184		32.4 (10%)		144 (36%)
Summer, 2012 (growing)	Barley	18	83	78.9	322	19.3	91.3	57.8	277
	Canola	61	70	185	3110	40.3	1490	142	3110
	Oats	3	100	131	235	121	234	9.4	27
	Peas	8	50	9.6	28.4	ND	ND	9.6	28.4
	Wheat	29	62	53.5	524	2.3	37.7	35	518
	Grassland	15	13	2.7	5.8	ND	ND	0.8	4.1
	Overall	134	62	76.8	3110		1490 (19%)		3110 (51%)
Fall, 2012 (harvest)	Barley	13	8	1.1	7	ND	ND	1.1	7
	Canola	35	20	5.4	32.6	2.2	20	2	30.9
	Oats	3	33	4.2	12	ND	ND	ND	ND
	Peas	5	40	5.3	16	3.6	14.6	ND	ND
	Wheat	15	0	ND	ND	ND	ND	ND	ND
	Grassland	9	22	13.5	101	11.9	100	ND	ND
	Overall	80	16	4	101		100 (6%)		30.9 (5%)
Spring, 2013 (pre-seeding)	Barley	16	94	74.9	212	19.8	107	53.2	157
	Canola	51	98	53.1	178	12.6	93.5	38.5	173
	Oats	3	100	60.7	102	41.9	79.4	16.9	20.4
	Peas	6	100	33.3	60.6	ND	ND	33.3	60.6
	Wheat	9	89	41.4	85.3	18.2	58.2	21.4	30.7
	Grassland	5	0	ND	ND	ND	ND	ND	ND

	Overall	90	91	52.7	212		107 (23%)		173 (87%)

Table 17. Summary of reported surface and ground water concentrations of neonicotinoids

Chemical	Year	Location	Water body	Land use	Detection Limit (µg/L)	Mean concentration (µg/L)	Max Concentration (µg/L)	Detections	Source reference
Clothianidin	2012	Quebec, Canada	Rivers	Agricultural (Corn and soybean)	NA	NA	0.37	NA	Giroux 2014 pers comm
Clothianidin	2013	Sydney, Australia	Rivers	Agricultural (vegetable and horticultural crops)	0.017	0.06 ± 0.13	0.42	53%	Sanchez-Bayo and Hyne 2014
Clothianidin	2012-13	Quebec, Canada	Ponded water on fields	Agricultural (corn)-during and post seeding	1.0	4.6	55.7	92–100%	Samson-Roberts et al (submitted)
Clothianidin	2012-13	Saskatchewan, Canada	Prairie wetlands	Agricultural (canola, cereals, grasslands)	0.0012	0.004 – 0.077*	3.1	5–87%	Main et al. 2014
Clothianidin	2009-10	Osaka, Japan	Estuaries and rivers	Urban, rice upstream	0.00062	0.0032	0.012	100%	Yamamoto et al. 2012
Clothianidin	2011-12	Wisconsin	Leachate (irrigation water)	Agricultural (potato, row crops-irrigated)	0.02	0.056	0.225	NA	Huseth and Groves 2014
Clothianidin	2008-2012	Wisconsin	Groundwater	Agricultural (potato, row crops)	NA	0.62	3.43	25%	State of Wisconsin Dept. of Agriculture Trade and Consumer Protection (in Huseth and Groves 2014)
Clothianidin	2013	Iowa, USA	Rivers	Agricultural	0.0062	0.008**	0.257	75%	Hladlik et al. 2014
Dinotefuran	2009-10	Osaka, Japan	Estuaries and rivers	Urban, rice upstream	0.00047	0.019	0.22	100%	Yamamoto et al. 2012
Dinotefuran	2013	Iowa, USA	Rivers	Agricultural	0.0055	NA	0.0027	1%	Hladlik et al. 2014
Imidacloprid	2010-11	California, USA	Rivers, creeks, drains	Agricultural	0.05	0.77	3.29	89%	Starner and Goh 2012
Imidacloprid	2008-11	California, USA	Surface water	Urban	NA	0.05	0.67	51%	Ensminger et al 2013
Imidacloprid	2009-10	Osaka, Japan	Estuaries and rivers	Urban, rice upstream	0.00088	0.0055	0.025	100%	Yamamoto et al. 2012

Chemical	Year	Location	Water body	Land use	Detection Limit (µg/L)	Mean concentration (µg/L)	Max Concentration (µg/L)	Detections	Source reference
Imidacloprid	2006-07	California, USA	Stormwater ponds	Urban	0.3	NA	9.0	7.1–10%	DeLorenzo et al. 2012
Imidacloprid	2001-02	Rio Grande do Sul, Brazil	Groundwater Wells	Tobacco	0.05	1.93 ± 1.69	6.22	28%	Bortoluzzi et al. 2007
Imidacloprid	2001-02	Rio Grande do Sul, Brazil	Creeks, agricultural channels	Tobacco	0.05	1.17 ± 0.77	2.59	19%	Bortoluzzi et al. 2007
Imidacloprid	2011-12	Georgia, USA	Streams	Forest, urban and agricultural	0.0049	NA	0.035	74%	Hladlik and Calhoun 2012
Imidacloprid	2005-07	Georgia/N Carolina, USA	Stream	Forests	0.6	<1.0	NA	NA	Churchel et al. 2011
Imidacloprid	2002-03	Mato Grosso, Brazil	Groundwater	Agricultural (cotton)	0.57	ND	ND	0%	Carbo et al. 2008
Imidacloprid	2003-06	New Brunswick, Canada	Streams	Agricultural, urban, forested	0.002	0.004 and 0.067	0.42, 0.46 (outlet)	7% ≥MDL 0.002	Xing et al. 2013
Imidacloprid	2003-04	New Brunswick and PEI, Canada	Runoff, Streams	Agricultural	NA	0.25 ± 0.07 to 15.88 ±0.99	NA	NA	Dunn 2004
Imidacloprid	2000-01	New York, USA	Streams	Forest 80%, Urban 13%, Agricultural 3.1%	0.106	NA	0.13	40%	Phillips and Bode 2004
Imidacloprid	2003-05	New Brunswick, Canada	Agricultural streams	Agricultural	0.2	NA	NA	3.6%	Murphy et al. 2006 Env Can report
Imidacloprid	2008	Northern Vietnam	Streams	Agricultural (rice paddies)	0.001	0.12 – 0.19	0.22	100%	Lamers et al. 2011
Imidacloprid	2008	Northern Vietnam	Groundwater wells	Agricultural (rice paddies)	0.001	0.30	1.53	46%	Lamers et al. 2011
Imidacloprid	2003-05	Central Florida, USA	Lakes	Agricultural (Citrus crops)	NA	ND	0.016	4%	Choquette and Kroening 2009
Imidacloprid	<2004	California, USA	Surface waters	Agricultural	NA	ND	ND	NA	Fossen 2006

Chemical	Year	Location	Water body	Land use	Detection Limit (µg/L)	Mean concentration (µg/L)	Max Concentration (µg/L)	Detections	Source reference
Imidacloprid	2001	Florida, USA	NA	Agricultural	NA	ND	1	3%	Pfeuffer and Matson 2001 (in Fossen 2006)
Imidacloprid	2003-05	New Brunswick, Canada	Runoff, streams	Potato fields	0.2	NA	0.3	NA	Hewitt 2006
Imidacloprid	2001-02	Prince Edward Island, Canada	Runoff	Agricultural (Potato)	0.5	NA	11.9	NA	Denning et al 2004
Imidacloprid	2005-07	Quebec, Canada	Rivers	Agricultural (Potato and vegetable)	0.001	1.26	7.8	100%	Gibeault-Delisle et al. 2010
Imidacloprid	2012	Quebec, Canada	Rivers	Agricultural (Potato)	NA	NA	7.7	NA	Giroux 2014 pers comm
Imidacloprid	2008	Sweden	Streams, rivers	Horticulture crops/ greenhouses	0.01	NA	15	36%	Kreuger et al 2010
Imidacloprid	1998, 2003-09	Netherlands	Drainage ditches	Agricultural	NA	Most samples 0.013 – 1.6	320	NA	Van Dijk 2010 and Van Dijk et al. 2013
Imidacloprid	2013	Sydney, Australia	Rivers	Agricultural (vegetable and horticultural crops)	0.013	0.20 ± 1.17	4.56	93%	Sanchez-Bayo and Hyne 2014
Imidacloprid	2012-13	Saskatchewan, Canada	Prairie wetlands	Agricultural (canola, cereals, grasslands)	0.0011	NA	0.25	0-8%	Main et al. 2014
Imidacloprid	2008-12	Wisconsin, USA	Groundwater	Agricultural (potato, row crops)	NA	0.79	3.34	30%	State of Wisconsin Dept. of Agriculture Trade and Consumer Protection (in Huseth and Groves 2014)
Imidacloprid	2013	Iowa, USA	Rivers	Agricultural	0.0049	<0.002**	0.0427	23%	Hladlik et al. 2014
Imidacloprid	2009-10	Massachusetts, USA	Rivers	Suburban	0.02	NA	6.9	15%	Wijnja et al. 2014
Thiamethoxam	2012	Switzerland	Rivers	Agricultural, urban areas, and WWTP discharges	0.003	NA	0.047	60%	Moschet et al. 2014

Chemical	Year	Location	Water body	Land use	Detection Limit (µg/L)	Mean concentration (µg/L)	Max Concentration (µg/L)	Detections	Source reference
Thiamethoxam	2009-10	Osaka, Japan	Estuaries and rivers	Urban, rice upstream	0.00063	0.00265	0.0011	100%	Yamamoto et al. 2012
Thiamethoxam	2012	Quebec, Canada	Rivers	Agricultural (Potato)	NA	NA	1.5	NA	Giroux 2014 pers comm
Thiamethoxam	2008	Sweden	Streams, rivers	Horticulture crops/ greenhouses	0.003	NA	0.16	3%	Kreuger et al 2010
Thiamethoxam	2005	Texas, USA	Playa wetlands	Agricultural (cotton)/ Grassland/	0.1	3.6	20.1/ 225	31%/ 25%	Anderson et al 2013
Thiamethoxam	2013	Sydney, Australia	Rivers	Agricultural (vegetable and horticultural crops)	0.014	0.10 ± 0.07	0.17	27%	Sanchez-Bayo and Hyne 2014
Thiamethoxam	2012-13	Quebec, Canada	Ponded water on fields	Agricultural (corn)- during and post seeding	0.1	7.7	63.4	72–100%	Samson-Roberts et al (submitted)
Thiamethoxam	2012-13	Saskatchewan, Canada	Prairie wetlands	Agricultural (canola, cereals, grasslands)	0.0018	0.004 – 0.077*	ND – 1.49	6–23%	Main et al. 2014
Thiamethoxam	2011-12	Wisconsin, USA	Leachate (irrigation water/ground water)	Agricultural (potato, row crops-irrigated)	0.02	0.44 / NA	0.58/ >20.0	NA	Huseth and Groves 2014
Thiamethoxam	2008-2012	Wisconsin, USA	Groundwater	Agricultural (potato, row crops)	NA	1.59	8.93	68%	State of Wisconsin Dept. of Agriculture Trade and Consumer Protection (in Huseth and Groves 2014)
Thiamethoxam	2013	Iowa, USA	Rivers	Agricultural	0.0039	<0.002**	0.185	47%	Hladlik et al. 2014

NA: not available; ND: not detected

*Reported as total neonicotinoids. Author reports total as dominantly clothianidin and thiamethoxam.

**Reported as the median, below method detection limit.

2.4. Terrestrial Exposures

2.4.1. Birds and Mammals

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals by emphasizing the dietary exposure pathway. Thiamethoxam is applied through aerial and ground application methods, which includes sprayers, chemigation and soil drenching, as well as through seed treatments. Therefore, potential dietary exposure for terrestrial wildlife in this assessment is based on consumption of thiamethoxam residues on food items following spray (foliar or soil) applications, and from possible dietary ingestion of thiamethoxam residues on treated seeds. Rates used in modeling for spray and seed treatment applications are presented below in **Tables 18 and 19**.

Table 18. Application rates used for T-REX modeling for foliar and soil applications of thiamethoxam

Use	Application Type	Application Rate (lb a.i./A)	Number of Applications	Application Interval (days)	Maximum Annual (lb a.i./A)
Agricultural	Foliar	0.086	1,2, or 3	7	0.258
Agricultural or non-agricultural	Soil	0.265	1		0.265

For treated seeds, the label lists all application rates in terms of lb a.i./A, while the T-REX modeling input value is in terms of fl oz/cwt. Different seed sizes and planting rates could result in ranges of exposure due to variability in the number of seed per acre. In order to account for seeding rates (included in T-REX and from USEPA 2011c), and seed size to get to that amount of a.i./A the application rates in terms of lbs a.i./cwt were calculated using the following equation:

Maximum application rate (fl oz/cwt) =

$$\frac{\text{(maximum application rate (lb a.i./A) / (\% a.i. in formulation/100)) * 128 fl oz/gal *100 lb seed/cwt}}{\text{maximum seeding rate (lb seed/A)}^{2} \text{* product density (lb a.i./gal)}^{1}}$$

Table 19. Modeled Application Rates of Thiamethoxam Treated Seeds.

Crop	Product (EPA Reg.)	Application Rate (lb a.i./A)[1]	Application Rate (fl oz/cwt)	Seed Rate[2]
Sugar Beet	Cruiser (100-941)[3]	0.167	188.3	4.8
Corn		0.113	20.7	29.6
Soy		0.083	2.7	166.7
Cotton		0.071	20.3	18.9

[1] Based on input from BEAD; Value used in aquatic modeling
[2] from USEPA, 2011c
[3] 47.6% thiamethoxam; density = 10.5lbs/gal

Foliar and Soil Application Exposure Estimates

EECs for birds and mammals via dietary residues resulting from foliar applications are presented below in **Tables 20-23** and were calculated using T-REX v.1.5.2. **Tables 20 and 22** represent EECs from agricultural uses at 1, 2, or 3 applications while **Tables 21 and 23** represent EECs from a single application for a non-agricultural use scenario. As mentioned in Problem Formulation **Section 1.2** these EECs are based on a streamlining strategy which considers past assessments and general low toxicity

relative to exposure values from the application of thiamethoxam. Estimated concentrations were calculated for the highest single and yearly foliar application rates to present an upper bound of thiamethoxam exposure potential from foliar application. EFED's default foliar dissipation rate of 35 days was used for this analysis to estimate dissipation after each application. Consideration of additional half-life values for characterization was not done based on the final EECs and subsequent LOC exceedances (or lack thereof) further explained in **Sections 4.1.4.1 and 4.1.4.2.** The default foliar dissipation half-life does only factors into calculated EECs for foliar applications. Upper-bound Kenaga nomogram values are used to derive EECs for thiamethoxam exposures to terrestrial mammals and birds **(Tables 20-23)**. EECs presented encompass rates for all agricultural uses as well as non-agricultural uses (e.g. turf, Christmas trees).

EECs for soil applications (Tables 21 and 23) were calculated within T-REX using two methodologies: 1) the LD_{50}/ft^2 methodology and 2) considering arthropod residues (used to simulate exposures from foliar applications). Specifically, the information in Table 21 and 23 relevant to soil applications are those EECs on arthropods and the mg a.i./ft^2.

Conceptually, an LD_{50}/ft^2 is the amount of a pesticide estimated to kill 50% of exposed animals in each square foot of applied area. Although a square foot does not have defined ecological relevance, and any unit area could be used, risk presumably increases as the LD50/ft2 value increases. The LD_{50}/ft^2 value is calculated using a toxicity value (adjusted LD50) and the EEC (mg a.i./ft2) and is directly compared with the Agency's levels-of-concern (LOCs) for acute exposures. For thiamethoxam, a scenario resulting in the highest exposure (a broadcast application to a level field with no incorporation or consideration of existing furrows) was modeled using a single maximum application rate of 0.265 lb a.i./A which is consistent with the highest application rate to soil.

For the second method, exposure from soil application is estimated using the upper bound EECs in arthropods (also used for foliar applications). The residue values for the arthropod are used to represent potential exposures to birds and mammals that consume invertebrates that may be present on the field at the time of application. Arthropods were chosen because they are assumed to be present if the insecticide is being applied. Additionally, unlike, the LD_{50}/ft^2 methodology, this second methods allows for consideration of chronic exposures using the Kenaga values.

Table 20. Avian EECs Based on the Maximum Single Application Agricultural Rate of 0.086 lb. a.i./A.

Food Items	Dose Based EECs (mg/kg-bw)									Dietary Based EECs (mg/kg-food item)		
	Small (20 g)			Medium (100 g)			Large (1000 g)					
	1 app	2 apps	3 apps	1 app	2 apps	3 apps	1 app	2 apps	3 apps	1 app	2 apps	3 apps
Short Grass	23.5	44.0	61.8	13.4	25.1	35.2	6.0	11.2	15.8	20.6	38.6	54
Tall Grass	10.8	20.2	28.3	6.1	11.5	16.1	2.8	5.1	7.2	9.5	17.7	25
Broadleaf plants	13.2	24.7	34.8	7.5	14.1	19.8	13.2	24.7	34.8	11.6	21.7	31
Fruits/pods	1.5	2.7	3.9	1.5	2.7	3.9	0.4	0.7	1.0	1.3	2.4	3
Arthropods	9.2	17.2	24.2	5.3	9.8	13.8	2.4	4.4	6.2	8.1	15.1	21
Seeds	0.3	0.6	0.9	0.3	0.6	0.9	0.1	0.2	0.2	1.3	2.4	3

Table 21. Avian Dose Based EECs, Dietary Based EECs, and mg a.i./ft^2 based on the Single Highest Non-agricultural Use Application Rate of 0.265 lb a.i./A[1]

Food Items	Dose Based EECs (mg/kg-bw)			Dietary Based EECs (mg/kg-food item)	mg a.i./ft^2
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Short Grass	72.4	41.3	18.5	63.6	2.76
Tall Grass	33.2	18.9	8.5	29.2	
Broadleaf plants	40.7	23.2	10.4	35.8	
Fruits/pods	4.5	2.6	1.2	4.0	
Arthropods	28.4	16.2	7.2	24.9	
Seeds	1.0	0.6	0.3	4.0	

[1] This rate represents non-agricultural foliar use and agricultural soil uses. The EECs relevant to soil use patterns are those for arthropods and the mg a.i./ft^2

Table 22. Mammalian EECs Based on the Maximum Single Application Agricultural Rate of 0.086 lb. a.i./A.

Food Items	Dose Based EECs (mg/kg-bw)									Dietary Based EECs (mg/kg-food item)		
	Small (15 g)			Medium (35 g)			Large (1000 g)					
	1 app	2 apps	3 apps	1 app	2 apps	3 apps	1 app	2 apps	3 apps	1 app	2 apps	3 apps
Short Grass	19.7	36.8	51.7	13.6	25.4	35.7	3.2	5.9	8.3	20.6	38.6	54.3
Tall Grass	9.0	16.9	23.7	6.2	11.7	16.4	1.4	2.7	3.8	9.5	17.7	24.9
Broadleaf plants	11.1	20.7	29.1	7.7	14.3	20.1	1.8	20.7	29.1	11.6	21.7	30.5
Fruits/pods	1.2	2.3	3.2	1.2	2.3	3.2	0.2	0.4	0.5	1.3	2.4	3.4
Arthropods	7.7	14.4	20.3	5.3	10.0	14.0	1.2	2.3	3.2	8.1	15.1	21.2
Seeds	0.3	0.5	0.7	0.3	0.5	0.7	0.0	0.1	0.1	1.3	2.4	3.4

Table 23. Mammalian Dose Based EECs, Dietary Based EECs, and mg a.i./ft^2 based on the Single Highest Non-agricultural Use Application Rate of 0.265 lb a.i./A[1]

Food Items	Dose Based EECs (mg/kg-bw)			Dietary Based EECs (mg/kg-food item)	mg a.i./ft^2
	Small (15 g)	Medium (35 g)	Large (1000 g)		
Short Grass	60.6	41.9	9.7	63.6	2.76
Tall Grass	27.8	19.2	4.5	29.2	
Broadleaf plants	34.1	23.6	5.5	35.8	
Fruits/pods	3.8	2.6	0.6	4.0	
Arthropods	23.7	16.4	3.8	24.9	
Seeds	0.8	0.6	0.1	4.0	

[1] This rate represents non-agricultural foliar use and agricultural soil uses. The EECs relevant to soil use patterns are those for arthropods and the mg a.i./ft^2

Seed Treatment Exposure Estimates

EECs resulting from planting of thiamethoxam treated seeds are provided in **Tables 24 and 25** Results include Nagy dose-based values (*i.e.*, mg/kg-bw) and available mass of active ingredient per unit area (*i.e.*, mg a.i/ft^2). Modeled scenarios were for three of the highest uses of thiamethoxam in treated seed which encompass a range of the foliar application rates (i.e. corn 0.113 lb a.i./A, soybean 0.083 lb. a.i./A, and cotton 0.071 lb a.i./A). Additionally, a seed treatment scenario was also run for smaller vegetable seeds (sugar beets) to be consistent with scenarios run in aquatic modeling. These rates considered were refined rates based on input from BEAD. Seed treatment exposure estimates are based not only on lb a.i. allowed per acre but how many seeds are planted. Fewer number of seeds planted per acre may increase dietary exposure due to more a.i. per unit of dietary item (the seed) available up to a maximum allowable poundage per acre.

Table 24. Avian Dose Based EECs and mg a.i./ft^2 EECs for Selected Thiamethoxam Treated Seed Uses

Crop	Small (20g)	Med (100g)	Large (1000g)	mg a.i./ft^2
Sugar beet	8867	5053	2262	1.74
Corn	974	555	249	1.17
Soy	127	72	32	0.87
Cotton	955	545	244	0.74

Table 25. Mammalian Dose Based EECs and mg a.i./ft^2 EECs for Selected Thiamethoxam Treated Seed Uses

Crop	Small (15g)	Med (35g)	Large (1000g)	mg a.i./ft^2
Sugar beet	7418	5127	1189	1.74
Corn	815	564	131	1.17
Soy	106	73	17	0.87
Cotton	800	553	128	0.74

2.4.2. Terrestrial Plants

Thiamethoxam exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant[17] (version 1.2.2). The TerrPlant model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. The EECs for terrestrial and semi-aquatic (*i.e.*, wetland) plants for the maximum single foliar (ground) application of thiamethoxam to turf/ornamentals modeled at the rate of 0.265 lb a.i./A are presented in **Table 26** (only modeled ground as aerial not anticipated to be prevalent based on use pattern for turf)**.**

Table 26. Terrestrial Plant EECs for Thiamethoxam. Units in lb a.i./A

Description	Equation	EEC
1 application at 0.265 lb a.i./A		
Runoff to dry areas	(A/I)*R	0.01325
Runoff to semi-aquatic areas	(A/I)*R*10	0.1325
Spray drift	A*D	0.00265
Total for dry areas	((A/I)*R)+(A*D)	0.0159
Total for semi-aquatic areas	((A/I)*R*10)+(A*D)	0.13515

[17] USEPA. 2013a. Pesticides: Science and Policy. Terrestrial Models, TerrPlant Version 1.2.2.

*Equation abbreviation: A – Application Rate; I – Incorporation; R – Runoff; and D – Drift Fraction
N/A = Not applicable

3. Ecological Effects Characterization

In this preliminary ecological risk assessment, the effects characterization describes the types of effects thiamethoxam can produce in exposed organisms. This characterization is generally based on toxicity studies (registrant-submitted studies and open literature) that describe acute and chronic effects of thiamethoxam on aquatic or terrestrial animals and plants under controlled exposures in the laboratory

3.1. Aquatic Organisms (Fish, Aquatic Invertebrates, and Aquatic Plants)

A brief description of available aquatic toxicity data used to calculate RQs is provided in **Table 27**. Available toxicity data for aquatic organisms are summarized in this section.

Table 27. Summary of the Endpoints from Aquatic Toxicity Studies used to derive RQs for thiamethoxam

Study Type	Species	Toxicity Value (µg a.i./L)	Source (MRID) & Classification	Comment
Acute – Freshwater Fish[1]	Bluegill Sunfish *(Lepomis machrochirus)*	96-hr LC_{50}: >114,000	44714917 Acceptable	Limit test, no mortality or sub-lethal effects
Chronic (early life stage) – Freshwater Fish[1]	Rainbow Trout *(Oncorhynchus mykiss)*	NOAEC = 20,000	44714923 Supplemental	no effects observed at highest test concentration (i.e., 20 mg/L)
Acute – Estuarine/Marine Fish	Sheepshead minnow (*Cyprinodon variegatus*)	96-hr LC_{50}: >111,000	44714920 Acceptable	no mortality or sublethal effects observed
Chronic (early life stage) – Estuarine/Marine Fish		NOAEC = 1700	49589511 Acceptable	5% decreased length at LOAEC of 4.1 mg a.i./L
Acute – Freshwater Invertebrate	Midge *(Chironomus riparius)*	48-h EC_{50} = 35	MRID 44714918 Acceptable	Water only exposure; Effect = immobility
Chronic – Freshwater Invertebrate		NOAEC = 0.74	Cavallaro et al. 2016 Quantitative	25% Decreased larval survival at 2.23 µg a.i./L
Acute — Estuarine/Marine Invertebrate	Mysid shrimp (*Mysidopsis bahia*)	96-hr LC_{50}=6900	44714922 Acceptable	None
Chronic — Estuarine/Marine Invertebrate		NOAEC = 1100	MRID 49589510 Acceptable	14% decrease in parent survival at LOAEC (2000 µg a.i./L)

Study Type	Species	Toxicity Value (µg a.i./L)	Source (MRID) & Classification	Comment
Acute Aquatic – Nonvascular Plants	Cyanobacteria (*Skeletonema costatum*)	96-hr IC_{50}: >99,000 NOAEC: 12,000	49346607 Acceptable	NOAEC based on decreased growth at LOAEC of 24,000 µg a.i./L
Aquatic – Vascular Plants	Duckweed (*Lemna gibba*)	7-day IC_{50}: >90,200 NOAEC: 22,000	44714925 Acceptable	NOAEC based on LOAEC of 43,900 µg a.i./L for phytotoxicity

[1] Freshwater fish acute and chronic toxicity data used as a surrogate for aquatic-phase amphibians.

Several studies (MRIDs 48432527-48432529) have been submitted with a formulated product containing thiamethoxam and cyantraniliprole (an insecticide). These studies are not discussed here.

In addition, a mesocosm study (MRID 50131101) involving thiamethoxam was submitted recently by the registrant. This study has not yet been reviewed by EFED.

3.1.1. Effects on Fish and Aquatic Phase Amphibians

Acute toxicity data are available for two species of freshwater fish and one estuarine/marine fish. Based on acute toxicity data for fish, thiamethoxam is characterized as practically non-toxic (LC_{50} > 100 mg/L) on an acute exposure basis. In all three studies, no effects (including mortality or behavior) were observed at concentrations >109 mg a.i./L. In a chronic toxicity study with rainbow trout, no effects to survival or growth were observed at the highest test concentration of 20 mg a.i./L. In a chronic toxicity study with sheepshead minnow, a 5% decrease in length was observed at 4.1 mg a.i./L, resulting in a NOAEC of 1.7 mg a.i./L. No acute or chronic toxicity data available for aquatic-phase amphibians; therefore, available data for freshwater fish will be used to represent amphibians. No additional acute or chronic toxicity data for fish were identified in ECOTOX[18]. **Table 28** summarizes the available acute and chronic toxicity data available for fish exposed to thiamethoxam.

Table 28. Acute and Chronic Effects of Thiamethoxam on Fish

Species	Test material (% a.i.)	Endpoint (Duration)	Toxicity Value (95% CI; units: mg a.i./L)	Source	Classification
Freshwater Fish					
Rainbow Trout *Oncorhynchus mykiss*	TGAI (98.6)	LC_{50} (96-hr)	>109	44714916	Supplemental (based on water source)/ Limit test; no effects observed
Rainbow Trout *Oncorhynchus mykiss*	TGAI (99.2%)	NOAEC (60 d)	20	44714923	Supplemental (because a LOAEC was not determined)/no effects (weight, length, survival) observed at highest test concentration (i.e., 20 mg/L)

[18] This analysis focuses on apical endpoints (i.e., survival, growth or reproduction); open literature reporting non-apical endpoints were not considered.

Bluegill Sunfish *Lepomis machrochirus*	TGAI (99.2%)	LC_{50} (96-hr)	>114	44714917	Acceptable/ no mortality or sublethal effects observed
Saltwater Fish					
Sheepshead minnow *Cyprinodon variegates*	TGAI (99.2%)	LC_{50} (96-hr)	>111	44714920	Acceptable / no mortality or sublethal effects observed
Sheepshead minnow *Cyprinodon variegates*	TGAI (99.8%)	NOAEC LOAEC (33-d)	1.7 4.1	49589511	Acceptable/5.5% decreased length at LOAEC (4.1 mg a.i./L)

3.1.2. Toxicity to Aquatic Invertebrates

Toxicity data are available for several different Orders of aquatic invertebrates. Among the different Orders, aquatic insect species are more sensitive compared to other classes of arthropods or other phyla. The following discussion of thiamethoxam aquatic invertebrate toxicity data first focuses on non-insect taxa and then considers aquatic insects (*e.g.,* Diptera). All registrant-submitted studies (acceptable or supplemental) are summarized here regardless if they produced the most sensitive endpoint for that species. For studies identified in the open literature, only those which produced the most sensitive endpoint for a given species and are classified as "quantitative" or "qualitative" are summarized in this section. This section focuses on apical endpoints, i.e., survival, growth and reproduction and those endpoints considered acute (i.e., 48-96 h EC_{50} or LC_{50}) or chronic (NOAEC, LOAEC)

3.1.2.1. Acute toxicity to Freshwater Non-Insect Taxa

Relevant acute toxicity data on the effects of thiamethoxam to non-insect aquatic invertebrates for 4 freshwater species distributed among various orders (**Table 29**). A summary of these data by broad taxonomic group is provided below.

Amphipoda. Acute toxicity data (LC50s) for the amphipod *Gammarus kischineffensis* exposed to a formulated product containing thiamethoxam ranged from 3,750 µg a.i./L for a 96 h exposure to 23,500 for 48 h.

Decapoda. Acute toxicity data are available from two studies for the same species of crayfish. In these studies, 96-h EC50 values ranged 967-2310 µg a.i./L.

Diplostraca. Available toxicity data for Daphnia magna, one of the most commonly tested aquatic invertebrate species, indicates that thiamethoxam is practically non-toxic to waterfleas. Only 15% immobility was observed at the limit concentration (i.e., 106,000 µg a.i./L).

Unionoida. In a study involving exposures to glochidia of wavy-rayed lampmussels, <50% mortality was observed after 48 h at 691 µg a.i./L.

Table 29. Most sensitive acute toxicity data (registrant and open literature) for freshwater non-insects exposed to thiamethoxam

Species	Test material (% a.i.)	Endpoint (Duration)	Toxicity Value (95% CI; units: µg a.i./L)	Source	Classification
Amphipoda					
Amphipod *(Gammarus kischineffensis)*	Actara 240SC (24%)	LC_{50} (48 h)	23,500	Ugurlu et al 2015; ECOTOX # 173084	Qualitative
		LC_{50} (72 h)	8,050		
		LC_{50} (96 h)	3,750		
Decapoda					
Red swamp crayfish *(Procambarus clarkia)*	TGAI (99.5)	LC_{50} (96 h)	967 (879-1045)	Barbee and Stout 2009; ECOTOX # 120043	Qualitative
	TGAI (98.4)	EC_{50} (96 h)	2310 (1630-3280)	MRID 47558106	Supplemental (quantitative; classification based on non-standard test species)
Diplostraca					
Waterflea *(Daphnia magna)*	TGAI (98.6)	EC_{50}** (48 h)	>106,000	MRID 44714919	Supplemental (water quality deviations from guideline; control contamination)
Unionoida					
Wavy-rayed lampmussel (*Lampsilis fasciola*)	TGAI (>95)	LC_{50} (48 h)	>691	Prosser et al. 2016; ECOTOX # 173464	Qualitative

*Immobility
** only 15% mortality observed at highest test level (i.e., 106,000 µg/L)

3.1.2.2. Acute Toxicity to Freshwater Insect Taxa

Aquatic insects appear to be among the most sensitive aquatic invertebrate taxa to thiamethoxam. Acute toxicity data are available for two Orders of aquatic insects including: Diptera and Ephemeroptera. Collectively, the range of acute toxicity values varied from 20-343 µg/L, which are generally more sensitive than the other tested aquatic invertebrates (toxicity data discussed above). **Table 30** summarizes the available acute toxicity endpoints for freshwater invertebrates (with 48-96 h median lethal endpoints and 50% effects concentrations).

Diptera (true flies). Toxicity data are available for one midge species (*Chironomus riparius*) and three species of mosquito (larval exposure). A 48-h EC_{50} of 35 µg a.i./L for the midge is used quantitatively in this assessment; i.e., to derive RQs for acute exposures to aquatic invertebrates. Qualitative toxicity data suggest that mosquito larvae are as sensitive or less sensitive compared to midge.

Ephemeroptera (mayflies). Qualitative data are available for an acute exposure of one species of mayfly exposed to thiamethoxam. These data suggest that mayflies are of similar acute sensitivity to midge (EC50 values are within a factor of 2). Available mayfly data (Van Den Brink et al. 2016) are considered qualitative because they involved a formulated product and raw toxicity data are not available to verify the reported endpoints.

Table 30. Most sensitive acute toxicity data (registrant and open literature) for freshwater insects exposed to thiamethoxam

Species	Test material (% a.i.)	Endpoint (Duration)	Toxicity Value (95% CI; units: µg a.i./L)	Source	Classification
Diptera					
Midge *(Chironomus riparius)*	TGAI (97.4)	EC_{50}* (48 h)	35 (33-38)	MRID 44714918	Acceptable
	TGAI (99.6)	EC_{50} (48 h)	86.4 (74.4-100)	Saraiva et al. 2017**	Qualitative
Mosquito (*Anopheles stephensi)*	TGAI (99.1)	LC_{50} (72 h)	52	Uragayala et al. 2015; ECOTOX #173152	Qualitative
	TGAI (99.1)	LC_{50} (72 h)	64		
Mosquito *(Aedes aegypti)*	TGAI (99.5)	LC_{50} (48 h)	130 (48-263)	Ahmed and Matsumura 2012; ECOTOX #168249	Qualitative
		LC_{50} (72 h)	90 (29-190)		
	TGAI (99.1)	LC_{50} (72 h)	298	Uragayala et al. 2015; ECOTOX #173152	Qualitative
Mosquito *(Culex quinquefasciatus)*	TGAI (99.1)	LC_{50} (72 h)	343	Uragayala et al. 2015; ECOTOX #173152	Qualitative
Ephemeroptera					
Mayfly *(Cloeon dipterum)*	Formulated (25)	EC_{50}* (96 h)	20 (15-26)	Van Den Brink et al. 2016; ECOTOX#173151	Qualitative

*Based on immobility
**Sand included in test vessels

3.1.2.3. Acute Toxicity to Saltwater Aquatic Invertebrates

Two acceptable registrant-submitted studies are available including the mysid shrimp and the Eastern oyster which both tested TGAI (**Table 31**). In the acute mysid shrimp (*Mysidopsis bahia*) study, the 96-hr LC_{50} value was 6900µg a.i./L. In the oyster study (*Crassostrea virginica*), the 96hr EC_{50}, based on shell deposition, was >119,000 µg a.i./L. no additional acute toxicity data involving saltwater invertebrates were identified in ECOTOX.

Table 31. Acute toxicity data for estuarine/marine invertebrates exposed to thiamethoxam

Species	Test material (% a.i.)	Endpoint (Duration)	Toxicity Value (95% CI; units: µg a.i./L)	Source	Classification
Mysid shrimp (*Mysidopsis bahia)*	TGAI (99.2)	LC50 (96 h)	6900 (5800-8400)	MRID 44714922	Acceptable
Eastern oyster (*Crassostrea virginica)*	TGAI (99.2)	EC50* (96 h)	>119,000	MRID 44714921	Acceptable

*Effect based on decreased shell deposition; 13% decrease in shell deposition observed at 119,000 µg/L

3.1.2.4. Chronic Toxicity to Freshwater and Saltwater invertebrates

Chronic toxicity data are available for five different aquatic invertebrate species including: mayflies, midges, waterfleas, and mysid shrimp. Studies are available where organisms were exposed through water only, as well as through sediment (**Tables 32 and 33**). As observed with the acute toxicity data above, tested aquatic insect species are more sensitive compared to other invertebrate species (e.g., water flea and mysid shrimp).

Table 32. Chronic toxicity data for freshwater and estuarine/marine invertebrates exposed to thiamethoxam in water. Studies involve non-insect taxa.

Species	Test material (% a.i.)	Endpoint (Duration)	Toxicity Value (effects observed; units: µg a.i./L)	Source	Classification
Mayfly *(Cloeon dipterum)*	Formulated (25)	EC_{10} (28 d)	0.43 (95% CI: 0.13-1.4; immobility)	Van Den Brink et al. 2016; ECOTOX#173151	Qualitative
Midge (*Chironomus dilutus*)	TGAI (98.9)	NOAEC LOAEC (14 d)	0.74 2.23 (25% decreased larval survival)	Cavallaro et al. 2016*	Quantitative
Midge *(C. riparius)*	TGAI (99.6)	NOAEC LOAEC (28 d)	6.5 10.5 (65% decreased emergence; no females emerged at LOAEC)	Saraiva et al. 2017*	Qualitative
Midge *(C. riparius)*	TGAI (99.6)	NOAEC LOAEC (10 d)	10.5 18 (decreased survival and length)	Saraiva et al. 2017*	Qualitative
Mysid shrimp (*Mysidopsis bahia*)	TGAI (99.8)	NOAEC LOAEC (28 d)	1100 2000 (14% decrease in parent survival)	MRID 49589510	Acceptable
Waterflea (*Daphnia magna*)	TGAI (98.6)	NOAEC LOAEC (21 d)	50,000 101,000 (LOAEC based on 16% decreased #offspring)	MRID 44714924	Acceptable

*Concentrations expressed as overlying water assumed to be comparable to pore water concentrations because 1) thiamethoxam has a low Koc value (it is expected that pore water and overlying water will be very similar at equilibrium); 2) there is a *de minimus* amount of organic carbon in the sand matrix used in this study (sorption to the solid portion of the benthic layer is not expected to be substantial) and 3) the coarse particle size of the sand facilitates exchange between the overlying water and pore water, allowing for equilibrium to occur within a short period of time

Table 33. Chronic toxicity data for freshwater and estuarine/marine invertebrates exposed to thiamethoxam via sediment; concentrations expressed on a pore water basis.

Species	Test material (% a.i.)	Endpoint (Duration)	Toxicity Value (effects observed; units: µg a.i./L pore water)	Chemical introduced through water (overlying) or sediment	Source	Classification
Midge (*Chironomus riparius)*	TGAI (98.6)	NOAEC LOAEC (30 d)	<1 (LOD)* 6	sediment	MRID 44714928	Under review
Midge (*C. riparius)*	TGAI (98.6)	NOAEC LOAEC (30 d)	10* 20 (decreased emergence)	water	MRID 44714928	Under review
Midge (*C. dilutus*)	TGAI (99.8)	NOAEC LOAEC (10 d)	120 360 (LOAEC based on 19% reduced weight)	sediment	MRID 49589512	Acceptable

*Study author reported results.

Data published by Cavallaro et al. (2016) is used to derive chronic RQs for aquatic invertebrates. The LOAEC calculated by EFED using the study author's raw data was 2.23 ug a.i./L. At this level, a 25% decline in larval survival was observed. Therefore, the NOEC is 0.71 ug a.i./L.

Other studies are also available for *Chironomus* species exposed to thiamethoxam. Table 34 summarizes the LOECs for the different endpoints measured in each of the studies involving *Chironomus* species. Saraiva et al. (2017) observed effects at a level that was a factor of 2-8x higher compared to Cavallaro et al. This difference in effect may be attributed to shorter observation periods (i.e., shorter observation periods usually yield less sensitive endpoints) and to a difference in observed endpoints. Sediment toxicity studies (MRID 44714928) showed effects to adult emergence in 30 d studies where *Chironomus* species were exposed to 6 or 9 ug a.i./L in pore water. This is similar to the level where effects to adult emergence was observed by Cavallaro et al. 2015. In a 10 d study (MRID 49589512), effects to larval survival and growth growth were observed at 360 ug a.i./L in pore water. Effects observed at an order of magnitude higher than other studies can likely be attributed to the shorter duration of this study.

Table 34. Summary of LOEC values (and observed declines relative to controls) from studies involving *Chironomus sp.*

Study	Duration (d)	Test design	LOEC (ug a.i./L in water or pore water; percent represents decline relative to control)			
			Larval survival	Larval growth	adult emergence	Adult body weight

Cavallaro et al. (2016)	40	Thia. spiked through water; sand as sediment	2.23 (25%)	NA	5.7 (69%)	NA
Saraiva et al. (2017)	28	Thia. spiked through water; sand as sediment	18 (44.5)	18 (~20%)**	10.5 (84%)	NA
MRID 44714928	30	Thia. spiked through water; artificial sediment	NA	NA	9 (100%)	NA
MRID 44714928	30	Thia. spiked through sediment; artificial sediment	NA	NA	6 (100%)	NA
MRID 49589512	10	Thia. spiked through water; artificial sediment	360 (10%)	360 (19%)*	NA	NA

NA = not available (endpoint not included in study or significant effects not observed)
*measured as dry weight
**measured as length

A 28-d study by Van Den Brink et al. (2016) reported LC10 and LC50 values of 0.81 and 0.94 ug a.i./L (respectively) for mayfly larvae exposed to thiamethoxam (as a formulated product). The LC10 and LC50 values are a factor of 2.8 and 2.4 (respectively) lower than the LOEC from Cavallaro et al. (2016) where 25% mortality was observed in *Chironomus* sp. (i.e., 2.23 ug a.i./L). These comparisons suggest that the tested mayfly species is of similar sensitivity to tested *Chironomus sp*.

3.1.2.5. Aquatic Plant Toxicity Data

EC_{50} values for aquatic plants were not established, with <50% effects observed at concentrations 90 mg a.i./L and higher. Significant effects to growth were observed in the most sensitive non vascular species at 24 mg a.i./L. No aquatic plant toxicity data were identified in ECOTOX. **Table 34** summarizes the available plant toxicity data for thiamethoxam.

Table 34. Summary of available aquatic plant toxicity data for thiamethoxam.

Species (% a.i.)	Endpoint (Duration)	Toxicity Value (mg a.i./L)	MRID	Study Classification / Comment
Aquatic Vascular Plants				
Duckweed (*Lemna gibba*) (TGAI, 98.6%)	7-d EC_{50} 7-d NOAEC	>90.2 22	MRID 44714925	Acceptable / no effects to frond # at 90.2 mg/L; NOAEC based on phytotoxicity observed at 43.9 mg/L
Aquatic Nonvascular Plants				
Saltwater diatom (*Skeletonema costatum*) (TGAI, 99.8%)	96-hr EC_{50} NOAEC	>99 12	MRID 49346607	Supplemental / LOAEC = 24 mg a.i./L (17% decline in area under the curve)
Cyanobacteria (*Anabaena flos-aquae*) (TGAI, 99.8%)	96-hr EC_{50} NOAEC	105 47	MRID 49346605	Supplemental / LOAEC = 97 mg a.i./L (44% decline in cell density)

Green Algae *Selenastrum capricornutum* (TGAI, 98.6%)	96-hr EC_{50} NOAEC	>97 97	MRID 44714926	Acceptable / no effects to biomass observed
Freshwater diatom (*Navicula pelliculosa*) (TGAI, 99.8%)	96-hr EC_{50} NOAEC	>98 98	MRID 49346606	Supplemental (qualitative) / no effects to growth observed

3.2. Effects to Terrestrial Organisms (Birds, Mammals, and Terrestrial Plants)

Tables 35 and 36 summarize the most sensitive terrestrial toxicity data used for risk estimation of thiamethoxam based on an evaluation of submitted studies and available open literature. In general, thiamethoxam is characterized as slightly toxic to birds on an acute oral exposure basis and practically non-toxic on a subacute dietary exposure basis. The most sensitive avian species is the mallard duck for both acute and chronic exposures. With respect to mammals, thiamethoxam is considered slightly toxic on an acute oral basis. Generally minimal effects are seen in plant studies where exposures were at max application rates. Additional information on effects seen in the toxicity studies is presented below.

Table 35. Summary of the Endpoints from terrestrial Toxicity Studies used to derive RQs for thiamethoxam

Taxonomic Group	Study Type (% a.i.)	Species	Toxicity Value	Acute Toxicity Category	Source and Classification
Birds (reptiles and terrestrial phase amphibians)	Acute – Avian Oral 850.2100 (98.6%)	Mallard Duck (*Anas platyrhynchos*)	LD_{50}: 576 mg/kg-bw/day NOAEC: Not determined	Slightly toxic	44703307 Acceptable
	Acute – Avian Dietary 850.2200 (98.6%)	Mallard Duck (*Anas platyrhynchos*)	LC_{50}: >5200 mg/kg-diet NOAEC: 1300 mg/kg-diet	Practically non-toxic	44703310 Acceptable
	Chronic – Avian Reproduction 850.2300 (98.3%)	Mallard Duck (*Anas platyrhynchos*)	NOAEC: 300 mg/kg-diet LOAEC: 900 mg/kg-diet (weight loss in parental males)	--	44703311 Acceptable
Mammals	Acute – Mammalian Oral 870.1100 (98.6%)	Rat (*Rattus norvegicus*)	LD_{50}: 1563 mg/kg-bw	Slightly toxic	44703314

	Chronic – Mammalian Reproduction 870.3800 (98.6%)	Rat (*Rattus norvegicus*)	NOAEL: 61 mg/kg-bw/day LOAEL: 158 mg/kg bw/day (reduced body weight gain in offspring during lactation period)	--	44718707

Table 36. Terrestrial Plant toxicity

Taxonomic Group	Study Type (% a.i.)	Species	Toxicity Value	Source and Classification
Terrestrial Plants	Vegetative Vigor 850.4150 (24.9%)	Multiple	Monocot: EC_{25}/IC_{25}: > 0.28 lb a.i/A NOAEC: 0.28 lb a.i/A No effects	49105801
			Dicot EC_{25}/IC_{25}: > 0.28 lb a.i/A NOAEC: 0.061 lb a.i/A Based on: Oilseed rape – Height	
	Seedling emergence 850.4100 (24.9%)		Monocot: EC_{25}/IC_{25}: > 0.28 lb a.i/A NOAEC: 0.28 lb a.i/A No effects	49108701
			Dicot: EC_{05}/IC_{05} = NC (unreasonable C.I.) EC_{25}/IC_{25}: 0.028 lb a.i/A (95% C.I.: 0.0025-0.23 lb a.i/A) NOAEC: <0.017 lb a.i/A Endpoint based on cucumber shoot length (height)	

3.2.1. Acute, Sub-Acute, and Chronic Effects on Birds

Additional studies submitted for avian toxicity (which were less sensitive) are included below in **Table 37.**

Table 37. Summary of the Additional Avian Endpoints from Submitted Toxicity Studies for Thiamethoxam

Study Type (% a.i.)	Species	Toxicity Value	Acute Toxicity Category	Source and Classification
Acute – Avian Oral 850.2100 (98.6%)	Bobwhite Quail (*Colinus virginianus*)	LD_{50}: 1552 mg/kg-bw/day NOAEC: 125 mg/kg-bw/day	Slightly toxic	447033-07 Acceptable

Study Type (% a.i.)	Species	Toxicity Value	Acute Toxicity Category	Source and Classification
Acute – Avian Dietary 850.2200 (98.6%)	Bobwhite Quail *(Colinus virginianus*)	LC_{50}: >5200 mg/kg-diet NOAEC: 2600 mg/kg-diet	Practically non-toxic	447033-09 Acceptable
Chronic – Avian Reproduction 850.2300 (98.3%)	Bobwhite Quail *(Colinus virginianus*)	NOAEC: 900 mg/kg-diet LOAEC: >900 mg/kg-diet (reduced egg size)	N/A	447033-12 Acceptable

In an acute toxicity study with the mallard duck the 14-day LD_{50} was 576 mg a.i./kg bw with sub-lethal effects observed including vomiting, lethargy, unsteadiness, and inability to stand. There was a reduction in feed consumption and body weights in treated birds as compared to the controls. Vomiting birds were observed at all treatment levels, although the study report was unclear if this was regurgitation directly after dosing or later in the study. While for the bobwhite quail the 21-day LD_{50} was 1552 mg a.i./kg-bw with observed sublethal effects observed including unsteadiness, lethargy, ruffled feathers and morbidity. There was also a reduction in feed consumption and body weights in treated birds as compared to the controls. The NOEL for mortality and clinical signs was 125 mg a.i./kg body weight. Two studies with passerines have been submitted to the agency conducted under the OECD TG223[19] one (MRID 49025801) was classified as invalid due to unavailable background mortality in birds (wild sparrows) used leading to uncertainties if effects are attributable to thiamethoxam. The other (MRID 49755701), is still under review by the Agency. This test had regurgitation in several of the test doses. The study authors analysis determined an LD_{50} value to be 431 mg/kg-bw based on mortality (not regurgitation) as all regurgitating birds died. Note: This endpoint is less sensitive than the LD_{50} used in the assessment for small birds based on a scaled value from the mallard duck endpoint.

There were no mortalities in dietary (LC_{50}>5200 mg a.i./kg-diet) tests for either the mallard or the bobwhite. Decreased body weight was the only sub-lethal effect seen (in the 2600 mg a.i./kg diet and 5200 mg a.i./kg diet treatment groups) for the bobwhite quail, while the mallard exhibited a reduction in both feed consumption and body weight gain (in the 1300 mg a.i./kg diet and higher dose levels). Additionally, a slight reduction in feed consumption was noted in birds at 325 mg a.i./kg diet and 650 mg a.i./kg diet treatment levels so the NOAEC was determined to be 163 mg a.i./kg diet.

There were no significant treatment-related effects on mortality, clinical symptoms, feed consumption or body weights at the dietary levels of thiamethoxam used in the reproductive effects test on the bobwhite quail. However, six mortalities (adults) occurred and were attributed to pair aggression, getting caught in the caging, and euthanization (based on an inability to walk). The NOAEC for reproductive effects was determined to be 900 mg a.i./kg diet (the highest dose tested). There were no significant treatment-related effects on adult mortality in the reproductive effects test on the mallard duck. Pathological examination of the one mortality during Week 15 in the 100 mg a.i./kg diet treatment group revealed blocked and infected intestines and emaciation. There was a significant reduction in body weights noted for males in the highest dose group as compared to the controls; females were not affected. There were no reproductive effects at any treatment level. The NOAEC based on weight loss in parental males was determined to be 300 mg a.i./kg diet.

[19] Agency guidance for considering TG223 studies as valid for risk assessments can be found here: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-classifying-studies-conducted-using-oecd

3.2.1.1. Other Avian Studies

The American Bird Conservancy (ABC) commissioned a report[20] (released in 2013), *"The Impact of the Nation's Most Widely Used Insecticides on Birds,"* reviewing 200 studies on neonicotinoids including industry research obtained through the US. Thiamethoxam is considered in this report along with other neonicotinoids including clothianidin and imidacloprid. No additional thiamethoxam toxicity data was in the ABC report outside of what is reported above. The ABC report's methods on how those data are used to evaluate risks was considered but ultimately determined not sufficiently robust for use in this assessment at this time for thiamethoxam. While data are available for the standard Agency test species (bobwhite quail and mallard duck) exposed to thiamethoxam through acute oral doses, several of these endpoints are non-definitive. As such, at this time, there are insufficient data to derive a species sensitivity distribution which could be used to estimate risk and further characterize the toxicity of thiamethoxam to birds. Regarding, methodological differences in data usage (e.g. SSDs in the ABC report), this assessment does address and refine concerns alluded to for effects on avian species consuming treated seeds.

3.2.2. Acute and Chronic Effects on Mammals

In the oral toxicity test with the rat, all observed mortalities (in each sex) in the 1500 (3), 2300 (4), 3800 (5) and 6000 (5) mg/kg-bw groups occurred within 6 hours of treatment. Clinical signs included ptosis (all doses), decrease in spontaneous movement and tonic convulsion (1500 mg/kg bw and above). The surviving animals returned to normal on the day following dosing. Reduced body weight gain was observed in all treated animals for the first two days following dosing.

In the 2-generation reproduction study, body weight gain (parents) was slightly lower in the 2500 ppm group during the first 6 weeks of the study, and F_0 and F_1 generations, in males only. However, the effect was marginal and was not considered to be toxicologically significant. Decreased testis weight was observed in the F_1 generation at 2500 ppm, and increased incidence and severity of tubular atrophy was observed in the testes in the F_1 generation at 30 ppm and above. Sperm motility was decreased in all treatment groups in both generations; however, there was no dose-response relationship. There was high variability among all groups and there were no treatment-related effects on sperm count or sperm morphology. A special investigation into the effects on sperm, concluded the initial findings were likely due to technical error and not treatment related. The supplemental information was limited to analysis of F_0 animals, hence no information relevant to the findings in F_1 animals is available. There were no other adverse, treatment-related effects on reproductive parameters (mating, gestation, fertility, viability) noted at any dose level tested for the parents.

For offspring, body weight gain was lower in the 2500 ppm group during the lactation period in the F_{1a}, F_{1b}, F_{2a} and F_{2b} litters, both sexes, resulting in lower body weights on days 7, 14 and/or 21 postpartum. Slightly lower body weight gains and body weights (days 7, 14 and/or 21 postpartum) were also noted in the 1000 ppm group for F_{2a} and F_{2b} females. However, the effect was marginal (≤8% lower than the control group values), F_{1a} and F_{1b} pups were not affected and males were not affected, and so this finding was not considered to be toxicologically significant. Based on reduced body weight gain during the lactation period in all litters, the NOAEL was determined to be 1000 ppm (61 mg/kg bw/day in males and 79 mg/kg bw/day in females).

[20] https://abcbirds.org/article/birds-bees-and-aquatic-life-threatened-by-gross-underestimate-of-toxicity-of-worlds-most-widely-used-pesticide-2/

3.2.3. Terrestrial Plant Toxicity Data

In a vegetative vigor test (maximum rate tested: 0.26 lb a.i/A), oilseed rape (dicot) was the only species to exhibit biologically meaningful effects (height). For soybean, a statistically significant reduction of 22% was detected for weight at the 0.033 lb a.i./A test level. While for sugar beet a statistically significant reduction of 12% was observed for height at the highest test level. However, the inhibitions at the test levels above and below fluctuated for these test crops, effects did not demonstrate a dose response relationship, and there was a significant lack of fit to the regression model. Consequently, EC_{25} values were not generated because effects greater than 25% were not seen. None of the other species showed effects.

In the seedling emergence test (maximum rate tested: 0.26 lb a.i/A) the % inhibition in seedling emergence in the treated species as compared to the control ranged from -3 to 25%. The most sensitive monocot species could not be determined as there was a lack of statistically significant reductions that culminated in a dose response relationship. The most sensitive dicot species was cucumber, based on reductions in height ranging from 20.9-32.9% (lowest-highest test concentrations), resulting in NOAEC and EC_{25} values of <0.017 and 0.028 lb a.i./A, respectively[21]. Based on these results another seedling emergence test was run with cucumber (MRID 50131103) to establish a NOAEC. The results of this study are still under review by the agency. Taken at face value results of this study showed no effects > 25% reduction of emergence, survival, length or weight, yielding an EC_{25}, NOAEC and LOAEC values (nominal concentration) of > 0.265, 0.265, and >0.265 lb a.i./A respectively.

Additionally, emergence and survival were significantly affected in onion and oilseed rape. However, these effects were determined not to be treatment related. For survival and emergence in onion, a statistically significant reduction was detected at the 0.033 lb a.i./A (only) test level, where inhibition was 25%. The other test levels showed promotion of emergence. For survival and emergence in oilseed rape a statistically significant reduction was only detected at the lowest test level, where inhibition was 24%. There was promotion of emergence, no emergence, or a 3% reduction in emergence in the remaining test levels. In both species, there was significant lack of fit reported for the linear regression analysis, and 95% confidence intervals could not be calculated. According to the reviewer's best professional judgment, the NOAEC was determined to be 0.28 lb a.i./A as none of the effects observed appeared to be treatment related and were not dose responsive.

3.3. Review of Incident Data

The Office of Pesticide Programs (OPP) maintains a database called the Incident Database System (IDS) in which wildlife incidents reported to the Agency from a variety of sources are maintained. For some of these incidents in IDS, a narrative of an incident is available and report information such as magnitude of the number of organisms impacted, location, date, product used, use pattern, whether the use was a registered use, and any confirmatory residue analysis if available. The sources of information for incidents include, registrant reports submitted under the Federal Insecticides, Fungicides, and Rodenticides Act (FIFRA) §6(a)(2) reporting requirement, as well as reports from local, state, national and international-level government reports on bee kill incidents, news articles, and correspondence made to EFED by phone or via email.

[21] Significant reductions in weight were also found; however the effects were not dose responsive and ranged from -5.54% in the second highest test level to 24.7% in the second lowest test level.

It is noted that not all reported incidents are associated with narrative or analytical information that definitively links thiamethoxam to the affected species. Analytical information can include residue analysis to confirm if thiamethoxam is present. Even in those cases, many incident reports are associated with findings of other pesticides, of which the interactions with thiamethoxam in contributing to potentially enhanced sensitivity for the affected entity are not fully understood. In other instances, thiamethoxam may only be suspected to be the cause of based on available observational data. This is not always supported by a confirmatory residue analysis. Typically, the reported wildlife incidents serve as a line of evidence in determining the potential effects of thiamethoxam, as the reports are useful in understanding how these chemicals may impact organisms under the actual use conditions. Much of the incident information made through phone and email correspondence to EFED does not usually include a thorough investigation of the incident or provide any confirmatory residue data to link a chemical with a particular incident. Rather, much of these reports are anecdotal in nature. A search of these databases in June of 2017 yielded 4 incidents for non-pollinator taxa. These identified incident are summarized below in **Table 38.**

Additional incidents (to those in IDS) are reported to the Agency in aggregated form. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as 'minor fish and wildlife' (W-B), 'minor plant' (P-B), and 'other non-target' (ONT) incidents. 'Other non-target' incidents include reports of adverse effects to insects and other terrestrial invertebrates.

Table 38. Summary of Terrestrial Plant and Animal incidents for Thiamethoxam

Incident ID	County	State	Magnitude	Year	Description	Legality	Certainty
I023444-001	Stearns	MN	100% of 285 Acres	2011	**Plant:** In Stearns County, MN one hundred percent of 285 acres of treated corn experienced stand issues after a diluted application of the product Avicta Duo (a.i. abamectin, thiamethoxam).	Undetermined	Abamectin: Possible Thiamethoxam: Possible
I022450-009	Buffalo	NE	50% of 80 Acres	2009	**Plant:** In Buffalo County, NE the product CruiserMaxx Beans was applied as a seed treatment to 80 acres of soybeans injuring 50% of the crop. CruiserMaxx Beans contains the active ingredients thiamethoxam, fludioxonil and mefenoxam.	Undetermined	Metalaxyl-M: Possible Fludioxonil: Possible Thiamethoxam: Possible
I024031-003	Hensel	Ontario	2 birds	2012	**Avian:** On April 12, 2012 in Hensel, Ontario, Canada a bee keeper reported chemical drifts from an air seeder used to plant corn. Corn field is about 75 feet north of bee yard. It was reported that mostly Pioneer (a.i. thiamethoxam) and some Dekalb (a.i. clothianidin) were applied. Talc powder was added to the seed. No wind at the time	Undetermined	Clothianidin: Possible Thiamethoxam: Possible

Incident ID	County	State	Magnitude	Year	Description	Legality	Certainty
					of planting and the temperature was around freezing. Samples were collected on April 17, 2012 by Health Canada Management Program were sent for analyzes. a dead robin was reported found on April 25,2012 and then a dead flycatcher a few days later. No laboratory analysis has been submitted on the dead bees or birds.		
I025475-001	Yakima	WA	Not reported	2002	**Plant:** On or about June 6, 2013 the following was reported to DuPont: in the late spring Fontelis (a.i. penthiopyrad) was applied in a large mixture of other products, including thinners, adjuvants, and plant growth regulators. This allegedly caused leaves to burn/speckle and the fruit to thin.	Registered use	Thiamethoxam : Possible Note multiple other a.i. (10) products present in incident package.

4. Risk Characterization

Risk characterization provides the final step in the risk assessment process. In this step, exposure and effects characterizations are integrated to provide an estimate of risk (i.e., Risk Quotient) relative to established levels of concern (LOCs; Section 5.1). The results are then interpreted through a risk description that considers multiple lines of evidences and an overall conclusion (Section 5.2). In addition, the risk description also contains a discussion of relevant sources of uncertainty in the risk assessment and sensitivity of the risk assessment findings to important methodological assumptions.

4.1. Risk Estimation – Integration of Exposure and Effects Data

As discussed in the problem formulation, risk characterization integrates EECs and toxicity estimates and evaluates the likelihood of adverse ecological effects to non-target species. For thiamethoxam, a deterministic approach is used to evaluate the likelihood of adverse ecological effects to non-target species. In this approach, RQs are calculated by dividing EECs by the lowest acceptable/quantitative acute and chronic toxicity endpoints for non-target species (i.e., Risk Quotient (RQ) = Exposure Estimate/Toxicity Estimate).

RQs are then compared to LOCs. These LOCs are criteria used to indicate potential risk to non-target organisms and the need to consider regulatory action. Exceeding an LOC is interpreted to mean that the labeled use of the pesticide has the potential to cause adverse effects on non-target organisms (USEPA 2004).

4.1.1. Risk to Fish and Aquatic Phase Amphibians

The acute and chronic RQs for fish did not exceed the acute or chronic LOC for all thiamethoxam uses (RQs ≤0.002). The highest RQs resulted from PWC and PFAM are presented in **Table 39**. Although the acute toxicity values for both freshwater and estuarine/marine fish were non-definitive (LC_{50} > limit concentration), RQs were calculated assuming this non-definitive value was the LC_{50} value. Therefore, actual acute RQs would be less than those presented, which are already at least an order of magnitude below the lowest LOC (i.e., 0.05). Additionally, fish were surrogates for aquatic-phase amphibians.

Table 39. Maximum acute and Chronic RQs for fish exposed to thiamethoxam. EECs generated using PWC.

Model	App method	Use	Sc
PWC	Foliar (aerial)	Forestry	N
PFAM	Seed	Rice (seed)	C

*Based on 1 d EEC and 96-hr LC_{50}: >114,000 µg a.i./L (MRID 44714917)
** Based on 60 d EEC and NOAEC = 1700 µg a.i./L (MRID 49589511)
*** Based on 60 d EEC and NOAEC = 20,000 µg a.i./L (MRID 44714923)

4.1.2. Risk to Aquatic Plants

The RQs for aquatic vascular and non-vascular plants did not exceed the LOC (1) for all thiamethoxam uses (RQs <0.001). **Table 40** depicts the RQs based on the highest 1-d EEC generated by PWC and PFAM. Although the IC_{50} toxicity values for aquatic plants were non-definitive (IC_{50} > highest concentration tested), RQs were calculated assuming this non-definitive value was the IC_{50} value. Therefore, actual RQs would be less than those presented.

Table 40. Maximum RQs for aquatic plants exposed to thiamethoxam. EECs generated using PWC.

Model	App method	Use	Scenario	1-day EEC (µg a.i./L)	Listed vascular RQ*	Non-listed vascular RQ**	Listed non-vascular RQ***	Non-listed non-vascular RQ****
PWC	Foliar (aerial)	Forestry	NC apple	5.82	<0.001	<0.001	<0.001	<0.001
PFAM	Seed	Rice (seed)	CA rice	66.4	0.006	0.003	0.001	0.001

*Based on 1 d EEC and 7-d NOAEC = 22,000 µg a.i./L (MRID 44714925)
**Based on 1 d EEC and 7-d IC_{50}: >90,200 µg a.i./L (MRID 44714925)
***Based on 1 d EEC and 96-hr NOAEC = 12,000 µg a.i./L (MRID 49346607)
****Based on 1 d EEC and 96-hr IC_{50}: >99,000 µg a.i./L (MRID 49346607)

4.1.3. Risk to Aquatic Invertebrates

As presented in **Tables 41-43**, for thiamethoxam uses with foliar, soil and seed treatments, there was one non-listed acute LOC freshwater (FW) exceedance, based on seed treatments to rice. No other uses resulted in RQs that exceeded the acute LOC for non-listed species (i.e., RQ<0.5). For foliar and soil treatments, the acute listed LOC (0.05) was exceeded for the majority of uses for freshwater (FW) invertebrates. For seed treatments, only use on rice exceed the listed species LOC for freshwater invertebrates.

The chronic LOC (1.0) was exceeded for FW invertebrates for all foliar and soil uses, except cranberry. For seed treatments, all modeled uses resulted in RQs below the chronic LOC, except rice. Because of the seed planting depth>2 cm for some crops (i.e., corn and wheat), EECs and resulting RQs were 0, resulting in no LOC exceedances.

None of the saltwater (SW) invertebrate acute or chronic RQs exceeded the non-listed or listed species LOCs.

Table 41. Foliar applications: Summary of Acute and Chronic RQs for Freshwater (FW) and saltwater (SW) Invertebrates.

App method	Use	Scenario	EEC (µg a.i./L)		RQ			
			1-day	21-day	FW Invert Acute[1]	SW invert acute[2]	FW Invert chronic[3]	SW Invert chronic[4]
Aerial	Cotton	MS cotton	3.01	2.49	**0.09***	<0.01	**3.4****	<0.01
	Cotton	CA cotton	1.05	0.82	0.03	<0.01	**1.1****	<0.01
	Potato	FL potato	2.64	2.30	**0.08***	<0.01	**3.1****	<0.01
	Potato	ID potato	0.72	0.64	0.02	<0.01	0.9	<0.01
	Cucurbit	FL cucumber	5.38	4.02	**0.15***	<0.01	**5.4****	<0.01
	Cucurbit/Lettuce	CA lettuce	2.95	2.58	**0.08***	<0.01	**3.5****	<0.01
	Tree fruit	Orchard	4.80	4.14	**0.14***	<0.01	**5.6****	<0.01
	Tree fruit/almonds	CA almond	0.89	0.73	0.03	<0.01	1.0	<0.01
	Nursery	CA nursery	2.00	1.73	**0.06***	<0.01	**2.3****	<0.01
	Forestry	OR Christmas tree	3.06	2.78	**0.09***	<0.01	**3.8****	<0.01
	Forestry	NC apple	5.82	5.02	**0.17***	<0.01	**6.8****	<0.01
Ground	Cotton	MS cotton	2.85	2.29	**0.08***	<0.01	**3.1****	<0.01
	Cotton	CA cotton	0.66	0.52	0.02	<0.01	0.7	<0.01
	Potato	FL potato	2.43	2.11	**0.07***	<0.01	**2.9****	<0.01
	Potato	ID potato	0.41	0.36	0.01	<0.01	0.5	<0.01
	Cucurbit	FL cucumber	5.03	3.76	**0.14***	<0.01	**5.1****	<0.01
	Cucurbit/Lettuce	CA lettuce	2.48	2.19	**0.07***	<0.01	**3.0****	<0.01
	Cranberry	OR berry	0.52	0.45	0.01	<0.01	0.6	<0.01
	Tree fruit	BSS Orchard	4.45	3.85	**0.13***	<0.01	**5.2****	<0.01
	Tree fruit/almonds	CA almond	0.49	0.42	0.01	<0.01	0.6	<0.01
	Nursery	TN nursery	2.77	2.16	**0.08***	<0.01	**2.9****	<0.01
	Nursery	CA nursery	1.10	0.95	0.03	<0.01	**1.3****	<0.01
	Turf	FL turf	1.44	1.14	0.04	<0.01	**1.5****	<0.01
	Turf	CAT turf	3.80	3.39	**0.11***	<0.01	**4.6****	<0.01
	Forestry	OR Christmas tree	2.19	1.99	**0.06***	<0.01	**2.7****	<0.01

	Forestry	NC apple	5.13	4.42	**0.15***	<0.01	**6.0****	<0.01

*Value exceeds listed species LOC (0.05).
**Value exceeds chronic LOC (1.0).
[1]Calculated using 1-d EEC and 48-h EC_{50} = 35 µg a.i./L (MRID 44714918).
[2]Calculated using 1-d EEC and 96-h LC_{50} = 6900 µg a.i./L (MRID 44714922).
[3] Calculated using 21-d EEC and NOAEC = 0.74 µg a.i./L (Cavallaro et al. 2016).
[4]Calculated using 21-d EEC and NOAEC = 1100 µg a.i./L (MRID 49589510).

Table 42. Soil treatments: Summary of Acute and Chronic RQs for Freshwater (FW) and saltwater (SW) Invertebrates

Use	Scenario	EEC (µg a.i./L)		RQ			
		1-day	21-day	FW Invert Acute[1]	SW invert acute[2]	FW Invert chronic[3]	SW Invert chronic[4]
Citrus	FL citrus	3.22	2.70	**0.09***	<0.01	**3.6****	<0.01
Cucurbit	FL cucumber	3.94	2.95	**0.11***	<0.01	**4.0****	<0.01
Cucurbit/Lettuce	CA lettuce	3.79	3.34	**0.11***	<0.01	**4.5****	<0.01
Radish/carrot	FL carrot	2.28	1.91	**0.07***	<0.01	**2.6****	<0.01
Radish/onion	CA onion	0.35	0.31	0.01	<0.01	0.4	<0.01
Grape	NY grape	2.08	1.71	**0.06***	<0.01	**2.3****	<0.01
Grape	CA grape	0.94	0.82	0.03	<0.01	**1.1****	<0.01
Cranberry	OR berry	0.74	0.65	0.02	<0.01	0.9	<0.01
Nursery	TN nursery	2.72	2.17	**0.08***	<0.01	**2.9****	<0.01
Nursery	CA nursery	1.05	0.91	0.03	<0.01	**1.2****	<0.01
Turf	FL turf	1.17	0.91	0.03	<0.01	**1.2****	<0.01
Turf	CA turf	3.08	2.75	**0.09***	<0.01	**3.7****	<0.01
Forestry	OR Christmas tree	1.98	1.77	**0.06***	<0.01	**2.4****	<0.01
Forestry	NC apple	3.65	3.13	**0.10***	<0.01	**4.2****	<0.01

*Value exceeds listed species LOC (0.05).
**Value exceeds chronic LOC (1.0).
[1]Calculated using 1-d EEC and 48-h EC_{50} = 35 µg a.i./L (MRID 44714918).
[2]Calculated using 1-d EEC and 96-h LC_{50} = 6900 µg a.i./L (MRID 44714922).
[3] Calculated using 21-d EEC and NOAEC = 0.74 µg a.i./L (Cavallaro et al. 2016).
[4]Calculated using 21-d EEC and NOAEC = 1100 µg a.i./L (MRID 49589510).

Table 43. Seed Treatments: Summary of Acute and Chronic RQs for Freshwater (FW) and saltwater (SW) Invertebrates

Use	Scenario	EEC (µg a.i./L)		RQ			
		1-day	21-day	FW Invert Acute[1]	SW invert acute[2]	FW Invert chronic[3]	SW Invert chronic[4]
Cotton	MS cotton	0.51	0.42	0.01	<0.01	0.6	<0.01
Cotton	CA cotton	0.08	0.07	<0.01	<0.01	0.1	<0.01
Corn	MS corn	0.00	0.00	0.00	0.00	0.0	0.00
Corn	CA corn	0.00	0.00	0.00	0.00	0.0	0.00
Soybean	MS soybean	0.03	0.02	<0.01	<0.01	0.0	<0.01

Soybean/corn	CA corn	0.01	0.01	<0.01	<0.01	0.0	<0.01
Sugar beet	MN sugar beet	0.27	0.25	0.01	<0.01	0.3	<0.01
Sugar beet	CA sugar beet	0.54	0.50	0.02	<0.01	0.7	<0.01
Wheat	TX wheat	0.00	0.00	0.00	0.00	0.0	0.00
Wheat	CA wheat	0.00	0.00	0.00	0.00	0.0	0.00
Rice	MS rice	4.13***	3.81***	**0.12***	<0.01	**5.1****	<0.01
Rice	CA rice	66.4***	35.5***	**1.90+**	0.01	**48****	0.03

*Value exceeds listed species LOC (0.05).
+Value exceeds non-listed (0.5) and listed species (0.05) LOCs.
**Value exceeds chronic LOC (1.0).
***EEC generated using PFAM
[1]Calculated using 1-d EEC and 48-h EC_{50} = 35 µg a.i./L (MRID 44714918).
[2]Calculated using 1-d EEC and 96-h LC_{50} = 6900 µg a.i./L (MRID 44714922).
[3] Calculated using 21-d EEC and NOAEC = 0.74 µg a.i./L (Cavallaro et al. 2016).
[4]Calculated using 21-d EEC and NOAEC = 1100 µg a.i./L (MRID 49589510).

4.1.4. Risk to Birds and Mammals

In the following sections, RQ values are calculated for terrestrial organisms (**Tables 44-**) based on the exposure estimates in **Section 2.4.1** and toxicity values outlined in **Section 3.2**. Risks are estimated based on an upper-bound of application rate for both foliar agricultural (0.086 lb a.i./A) and soil agricultural/non-agricultural uses (0.265). This use rate is also considered protective of the seed treatment uses as the amount of a.i. per unit area approaches the maximum amount allowed for seed treatments. In general, there are few exceedances of the LOC for all scenarios. The results are presented below with additional characterization where necessary.

4.1.4.1. Risk to Birds

Foliar and Soil Applications

Tables 44 and 45 show both acute dose-based and chronic dietary based risk quotients for thiamethoxam applied 1, 2, or 3 times the maximum foliar rate (0.086 lb a.i./A) and a single application to soil (inclusive of dietary residues resulting from turf and non-agricultural Christmas tree applications at 0.265 lb a.i./A). Ranges are provided to simplify rows where all feeding categories were below both the listed and non-listed LOCs. As shown by the table, the acute listed (0.1) LOC was mostly exceeded for herbivorous small bids at the higher application rates (2 or 3 apps at 0.086 lb a.i./A or 1 app at 0.265 lb a.i./A). RQs were also at the listed LOC of 0.1 for small insectivorous birds and medium herbivorous birds at 1 application of 0.256 lb a.i./A.

Table 44. Avian acute dose-based[1] and chronic dietary-based[2] RQs based on maximum single application rate of 0.086 lb a.i./A

Feeding Category	Acute dose-based RQs								
	Small (20 g)			Medium (100 g)			Large (1000 g)		
	1 app	2 apps	3 apps	1 app	2 apps	3 apps	1 app	2 apps	3 apps
Short Grass		0.15*	0.21*	All RQs <0.01-0.09					
Tall Grass			0.09						

Broadleaf plants	All RQs <0.01-0.08	All RQs <0.01-0.08	0.12*	
Fruits/pods			All RQs <0.01-0.08	
Arthropods				
Seeds				
	Chronic Dietary Based RQs (mg/kg-diet)			
Short Grass	All RQs <0.01-0.18			
Tall Grass				
Broadleaf plants				
Fruits/pods				
Arthropods				
Seeds				

[1] Mallard duck LD_{50} of 576 mg/kg-bw (MRID 44703307)
[2] Mallard duck NOAEL 61 mg/kg-bw per day (MRID 44718707)
*At or exceeds the listed species LOC (0.1)

Table 45. Avian acute dose-based[1] and chronic dietary-based[2] RQs based on maximum single application rate of 0.265 lb a.i./A

Feeding Category	Acute dose-based RQs (mg/kg-bw)		
	Small (20 g)	**Medium (100 g)**	**Large (1000 g)**
Short Grass	0.2*	0.1*	All RQs ≤0.01
Tall Grass	0.1*	0.05	
Broadleaf plants	0.1*	0.1*	
Fruits/pods	0.02	All RQs <0.01-0.04	
Arthropods	0.1*		
Seeds	<0.01		
	Chronic Dietary Based RQs (mg/kg-diet)		
Short Grass	All RQs ≤0.02		
Tall Grass			
Broadleaf plants			
Fruits/pods			
Arthropods			
Seeds			

[1] Mallard duck LD_{50} of 576 mg/kg-bw (MRID 44703307)
[2] Mallard duck NOAEL 61 mg/kg-bw per day (MRID 44718707)
*At or exceeds the acute listed species LOC (0.1)

Treatment directly to soil (rows, in-furrow, band) is an additional potential route of exposure for birds via dietary items. The LD_{50}/ft^2 [22] analysis is used to estimate risk for this type of application (in addition to granular applications). As a conservative screen, a broadcast application rates 0.265 to soil with no incorporation were modeled and yielded an estimated 2.76 mg a.i./ft^2. This is considered conservative because it is the highest amount of a.i. with no modeled incorporation or covering leaving the entire treated area as a potential route of exposure. The results showed a potential risk concern for listed (LOC of 0.1 exceeded) small birds (**Table 46**). Additionally, as noted in **Section 2.4.1** EFED compared the upper bound Kenaga EECs in arthropods following foliar applications as a surrogate for potential exposures of likely dietary items following soil exposures. Based on this analysis, there are no LOC exceedances for birds consuming arthropods. However, based on the conservative assumptions of the

[22] The LD_{50}/ft^2 is only used to estimate risk from acute exposures.

LD_{50}/ft^2 analysis there are potential risk issues for listed small birds from soil treatments at these application rates.

Table 46. Avian acute and chronic RQs for soil applications at 0.265 lb a.i./A based on LD^{50}/ft^2 and dietary analysis

Size Class	LD_{50}/ft^2		Acute - Arthropod		Chronic - Arthropod	
	EEC	RQ	EEC - Dose	RQ	EEC - Dietary	RQ
Small (20 g)	2.76[1]	**0.46**	28.4	0.09	25	0.1
Medium (100 g)		0.07	16.2	0.04		
Large (1000 g)		0.01	7.2	0.01		

[1] mg a.i./ft^2 and based on broadcast spray with no incorporation.
Bold values exceed the acute listed (0.1) LOC.

Seed Treatments

For assessing acute risk related to treated seeds, a dose-based RQ[23] is calculated, where the exposure metric is an estimated ingested dose (mg a.i./kg-bw) based on the pesticide concentration on the treated seed and the allometric food ingestion rate[24]. An area-based RQ[25], analogous to an LD_{50} ft^2 is also calculated based on the mass of active ingredient per unit area (square foot). This method simply compares the amount pesticide expected to be present in a square foot to the acute LD_{50} and does not include any specific estimation of pesticide ingested doses. Chronic risks are estimated using a "diet based" approach by comparing the concentration of pesticide on the treated seed divided by the chronic diet-based NOAEC.

Table 47 below shows the calculated RQs for birds for several different crop commodities sewn with treated seed. As previously mentioned these were chosen based on high acreage planted (e.g. corn, soybean, cotton) and to provide a range of application rates (e.g. cotton 0.071 lb a.i./A to sugar beet 0.167 lb a.i./A), use consideration, and seed size. Depending on the size of the bird, there are acute non-listed exceedances for all crops except soybean, acute listed exceedances for all crops (mainly for small birds), and chronic exceedances for all modeled crops and size classes.

Table 47. Acute Dose based, mg a.i./ft2 based and Chronic[1] exposure based RQs for birds from exposure to thiamethoxam treated seed.

Crop	Exposure	Small (20g)	Med (100g)	Large (1000g)
Sugar Beet	Dose Based	29.6*	13.3*	4.2*
	LD_{50}/ft^2	*0.29*	0.05	<0.01
	Chronic	**117**		
Corn	Dose Based	3.26*	1.46*	*0.46*
	LD_{50}/ft^2	*0.20*	0.03	<0.01
	Chronic	**12.8**		
Soy	Dose Based	*0.42*	*0.19*	0.06
	LD_{50}/ft^2	*0.15*	0.02	<0.01

[23] RQ = [(Seed Application Rate (mg a.i./kg-seed) * daily food intake (g/day) * 0.001 kg/g) / body weight of animal (kg)] / Adjusted (bw) Toxicity Endpoint (LD50)
[24] Assumes 100% of the diet is composed of treated seeds and does not presently account for the probability of consuming a treated seed which may be reduced with soil incorporation of seeds.
[25] RQ = [(Application Rate (lbs a.i./A) * 1,000,000 mg/kg) / (43,560 ft2 * 2.2 lb/kg)] / Adjusted LD50)

Crop	Exposure	Small (20g)	Med (100g)	Large (1000g)
	Chronic	**1.7**		
Cotton	Dose Based	3.19*	1.43*	*0.45*
	LD_{50}/ft^2	*0.12*	0.02	<0.01
	Chronic	**12.6**		

[1] Chronic RQ values are the same for all size classes.
* Exceeds the non-listed LOC (0.5) and listed LOC (0.1); *Italicized* text exceeds the listed LOC (0.1); **Bold** text exceeds the chronic listed and non-listed LOC (1)

4.1.4.2. Risks to Mammals

Foliar and Soil Applications

There were no LOC exceedances (**Tables 48, 49, and 50**) for mammals from any application rate (0.086 lb a.i./A, 0.265 lb a.i/A), application number (1, 2, 3)[26], or type (for foliar or soil applications). Unlike birds, the LD_{50}/ft^2 analysis did not yield any concerns for foraging mammals. Additionally, considering arthropod RQs did not exceed the LOC, so no further characterization was done.

Table 48. Mammalian dose-based acute and chronic RQs based on maximum single application rate of 0.086 lb a.i./A

Feeding Category	Acute dose-based RQs								
	Small (15 g)			Medium (35 g)			Large (1000 g)		
	1 app	2 apps	3 apps	1 app	2 apps	3 apps	1 app	2 apps	3 apps
Short Grass	All RQs ≤0.01								
Tall Grass									
Broadleaf plants									
Fruits/pods									
Arthropods									
Seeds									
	Chronic dose-based RQs								
Short Grass	0.07-0.39								
Tall Grass	0.03-0.18								
Broadleaf plants	0.04-0.22								
Fruits/pods	<0.01-0.02								
Arthropods	0.03-0.15								
Seeds	All RQs All RQs ≤0.01								

Table 49. Mammalian dose-based RQs based on single application rate of 0.256 lb a.i./A

Feeding Category	Acute dose-based RQs (mg/kg-bw)		
	Small (15 g)	Medium (35 g)	Large (1000 g)
Short Grass	All RQs <0.01-0.02		
Tall Grass			
Broadleaf plants			
Fruits/pods			
Arthropods			
Seeds			

[26] 2 or 3 applications for foliar rate of 0.086 lb a.i./A only.

	Chronic dose-based RQs (mg/kg-bw)
Short Grass	0.21-0.45
Tall Grass	0.09-0.21
Broadleaf plants	0.12-0.25
Fruits/pods	0.01-0.03
Arthropods	0.08-0.18
Seeds	All RQs ≤0.01

Table 50. Mammalian acute and chronic RQs for soil applications at 0.265 lb a.i./A based on LD^{50}/ft^2 and dietary analysis

Size Class	LD_{50}/ft^2		Acute - Arthropod		Chronic - Arthropod	
	EEC	RQ	EEC – Dose	RQ	EEC - Dietary	RQ
Small (15 g)	2.76[1]	0.05	23.7	≤0.01	25	0.02
Medium (35 g)		0.03	16.4			
Large (1000 g)		<0.01	3.8			

[1] mg a.i./ft^2 and based on broadcast spray with no incorporation.

Seed treatments

Acute RQs from seed treatment uses are calculated for mammals in the same manner as birds (**Section 4.1.4.1 – *Seed treatments***). For mammals (unlike birds), chronic RQs are calculated using a "dose-based" approach whereby the ingested dose of pesticide is divided by the dose-based NOAEL. The non-listed acute LOC was exceeded (**Table 51**) for seed treatment uses on sugar beet only while the acute listed LOC was exceeded for corn and cotton. The chronic LOC was exceeded for corn, cotton, and sugar beet. There were no LOC exceedances for soybean.

Table 51. Acute Dose based, mg a.i./ft^2 based and Chronic exposure based RQs for Mammals from exposure to thiamethoxam treated seed.

Crop	Exposure	Small (15g)	Med (35g)	Large (1000g)
Sugar Beet	Dose Based	2.16*	1.84*	0.99*
	LD50/ft2	0.03	0.02	0.00
	Chronic	**55.33**	**47.26**	**25.33**
Corn	Dose Based	*0.24*	*0.20*	*0.11*
	LD50/ft2	0.08	0.10	0.00
	Chronic	**6.08**	**5.20**	**2.79**
Soy	Dose Based	0.03	0.03	0.01
	LD50/ft2	0.02	0.01	0.00
	Chronic	0.79	0.68	0.36
Cotton	Dose Based	*0.23*	*0.20*	*0.11*
	LD50/ft2	0.01	0.01	0.00
	Chronic	**5.97**	**5.10**	**2.73**

* Exceeds the non-listed LOC (0.5) and listed LOC (0.1); *Italicized* text exceeds the listed LOC (0.1); **Bold** text exceeds the chronic listed and non-listed LOC (1)

4.1.4.3. Risks to Terrestrial Plants

RQs for terrestrial plants are presented below in **Table 52.** These are based on the single highest rate: 1 ground application at 0.265 lb a.i./A. RQs. Based on the reviewed data there are exceedances for non-listed dicots in semi-aquatic habitats. RQs for non-listed monocots could not be calculated due to non-definitive values which were greater than the maximum application rate in both the vegetative vigor and seedling emergence studies. RQs were not calculated for non-listed monocots due to non-definitive IC_{25} values in both the seedling emergence and vegetative vigor tests. At the maximum application rate tested (0.28 lb a.i./A), the highest % effect seen was in onion weight at 23% in the seedling emergence test, and in the vegetative vigor test 11.1% effect on sugar beet height. RQs were not calculated for listed dicots because there were statistically significant reductions in height at the lowest treatment level (0.017 lb a.i./A) resulting in a non-definitive NOAEC. It was determined the IC_{05} could not be used in lieu of the NOAEC due to unbounded 95% confidence interval.

Table 52. Risk Quotients for terrestrial plants in dry areas, semi-aquatic areas, and due to spray drift

Application Rate	Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
1 ground application@ 0.265 lb a.i/A	Monocot	non-listed	NC	NC	NC
		Listed	<0.1	0.48	<0.1
	Dicot	non-listed	0.57	**4.83**	<0.1
		listed	NC	NC	NC

Bold value exceeds the plant LOC (1)

4.2. Risk Description

In risk description, results from the risk estimation are interpreted and synthesized into overall risk conclusions. This description considers other lines of evidence (e.g., monitoring data, field data, incident reports, etc.) for characterizing ecological risk. In addition, the risk description also contains a discussion of relevant sources of uncertainty in the risk assessment and sensitivity of the risk assessment findings to important methodological assumptions. It also addresses other concerns including risks to threatened and endangered species.

4.2.1. Fish, Aquatic-Phase Amphibians and Aquatic Plants

LOCs were not exceeded for fish (surrogates for aquatic-phase amphibians) or aquatic plants. When compared to EECs, the toxicity values are orders of magnitude higher than the EECs. Therefore, potential risk to fish, aquatic-phase amphibians, and aquatic plants are considered low.

4.2.2. Aquatic Invertebrates

Based on RQs for freshwater invertebrates, there are risk concerns for acute exposures from some uses (rice seed treatment for non-listed species; several foliar and soil treatments for listed species) There are chronic risk concerns for the majority of foliar and soil treatment uses, as well as seed treatment of rice.

When considering the LOEC for chronic effects, EECs for several foliar and soil treatment uses and seed treatment on rice also exceed the LOEC. Exceptions include foliar and soil applications to nurseries, ground applications to potatoes, soil applications to radish, soil applications to grape. For these uses, there is uncertainty in the chronic risks as effects occur between the NOEC and LOEC. For those uses

where exposure exceeds the LOEC (e.g., foliar applications to cotton, foliar and soil applications to cucurbits), there is less uncertainty in the chronic risk conclusions.

RQs are based on 1-in-10 year frequencies. An analysis was conducted on the 30-year time series generated by PWC to evaluate how frequently daily values exceed toxicity endpoints (i.e., LOECs and NOECs) for aquatic invertebrates (**Table 53**). This analysis focuses on foliar thiamethoxam uses on cotton. These uses were selected because they are major uses of thiamethoxam, as identified in the SLUA and pose a risk (i.e., RQ>LOC). As summarized in **Table 53,** exposure estimates for foliar applications may exceed the NOEC 10-29 of the simulated years, with several exceedances of the LOEC (for the MS cotton scenario). In general, the number of exceedances in the CA scenarios are less than those in the MS scenarios. This can be attributed to more frequent rainfall events in MS. **Figures 1-3** depict the 21-d rolling water column concentrations for foliar treatments to cotton.

Table 53. Comparison of 30 years of daily water column concentrations to chronic endpoints (i.e., NOEC and LOEC) for aquatic invertebrates.

Application method	PWC scenario	Chronic RQ	# years where NOEC (0.74 ug/L) is exceeded	# years where LOAEC (2.23 ug/L) is exceeded
Foliar (aerial)	CA cotton	1.1	29	0
	MS cotton	3.4	15	3
Foliar (ground)	CA cotton	0.7	0	0
	MS cotton	3.1	10	3

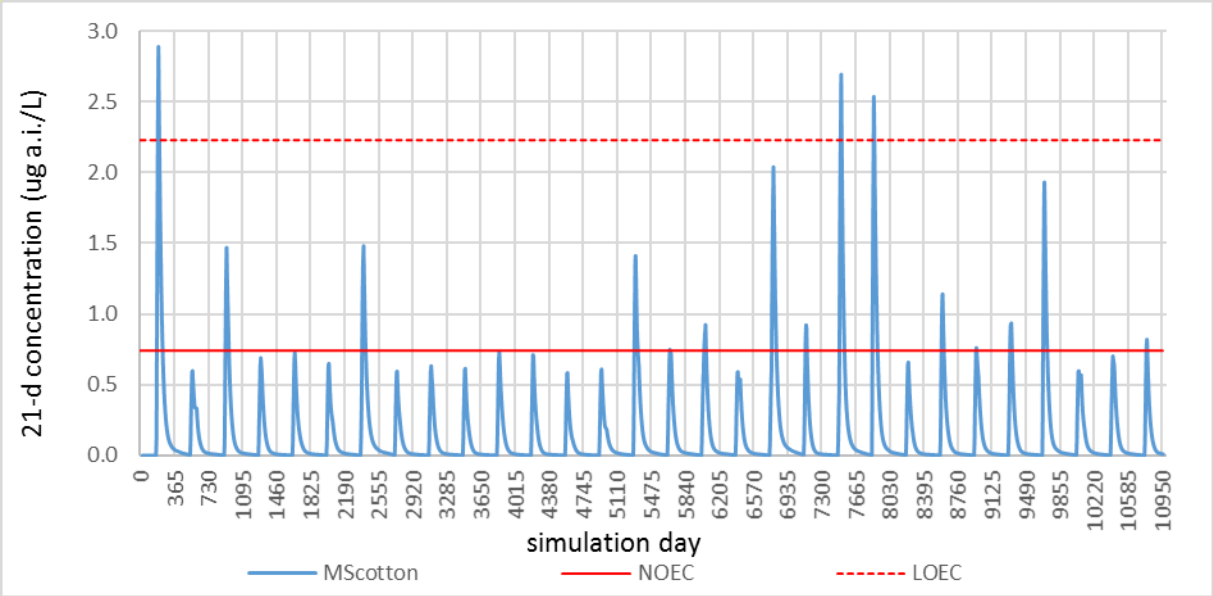


Figure 1. 21-d rolling EECs generated using MScotton scenario for aerial applications to cotton. Chronic invertebrate LOEC and NOEC included for reference.

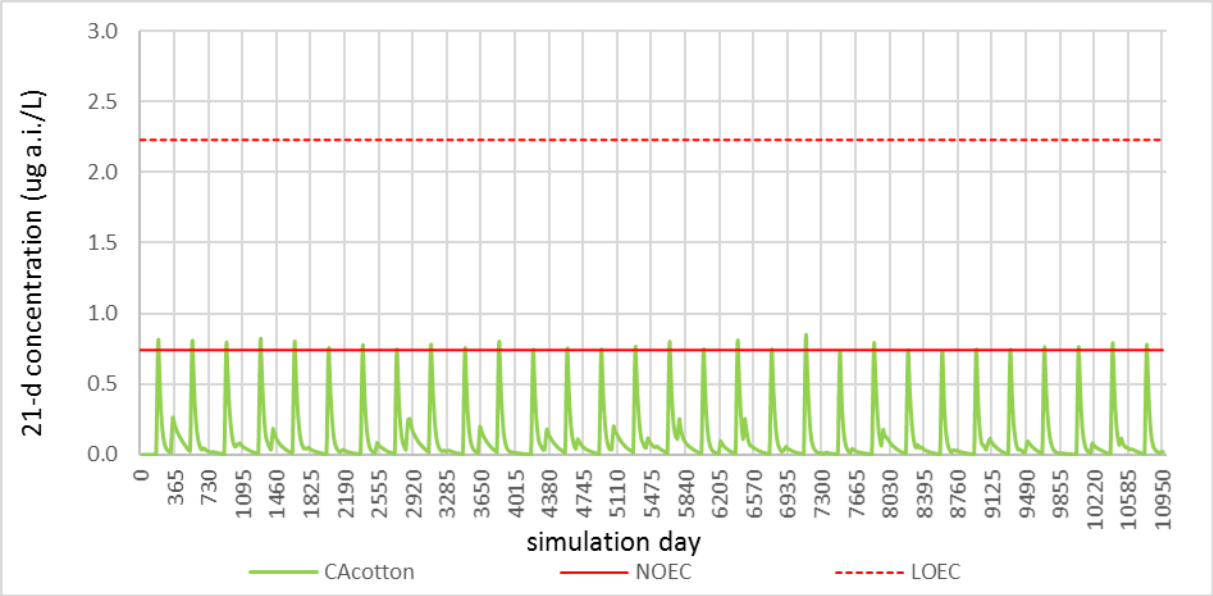


Figure 2. 21-d rolling EECs generated using <u>CAcotton</u> scenario for <u>aerial</u> applications to cotton. Chronic invertebrate LOEC and NOEC included for reference.

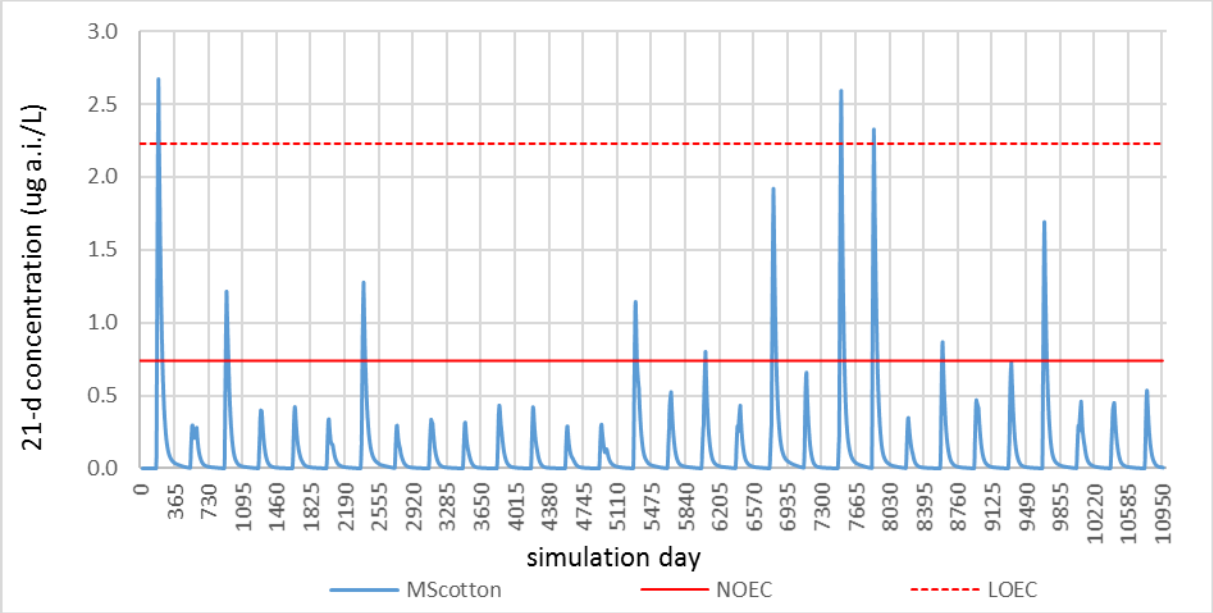


Figure 3. 21-d rolling EECs generated using <u>MScotton</u> scenario for <u>ground</u> applications to cotton. Chronic invertebrate LOEC and NOEC included for reference.

Incorporation depth has a significant impact on aquatic EECs, with deeper seeds resulting in lower EECs (for more on this the reader is referred to the analysis conducted in the imidacloprid ecological risk assessment [USEPA, 2017]). As a result, the aquatic EECs for seed treatment generated in this assessment may under- or over-estimate concentrations typically seen in waterbodies receiving runoff from fields with treated seeds.

When considering the available monitoring data, the highest detected sample was 4.37 µg a.i./L (sample from CA collected in 2016). This value is within the same order of magnitude of 1-in-10 year 1-day EECs range 0.14-5.8 µg a.i./L. The highest concentration detected in the monitoring data is above the NOEC (0.74 ug a.i./L) and LOEC (2.23) for chronic effects to invertebrates.

There is some uncertainty associated with the chronic toxicity endpoint used in this assessment for aquatic invertebrates. Test organisms were exposed to thiamethoxam through the benthic layer (composed of sand and pore water); however, exposure was quantified in the overlaying water. It is assumed that pore water and overlaying water concentrations were equivalent because of the following:

1. Thiamethoxam has low Koc values (it is expected that pore water and overlying water will be very similar at equilibrium; this is supported by comparison of water column and pore water EECs generated by PWC that differ by a factor of 1.3-4.4)
2. There is a *de minimus* amount of organic carbon in the sand matrix, therefore, sorption of compounds to the organic of the benthic layer is not expected to be substantial.
3. The coarse particle size of the sand facilitates exchange between the overlying water and pore water, allowing for equilibrium to occur within a short period of time.

When considering toxicity data available for other aquatic invertebrates, those species that are not in the insect class are orders of magnitude less sensitive. Exposure estimates are below the toxicity endpoints, suggesting that non-insect aquatic invertebrates (e.g., cladocerans, bivalves) are less likely to be impacted by thiamethoxam exposures. Toxicity data used quantitatively in this assessment (i.e., to derive RQs) were based on midges (48-EC_{50} = 35 ug a.i./L; 40-d NOAEC = 0.74 ug a.i./L). Qualitative data available for another species of insect (mayfly *(Cloeon dipterum)*; 96-h EC50 = 20 ug a.i./L; 28-d EC_{10} = 0.13 ug a.i./L; Van Den Brink et al. 2016) show a similar level of sensitivity compared to midges.

One uncertainty associated with this assessment is that the stressor of concern is thiamethoxam only. Three of 14 aerobic soil metabolism studies reported the formation of clothianidin as a major degradate. As discussed previously, clothianidin is a neonicotinoid insecticide. Available toxicity data suggest that clothianidin may be more toxic to midges compared to thiamethoxam (e.g., Cavallaro et al. 2016). Thiamethoxam alone poses a risk to aquatic invertebrates for the majority of foliar and soil uses. Also, since clothianidin was only observed as a major degradate in 3 of 14 aerobic soil metabolism studies, it is not expected that the soil metabolism half-life parameter (which is based on the 90th percentile value) will be substantially impacted. Therefore, EECs are not expected to be impacted substantially. Another degradate NOA-404617, which maintains the N-nitro group, may also be of similar toxicity compared to thiamethoxam. This degradate was detected as a major degradate in one study (aerobic aquatic metabolism). If the aerobic aquatic metabolism half-life is assumed to be stable to account for this degradate, 1-d EECs would increase slightly (a factor of 1.0-2.8). Since no toxicity data are available for this degradate, it is unknown whether this compound is of similar toxicity to thiamethoxam. In summary, although clothianidin and NOA-404617 were not quantitatively incorporated into this assessment (i.e., through modeling a total residue approach to derive EECs), EECs for thiamethoxam alone are sufficient to pose a risk to aquatic invertebrates for all uses. Given that EECs for thiamethoxam alone are orders of magnitude below endpoints for other aquatic taxa (i.e., fish and aquatic plants), risk conclusions are expected to be influenced by exclusion of degradates from the EECs.

4.2.3. Birds

Foliar Applications

Acute, dose-based RQs were calculated for birds. When considering LOCs, these RQs suggest potential risk of mortality to listed species (no non-listed exceedances) from multiple applications of 0.086 lb a.i./A or the single highest application rate (0.265) for turf or ornamentals. Specifically, potential effects were identified for small and medium herbivorous birds and small insectivores. Acute listed LOC exceedances exist for the small birds consuming short grass (the highest RQs) for up to 45 days based on a 3 applications at 0.086 lb a.i./A or a single application at 0.256 lb a.i./A, suggesting foliar residues are present to cause mortality for a significant window after application. Given that most herbivorous species are expected to be classified large (USEPA 2015), it is less likely that herbivorous species will be at risk; however, smaller omnivorous species that consume available foliage (e.g., seedlings) may be at risk.

Acute dietary RQs were not calculated because the dietary LC_{50} study endpoints were all non-definitive (> 5200 mg a.i./kg-diet). This endpoint compared to the highest dietary EEC (64 mg a.i./kg-diet) is 2 orders of magnitude greater. Even comparing the NOAEC for sub-lethal effects 163 mg a.i./kg-diet is almost 3X this concentration.

The dose-based and diet-based toxicity testing approaches involve two different types of exposures and have inherent in them certain assumptions and uncertainties. The acute dose-based test is conducted with adult birds and assumes uptake and absorption kinetics of receiving a laboratory gavage dose (in which the chemical exposure is intense, and potentially highly bioavailable) could approximate the uptake and absorption from a dose in a dietary matrix. The acute dietary study is conducted with young chicks consuming food (that has potentially different nutrient content) at a rate also assumed to be similar to that in the field. Absorption and metabolism of a toxicant are likely variable across chemicals, organisms, and life stages. The oral dose test could represent a short-term exposure whereas the dietary exposure test could be representative of a more prolonged exposure period. Risk estimates suggest short-term intense exposures are more likely to result in mortality to listed bird species.

Risk quotients (and the number of days these RQs exceed the LOC noted above) are based on a default foliar dissipation half-life value of 35 days and the upper-bound Kenaga values on predicted in dietary items of birds, which represent a conservative estimate of thiamethoxam residues on plants. A shorter half-life would reduce potential exposure and the number of days LOC exceedances would occur leaving a shorter window for foliar residues to be at levels potentially causing mortality. Additionally, when mean Kenaga values, representing the average residues, along with the 35-day default half-life, are compared to the same toxicity data (**Table 54**), exposures are all well below levels that would represent an acute risk to birds (including listed and non-listed).

Table 54. Risk quotients generated using mean Kenaga residues for birds.

Application Rate	Number of Apps	Size Class	Herbivores and Omnivores				Insectivore	Granivore
			Short Grass	Tall Grass	Broadleaf plants	Fruits/pods	Arthropods	Seeds
0.086 lb a.i./A	2	Small (20 g)	0.05	0.02	0.03	<0.01	0.04	<0.01
	3		0.07	0.03	0.04	0.01	0.06	<0.01
0.265 lb a.i./A	1		0.09	0.04	0.05	0.01	0.07	<0.01

		Medium (100 g)	0.04	0.02	0.02	<0.01	0.03	<0.01

When considering the available weight of evidence, although there are LOC exceedances, the risk of mortality to birds from acute exposures following foliar application appears low.

Soil Applications

The application rates of 0.086 and 0.256 lb a.i./A via broadcast spray were used as upper bounds contributing the most potential a.i./ft2 in any given foraging area for soil applications. According to the LD50/ft2 analysis, the assumption of a spray with 0 incorporation yielded listed LOC exceedances for small birds. The same analysis, assuming light incorporation (assumed 85%), would result in no LOC exceedances (RQ = 0.07) for small birds at 0.265 lb a.i./A (at a single application of 0.083 amount incorporated as low as 35% would keep RQs below the listed LOC). Many thiamethoxam soil uses are for band applications which are expected to be incorporated into the soil. Additionally, soil treatments (pre-plant) are expected to spray only sparse vegetation (less potential exposure) on the field rather than a dense patch of plant material. The dietary item subject to exposure in this scenario is insect s. The only RQ (0.1) was at the listed species LOC (also 0.1) for a single application at 0.256 lb a.i/A for arthropods. Considering incorporation is an expected practice and coupled with the likely sparse vegetative or insect dietary items lacking in a square foot of a soil treated field, lines of evidence suggest mortality resulting from thiamethoxam treated soil is unlikely.

Seed treatments

Seed treatments are the only use patterns with exceedances for both listed and non-listed bird species. There are several factors to consider when estimating risks to birds from seed treatment uses. Some of these factors include how much a.i. is on any given seed, how available that seed is (magnitude (#) and spatially (how close together available seeds are), and feeding biology of the foraging animal (e.g., can the bird physically handle/swallow the seed, the dietary requirements of a given bird species, and if the seed is palatable). Based on information from BEAD and EFED's Refinements for Risk Assessment of Pesticide Treated Seeds – Interim Guidance, **Table 49** provides an analysis to refine conclusions from RQ exceedances for birds. Considerations include how many seeds a bird would have to consume to reach the non-listed LOC, how much a granivorous bird eats in a day according to default T-REX assumptions, and size of the seed being consumed. This analysis assumes both availability and palatability of seed being 100%.

Acute Risks

The RQ analysis identified acute risk concerns for all size classes of non-listed birds consuming treated sugar beet seed and small/medium sized birds consuming treated corn and cotton seed. There were no non-listed exceedances for birds consuming soybean seed. According to EFED's Refinements for Risk Assessment of Pesticide Treated Seeds – Interim Guidance the species specific information on maximum seed size (mg) consumed by 20 g passerine birds (derived from Benkman and Pulliam 1988[27]) is 60 mg

[27] Benkman, C.W. and H.R. Pulliam. 1988. Comparative Feeding Ecology of North American Sparrows and Finches. Ecology. 69: 1195—1199.

and for medium (100g) passerines is 120 mg. Based on an average weight of one field corn seed (270), and one cotton seed (101), these seeds are considered too big for most small passerine birds to consume. Field corn seeds are also considered too big for medium sized passerine birds to consume[28]. According to USEPA 2015 there are 117 common species of birds associated with agricultural fields or their adjacent edge habitats and 89 of those species are passerines.

There is a noted uncertainty using size of seed as a limiting factor for consumption for all passerine species based on data from a few and using weight as the sole determination of seed size[29]; however, EFED considers this approach reasonable for foraging birds. Thus, acute and dietary risks from consumption of these seeds can be discounted for these size classes of passerines. Depending on the type of corn seed (e.g. sweet, pop, field, etc.) a size range of corn seeds exists such that the average seed size is below the weight threshold medium sized birds. Consequently, medium sized birds could be affected by consuming sweet corn or popcorn seeds. There were no non-listed LOC exceedances for birds consuming soybean seeds. **Table 56** shows the analysis and risk conclusions for non-listed bird species consuming treated seeds where the LOC was exceeded. This analysis includes the fraction of the diet represented by contaminated seeds that would constitute a risk to non-listed species.

Table 56. Number of seeds required to reach the LOC and % diet for bird size classes with LOC exceedances

Bird Size	Seed (weight in g)	Seeds to Reach LOC (0.5)	% Diet seeds to reach LOC (0.5)[1]	Potential Risks
Small (20g)	Field Corn (0.27 g)	2	11%	Small and medium sized birds (excluding passerines)
Medium (100g)		15	29%	
Small (20g)	Cotton (0.101g)	8	16%	Small birds (excluding passerines) and medium sized birds
Medium (100g)		50	36%	
Small (20g)	Sugar beet (0.014g)	4	1%	All size classes
Medium (100g)		26	3%	
Large (1000g)		368	8%	

[1] Assuming 100% of diet is treated seed

This leaves non-listed LOC exceedances for all bird size classes potentially consuming smaller treated vegetable seeds (e.g. sugar beet), small (excluding passerines) and medium sized birds consuming cotton seeds, and small/medium birds (excluding passerines) consuming treated corn seeds. Additionally, any medium sized bird consuming popcorn or sweet corn seeds would also trigger a risk concern. The % of diet ranges from 1-36% required to reach the non-listed LOC. This analysis does not take into account seed availability due to incorporation, planting depth, availability, or palatability. Planted seeds were assumed available; however, the extent to which a bird will forage for planted seeds presumable covered by a layer of soil, or if seeds are uncovered, even how close these seeds may be spatially is an uncertainty. While 2 corn seeds are necessary to cause mortality for small birds, there is a difference if these seeds are 2 meters or an acre apart and the time commitment it would potentially take to find and consume these two seeds in the different scenarios.

[28] There were no non-listed exceedances for soybean; however, based on the average weight of one seed (178mg) this would be considered too large for small/medium passerine species.

[29] Differing chemical properties or coatings along with variation in the seed itself will alter the size of an individual seed.

There is also one incident reported that associated mortality of one robin and one flycatcher with corn planting. There is also uncertainty of the effects of this incident relatable directly to thiamethoxam as clothianidin was also used on the seed, and the plant based diets of these birds are more likely to be fruits. Although there is uncertainty in the, palatability, availability, and foraging effort to consume treated seeds, the low % of dietary requirement to consume these seeds suggest mortality is possible for birds from seed treatment uses, with higher concerns for those consuming smaller vegetable seeds.

Chronic risks to Birds

Chronic exceedances were also identified for all size classes and use patterns for both listed and non-listed species based on a NOAEC for the mallard duck at 300 mg/kg-bw. Effects seen were reduced body weight in parental males, with no other reproductive effects noted. The next dose (the LOAEC) was the highest tested (900 mg a.i./kg-bw). Comparisons of EECs to the LOAEC indicate that EECs are 4x higher for corn and cotton, and about 40x higher for sugar beet. Comparing results for soybean would suggest that the exposure is below the LOAEC.

There are several uncertainties related to chronic risks from seed treatments. It is not known if the effects seen (in this case weight loss in males) occur at a sensitive life stage or are due to the entire exposure period. This is particularly relevant when considering how many seeds an organism would have to consume to elicit the toxicological effect. Depending on the size of the bird as little as one seed per day could be consumed (if physically available) for the appropriate exposure period (either at the sensitive life stage, or a specific period of time) to produce toxicological effects.

Similar to analyses performed when considering acute exposures, corn, cotton, and soybean seeds are considered too big for small (20g) birds to consume while corn and soybean seeds are also considered too big for medium (100g) birds to consume based on EFED guidance. This leaves risk concerns for larger (1000g) birds and non-passerine smaller/medium birds. The number of seeds to reach the chronic NOAEC for all crops of these species ranged from 1-13 for corn, 2-110 for soybean, 1-43 for cotton and 1-23 for sugar beet. Considering this is a no effect level and there are doses between the NOAEC and LOAEC where exceedances start, the same seed number analysis was performed based on the LOAEC. The number of seeds to reach the chronic LOAEC for all crops of these species ranged from 1-39 for corn, 20-1793 for soybean, 3-130 for cotton and 1-68 for sugar beet.

How far apart and how many seeds are available are important factors to consider when discussing potential chronic risks. Seeds on the surface versus those incorporated and not as easily found by foraging birds reduce potential exposure and increase time required to find them decreasing the likelihood of potential chronic exposure. However, due to the low numbers of daily seed doses required to be at the NOAEL, risks from chronic exposure to treated seed cannot be discounted. The extent to which the effect seen in laboratory studies (decreased parental male size) is an uncertainty as to how this would ultimately translate to reproductive effects (i.e. decreased size could result in decreased mating success)

4.2.4. Mammals

Foliar and Soil applications

There were no LOC exceedances for mammals from any application rate (0.086 lb a.i./A, 0.265 lb a.i/A), application number (1, 2, 3)[30], or type (for foliar or soil applications). Unlike birds, the LD_{50}/ft^2 or arthropod dietary analysis did not yield any concerns for foraging mammals so no further characterization was done. Since RQs were all blow both the acute listed (0.1) acute non-listed (0.5) and chronic (1) LOC for foliar and soil applications there are no mortality or reproductive risk concerns for mammals.

Seed Treatments

The non-listed acute LOC (0.5) was exceeded for seed treatment uses on sugar beet only while the acute listed LOC (0.1) was exceeded for corn and cotton. There were no LOC exceedances for soybean. Unlike birds there is no size specific restriction for seed consumption considered. The number of seeds consumed required to reach the non-listed LOC ranges from 35-823 and would need to be 16-34% of the animal's diet consumed (depending on size). For mammals consuming corn and cotton seeds the number of seeds consumed required to reach the listed LOC (0.1) ranges from 14-313 (depending on size) and 4-95 for cotton and corn respectively. This ranges from 36-75% of a diet for corn seed consumers and 47-93% of diet for cotton seed consumers. These data suggest mortality is expected for listed seed eating mammals consuming treated seeds.

The chronic LOC was exceeded for corn, cotton, and sugar beet. There were no LOC exceedances for soybean. The reproductive effects seen in the chronic mammalian study were reduced body weight gain for offspring during the lactation period (NOAEL 61 mg/kg-bw/day; LOAEL 158 mg/kg-bw/day), with no other adverse, treatment-related effects (except some uncertain effects seen on tubular atrophy and sperm motility see effects **Section 3.2.2**) on reproductive parameters (mating, gestation, fertility, viability) noted at any dose level tested for the parents. The number of seeds required to reach the chronic LOC for corn, cotton, and sugar beet based on the NOEL ranges from 2-37, 5-123, and 3-64 respectively. While the range of seeds required to reach the chronic LOC for corn, cotton, and sugar beet based on the LOAEL is 4-96, 14-320, and 7-166 respectively. Newly planted fields, which are likely open and providing little cover for smaller foraging mammals may be less likely to pose a risk to seed eating mammals than those of the no till variety based on foraging behavior (assuming no cover = no forage). Additionally, similar to birds, actual chronic exposures from eating treated seeds per day is uncertain based on how many are available and how close they are. Despite these uncertainties, however, the low number of seeds required to reach even effects levels means reproductive effects to mammals cannot be discounted.

4.2.5. Terrestrial Plants

Risks are not expected for terrestrial monocots from runoff or spray drift. Although risk quotients were not calculated for non-listed species, RQs were below the LOC (1) based on a the NOAEC value for listed species. A definitive EC_{25} value would not be less sensitive (lower) than the NOAEC for monocots and consequently any resulting RQs from a definitive endpoint would be higher than those based on the NOAEC. The RQ (4.8) exceedance for non-listed dicots in semi-aquatic habitats is based on the EC_{25} value of 0.028 lb a.i/A. The reliability of this endpoint is considered highly uncertain. The confidence intervals in the regression for the IC_{25} span an order of magnitude in the upper and lower bound (0.0025-0.23 lb a.i/A). With significant reductions in all test levels a NOAEC was not established < 0.017 lb a.i./A based on reduced cucumber height (weight reductions were not statistically significant and

[30] 2 or 3 applications for foliar rate of 0.086 lb a.i./A only.

ranged from 1.76% to 24.7% effects in the middle treatment doses). The IC_{05} value calculated from the regression was not bounded by a lower CI and the upper CI was 7 orders of magnitude different than the estimate, indicating an unreliable regression model. Cucumber height effects ranted from 20.9% in the lowest (0.017 lb a.i./A) group to 32.9% in the highest (0.28 lb a.i./A) treatment group.

A new study with cucumber was submitted to the Agency (MRID 50131103) and is currently under review. The study authors reported no effects seen in cucumber at the highest application rate tested (0.265 lb a.i./A). This study used a different variety (Marketmore)[31] of cucumber than the previous study (Spacemaster)[32]. It is possible effects seen in the original study are specific to the life stage of the specific variety of cucumbers as the effects seen in MRID 5013110 were in line with the other plant studies including no effects seen on cucumber in the vegetative vigor study (Spacemaster).

Considering study 50131103 (no effects) for cucumber would mean for seedling emergence all endpoints EC_{25} endpoints would be > the highest test concentration (0.265) with NOAEC values equal to or > the same concentration. It was also noted in the vegetative vigor study effects were seen in oilseed rape and onion at the lowest test concentration; however, the reviewer determined these effects were not treatment related and determined the EC_{25} and NOAEC values to be > and ≥ the highest test concentration which would result in the following RQs (**Table 57**).

Table 57. RQs[1] for Terrestrial plants considering additional data.

Application Rate	Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
1 ground application @ 0.265 lb a.i/A	Monocot	non-listed	NC	NC	NC
		Listed	<0.1	0.47	<0.1
	Dicot	non-listed	NC	NC	NC
		listed	<0.1	0.49	<0.1

NC = Not calculated due to non-definitive endpoint (>)

[1] Based on seedling emergence EC_{25} and NOAEC values of >0.28/>0.265 and 0.28/0.265 respectively for monocots and dicots. Based on vegetative vigor EC_{25} and NOAEC values of >0.28/0.28 for monocots and >0.28/0.061 for dicots

There are not RQ exceedances for any listed species, and subsequently none would be expected for non-listed species. There are two incidents for corn (stand issues) and soybean (plant damage) reported. In both plant toxicity tests, corn and soybean had no effects reported and the plant injury scores were 0 for corn and only ranged from 0-9 for soybean, and although effects seen to cucumbers in one seedling emergence study cannot completely resolve uncertainty of potential risks to terrestrial dicots, the lines of evidence suggest risks to terrestrial plants are not expected (no effects greater than 25% in any other plants for survival, height, or weight).

4.3. Overall Conclusions

The primary risk concerns identified in this assessment involve acute and chronic exposures to freshwater aquatic insects as well as acute and chronic exposures to birds and mammals. For aquatic invertebrates, chronic risks are identified for all modeled foliar applications and soil applications (except

[31] Supplied by Johnny's Selected Seeds, Windlow, Maine.

[32] Supplied by Burpee, W. Atlee Burpee and Company, Burlington, North Carolina

cranberries) and seed treatment of rice. For birds and mammals, risks are focused around consuming treated seeds. No risk concerns were identified for fish or plants. There are no major gaps related to the environmental fate or toxicity databases. No acceptable data have been submitted to fulfill the requirement for acute oral toxicity data for a passerine species; however, sufficient avian toxicity data are available to complete the risk assessment.

5. Federally Threatened and Endangered (Listed) Species Concerns

Consistent with EPA's responsibility under the Endangered Species Act (ESA), the Agency will evaluate risks to listed species from registered uses of pesticides in accordance with the Joint Interim Approaches developed to implement the recommendations of the April 2013 National Academy of Sciences (NAS) report, *Assessing Risks to Endangered and Threatened Species from Pesticides*. The NAS report[33] outlines recommendations on specific scientific and technical issues related to the development of pesticide risk assessments that EPA and the Services must conduct in connection with their obligations under the ESA and FIFRA. EPA will address concerns specific to thiamethoxam in connection with the development of its final registration review decision for thiamethoxam.

In November 2013, EPA, the U.S. Fish and Wildlife Service, National Marine Fisheries (the Services), and USDA released a white paper containing a summary of their joint Interim Approaches for assessing risks to listed species from pesticides. These Interim Approaches were developed jointly by the agencies in response to the NAS recommendations, and reflect a common approach to risk assessment shared by the agencies as a way of addressing scientific differences between the EPA and the Services. Details of the joint Interim Approaches are contained in the November 1, 2013 white paper[34], *Interim Approaches for National-Level Pesticide Endangered Species Act Assessments Based on the Recommendations of the National Academy of Sciences April 2013 Report.*

Given that the agencies are continuing to develop and work toward implementation of the Interim Approaches to assess the potential risks of pesticides to listed species and their designated critical habitat, this ecological risk assessment supporting the registration review of thiamethoxam does not describe the specific ESA analysis, including effects determinations for specific listed species or designated critical habitat, to be conducted during registration review. While the agencies continue to develop a common method for ESA analysis, the risk assessment for the registration review of thiamethoxam describes only the level of ESA analysis completed at this time. This assessment allows EPA to focus its future evaluations on the types of species where the potential for effects exists, once the scientific methods being developed by the agencies have been fully vetted. Once the agencies have fully developed and implemented the scientific methods necessary to complete risk assessments for listed species and their designated critical habitats, these methods will be applied to subsequent analyses of thiamethoxam as part of completing this registration review.

6. Endocrine Disruptor Screening Program

As required by FIFRA and the Federal Food Drug and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which

[33] http://www.nap.edu/catalog.php?record_id=18344
[34] http://www.epa.gov/espp/2013/nas.html

may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of its registration review decision, EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), thiamethoxam is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013[35] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. Thiamethoxam is not on List 1 or 2. For further information on the status of the EDSP, the policies and procedures, the lists of chemicals, future lists, the test guidelines and the Tier 1 screening battery, please visit our website.[36]

7. References Cited

Ahmed, M. A. I. and F. Matsumura (2012). Synergistic Actions of Formamidine Insecticides on the Activity of Pyrethroids and Neonicotinoids Against Aedes aegypti (Diptera: Culicidae). J. Med. Entomol., AQUA,MIXTURE. 49: 1405-1410.

Barbee, G. C. and M. J. Stout (2009). Comparative Acute Toxicity of Neonicotinoid and Pyrethroid Insecticides to Non-Target Crayfish (Procambarus clarkii) Associated with Rice-Crayfish Crop Rotations. Pest Manag. Sci. gbarbee7@lsu.edu//, AQUA. 65: 1250-1256.

Cavallaro, M. C., Morrissey, C. A., Headley, J. V., Peru, K. M., & Liber, K. (2016). Comparative chronic toxicity of imidacloprid, clothianidin, and thiamethoxam to Chironomus dilutus and estimation of toxic equivalency factors. Environmental Toxicology & Chemistry, Accepted Article DOI: 10/1002/etc.3536

Food and Agriculture Organization of the United Nations (FAO). 2014. Assessing soil contamination.

[35] See https://www.regulations.gov/document?D=EPA-HQ-OPPT-2009-0477-0074 for the final second list of chemicals.

[36] http://www.epa.gov/endo/

reference manual; Parameters of pesticides that influence processes in the soil. Agriculture and Consumer Protection Department. http://www.fao.org/docrep/003/x2570e/x2570e06.htm

Hladik ML, Koplin DW. First national-scale reconnaissance of neonicotinoid insecticides in streams across the USA. Environ. Chem. 2016; 13: 12-20.
Huseth AS, Groves RL. Environmental fate of soil applied neonicotinoid insecticides in an irrigated potato agroecosystem. PLoS One. 2014; 9: e97081.

Main AR, Michel NL, Headley JV, Peru KM, Morrissey CA, et al. Ecological and Landscape Drivers of Neonicotinoid Insecticide Detections and Concentrations in Canada's Prairie Wetlands. Environ Sci Technol. 2015; 49: 8367-8376.

Main AR, Headley JV, Peru KM, Michel NL, Cessna AJ, Morrissey CA. 2014. Widespread use and frequent detection of neonicotinoid insecticides in wetlands of Canada's Prairie Pothole Region. PLoS ONE. 9:e92821. https://doi.org/10.1371/journal.pone.0092821 PMID: 24671127

Miles J.C., Hua J., Sepulveda M.S., Krupke, C.H., Hoverman, J.T. 2017. Effects of clothianidin on aquatic communities: Evaluating the impacts of lethal and sublethal exposure to neonicotinoids. PLoS ONE 12(3): e0174171. https://doi.org/10.1371/journal.pone.0174171

Mineau, P., Palmer, C. 2013. The Impact of the Nation's Most Widely Used Insecticides on Birds. American Bird Conservancy, March 2013.

Morrissey CA, Mineau P, Devries JH, Sanchez-Bayo F, Liess M, Cavallaro MC. 2015. Neonicotinoid contamination of global surface waters and associated risk to aquatic invertebrates: A review. Environ Int. 74:291±303. https://doi.org/10.1016/j.envint.2014.10.024 PMID: 25454246

Saraiva, A.S., R.A. Sarmento, A.C.M. Rodrigues, D. Campos, G. Federova, V. Zlabek, C. Gravato, J.L.T. Pestana and A.M.V.M. Soares. 2017. Assessment of thiamethoxam toxicity to Chironomus riparius. Ecotoxicol. and Environ. Safety. 137: 240-246.

Schaafsma A, Limay-Rios V, Baute T, Smith J, Xue Y, et al. Neonicotinoid insecticide residues in surface water and soil associated with commercial maize (corn) fields in southwestern Ontario. PLoS One. 2015; 10: e0118139

Tuttle G. 2014. Surface Water Monitoring Program for Pesticides in Salmonid-Bearing Streams, 2013 Data Summary. Data summary: a cooperative study by the Washington State Departments of Ecology and Agriculture. AGR PUB 103-411 (N/8/14)

Ugurlu, P., et al. (2015). The Toxicological Effects of Thiamethoxam on Gammarus kischineffensis (Schellenberg 1937) (Crustacea: Amphipoda). Environ. Toxicol. Pharmacol., AQUA. 39: 720-726.

Uragayala, S., et al. (2015). Adulticidal & Larvicidal Efficacy of Three Neonicotinoids Against Insecticide Susceptible & Resistant Mosquito Strains. Indian J. Med. Res., AQUA,TOP. 142: 64-70.

USEPA. 1999. Thiamethoxam: Results of the Health Effects Division's (HED) Metabolism Assessment Review Committee meeting (DP 258614). U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide

Programs, Washington DC.

USEPA. 1998. Guidelines for Ecological Risk Assessment. Published on May 14, 1998, Federal Register 63(93): 26846 – 26924. http://www.epa.gov/raf/publications/pdfs/ECOTXTBX.PDF

USEPA. 2011a. Registration Review: Problem Formulation for the Environmental Fate, Ecological Risk, Endangered Species, and Drinking Water Exposure Assessments for Thiamethoxam. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division, December 13, 2011.

USEPA. 2011b. Thiamethoxam Summary Document Registration Review: Initial Docket December 2011. Environmental Protection Agency, Office of Pesticide Programs, Pesticide Re-evaluation Division and Antimicrobials Division, December 20, 2011.

USEPA, 2011c. Acres Planted per Day and Seeding Rates of Crops Grown in the United Sates. Biological and Economic Analysis Division (BEAD), Office of Pesticide Programs, United States Environmental Protection Agency.

USEPA. 2012. Thiamethoxam Final Work Plan Registration Review. Environmental Protection Agency, Office of Pesticide Programs, Pesticide Re-evaluation Division and Antimicrobials Division, June 2012.

USEPA. 2013. Generic Data Call-In Notice for Thiamethoxam (GDCI-060109-1309). Environmental Protection Agency, Office of Pesticide Programs, Pesticide Re-evaluation Division, March 18, 2013.

USEPA, 2013b. Guidance on modeling off-site deposition of pesticides via spray drift for ecological and drinking water assessments. Environmental Fate and Effects Division, Office of Chemical Safety and Pollution Prevention. U. S. Environmental Protection Agency.

USEPA. 2015. G Technical description and user's guidance document for the terrestrial investigation model (TIM). Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division, March 25, 2015.

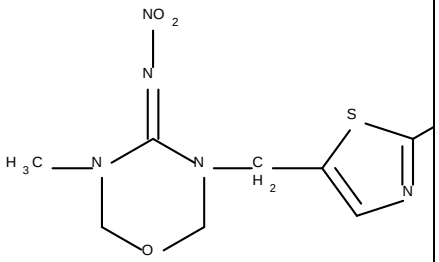
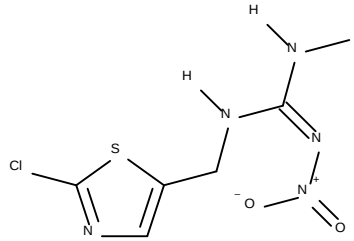
USEPA. 2016. Guidance for Selecting Input Parameters for the Pesticide in Flooded Applications Model (PFAM) Including Specific Instructions for Modeling Pesticide Concentrations in Rice Growing Areas, Version 1.0, PFAM Version 2.0. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division, September 27, 2016.

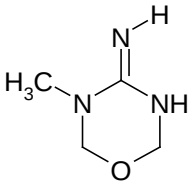
USEPA. 2017a. Preliminary Bee Risk Assessment to Support the Registration Review of Clothianidin and Thiamethoxam. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division, January 5, 2017.

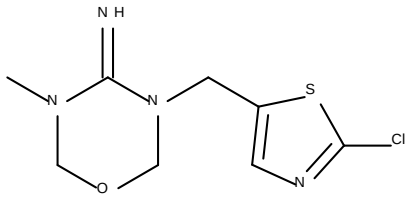
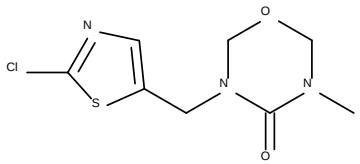
USEPA. 2017b. Preliminary Aquatic and Non-Pollinator Terrestrial Risk Assessment to Support the Registration Review of Clothianidin. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division.

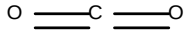
Van Den Brink, P. J., et al. (2016). Acute and Chronic Toxicity of Neonicotinoids to Nymphs of a Mayfly Species and Some Notes on Seasonal Differences. Environ. Toxicol. Chem., AQUA. 35: 128-133 (Supplemental Journal Materials).

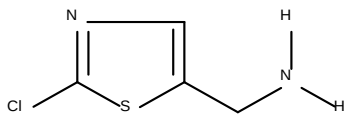
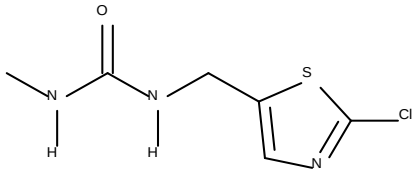
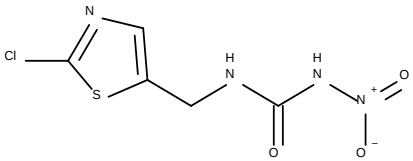
Appendix A. Degradates formed in Environmental Fate Studies with Thiamethoxam

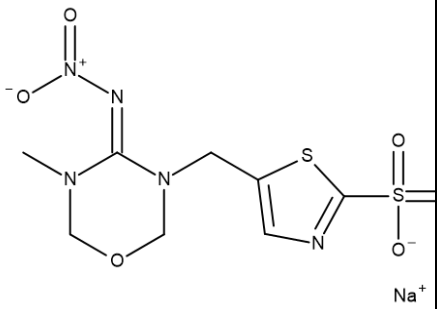
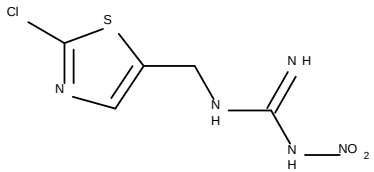
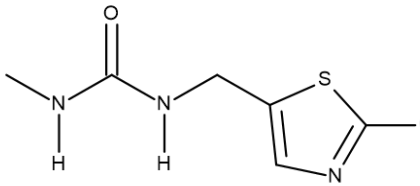
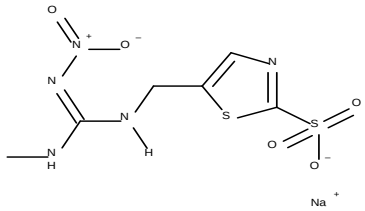
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
PARENT						
Thiamethoxam (CGA293343)	**IUPAC:** (EZ)-3-(2-chloro-1,3-thiazol-5-ylmethyl)-5-methyl-1,3,5-oxadiazinan-4-ylidene(nitro)amine **CAS:** 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine **CAS No.:** 153719-23-4 **Formula:** $C_8H_{10}ClN_5O_3S$ **MW:** 291.71 g/mol **SMILES:** CN1COCN(C1=N[N+](=O)[O-])Cc2cnc(s2)Cl		PARENT			
MAJOR (>10%) AND MINOR TRANSFORMATION PRODUCTS						
CGA 322704 (Clothianidin)	**IUPAC:** N -[(2-chloro-1,3-thiazol-5-yl)methyl]-N'-methyl-N''-nitroguanidine **CAS:** Guanidine, N -[(2-chloro-5-thiazolyl)methyl]-N'-methyl-N''-nitro- **CAS No.:** 131748-59-9 **Formula:** $C_6H_8ClN_5O_2S$ **MW:** 249.67 g/mol **SMILES:** CN/C(=N/[N+](=O)[O-])/NCc1cnc(s1)Cl		Aerobic Soil Metabolism	44703418	**23.7%** (365 d)	**23.7%** (365 d)
				49589503	**29.4%** (220 d)	**29.4%** (220 d)
				49589504	7.74% (120 d)	7.74% (120 d)
				49589505	3.4% (118 d)	3.4% (118 d)
				49589506	**18.9% (121 d)**	**18.9% (121 d)**
				49589507	**36.8% (90 d)**	**15.1% (363 d)**
			Anaerobic soil metabolism	49829901	7.2% (90 d)	3.1% (153 d)
				49829902	**17.3%** (30 d)	**10.1%** (120 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
CGA 353042	**CAS:** 2H-1,3,5-Oxadiazine-4-amine, 3,6-dihydro-3-methyl		Aqueous Photolysis	44715024	**60.7 (30 d)**	**60.7 (30 d)**

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
NOA 407475 (CSAA468313)	**IUPAC:** 3-(2-Chloro-thiazol-5-ylmethyl)-5-methyl-[1,3,5]oxadiazinan-4-ylideneamine **CAS:** 4H-1,3,5-Oxadiazin-4-imine, 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl- **Formula:** $C_8H_{11}ClN_4OS$ **MW:** 246.72 g/mol **SMILES:** CN1COCN(C1=N)Cc2cnc(s2)Cl		Anaerobic soil metabolism	49829901	**14.2%** (153 d)	**14.2%** (153 d)
				49829902	**13.5%** (120 d)	**13.5%** (120 d)
			Aerobic Aquatic Metabolism	44715032	**52.0% (30 d)**	**29.8% (365 d)**
				49589509	**21.8% (70 d)**	6.99% (100 d)
			Anaerobic Aquatic Metabolism	44715031	**69.1 (271 d)**	**63.0 (365 d)**
				49589508	**17.6 (70 d)**	**15.6 (100 d)**
CGA 355190	**IUPAC:** 3-(2-Chloro-thiazol-5-ylmethyl)-5-methyl-[1,3,5]oxadiazinan-4-one **CAS:** 4H-1,3,5-Oxadiazin-4-one, 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl- **Formula:** $C_8H_{10}ClN_3O_2S$ **MW:** 247.7 g/mol **SMILES:** CN1COCN(C1=O)Cc2cnc(s2)Cl		Hydrolysis	44703417	**59.5% (30 d)**	**59.5% (30 d)**
			Aerobic Soil Metabolism	44703418	**23.7 (365 d)**	**23.7 (365 d)**
			Anaerobic soil metabolism	49829901	**14.0%** (90 d)	6.0% (153 d)
				49829902	**31.0%** (120 d)	**31.0%** (120 d)
			Aerobic Aquatic Metabolism	44715032	**78.9%** (115 d)	**46.6%** (365 d)
				49589509	6.92% (48 d)	3.04% (100 d)
			Anaerobic Aquatic Metabolism	44715031	**24.4 (180 d)**	**19.0 (365 d)**
				49589508	**31.3 (48 d)**	**21.7 (100 d)**

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
Carbon dioxide	**IUPAC:** Carbon dioxide **Formula:** CO_2 **MW:** 44 g/mol **SMILES:** C(=O)=O		Aerobic Soil Metabolism	49589503	**38.2%** (220 d)	**38.2%** (220 d)
				49589504	7.76% (120 d)	7.76% (120 d)
				49589505	4.20% (118 d)	4.20% (118 d)
				49589506	**21.1% (181 d)**	**21.1% (181 d)**
				49589507	**44.2% (363 d)**	**44.2% (363 d)**
			Anaerobic soil metabolism	49829902	**14.2%** (120 d)	**14.2%** (120 d)
			Aerobic Aquatic Metabolism	44715032	**33.3 (365 d)**	**33.3 (365 d)**
				49589509	**12.0 (100 d)**	**12.0 (100 d)**
			Anaerobic Aquatic Metabolism	49589508	2.58% (100 d)	2.58% (100 d)
Unextractable Residues	NA	NA	Aerobic Soil Metabolism	49589503	**12.1%** (220 d)	**12.1%** (220 d)
				49589504	**10.9% (120 d)**	**10.9% (120 d)**
				49589506	**17.1% (181 d)**	**17.1% (181 d)**
				49589507	**21.4% (363 d)**	**21.4% (363 d)**
			Anaerobic Soil Metabolism	49829901	**41.5%** (153 d)	**41.5%** (153 d)
				49829902	**20.9%** (120 d)	**20.9%** (120 d)
			Aerobic Aquatic Metabolism	44715032	**38.6%** (365 d)	**38.6%** (365 d)
				49589509	**59.1%** (70 d)	**51.1%** (100 d)
			Anaerobic Aquatic Metabolism	49589508	**51.2% (70 d)**	**48.1% (100 d)**

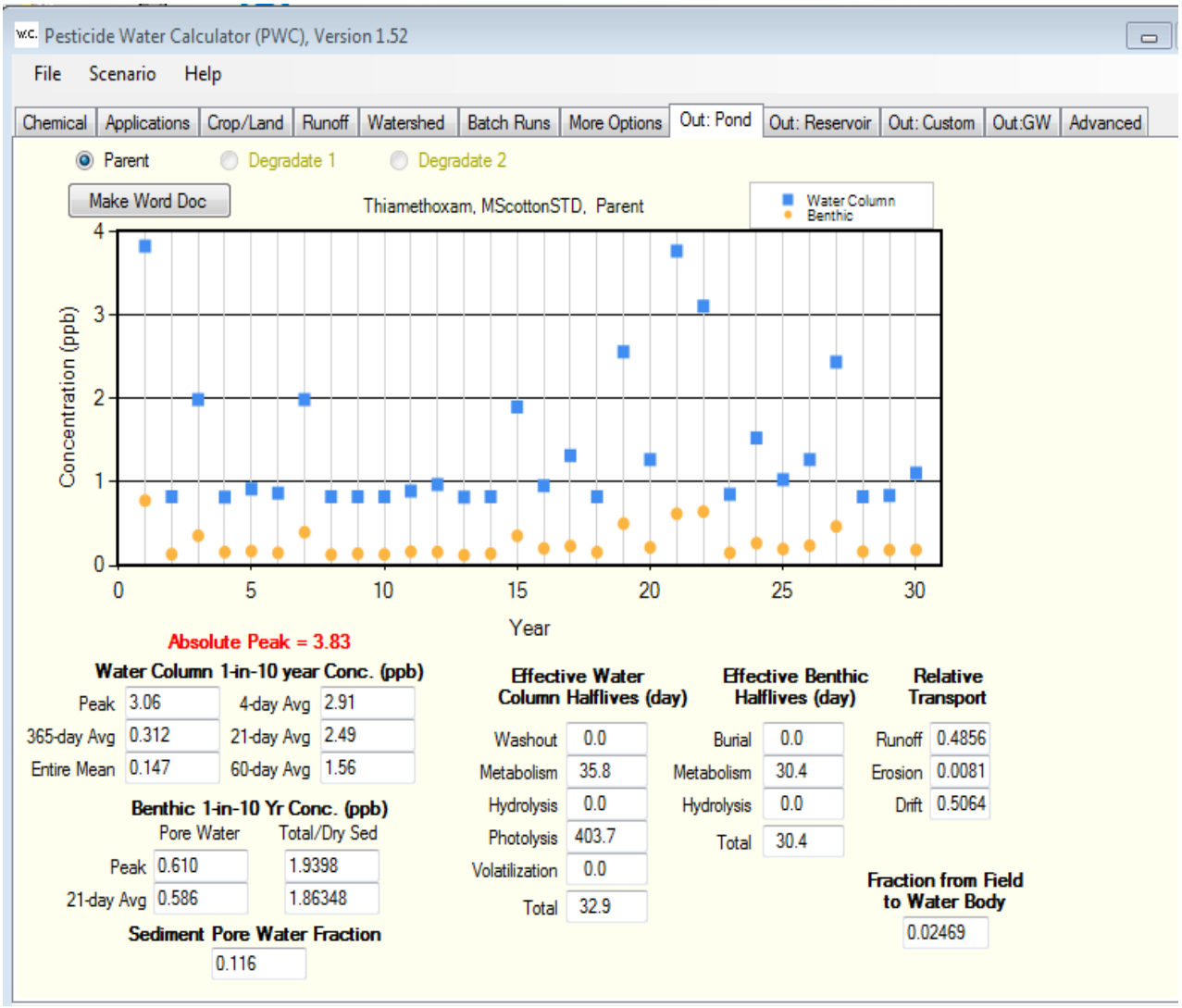
Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
CGA 309335	**IUPAC:** (2-Chlorothiazol-5-yl)-methylamine **Formula:** $C_4H_5ClN_2S$ **MW:** 148.6 g/mol **SMILES:** [H]N([H])Cc1cnc(s1)Cl		Hydrolysis	44703416	9.1% (30 d)	9.1% (30 d)
CGA 282149	**IUPAC:** 1-(2-Chlorothiazol-5-ylmethyl)-3-methylurea **CAS No.:** 153719-38-1 **Formula:** $C_6H_8ClN_3OS$ **MW:** 205.6 g/mol **SMILES:** [H]N(C)C(=O)N([H])Cc1cnc(s1)Cl		Soil Photolysis	44715028	3.17 (14 d)	0.75 (30 d)
			Aerobic Soil Metabolism	44703418	6.80 (180 d)	2.75 (365 d)
NOA 404617	**IUPAC:** 1-(2-Chlorothiazol-5-ylmethyl)-3-nitrourea **CAS:** Urea, N-[(2-chloro-5-thiazolyl)methyl]-N'-nitro- **Formula:** $C_5H_5ClN_4O_3S$ **MW:** 236.63 g/mol **SMILES:** c1c(sc(n1)Cl)CNC(=O)N[N+](=O)[O-]		Anaerobic soil metabolism	49829901	6.6% (120 d)	0.8% (153 d)
				49829902	7.6% (120 d)	7.6% (120 d)
			Aerobic Aquatic Metabolism	44715032	**36.0%** (21 d)	1.6% (365 d)
				49589509	8.00% (48 d)	1.10% (100 d)
			Anaerobic Aquatic Metabolism	49589508	7.67% (48 d)	2.47% (100 d)
			Hydrolysis	44703416	**35.2% (21 d)**	**33.3% (30 d)**
NOA 459602 (CSCC183497)	**IUPAC:** Sodium; 5-{5-methyl-4-[nitroimino]-[1,3,5]oxadiazinan-3-ylmethyl}-thiazole-2-sulfonate		Anaerobic soil metabolism	49829901	0.6% (62 d)	ND (153 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
	Formula: $C_8H_{10}N_5NaO_6S_2$ **MW:** 359.31 g/mol **SMILES:** CN\1COCN(/C1=N/[N+](=O)[O-])Cc2cnc(s2)S(=O)(=O)[O-].[Na+]			49829902	4.0% (30 d)	0.5% (120 d)
CGA 265307 (CSAA250354)	**IUPAC:** N-(2-Chlorothiazol-5-ylmethyl)-N'-nitroguanidine **CAS No.:** 135018-15-4 **Formula:** $C_5H_6ClN_5O_2S$ **MW:** 235.6 g/mol **SMILES:** c1c(sc(n1)Cl)CNC(=N)N[N+](=O)[O-]		Aerobic Soil Metabolism	49589503	5.1% (220 d)	5.1% (220 d)
			Anaerobic Soil Metabolism	49829901	0.3% (120 d)	ND (153 d)
CGA 353968	**IUPAC:** 1-(2-Chlorothiazol-5-ylmethyl)-3-methylurea **Formula:** $C_6H_8ClN_3OS$ **MW:** 205.6 g/mol **SMILES:** [H]N(C)C(=O)N([H])Cc1cnc(s1)Cl		Soil Photolysis	44715028	1.13 (30 d)	1.13 (30 d)
			Aerobic Soil Metabolism	44703418	3.80 (365 d)	3.80 (365 d)
			Aerobic Aquatic Metabolism	44715032	9.8% (365 d)	9.8% (365 d)
SYN501406 (CSCC188737)	**IUPAC:** Sodium; 5-(N'-Methyl-N''-nitro-guanidinomethyl)-thiazole-2-sulfonate **Formula:** $C_6H_8N_5NaO_5S_2$ **MW:** 317.27 g/mol **SMILES:** CN/C(=N/[N+](=O)[O-])/NCc1cnc(s1)S(=O)(=O)[O-].[Na+]		Anaerobic Soil Metabolism	49829902	2.6% (120 d)	2.6% (120 d)

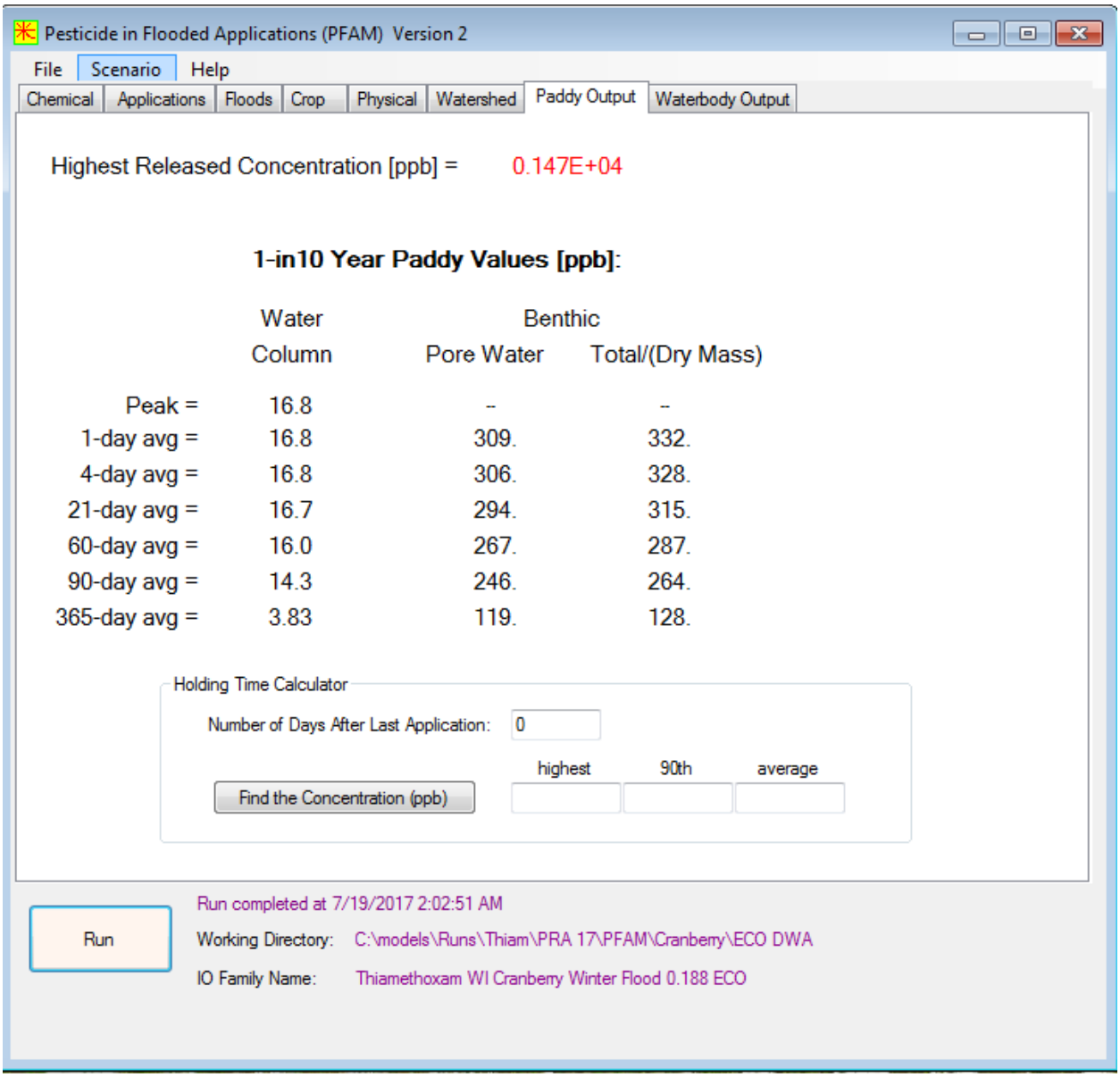
[A] AR means "applied radioactivity". MW means "molecular weight". PRT means "parent". NA means "not applicable". ND means "not detected

Appendix B. PWC and PFAM Example Outputs for Thiamethoxam.

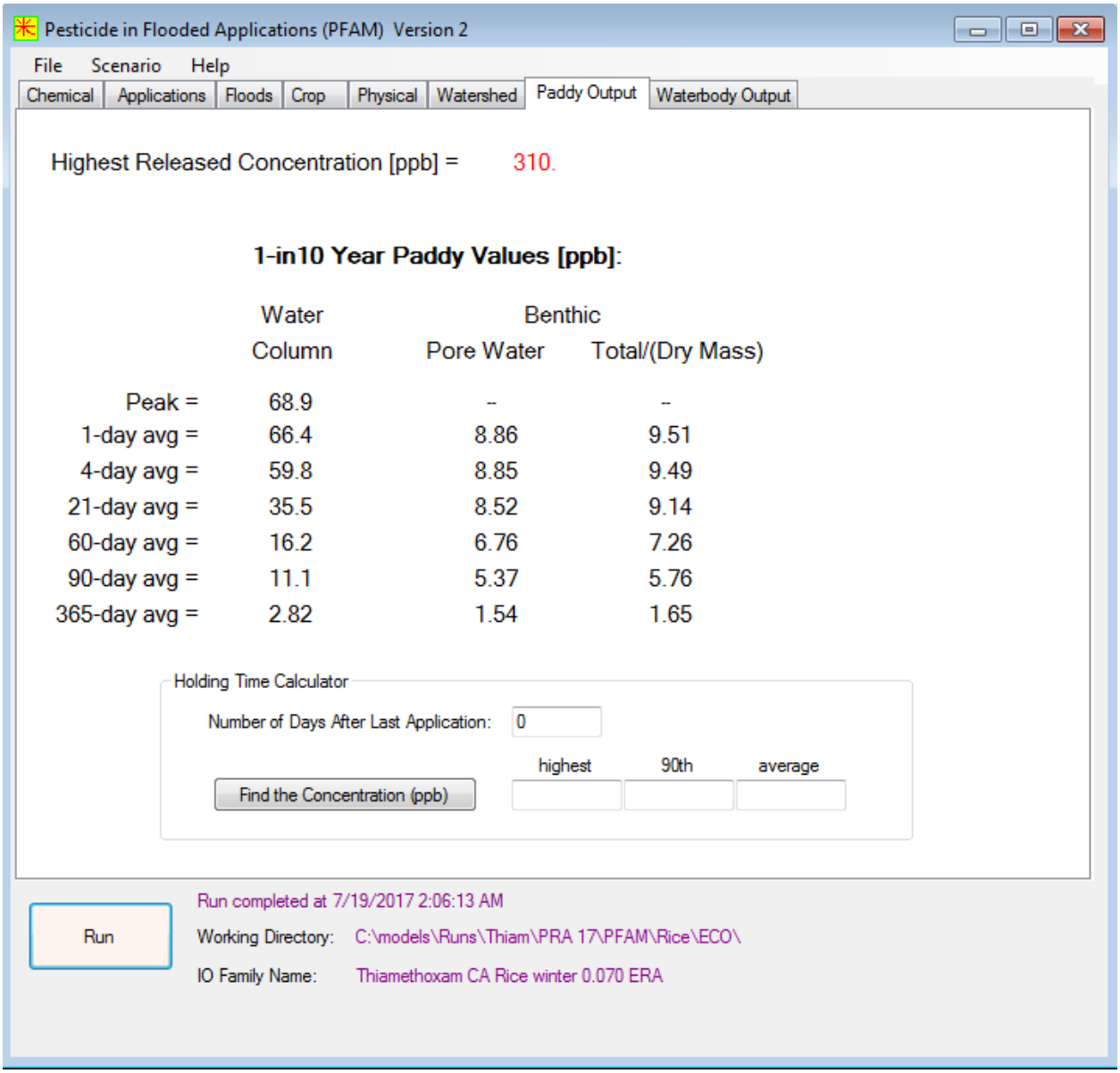
PWC Output for Surface Water representing Mississippi Cotton – Foliar Application



PFAM Output for Surface Water representing Wisconsin Cranberry – Ground application



PFAM Output for Surface Water representing California Rice – Seed Treatment



Pesticide in Flooded Applications (PFAM) Version 2

File Scenario Help

Chemical | Applications | Floods | Crop | Physical | Watershed | Paddy Output | Waterbody Output

Highest Released Concentration [ppb] = 310.

1-in10 Year Paddy Values [ppb]:

	Water Column	Benthic Pore Water	Benthic Total/(Dry Mass)
Peak =	68.9	--	--
1-day avg =	66.4	8.86	9.51
4-day avg =	59.8	8.85	9.49
21-day avg =	35.5	8.52	9.14
60-day avg =	16.2	6.76	7.26
90-day avg =	11.1	5.37	5.76
365-day avg =	2.82	1.54	1.65

Holding Time Calculator

Number of Days After Last Application: 0

Find the Concentration (ppb) | highest | 90th | average

Run

Run completed at 7/19/2017 2:06:13 AM

Working Directory: C:\models\Runs\Thiam\PRA 17\PFAM\Rice\ECO\

IO Family Name: Thiamethoxam CA Rice winter 0.070 ERA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

MEMORANDUM

Date: December 16, 2011

SUBJECT: **Thiamethoxam.** Human Health Assessment Scoping Document in Support of Registration Review.

PC Code: 060109
Decision No.: 451006
Petition No.: NA
Risk Assessment Type: NA
TXR No.: NA
MRID No.: NA

DP Barcode: D391193
Registration No.: NA
Regulatory Action: Registration Review
Case No.: 7614
CAS No.: 153719-23-4
40 CFR: 180.565

FROM: Dennis McNeilly, Chemist/Risk Assessor
Margarita Collantes, Biologist
Alan Levy, Ph.D., Toxicologist
Risk Assessment Branch II
Health Effects Division (7509P)

THROUGH: Christina Swartz, Branch Chief
Risk Assessment Branch II
John R. Fowle III, Ph.D., Deputy Division Director
Health Effects Division (7509P)
Office of Pesticide Programs

TO: Carissa Cyran, Chemical Review Manager
Pesticide Re-Evaluation Division (7508P)
Office of Pesticide Programs

Attached is the Health Effects Division's (HED) and Antimicrobials Division's (AD) combined human health risk assessment scoping document for the insecticide thiamethoxam to support registration review.

Executive Summary

The Health Effects Division (HED) and the Antimicrobials Division (AD) Thiamethoxam Registration Review teams have evaluated the database and the most recent human health risk

assessments for the insecticide thiamethoxam. AD and HED performed this evaluation in order to determine the scope of work necessary to support the established tolerances and existing registrations through registration review. The primary source of information for this evaluation was the most recent human health risk assessments performed by the two Divisions (HED's D373376, D. McNeilly, 12/20/2010; and, AD's D393661, T. Dole, 10/31/2011; and D396697, T. Dole, 12/13/2011).

Thiamethoxam is a broad spectrum nitroguanidine insecticide which belongs to the pesticide class of compounds known as the neonicotinoids (Group 4A; Insecticide Resistance Action Commitee). It has activity against sucking and chewing insects on a wide variety of crops for both foliar and seed treatments, on turf, ornamentals, as well as in indoor settings, and as a wood preservative. Thiamethoxam appears to interfere with the nicotinic acetylcholine receptors of the insect's nervous system, but the specific receptor site is unknown at this time. It does not inhibit cholinesterase or interfere with sodium channels and, therefore, has a different mode of action than organophosphate, carbamate, and pyrethroid insecticides.

The toxicology database for thiamethoxam is complete for the purpose of human health risk assessment, with the exception of a 21/28-day inhalation toxicity study; a 21/28 day inhalation study is required to support both the conventional and wood treatment uses. The registrant recently submitted an immunotoxicity study and HED has screened that study for this scoping document.

Subchronic and chronic toxicity studies across various species, including rats, rabbits, dogs and mice demonstrated that toxicity associated with thiamethoxam includes effects on the liver, testes, kidney, thyroid and hematology parameters. No developmental effects were observed in rat or rabbit developmental studies. A rat developmental neurotoxicity study indicated a decrease in brain weights and size, implying some potential to impact the nervous system. In two 2-generation reproduction studies in rats, there was an increase in the incidence and severity of testicular tubular atrophy in one study and sperm abnormalities in the other study.

There was no increase in quantitative or qualitative susceptibility in the rat or rabbit developmental studies. In the rat developmental neurotoxicity study, there was evidence of increased qualitative susceptibility due to effects in the pups (reduced brain weight and significant changes in brain morphometric measurements) which were considered to be more severe than the body weight and food consumption changes noted in the dams. The increased incidence of testicular changes in the 2-generation reproduction studies in the rat were considered to be evidence of increased quantitative susceptibility for male pups. However, overall HED had a low degree of concern for the increased susceptibility due to the completeness of the database overall and with respect to the potential for neurotoxicity; the endpoints and doses selected for risk assessment to be protective of the potential susceptibility; and due to the assumptions used in the exposure assessment, which would not underestimate risk. Based on these considerations, HED concluded the 10X safety factor required under the Food Quality Protection Act (FQPA) could be reduced to 1X.

Thiamethoxam induces hepatocellular adenomas and carcinomas in male and female mice. The HED Cancer Assessment Review Committee (CARC) concluded that humans are unlikely to be

at risk for developing tumors following exposures to thiamethoxam based on the threshold mode of action and, therefore classified the chemical as "Not likely to be carcinogenic to humans." The submitted mutagenicity studies were considered to be adequate and indicated that thiamethoxam is not mutagenic.

The endpoints, doses, and safety factors used in the most recent human health risk assessments are considered to be appropriate. The dietary exposure database is adequate to support registration review of thiamethoxam. Based on the currently registered uses, HED has concluded there are no acute or chronic dietary risks of concern. However, HED notes that the potential for drinking water exposure from thiamethoxam treated wood was not included in the current dietary exposure assessment. The potential for drinking water exposure from thiamethoxam wood treatment facilities will be evaluated as down the drain releases to waste water treatment plants using standard models and environmental fate studies.

Thiamethoxam is registered for use on various agricultural crops, turf, sod farms, golf course, residential lawns, indoor residential crack and crevice treatment, ornamental plants grown in greenhouses, and Christmas trees, domestic dwellings, food handling establishments, commercial/institutional/industrial areas, livestock pens, poultry houses as well as use in seed treatment and wood preservation. Based on application rates and label information, exposure is expected to occur for short- and intermediate-term durations, with the exception of the wood treatment use, which could result in long-term or chronic exposure for occupational handlers. The most recent risk assessments indicate there are no risks associated with residential or occupational exposure to thiamethoxam, based on the currently registered uses. In order to fully assess thiamethoxam during registration review, a subchronic (21/28) day inhalation study is needed in accordance with the 40 CFR §158 data requirements for conventional and wood treatment uses; in addition, occupational dermal and inhalation exposure studies (Guidelines 875.1100 and 875.1300 respectively) are required to assess exposures which occur during pressure treatment of lumber. During registration review, HED may conduct a new residential exposure assessment that incorporates any potential changes in new methods or policies for estimating exposure associated with residential use patterns as a result of the revisions to HED's Residential Standard Operating Procedures (SOPs).

Furthermore, residential bystander exposures might occur as a result of thiamethoxam aerial and airblast applications, volatilization, and/or transport from treated areas. HED will evaluate the need for a bystander assessment under registration review. Occupational exposure and risk assessments may also need to be updated to reflect revised policies and procedures, including updated unit exposures for occupational/commercial handlers (i.e., including primary and secondary seed treatment handlers and handlers of wood preservative products), and postapplication assumptions including revised transfer coefficients.

Based on the current uses of thiamethoxam and HED's policies and procedures for performing aggregate risk assessment, all aggregate risk estimates for all durations and all population subgroups are not of concern. However, during registration review, updated aggregate assessments may be conducted to include any changes that have been made in toxicological endpoints or dietary exposure estimates; in addition, the methods or data HED uses to calculate residential exposure may result in the need for revised aggregate exposure and risk assessments.

Introduction

HED and AD evaluated the most recent human health risk assessment for thiamethoxam to determine if sufficient data are available to support registration review. The most recent human health risk assessment on conventional uses of thiamethoxam was performed in 2010 when the registrant proposed uses on alfalfa and peanuts as well as use in food handling establishments (Memo, D373376, D. McNeilly, 7/14/2010). The most recent risk assessment conducted in 2006 by AD was in support of a wood preservative use (D285854, G. Angle and D. Aviado, 4/18/2006). During the development of this human health scoping document, HED and AD considered the latest Agency science policies and risk assessment methodologies.

Thiamethoxam is a broad spectrum nitroguanidine insecticide which belongs to the pesticidal class of compounds known as the neonicotinoids (Group 4A; Insecticide Resistance Action Commitee). The structure of thiamethoxam, as well as its chemical names and other identifiers can be found in the chemical identity table attached to this document (Attachment 1). It has activity against sucking and chewing insects in a wide variety of use sites. Thiamethoxam appears to interfere with the nicotinic acetylcholine receptors of the insect's nervous system, but the specific receptor site is unknown at this time. It does not inhibit cholinesterase or interfere with sodium channels and, therefore, has a different mode of action than organophosphate, carbamate, and pyrethroid insecticides.

Thiamethoxam is registered for use in domestic dwellings, food handling establishments, commercial/institutional/industrial areas, livestock pens, poultry houses, wood treatment, seed treatment, transportation vehicles, and various agricultural crops, turf, sod farms, golf course, ornamental plants grown in greenhouses, and Christmas trees. The following is a partial list of registered crop uses: alfalfa, avocado, artichoke, barley, bushberry subgroup, *brassica* subgroups 5-A and 5-B, caneberry subgroup, cantaloupe, cauliflower, citrus, corn (field and sweet), cotton, cranberry, cucurbit vegetables, dry beans, fruiting vegetables, globe artichoke, leafy vegetables, legume vegetables, low growing berry subgroup, mint, peanuts, peas, pecans, pome fruit, root vegetables subgroup 1-A , rice (dry-seeded only), small fruit vine climbing subgroup (includes grapes), sorghum, soybeans, stone fruit, sugarbeets, sunflower, tobacco, tuberous and corm vegetables subgroup 1-D, tree nuts, tropical fruit, and wheat. Thiamethoxam is also registered as a wood preservative to protect wood from termites and wood boring insects. Thiamethoxam must be applied as a pressure treatment or equivalent method and the wood must be machined, cut, glued and sanded prior to treatment.

Tolerances are established for residues of thiamethoxam in or on food and feed commodities under 40 CFR §180.565:

> Tolerances are established for residues of the insecticide thiamethoxam, including its metabolites and degradates. Compliance with the tolerance levels is to be determined by measuring only thiamethoxam (3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine) and its metabolite CGA-322704 [*N* -(2-chloro-thiazol-5-yl)methyl) - *N* '-methyl- *N* ' '-nitro-guanidine], calculated as the stoichiometric equivalent of thiamethoxam.

Hazard Identification/Toxicology

The toxicology database for thiamethoxam is complete, with the exception of a 21/28-day rat inhalation toxicity study. Short- and intermediate-term durations of exposure are anticipated for most uses, although chronic durations of exposure may occur for occupational handlers for the wood preservative use. In the absence of a route-specific inhalation toxicity study, HED and AD have used the endpoint and dose from 2 oral two-generation reproduction studies in rats, and assumed toxicity by the inhalation route to be equivalent to toxicity by the oral route. In many cases, toxicity observed via the inhalation route occurs at lower doses than toxicity observed via oral exposure, which results in an underestimation of risks through the inhalation route. In addition, portal of entry effects associated with the inhalation route would not be addressed through the use of an oral study. An inhalation study might result in changes to the endpoints and how the risks are quantified. The recently submitted immunotoxicity study has been screened for the purpose of this scoping document, and HED has concluded the study is acceptable for review; further, the results of the study are not expected to have an impact on the endpoints and doses selected for risk assessment.

Liver effects occurred across species, sexes and routes of administration. Subchronic rat studies indicated hepatocellular changes with females appearing to be more sensitive than males. Mice showed hepatocellular changes as well as Kupffer cell alteration and increased mitotic activity. Males appeared to be more sensitive than females. Chronic dosing resulted in an increase in the number of males and females with benign and malignant liver tumors. In both rats and mice there was an apparent increase in severity of effects with increasing doses.

Testicular effects were observed in rats and dogs. In rats, findings were decreased testes weights, increased incidence and severity of seminiferous tubular atrophy as well as sperm abnormalities. In the subchronic dog study, the following were noted: decreased testes weights, microscopic evidence of reduction in spermatogenesis and occurrence of spermatic giant cells. There was atrophy of the seminiferous tubules in the chronic dog study. Testicular effects were reported in both of the 2-generation reproduction studies in rats. Male reproductive effects appeared in the form of increased incidence and severity of testicular tubular atrophy in one study and sperm abnormalities in the other study.

Kidney effects occurred in both sexes of rats, but were primarily in males. They were observed following oral or dermal exposure and consisted primarily of hyaline changes in the renal tubules. Effects on the thyroid were noted in the rat (follicular cell hypertrophy) and dog (increase in weight). Adrenal changes consisting of fatty change and inflammatory cell infiltration of the cortex were observed in subchronic rat studies.

Hematological effects were observed in the rat, dog and mouse with the dog being the most sensitive species. In the rat, there were increased spleen weights as well as increases in the incidence and severity of hemosiderosis and/or extramedullary hematopoiesis. Mice showed a slight reduction in erythrocytes, hemoglobin and hematocrit. Leukopenia and slight microcytic anemic were observed in the subchronic oral dog study.

In the rat and rabbit developmental studies, there were no major effects on fetuses (decreases in body weights and some skeletal anomalies), and there was no evidence of increased quantitative or qualitative susceptibility. In the rat developmental neurotoxicity study, there was an increase in qualitative susceptibility due to reduced brain weight and changes in brain morphometric measurements in the pups, which were considered to be more severe than the effects observed in the dams. In the two 2-generation rat reproduction studies, evidence of increased quantitative susceptibility for male pups was seen in the increased incidence and severity of testicular tubular atrophy in one study and sperm abnormalities in the other study.

Although there was evidence of increased qualitative and quantitative susceptibility in the toxicity database, HED had a low degree of concern for the observed susceptibility based on the following:

- The database is complete with the exception of a 21/28-day rat inhalation study;
- The potential for neurotoxicity is adequately characterized, including all of the required neurotoxicity studies (ACN, SCN, and DNT);
- The doses and endpoints for risk assessment were selected to be protective of the potential increased susceptibility; and
- The exposure assessment is conservative, and will not underestimate potential dietary, residential and aggregate risk.

Long-term studies in rats and mice indicated an increase in the incidence of liver andenomas and carcinomas only in male and female mice. The HED Cancer Assessment Review Committee concluded that these tumors arose through a non-genotoxic mode of action characterized by a series of key events that included perturbation of cholesterol biosynthesis, hepatotoxicity, cell death (single cell necrosis and apoptosis) and a sustained increase in cell replication rates. The Committee determined that the mouse appeared to be uniquely sensitive to this mode of action. Because of the threshold nature of the mode of action and the unique sensitivity of the mouse, it was determined that humans were unlikely to be at risk for developing tumors following exposures to thiamethoxam. The cancer classification was "Not likely to be carcinogenic to humans."

There was no indication in the submitted studies that thiamethoxam is mutagenic. Thiamethoxam has mild or low acute toxicity (Categories III or IV) when administered orally, dermally or by inhalation. It is not an eye or skin irritant nor a dermal sensitizer.

The most current endpoints and doses selected for thiamethoxam human health risk assessment are provided in Attachment 2.

Conclusions for Hazard Identification/Toxicology

The toxicity database is largely complete, and therefore HED does not anticipate significant changes in the hazard assessment for thiamethoxam during registration review, including the doses and endpoints selected for most risk assessment scenarios. However, in order to fully characterize toxicity via the inhalation route, and in order to assess potential occupational

handler exposure via the inhalation route, a 21/28-day inhalation toxicity study is required to assess both conventional and wood treatment uses.

Dietary Exposure

Thiamethoxam is registered for use on a wide variety of field crops and in commercial use sites. The following is a partial list of registered crop uses: alfalfa, apple, artichoke, broccoli, cabbage, caneberries, cantaloupe, carrot, cauliflower, celery, cherries, com, cotton, cucumbers, dry beans, grapefruit, grapes, lemons, lettuce, oranges, peaches, peanuts, peas, pears, pecans, peppers, plums/prunes, potatoes, pumpkins, sorghum, soybeans, spinach, squash, strawberries, sunflower, sugarbeet, tobacco, tomatoes, watermelons, and wheat. Thiamethoxam is registered for use on or in domestic dwellings, food handling establishments, commercial/institutional/industrial areas, livestock pens, poultry houses and for use as a wood preservative. The physical/chemical properties of thiamethoxam are shown in Appendix 1.

Overall, the residue chemistry database is considered to be complete, and supports the established tolerances as well as the dietary exposure assessment. Thiamethoxam tolerances range from 0.02 to 4.0 ppm [40 CFR 180.565]. A significant number of the tolerances are at LOQ levels (0.02 ppm combined for thiamethoxam and clothianidin).

HED used the Dietary Exposure Evaluation Model (DEEM-FCID™ Version 2.03) to conduct the most recent acute and chronic dietary (food and drinking water) risk assessments for thiamethoxam. This model incorporates consumption data from the USDA's Continuing Survey of Food Intakes by Individuals taken between 1994 and 1996 along with a supplemental children's survey taken in 1998. The acute dietary assessment is based on tolerance level residues of thiamethoxam and assumes 100% crop treated for all commodities. The chronic dietary assessment is based on tolerance level residues and anticipated residues from thiamethoxam field trials, and also incorporates the assumption of 100% CT.

Based on these highly conservative assumptions, acute dietary (food and water) risk estimates at the 95th percentile of exposure are less than or equal to 9.5% of the acute population adjusted dose (aPAD) for all population subgroups. Chronic dietary (food and water) risk estimates are less than or equal to 43% of the chronic population adjusted dose (cPAD) for all population subgroups.

The analyses included direct incorporation of estimated thiamethoxam residues in drinking water. Clothianidin is not a major degradate of thiamethoxam in water; therefore the water numbers reflect residues of the parent compound only. For water, the highest estimate from conservative models was used for both the acute and the chronic dietary exposure analyses.

The potential for drinking water exposure from thiamethoxam treated wood was not included in the current dietary exposure assessment. The potential for drinking water exposure from thiamethoxam wood treatment facilities will be evaluated based on the down the drain releases to waste water treatment plants using standard models and environmental fate studies anticipated to be required as discussed in the AD problem formulation document (US EPA, 2011).

At the time of registration review, if it is determined that an updated drinking water assessment is needed, the results will be included in an updated dietary exposure assessment. There are also some residue chemistry data for carrot, leaf lettuce, and mustard green seed treatments, conducted at the maximum use rate, that were submitted as a condition of registration that should be reviewed. HED has concluded it is very unlikely that these data for seed treatment uses or the drinking water exposure from wood treatment uses would change the dietary exposure analysis.

Conclusions for Dietary Exposure

Currently, the acute and chronic dietary risk estimates are not of concern. A new drinking water assessment might be conducted during registration review. Further, although it is not anticipated to be needed at this time, a revised dietary risk assessment may be conducted to include potential changes in toxicological endpoints, revised estimated drinking water concentrations, and any refinements that might be needed as a result of these revisions.

Residential Exposure

Thiamethoxam is registered for use on turf (i.e., lawns, parks, play grounds, athletic fields, etc), golf courses and sod farms, ornamentals, and indoor surfaces. As a result of these uses, residential handler/applicator and postapplication exposures are possible. Although registered labels indicate that thiamethoxam is to be applied by commercial applicators only, HED does not consider this statement to be enforceable for actives that are not formally designated as restricted use pesticides, and routinely conducts residential handler assessments for products that could be used by residential handlers in and around homes. In the past, HED did not assess these types of products for residential handler exposure, and therefore during registration review, these assessments will be needed to support uses on turf and indoor surfaces.

Although thiamethoxam is registered as a wood preservative, the use sites are limited to millwork components for window and door manufacture, dimensional softwood for structural uses, structural panels and structural engineered wood that are used in above ground applications and protected from weathering. Given this millwork and structural use pattern, the potential for dermal and incidental oral exposures is much more limited than for other wood preservatives that can be used on picnic tables, decking and playground equipment. Therefore, AD does not anticipate the need to perform a residential risk assessment for the wood preservative use of thiamethoxam for this registration review..
A chemical specific turf transferrable residue (TTR) study for a water dispersible granule formulation was submitted to support use on turf. Previously, HED used TTR data and default assumptions from the Residential Standard Operating Procedures (SOP), April 5, 2000 to assess postapplication exposure resulting from use of thiamethoxam on turf and indoor surfaces. Residential postapplication (dermal and oral) exposure scenarios resulting in margins of exposures (MOEs) equal to or greater than 100 are not of concern. All previously assessed postapplication exposure scenarios resulted in MOEs significantly greater than 100, and were not of concern. However, as a result of the revisions to HED's Residential Standard Operating Procedures (SOPs), the parameters and algorithms for dermal and hand-to-mouth exposure calculations will likely change. These changes could result in significantly different postapplication exposure estimates for turf and indoor surface exposure scenarios. Therefore,

during registration review, HED may conduct new residential handler and postapplication exposure assessments that incorporate new methods or policies for estimating exposure associated with residential use patterns.

Based on HED's current practices, a quantitative postapplication inhalation exposure assessment has not been performed for thiamethoxam, primarily because it has a very low vapor pressure (5×10^{-11} mmHg @ 25° C). Residential bystander exposures might occur as a result of thiamethoxam aerial and airblast applications and/or transport from treated areas. Spray drift is always a potential source of exposure to residents nearby spraying operations. This is particularly the case with aerial application, but, to a lesser extent, could also be a potential source of exposure from the ground application method employed for thiamethoxam. The Agency has been working with the Spray Drift Task Force, EPA Regional Offices and State Lead Agencies for pesticide regulation and other parties to develop the best spray drift management practices (see the Agency's Spray Drift website for more information at http://www.epa.gov/opp00001/factsheets/spraydrift.htm). On a chemical by chemical basis, the Agency is now requiring interim mitigation measures for aerial applications that must be placed on product labels/labeling.

Other potential sources of residential exposure include volatilization of pesticides and re-suspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (*http://www.epa.gov/scipoly/SAP/meetings/2009/120109meeting.html*). The Agency is in the process of evaluating the SAP report as well as available postapplication inhalation exposure data generated by the Agricultural Reentry Task Force and may, as appropriate, develop policies and procedures, to identify the need for and, subsequently, the way to incorporate residential postapplication inhalation exposure into the Agency's risk assessments. If new policies or procedures are put into place, the Agency may revisit the need for a quantitative residential postapplication inhalation exposure assessment for thiamethoxam.

Although a quantitative residential postapplication inhalation exposure assessment was not performed as a result of pesticide drift from neighboring treated agricultural fields, an inhalation exposure assessment was performed for flaggers, and is considered representative of a worst case inhalation (drift) exposure.

Conclusions for Residential Exposure

All residential postapplication exposure scenarios associated with registered uses of thiamethoxam resulted in risks that were not of concern. During registration review, HED may conduct a new residential exposure assessment that incorporates any potential new methods or policies for estimating exposure associated with residential use patterns as a result of the revisions to HED's Residential Standard Operating Procedures (SOPs). Furthermore, residential bystander exposures might occur as a result of thiamethoxam aerial and airblast applications, volatilization, and/or transport from treated areas. HED will evaluate the need for a bystander

assessment during registration review. Finally, HED will likely conduct residential handler assessments to support indoor uses and the use on turf.

Aggregate Risk Assessment

Note that because clothianidin is a major metabolite of thiamethoxam, EPA has included exposure to both thiamethoxam and clothianidin in its dietary assessment for thiamethoxam in food. However, clothianidin is not expected to be a significant residue in drinking water following application of thiamethoxam, so drinking water residues consist of parent thiamethoxam only. For clothianidin, the dietary assessments incorporate direct application of clothiandin to food crops, potential residues of clothianidin in foods resulting from application of thiamethoxam, and estimated clothiaindin residues in drinking water. Given this approach, in combination with the assumption of 100% crop treated for both the acute and chronic dietary (and therefore the acute and chronic aggregate) assessments for both chemicals, the risk assessments are considered to be conservative and protective. In addition, labels for both clothianidin and thiamethoxam indicate that other neonicitinoid pesticides should not be applied during the growing season.

Based on the current uses of thiamethoxam and HED's policies and procedures for performing aggregate risk assessment, all aggregate risk estimates for all durations and all population subgroups are not of concern. Potential revisions to the dietary exposure based on the results from the required leaching studies for drinking water may result in revised aggregate exposure and risk estimates during registration review.

Acute. Other than dietary exposure, there are no other sources of exposure that constitute an acute exposure scenario; therefore, acute aggregate exposure and risk estimates are equivalent to the acute dietary exposure and risk estimates and are below HED's level of concern.

Short- and Intermediate-Term. Short-term aggregate MOEs range from 370 to 490 and are not of concern based on the level of concern of 100. These MOEs take into account postapplication exposure from indoor surfaces and background exposure from food and drinking water.

Chronic. Other than dietary exposure, there are no other sources of exposure that constitute a chronic exposure scenario; therefore, chronic aggregate exposure and risk estimates are equivalent to the chronic dietary exposure and risk estimates and are below HED's level of concern.

Cancer. Clothianidin has been classified as "not likely to be carcinogenic to humans." Therefore, cancer risk is not a concern for this chemical.

Conclusions for Aggregate Exposure and Risk

There is sufficient information available to assess aggregate exposure and risk for thiamethoxam. All of the aggregate exposure scenarios for the registered uses of thiamethoxam have been assessed, with the exception of potential short-term aggregate exposure and risk for residential handlers, and potential drinking water exposure from the wood preservative use. For those scenarios which have been assessed, there are no risks of concern. If residential and/or dietary

exposure estimates are revised (see above), then new aggregate risk estimates may be needed during registration review. In addition, potential revisions to the residential exposure assessment, based on new SOPs for Residential Exposure Assessment, and dietary exposure based on the results form required leaching studies may result in revised aggregate exposure and risk.

Occupational Exposure

A wide range of uses and the associated occupational and commercial handler and postapplication scenarios have been assessed for thiamethoxam. Registered formulations include liquids, soluble concentrates, water dispersible granules, water soluble granules, wettable powders, granular products and foams. Thiamethoxam may be applied using ground spray (i.e., groundboom and airblast), chemigation, and aerial equipment, backpack, low and high pressure handwand, and drop-type or rotary (push) type spreader. It is registered for use on a wide variety of agricultural crops and sites as well as in commercial livestock houses (i.e. stables, barns, poultry houses), food handling establishments, as a seed treatment and wood preservative. The personal protective equipment (PPE) for agricultural and commercial labels, other than seed treatment, consists of single layer clothing (long sleeve shirt, long pants, socks, shoes) and chemical resistant gloves. The PPE for seed treatment labels consists of single layer clothing, chemical resistant gloves and filtering facepiece respirators (PF5) or elastomeric half face respirators (PF10) meeting MSHA and/or NIOSH standards and closed mixing/loading seed treatment systems as engineering controls. The use patterns suggest that short-term (1-30 days) and intermediate-term (1-6 months) exposures are expected via inhalation and dermal routes. However, there may be long term occupational exposure associated with the wood preservative use. The use sites, formulation types, and application methods for the active ingredient reviewed by HED are listed in Attachment 3.

Occupational Handlers

Occupational dermal and inhalation exposures resulting from agricultural, commercial and antimicrobial uses (i.e., poultry houses, seed treatment, wood preservation, golf courses, sod farms, turfgrass and wood preservatives) have been evaluated quantitatively for all registered thiamethoxam uses. However, during registration review an inhalation exposure assessment will be needed based on the potential for release of aerosols from the pressure treatment process (i.e., wood treatment use). In order to fully assess thiamethoxam during registration review, occupational dermal and inhalation exposure studies (Guidelines 875.1100 and 875.1300 respectively) and product use information (875.1700) will be required for assessing exposures which occur during pressure treatment of lumber.

No chemical specific handler data were submitted in support of existing registrations. Therefore, handler dermal and inhalation exposure assessments were performed based on surrogate data from the Pesticide Handler's Exposure Database (PHED, August 1998), the Occupational Residential Exposure Task Force (ORETF) summary of handler exposure studies (MRID No. 45663701), Seed Treatment SOPs 14 and 15 (March 2004) and the CCA Pressure Treatment Worker Exposure Study. Occupational and commercial handler exposure (dermal and inhalation) scenarios resulting in MOEs equal to or greater than 100 are not of concern. For

thiamethoxam, all handler exposure scenarios resulted in MOEs greater than 100 either at baseline (single layer clothing) or with the addition of PPE (i.e., gloves, respirators) or engineering controls (i.e., water soluble packets, closed seed treatment systems). Recently, PHED has been updated by the Occupational Pesticide Handler Unit Exposure (OPHED) Surrogate Reference Table (June 21, 2011). Therefore, HED may conduct updated handler dermal and inhalation exposure and risk assessments during registration review. Furthermore, HED is currently revising both Seed Treatment SOPs (14 and 15) with new survey data collected by the Agricultural Handlers Exposure Task Force (AHETF) and additional observational seed treatment studies. Therefore, seed treatment exposure scenarios may be re-assessed during registration review.

Occupational Postapplication

Thiamethoxam uses can potentially result in postapplication exposure to workers reentering treated agricultural fields and commercial sites. Chemical specific dislodgeable foliar residue (DFR) and TTR studies were submitted in support of the use of thiamethoxam on ornamentals and turf, respectively. All other postapplication exposure assessments were based on HED defaults and current transfer coefficient policies and AD surrogate data for wood preservatives. Risks associated with occupational and commercial postapplication exposure are not of concern. During registration review, HED and AD may update the occupational postapplication exposure and risk assessments with updated assumptions, including updated transfer coefficients.

Based on the Agency's current practices, a quantitative postapplication inhalation exposure assessment was not performed for thiamethoxam. However, there are multiple potential sources of inhalation exposure to individuals performing postapplication activities in previously treated fields. These potential sources include volatilization of pesticides and re-suspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (*http://www.epa.gov/scipoly/SAP/meetings/2009/120109meeting.html*). The Agency is in the process of evaluating the SAP report as well as available postapplication inhalation exposure data generated by the Agricultural Reentry Task Force and may, as appropriate, develop policies and procedures, to identify the need for and, subsequently, the way to incorporate occupational postapplication inhalation exposure into the Agency's risk assessments. If new policies or procedures are put into place, the Agency may revisit the need for a quantitative occupational postapplication inhalation exposure assessment for thiamethoxam.

Although a quantitative postapplication inhalation exposure assessment was not preformed, an inhalation exposure assessment was performed for occupational/commercial handlers (i.e., agricultural use sites, non-agricultural turf use site, animal houses, seed treatment and food handling establishments). Handler exposure resulting from application of pesticides outdoors is likely to result in higher exposure than postapplication exposure. Therefore, if handler exposure results in a MOE greater than or equal to the level of concern (LOC = MOE $\geq$ 100) it is not considered a risk of concern, and the quantitative handler inhalation exposure assessment may be protective of outdoor inhalation postapplication exposure. Since the indoor commercial applicators are simply applying the pesticide and not returning to the treated areas, a

postapplication inhalation exposure assessment was not performed for commercial applicators applying thiamethoxam within indoor settings.

Thiamethoxam is classified as Toxicity Category III in the acute oral and dermal studies and Category IV in the acute inhalation study. It is not irritating to the skin and minimally irritating to the eye. It is not a dermal sensitizer. In accordance with the Worker Protection Standard (WPS), a 12 hour restricted entry interval (REI) is required. The 12-hour REI appearing on existing labels is appropriate.

Conclusions for Occupational Exposure and Risk

The registered uses of thiamethoxam have been assessed for the majority of the occupational and commercial handler and postapplication exposure scenarios, which address the most significant sources of exposure. During registration review, HED may assess additional labels as indicated in Attachment 3. All handler exposure scenarios resulted in MOEs greater than 100 either at baseline (single layer clothing) or with the addition of PPE (i.e., gloves, respirators) or engineering controls (i.e., water soluble packets, closed mixing loading systems) using PHED, the CCA Pressure Treatment Worker Exposure Study, and Seed Treatment SOPs 14 and 15. Updates to HED's and AD's standard assumptions for conducting handler exposure assessments, including revised unit exposures based on surrogate data, are ongoing. During registration review, AD and HED may conduct updated handler dermal and inhalation exposure and risk assessments, especially for wood preservatives and seed treatment uses.

All postapplication exposure scenario calculations based on current policies resulted in risks that were not of concern. However, HED and AD may conduct an updated postapplication exposure assessment during registration review, incorporating new policies, seed treatment SOPs, updated agricultural unit exposures, and transfer coefficients.

Public Health and Pesticide Epidemiology Data

HED used OPP's Incident Data System (IDS) to determine the number and severity of incidents that resulted from thiamethoxam exposure. IDS records incidents resulting in higher severity outcomes in more detail, in a module called the Main IDS module. This system stores incident data for death, major and moderate incidents, and it includes more details about the location, date and nature of the incident. Main IDS incidents involving only one pesticide are considered to provide more certain information about the potential effects of exposure from the pesticide. The less severe human incidents (minor, unknown, or no effects outcomes) are reported by registrants as counts called aggregate summaries and are recorded in a separate module called Aggregate IDS.

In Aggregate IDS, from January 1, 2006 to June 6, 2011, there are 35 incidents involving thiamethoxam. For the Main IDS, from January 1, 2006 to June 6, 2011, there are five incidents reported for thiamethoxam in the database (one classified as major severity, four classified as moderate severity), and 16 additional incidents that involved more than one chemical (and were all classified as moderate severity). Overall, there are few incidents involving thiamethoxam reported to IDS, and most are classified as moderate or low severity.

Based on the low frequency and severity of incident cases, there does not appear to be a concern at this time that would warrant further investigation. The Agency will continue to monitor the incident information and if a concern is triggered, additional analysis will be included in the risk assessment.

Tolerance Assessment and International Harmonization

Tolerances are established for residues of thiamethoxam in or on food and feed commodities under 40CFR §180.565. The current tolerance expression reflects the need for both coverage and compliance statements: Tolerances are established for residues of the insecticide thiamethoxam, including its metabolites and degradates. Compliance with the tolerance levels is to be determined by measuring only thiamethoxam (3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine) and its metabolite CGA-322704 [*N* -(2-chloro-thiazol-5-yl)methyl) - *N* '-methyl- *N* ' '-nitro-guanidine], calculated as the stoichiometric equivalent of thiamethoxam.

The Codex Alimentarius Commission (Codex) and Canada have established numerous maximum residue limits (MRLs) for thiamethoxam. Mexico adopts U.S. tolerances and/or Codex MRLs for its export purposes. In cases where there are no Codex MRLs for thiamethoxam, Mexico's MRLs are equivalent to the U.S. tolerances.

The international residue limit status sheet can be found in Attachment 5.

During registration review, if Codex has established tolerances for thiamethoxam, HED will reconsider the U.S. tolerances and will harmonize them with Codex MRLs when the data warrant harmonization.

Environmental Justice

Potential areas of environmental justice concerns, to the extent possible, were considered in the human-health risk assessment, in accordance with U.S. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," (http://www.hss.energy.gov/nuclearsafety/env/guidance/justice/eo12898.pdf). The OPP typically considers the highest potential exposures from the legal use of a pesticide when conducting human-health risk assessments, including, but not limited to, people who obtain drinking water from sources near agricultural areas, the variability of diets within the U.S., and people who might be exposed when harvesting crops. Should these highest exposures indicate potential risks of concern, OPP further refines the risk assessments to ensure that the risk estimates are based on the best available information.

Endocrine Disruptor Screening Program

As required by FIFRA and FFDCA, EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental,

reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental, and reproductive effects in different taxonomic groups. As part of its most recent registration decision, EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), thiamethoxam is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. Thiamethoxam is not among the group of 58 pesticide active ingredients on the initial list to be screened under the EDSP. Accordingly, as part of registration review, EPA will issue future EDSP orders/data call-ins, requiring the submission of EDSP screening assays for thiamethoxam. For further information on the status of the EDSP, the policies and procedures, the list of 67 chemicals, future lists, the test guidelines, and the Tier 1 screening battery, please visit EPA's website: http://www.epa.gov/endo/.

Cumulative Risk Assessments

Unlike other pesticides for which EPA has followed a cumulative risk approach based on a common mechanism of toxicity, EPA has not made a common mechanism of toxicity finding as to thiamethoxam and any other substances, and thiamethoxam does not appear to produce a toxic metabolite produced by other substances. For the purposes of this action, therefore, EPA has not assumed that thiamethoxam has a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at http://www.epa.gov/pesticides/cumulative/.

Human Studies

Past thiamethoxam risk assessments rely in part on data from studies in which adult human subjects were intentionally exposed to a pesticide to determine their dermal and inhalation exposure. Many such studies, involving exposure to many different pesticides, comprise generic pesticide exposure databases such as the Occupational Pesticide Handlers Unit Exposure Surrogate Reference Table (OPHED) and the Agricultural Reentry Task Force (ARTF) Database. EPA has reviewed all the studies supporting these multi-pesticide generic exposure databases, and has found no clear and convincing evidence that the conduct of any of them was either fundamentally unethical or significantly deficient relative to the ethical standards prevailing at the time the research was conducted. All applicable requirements of EPA's Rule for the Protection of Human Subjects of Research (40 CFR Part 26) have been satisfied, and there is no regulatory barrier to continued reliance on these studies.

Additional Information from Literature Sources

A literature search was conducted on August 2, 2011 through PubMed and Google Scholar. There were no articles found which appeared to provide additional information and/or to be applicable to the hazard evaluation or endpoint selection.

Data Requirements

Toxicology

- A 21/28-day rat inhalation study (870.3465) is needed in accordance with the 40 CFR Part 158 data requirements, and in order to fully characterize inhalation risk associated with the conventional and wood preservative uses.

Chemistry

There are no outstanding residue chemistry data requirements.

Occupational and Residential

The following data are needed to support the wood preservative use (refer to DCI tables):

- Occupational dermal and inhalation exposure studies (Guidelines 875.1100 and 875.1300 respectively); and
- Product use information (875.1700)

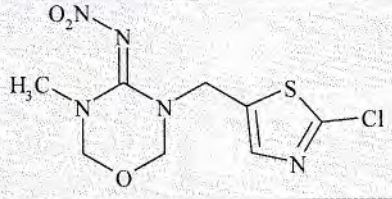
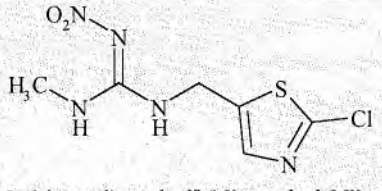
References

Author	Barcode	Date	Title
T. Dole	D396697	12/13/2011	Thiamethoxam Registration Review: Human Health Scoping Information Regarding the Wood Preservative Uses (Post Peer Review Update)
D. McNeilly	D373376	12/20/2010	Thiamethoxam – Human Health Risk Assessment for New Seed Treatment Uses on Alfalfa and Peanuts, and Use in Food Handling Establishments.
M. Collantes	D332064	3/6/2007	Thiamethoxam: Occupational and Residential Exposure Assessment for Section 3 Registration for use of Thiamethoxum on Berries, Brassica Cole Leafy Vegetables, Curcurbits, Fruiting Vegetables, Leafy Vegetables, Grapes, Hops, Root Vegetables, Strawberries, Tobacco, Tuberous and Corm Vegetables, Barley, Cranberries, Artichokes, Mint, Pome Fruit, Stone Fruit, Cotton, Pecans, Turf, Sod Farm, Ornamentals grown in Green Houses and Christmas Trees.
T. Dole	D393661	10/31/2011	Thiamethoxam Registration Review: Human Health Scoping Information Regarding the Wood Preservative Uses
G. Angle	D285854	4/18/2006	Human Exposure Review of XAMOX™ 3OL and XAMOX™ 100 SL : Proposed New Wood Preservative Use Patterns for Thiamethoxam

Attachments

Attachment 1. Chemical Identity Table
Attachment 2. Thiamethoxam Endpoint Selection Tables
Attachment 3. Application Sites Assessed for Occupational and Residential Exposures
Attachment 4. DCI Justification for Required Studies
Attachment 5. International Residue Limit Status

Attachment 1. Chemical Identity Table

Chemical Identity Table	
Chemical structure	
Empirical Formula	$C_8H_{10}ClN_5O_3S$
Common name	Thiamethoxam
Company experimental name	CGA 293343
IUPAC name	3-(2-chloro-1,3-thiazol-5-ylmethyl)-5-methyl-1,3,5-oxadiazinan-4-ylidene(nitro)amine
CAS name	3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine
CAS registry number	153719-23-4
End-use products (EP)	70% WS formulation in water soluble bags (Cruiser® 70WS; EPA Reg. No. 100-1294) 25% WG formulation (Actara® Insecticide; EPA Reg. No. 100-938) 2 lb/gal FlC formulation (Platinum® Insecticide; EPA Reg. No. 100-939) 40% WG formulation (Centric® 40WG Insecticide; EPA Reg. No. 100-1147) 2 lb/gal FlC formulation (Actara® 240 SC Insecticide; EPA File Symbol 100-RELN) 47.6% liquid formulation (Cruiser® Insecticide; EPA Reg. No. 100-941) 0.22% granular formulation (Flagship® Insecticide; EPA File Symbol 100-OAN) 0.33% granular formulation (Meridian® Insecticide; EPA File Symbol 100-OAR) 25% WG formulation (Meridian™ Insecticide; EPA File Symbol 100-OUG)
Chemical Class	Neonicotinoid, Group 4A
Known Impurities of Concern	None
Chemical structure of CGA-322704 metabolite	 N-[(2-chloro-5-thiazoyl)methyl]-N'-methyl-N"-nitroguanidine
Common Name	Clothianidin

Attachment 2. Thiamethoxam Endpoint Selection Tables

Table 2.1. Toxicological Doses and Endpoints for Thiamethoxam for Use in Dietary and Residential Human Health Risk Assessments.

Exposure/ Scenario	Point of Departure	Uncertainty/FQPA Safety Factors	Level of Concern for Risk Assessment	Study and Toxicological Effects
Acute Dietary All populations including infants and children	NOAEL = 34.5 mg/kg/day	UF_A= 10x UF_H= 10x SF_{FQPA}=1	aRfD=0.35 mg/kg/day aPAD=0.35 mg/kg/day	**Rat Developmental Neurotoxicity study** LOAEL = 298.7 mg/kg/day based on delayed sexual maturation in male pups, and reduced brain morphometric measurements.
Chronic Dietary All populations including infants and children	NOAEL= 1.2 mg/kg/day (MRID 46402904)	UF_A= 10x UF_H= 10x SF_{FQPA}=1	cRfD=0.012 mg/kg/day cPAD=0.012 mg/kg/day	**2-Generation reproduction study** LOAEL = 1.8 mg/kg/day based on increased incidence and severity of tubular atrophy in testes of F_1 generation males. **2-Generation reproduction study** LOAEL = 3 (males), not determined (females) mg/kg/day based on sperm abnormalities in F_1 males.
Incidental Oral (all durations)	NOAEL= 8.23 mg/kg/day	UF_A= 10x UF_H= 10x SF_{FQPA}=1	MOE= 100 (residential)	**90-day Dog study** LOAEL= 32 (males) 33.9 (females) mg/kg/day based on slightly prolonged prothrombin times and decreased plasma albumin and A/G ratio (both sexes); decreased calcium levels and ovary weights and delayed maturation in the ovaries (females); decreased cholesterol and phospholipid levels, testis weights, spermatogenesis, and spermatic giant cells in testes (males).
Dermal (all durations) (Adults)	Oral study NOAEL= 1.2 mg/kg/day (dermal absorption rate = 5%)	UF_A= 10x UF_H= 10x SF_{FQPA}=1	MOE= 100 (residential)	**2-Generation reproduction study** LOAEL = 1.8 mg/kg/day based on increased incidence and severity of tubular atrophy in testes of F_1 generation males. **2-Generation reproduction study** LOAEL = 3 (males), not determined (females) mg/kg/day based on sperm abnormalities in F_1 males.
Dermal (all durations) (infants/ children 1-6 yrs)	Dermal Study NOAEL=60 mg/kg/day	UF_A= 10x UF_H= 10x SF_{FQPA}=1	MOE= 100 (residential)	**Rat 28-Day Dermal Toxicity Study** LOAEL = 250 (females) mg/kg/day based on increased plasma glucose, triglyceride levels, and alkaline phosphatase activity and inflammatory cell infiltration in the liver and necrosis of single hepatocytes in females.
Inhalation (all durations)	Oral study NOAEL= 1.2 mg/kg/day (inhalation toxicity	UF_A= 10x UF_H= 10x SF_{FQPA}=1	MOE= 100 (residential)	**2-Generation reproduction study** LOAEL = 1.8 mg/kg/day based on increased incidence and severity of tubular atrophy in testes of F_1 generation males.

Table 2.1. Toxicological Doses and Endpoints for Thiamethoxam for Use in Dietary and Residential Human Health Risk Assessments.

Exposure/ Scenario	Point of Departure	Uncertainty/FQPA Safety Factors	Level of Concern for Risk Assessment	Study and Toxicological Effects
	assumed equivalent to oral toxicity)			**2-Generation reproduction study** LOAEL = 3 (males), not determined (females) mg/kg/day based on sperm abnormalities in F_1 males.
Cancer (oral, dermal, inhalation)	**"Not Likely to be Carcinogenic to Humans"** based on convincing evidence that a non-genotoxic mode of action for liver tumors was established in the mouse.			

Point of Departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no observed adverse effect level. LOAEL = lowest observed adverse effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). UF_L = use of a LOAEL to extrapolate a NOAEL. UF_S = use of a short-term study for long-term risk assessment. UF_{DB} = to account for the absence of key date (i.e., lack of a critical study). FQPA SF = FQPA Safety Factor. PAD = population adjusted dose (a = acute, c = chronic). RfD = reference dose. MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

Table 2.2. Summary of Toxicological Doses and Endpoints for Thiamethoxam for Use in Occupational Human Health Risk Assessments.

Exposure/ Scenario	**Point of Departure**	**Uncertainty Factors**	**Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Dermal Short-term (1-30 days) and Intermediate-term (1-6 months)	Oral study NOAEL= 1.2 mg/kg/day (dermal absorption rate = 5%)	UF_A= 10x UF_H= 10x	MOE= 100 (occupational)	**2-Generation reproduction study** LOAEL = 1.8 mg/kg/day based on increased incidence and severity of tubular atrophy in testes of F_1 generation males. **2-Generation reproduction study** LOAEL = 3 (males), not determined (females) mg/kg/day based on sperm abnormalities in F_1 males.
Inhalation Short-term (1-30 days) and Intermediate-term (1-6 months)	Oral study NOAEL= 1.2 mg/kg/day (inhalation toxicity is considered equivalent to oral toxicity)	UF_A= 10x UF_H= 10x	MOE= 100 (occupational)	**2-Generation reproduction study** LOAEL = 1.8 mg/kg/day based on increased incidence and severity of tubular atrophy in testes of F_1 generation males. **2-Generation reproduction study** LOAEL = 3 (males), not determined (females) mg/kg/day based on sperm abnormalities in F_1 males.

Point of Departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no observed adverse effect level. LOAEL = lowest observed adverse effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). UF_L = use of a LOAEL to extrapolate a NOAEL. UF_S = use of a short-term study for long-term risk assessment. UF_{DB} = to account for the absence of key data (i.e., lack of a critical study). FQPA SF = FQPA Safety Factor. PAD = population adjusted dose (a = acute, c = chronic). RfD = reference dose. MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

Attachment 3. Thiamethoxam Application Sites Assessed for Occupational and Residential Exposure

Table A3.1.: Registered Thiamethoxam Products Reviewed by HED and AD

Registration #	Product Name(s)	Registrant	% Active Ingredient	Formulation	Use Site
100-935	Helix Xtra	Syngenta Crop Protection	20.7	liquid	Seed treatment (Canola)
100-936	Technical		99.1		Technical
100-938	Actara		25	WDG	Variety of agricultural and orchard crops
100-939	Platinum		21.6	SC	
100-941	Cruiser* Adage**		47.6	FS	Seed treatment
100-943	Meridian		25	WDG	Turf and sod farms
100-955	Flagship		25	WDG	Cucurbits, fruiting vegetables, fruit and nut trees, cut flowers, ornamentals, and fire ants
100-960	Flagship		.22	G	Christmas trees, ornamentals, turf and sod farms
100-961	Meridian		.33	G	Turf
100-1147	Centric		40	WDG	nuts
100-1170	Optigard ZT		21.6	SC	Indoor surface (crack & crevice)
100-1294	Cruiser		70	WS	Seed Treatment (onions)
100-1305	Cruiser MAXX		2.8		Seed Treatment (cereal grains)
100-1306	Optigard Flex		21.6	Liquid/foam	Indoor crack and crevice
100-1350	Agri-Flex		13.9	SC	Orchard crops
100-1365	Cruiser		70	PD	Seed Treatment (peanuts)
43813-29	XAMOX	Janssen PMP	98		Technical
43813-30	XAMOX 3OL		.49	liquid	Wood Preservatives
43813-31	XAMOX 10TK		9.9	liquid	
43813-36	XAMOX 100 SL		9.9	liquid	
70585-9	AGITA	Novarits	10	WG	Animal and poultry houses
70585-10	AGITA 1 GB Fly Bait		1	granule	

* current registration **previous registration

Table A3.2.: Additonal Thiamethoxam Registered Products Which May Require An ORE Review*

Registration #	Product Name (s)	Registrant	% Active Ingredient
100-973	Helix Insecticide w/Fungicide	Syngenta Crop Protection	10.3
100-974	Platinum Ridomil Gold		4.5
100-1184	Cruiser XL Insecticide & Fungicide Prepack		25
100-1208	Cruiser Extreme		25
100-1246	Thiamethoxam 240 SC MUP		21.6
100-1247	CruiserMAXX		22.61
100-1248	CruiserMAXX Potato Insecticide & Fungicide		28
100-1249	Adage-Maxim 4FS TwinPak		47.6
100-1250	Actara 240 SC Insecticide		21.6
100-1260	Optigard Ant Gel Bait		.01
100-1261	Thiamethoxam Ant Killer Gel		.003
100-1276	Endigo ZC		12.6
100-1283	THX/MXM/FDL CZ		21.5

Table A3.2.: Additonal Thiamethoxam Registered Products Which May Require An ORE Review*			
Registration #	**Product Name (s)**	**Registrant**	**% Active Ingredient**
100-1288	Thiamethoxam Lawn&Landscape .33G		.33
100-1289	Thiamethoxam Lawn&Landscape .22G		0.22
100-1291	Platinum 75 SG Insecticide		75
100-1304	Thiamethoxam 0.02 Lambda Cyhalothrin		0.2
100-1318	Durivo		17.5
100-1319	Voliam Flexi Insecticide		20
100-1321	Avicta Duo		28.1
100-1334	Thiamethoxam 0.40 /Lambda-cyhalothrin 0.16 ME Concentrate		0.4
100-1336	Thiamethoxam 0.010/ Lambda-cyhalothrin 0.004 ME Concentrate		0.01
100-1341	Meridian 0.20G		
100-1346	Meridian 0.14G		0.14
100-1353	Avicta Duo 250		14.2
100-1366	Difenoconazole 0.170/ Thiamethoxam 0.010/ Lambda Cyhalothrin 0.004 ME RTU		0.01
100-1367	Difenoconazole 0.66/ Thiamethoxam 0.40/ Lambda Cyhalothrin 0.16 ME Concentrate		0.4
100-1369	CruiserMAXX Rice		26.4
100-1370	Optigard Liquid Ant Bait		.003
100-1384	Four-Way VAP		22.6
100-1399	Avicta Complete Corn 500 Premix		23.1
34704-939	DYNA- Shield Thiamethoxam Fungicide	Loveland Products, Inc.	47.6

*Table A3.2 provides a list of products registered for thiamethoxam which do not have formal occupational and residential exposure (ORE) reviews. Most of these registrations are for products which have the same or lower application rates and percent active ingredient as the products reviewed by HED, with the addition of a second active ingredient. During registration review, HED will review these registrations to ensure that all uses have been covered by previous ORE assessments and to ensure there are no residential risks of concern which may impact the aggregate assessment for thiamethoxam.

Attachment 4. DCI Justifications for Required Studies

Study Titles: Outdoor Exposure Dermal, Outdoor Exposure Inhalation, Data Reporting and Calculations **Guideline Numbers:** 875.1100, 875.1300, 875.1600
Rationale for Requiring the Data
Occupational dermal and inhalation exposures to thiamethoxam are expected during the pressure treatment applications of thiamethoxam to millwork and structural wood. There are no open literature studies available to assess these exposures*.
Practical Utility of the Data
1) How would the data be used? The exposure data would be used to assess thiamethoxam exposures that result from the pressure treatment applications of thiamethoxam. **2) How could the data impact the Agency's future decision making?** Currently there are no open literature data available to assess the exposure of thiamethoxam from the use of thiamethoxam in pressure treatment. The exposure data would be used to assess these risks and determine what if any, mitigation is needed to reduce these risks. Without this data, conservative assumptions of exposure will have to be made to account for uncertainties and the resulting risks might trigger the need for excessive mitigation.

*There are proprietary studies, such as the CCA Pressure Treatment Worker Exposure Study (MRID 455021-01) that can be used as surrogate data for this exposure scenario if data compensation issues are addressed.

Study Title: Product Use Information **Guideline Numbers:** 875.1700
Rationale for Requiring the Data
Product use information serves as the basis for determining what exposure scenarios should be assessed and what assumptions and exposure data are needed to perform these assessments in manner that does not over or underestimate the actual risk.
Practical Utility of the Data
1) How would the data be used? The product use information will be used to define and characterize the exposure scenarios that will be assessed in the risk assessment. **2) How could the data impact the Agency's future decision making?** A complete description of product use would ensure that the risk assessment is inclusive of the types of exposures occurring during use and that these exposures are accurately assessed. Without product use information the Agency will have to use default assumptions that might over estimate the actual risk.

Attachment 5. International Residue Limit Status
Thiamethoxam (060109; 07/13/2011)

Summary of US and International Tolerances and Maximum Residue Limits			
Residue Definition:			
US	Canada	Mexico[2]	Codex[3,4]
40 CFR 180.565 thiamethoxam (3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl- *N* -nitro-4 *H* -1,3,5-oxadiazin-4-imine) and its metabolite CGA-322704 [*N* -(2-chloro-thiazol-5-ylmethyl)- *N* '-methyl- *N* '-nitro-guanidine], calculated as the stoichiometric equivalent of thiamethoxam	3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-*N*-nitro-4*H*-1,3,5-oxadiazin-4-imine, including the metabolite (*E*)-*N*-[(2-chloro-5-thiazolyl)methyl]-*N'*-methyl-*N"*-nitroguanidine	-	thiamethoxam

Commodity[1]	*Tolerance (ppm) /Maximum Residue Limit (mg/kg)*			
	US	Canada	Mexico[2]	Codex
Almond, hulls	1.2			
Artichoke, globe	0.45	0.45		0.5
Avocado	0.40	0.4		
Barley, grain	0.30	0.3		0.4
Barley, hay	0.40			
Barley, straw	0.40			2 (straw and fodder, dry)
Bean, succulent	0.02			See legume vegetables
Berry, low growing, subgroup 13-07G, except cranberry	0.30	0.3		0.5 (berries and other small fruits)
Borage, seed	0.02			0.02 (*) (oilseed)
Brassica, head and stem, subgroup 5-A	4.5	4.5		5 Brassica,(Cole or Cabbage) Vegetables, Head Cabbage, Flowerhead Brassica
Brassica, leafy greens, subgroup 5-B	3.0	3.0		3. (includes Brassica and non-Brassica)
Bushberry subgroup 13-07B, except lingonberry and blueberry, lowbush	0.20	0.2 (specific commodities listed)		0.5 (berries and other small fruits)
Caneberry subgroup 13-07A	0.35	0.35		0.5 (berries and other small fruits)
Canistel	0.40	0.4		
Canola, seed	0.02			0.02 (*) (oilseed)

Summary of US and International Tolerances and Maximum Residue Limits				
Residue Definition:				
US		Canada	Mexico[2]	Codex[3,4]
Cattle, meat	0.02	0.02		0.02 (meat from mammals other than marine)
Cattle, meat byproducts	0.04	0.02		0.01 (*) Edible offal (mammalian)
Citrus, dried pulp	0.60			
Coffee, bean, green[1]	0.05	0.05		0.2
Corn, field, forage	0.10			
Corn, field, grain	0.020			0.05
Corn, field, stover	0.05			0.05 (fodder, dry)
Corn, pop, forage	0.10			
Corn, pop, grain	0.02			0.01 (*)
Corn, pop, stover	0.05			
Corn, sweet, forage	0.10			
Corn, sweet, kernel plus cob with husks removed	0.02			0.01 (*)
Corn, sweet, stover	0.05			
Cotton, gin byproducts	1.5			
Cotton, undelinted seed	0.10	0.1		0.02 (*) (oilseed)
Crambe, seed	0.02			0.02 (*) (oilseed)
Cranberry	0.02			0.5 (berries and other small fruits)
Flax, seed	0.02			0.02 (*) (oilseed)
Fruit, citrus, group 10	0.40	0.4		0.5
Fruit, pome, group 11	0.2	0.2		0.3
Fruit, small, vine climbing, subgroup 13-07F, except fuzzy kiwifruit	0.20	0.2 except gooseberries		
Fruit, stone, group 12	0.5	0.5		1.
Goat, meat	0.02	0.02		0.02 (meat from mammals other than marine)
Goat, meat byproducts	0.04	0.02		0.01(*) Edible offal (mammalian)
Grain, aspirated fractions	0.08			
Grape, raisin	0.30	0.3		
Hog, meat	0.02	0.02		0.02 (meat from mammals other than marine)

Summary of US and International Tolerances and Maximum Residue Limits				
Residue Definition:				
US		Canada	Mexico[2]	Codex[3,4]
Hog, meat byproducts	0.02	0.02		0.01 (*) Edible offal (mammalian)
Hop, dried cones	0.10	0.1		
Horse, meat	0.02			0.02 (meat from mammals other than marine)
Horse, meat byproducts	0.04			0.01(*) Edible offal (mammalian)
Mango	0.40	0.4		
Milk	0.02	0.01		0.05
Mustard, seed	0.02			0.02 (*) (oilseed)
Nut, tree, group 14	0.02			0.01 (*) (pecan)
Onion, dry bulb	0.03			
Papaya	0.40	0.4		0.01 (*)
Peppermint, tops	1.5	1.5		
Pistachio	0.02			
Potato	0.25	0.15		
Radish, tops	0.80	0.8 (radish tops, black salsify tops, celeriac tops, chicory tops, edible burdock tops, garden beet tops, oriental radish tops, rutabaga tops, turnip tops, turnip-rooted chervil tops)		
Rapeseed, seed	0.02			0.02 (*) (oilseed)
Rice, grain	0.02			
Safflower, seed	0.02			0.02 (*) (oilseed)
Sapodilla	0.40	0.4		
Sapote, black	0.40	0.4		
Sapote, mamey	0.40	0.4		
Sheep, meat	0.02	0.02		0.02 (meat from mammals other than marine)
Sheep, meat byproducts	0.04	0.02		0.01(*) Edible offal (mammalian)
Sorghum, forage	0.02			
Sorghum, grain	0.02			
Sorghum, grain, stover	0.02			
Soybean, hulls	2.0			
Spearmint, tops	1.5	1.5		
Star apple	0.40	0.4		

Summary of US and International Tolerances and Maximum Residue Limits				
Residue Definition:				
US		Canada	Mexico[2]	Codex[3,4]
Sunflower	0.02			0.02 (*) (oilseed)
Tomato, paste	0.80			
Vegetable, cucurbit, group 9	0.2	0.2		0.5
Vegetable, fruiting, group 8	0.25			0.7
Vegetable, leafy, except brassica, group 4	4.0	4.0		3 (including Brassica leafy) 1 (celery)
Vegetable, legume, group 6	0.02			0.01 (*)
Vegetable, root, subgroup 1A	0.05	0.05		0.3 (root and tuber vegetables)
Vegetable, tuberous and corm, except potato, subgroup 1D	0.02			
Wheat, forage	0.50			
Wheat, grain	0.02			0.05
Wheat, hay	0.02			
Wheat, straw	0.02			2. (wheat straw and fodder,dry)
MRLs with no US Equivalent				
Avonia berries		0.2		
Banana				0.02 (*)
Cacao bean				0.02 (*)
Eggs		0.02		0.01 (*)
Gooseberries		0.2		
Lingonberries		0.3		
Pea hay or pea fodder (dry)				0.3
Peppers, chili, dried				7.
Pineapple				0.01 (*)
Poultry meat		0.02		0.01 (*)
Poultry, edible offal of		0.02		0.01 (*)
Pulses				0.04
Tea, green, black (black fermented and dried)				20.
Prepared by S. Funk, 07/13/2011.				

[1] There are no U.S. registrations as of September 17, 2003. [2] Mexico adopts US tolerances and/or Codex MRLs for its export purposes. [3] * = absent at the limit of quantitation; Po = postharvest treatment, such as treatment of stored grains. PoP = processed postharvest treated commodity, such as processing of treated stored wheat. (fat) = to be measured on the fat portion of the sample. [4] MRLs are proposed. Thiamethoxam (#245) was reviewed by the JMPR in 2010. All MRLs were recommended by CCPR in 2011 at Step 8. These MRLs will be official (CXL status) with approval by the CAC in 07/2011.