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OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Tebuconazole – Drinking Water Assessment for Registration Review

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The Environmental Fate and Effects Division (EFED) of the Office of Pesticide Programs (OPP) has completed a drinking water assessment as part of the registration review of the fungicidal active ingredient tebuconazole (PC Code 128997). Input on drinking water impacts from antimicrobial uses of tebuconazole from the Antimicrobial Division (AD) has also been characterized in this assessment. A preliminary problem formulation for the environmental fate and ecological risk, endangered species, and drinking water assessments was conducted as part of the registration review of tebuconazole in 2015 (EPA, 2015).

Tebuconazole is a triazole fungicide that has protective, curative, and systemic activity, and shows activity against rusts (*Puccinia* spp.) and powdery mildew. The mode of action is based on inhibition of cytochrome P450 sterol 14α-demethylase activity, a key enzyme in the sterol biosynthetic pathway. It is rapidly absorbed by plants and translocated systemically in the young growing tissues. The residue of concern in drinking water is tebuconazole only as cited in the problem formulation (EPA, 2015).

The most recent comprehensive drinking water assessment (DWA) for tebuconazole was for a proposed increase of the maximum application rate of tebuconazole on golf course turf which was conducted in 2011. At that time, tebuconazole estimated groundwater concentrations were calculated using the SCIGROW (Screening Concentration In Ground Water) model. The most recent new use drinking water assessment for tebuconazole referenced back to the 2011 DWA for estimated drinking water concentrations (EDWCs) (EPA, 2018a) in accordance with the new use policy (EPA, 2018b) which recommends relying on previous EDWCs if no other factors, aside from a new model, indicate a potential for an increase in real-world exposures in drinking water. This Registration Review drinking water assessment accounts for the update in exposure model, Pesticide in Water Calculator (PWC v1.52), as well as new submitted data.

Highest screening-level estimated drinking water concentrations (EDWCs), when considering all currently registered tebuconazole uses, result from modeled groundwater concentrations for use on turf and flower beds. The flower bed use pattern is applicable to residential, recreational, institutional and retail applications to roses, flowers, iris, hibiscus, azaleas, camellias, rhododendrons and other shrubs. Highest surface water EDWCs also result from these use patterns. Though it is expected that the spatial extent of a given flower bed is typically smaller than a groundwater wellhead zone of influence, other residential or agricultural uses of tebuconazole may be present in a given zone of influence. PWC groundwater modeling conservatively assumes that the pesticide application occurs over the entire zone of influence. The following are the highest screening-level groundwater EDWCs and result from use the ornamental/flower beds in using the North Carolina Cotton groundwater scenario (the highest of the six scenarios) in a 30-year simulation:

1,570 µg/L for acute exposure concentration
1,560 µg/L for chronic and cancer exposure concentrations

These screening-level EDWCs were subsequently refined. The modeling input refinement included the consideration of terrestrial field dissipation (TFD) data to inform the aerobic soil metabolism input parameter. The scenario refinement, recommended by the Biological and Economic Analysis Division (BEAD), parameterized the flower bed use pattern to have soils with 2.0% organic carbon in the top soil layer as a conservative lower-bound estimate. It is possible that flower bed organic carbon may be lower than 2.0% in isolated instances, but it is not likely that tebuconazole would be continuously applied to flowerbeds with organic carbon this low for more than 30 years. Incorporating these refinements, the highest representative EDWCs still result from the ornamental/flower bed use pattern. The following refined EDWCs result from the Wisconsin Sand groundwater scenario (the highest of the six scenarios) in a 100-year simulation:

648 µg/L for acute exposure concentration
620 µg/L for chronic and cancer exposure concentrations

Modeled Use Patterns

This registration review DWA was conducted for the maximum labeled tebuconazole use patterns with highest labeled application rates, highest usage based on pounds applied, and highest percent crop treated based on Biological and Economic Analysis Division (BEAD) SUUM and PLUS reports, and incorporates model estimates of tebuconazole in drinking water using the Groundwater and Index Reservoir conceptual models. EDWCs are reported based on parent tebuconazole only due to the lack of major degradate formation in relevant environmental fate studies and the persistence of the parent compound.

There are 145 Section 3 end-use product registrations for conventional pesticide products containing tebuconazole, with several co-formulated products which contain other pesticide active ingredients. Tebuconazole is currently registered on many agricultural crops including some tree nuts, stone fruits, pome fruits, beans, and field crops like corn, soybeans, and wheat (including seed treatment use for wheat). It is also registered for use on golf course turf, ornamentals/flower beds, and grasses grown for seed. Details on all significant use patterns are available in the problem formulation (DP 427434, 11/24/2015).

Tebuconazole is also registered for many antimicrobial uses (*e.g.*, wood preservatives, materials preservative for plastics, glue and adhesives, and metal working fluid uses). These uses are not expected to result in human drinking water exposure higher than the conventional uses because exposure from leaching-from wood, plastics, glues and adhesives occur at a low rate, and the treated wood and other materials are expected to be geographically dispersed. For metal working fluid (MWF) uses, the injection water is reused and exposure to tebuconazole from MWF is not expected. Because conventional crop uses are expected to result in higher drinking water residues than would result from the antimicrobial uses, drinking water exposures from antimicrobial uses are not further assessed.

This registration review drinking water assessment is streamlined and models conventional tebuconazole uses with the highest usage, highest application rates, and highest percent cropped treated to focus modeling efforts on use patterns with most significant potential drinking water risk. A summary of all registered tebuconazole uses and application parameters can be found in **Appendix 1.** EDWCs for all other currently registered but unmodeled use sites are expected to be lower, and thus those presented in this document are considered protective of all registered use patterns.

Fate and Transport Characterization

Based on guideline studies, tebuconazole is persistent in soil (aerobic metabolism $T_{1/2}$ = 783 days) and moderately mobile to slightly mobile (adsorption K_d range from 7.69 to 16.39, adsorption K_{OC}s range from 463 to 1251 ml/g). Tebuconazole has little potential to reach ground water in the initial years of application due to its limited mobility, however consistent use of tebuconazole over many years may result in groundwater contamination. During a runoff event, tebuconazole adsorbed onto soil particles could enter adjacent bodies of surface water via runoff. During an application, tebuconazole may drift off-site into surface water. Tebuconazole is stable to hydrolysis (stable at pH 5, 7, and 9), but degrades slowly via aqueous and soil photodegradation ($T_{1/2}$= 590 days and 193 days, respectively). Terrestrial field dissipation half-lives varied from about 1.6 to 10 months. Tebuconazole dissipated with an extrapolated half-life of 301 days from loamy sand turf plots at one site in Glenmark, New York, when LYNX 25DF fungicide was surface broadcasted three times at 1.40 lb a.i./A and once at 0.68 lb a.i./A (applications separated by one-month). A supplemental study on bare ground in Florida showed leaching of tebuconazole in to a lower horizon. In sand soil of Vero Beach, FL (sand = 92%, silt = 0.4%, clay = 7.6%, and organic matter = 1%) tebuconazole was detected up to 0.12 ppm in the depth of 6 to 12 inches 30 days after surface application of 1.5 lbs a.i./A (lower depths were not sampled, MRID 40700963). Terrestrial field dissipation data indicate that dissipation may occur more readily in the field than is represented in laboratory degradation studies. Open literature indicates aerobic soil metabolism half-lives ranging from 49 to 610 days (Wang, 2017). Similar to the registrant submitted terrestrial field dissipation studies, the open literature aerobic soil metabolism data are indicative of substantial variability in tebuconazole degradation and dissipation.

The registrant submitted a paper (MRID 50681903) that provides a rationale for the use of K_D rather than K_{OC} to represent adsorption of tebuconazole in groundwater and surface water modeling. The rationale updates an adsorption analysis done by EPA in 2006 on four soils with four more additional soils. The analysis relies upon a comparison of r^2 values indicating the extent to which the adsorption behavior of tebuconazole is explained by percentage of organic carbon in soil. This analysis effectively characterizes adsorption of tebuconazole, and further analysis of cation exchange capacity and clay content indicates that clay content has more explanatory power than organic carbon (r^2 = 0.534). However, current input parameter guidance (EPA, 2009) indicates binding is correlated with organic carbon content if the coefficient of variation (*i.e.*, the standard deviation divided by the mean) for K_{OC} values is less than that for K_d values. In this instance the coefficient of variation of all eight K_{OC} values (0.25) is less than that for K_d values (0.40). For this reason, EFED utilized the K_{OC} value for groundwater and surface water modeling.

The following environmental fate and transport parameters were utilized as the input parameters in the surface water model, Pesticide in Water Calculator (PWC v1.52), for the derivation of EDWCs:

Table 1. Environmental fate and transport parameters for tebuconazole

PARAMETER (units)	VALUE	SOURCE / COMMENT
Molecular Weight (g/mol)	307.8	EPA, 2015
Henry's Law Constant (atm-m^3/mol)	1.4 x 10^{-10}	EPA, 2015
Vapor Pressure (torr)	1.3 x 10^{-8}	EPA, 2015
Solubility in Water @ 20 ^{O}C, (mg/L or ppm)	36	EPA, 2015
Organic Carbon Partition Coefficient (mL/g)	937.5	MRIDs 40995922, 50681901, and 50681902 Average of all Koc values of 463, 1084, 1057, 803, 1025, 911, 1251, and 906 ml/g_{oc}
Application Efficiency (decimal)	0.95 (aerial) 0.99 (ground spray) 1.0 (ground granule)	Offsite Transport Guidance. Based on product labels, turf use, and garlic/onion/shallot use applied ground only and flower bed use applied as granule.
Spray Drift Fraction (decimal)	0.135 (aerial) 0.066 (ground spray) 0 (ground granule)	Offsite Transport Guidance.
Percent Cropped Area	1.0	With a wide range of agricultural uses in addition to turf and ornamentals, a PCA is not appropriate for a national scale screening level assessment. If refinements are made to include a regional scale drinking water assessment, regional PCAs may be considered.
Initial application date - Peanut	25 days post-emergence	Growers begin spraying about 30 to 35 days after planting and then spray every 14 days. Start 25 days after emergence. 4 apps, 14 day interval https://www.farmprogress.com/application-timing-critical-peanut-fungicides
Initial application date – Winter Wheat	March 15	Predominant production in Kansas. Flowering in spring corresponds with application window. https://ipmdata.ipmcenters.org/documents/cropprofiles/KSwheat.pdf
Initial application date – Spring Wheat	50 days post-emergence	https://www.ag.ndsu.edu/cpr/plant-pathology/fungicide-choice-and-growth-stage-timing-for-wheat-and-barley-06-18-15

PARAMETER (units)	VALUE	SOURCE / COMMENT
Initial application date – Cherry	May 1	Label specifies applications occur around bloom and bloom occurs in mid-May https://www.traversecity.com/blog/post/the-top-3-things-to-know-about-the-cherry-blossoms-around-traverse-city/
Initial application date – Watermelon	March 21	First application 3 weeks after transplant. Assume transplant of March 1. https://plantpath.ifas.ufl.edu/u-scout/ewExternalFiles/UF_Watermelon_Spray_Guide_2019.pdf
Initial application date – Asparagus	Emergence	Found early season. https://plant-pest-advisory.rutgers.edu/controlling-important-fungal-diseases-in-asparagus-during-the-summer/
Flowering Plants / Ornamentals	March 1	Reg. Nos. 92564-48 and 92564-66 instruct user to apply throughout growing season with a minimum application window of 84 days.
Turf / Golf Course	Emergence	Application timing can be variable and based on when pest pressure occurs.
Garlic / Onion / Shallot	January 1	Labeled maximum application regime involves 1 in-furrow and 2 broadcast foliar applications. The in-furrow application is at planting.
Hydrolysis Half-life (days)	Stable	MRID 40700957
Aqueous Photolysis Half-life @ pH 7 (days)	Stable	MRID 40700958
Aerobic Aquatic Metabolism Half-life	Stable	MRID 48707405; The supplemental study indicates a half-life of greater than one year. Because surface water EDWCs are lower than refined groundwater EDWCs, this parameter is conservatively assumed to be stable and does not currently need to be refined.
Anaerobic Aquatic Metabolism Half-life	Stable	MRID 48707403; The supplemental study indicates a half-life of greater than one year. Because surface water EDWCs are lower than refined groundwater EDWCs, this parameter is conservatively assumed to be stable and does not currently need to be refined.
Aerobic Soil Metabolism Half-life (days)	2,349	MRID 40700959; $t_{1/2}$ = 783 d (SFO). 3X adjustment for single soil per Input Parameter Guidance[1].

[1] "Input Parameter Guidance" refers to Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides; Version 2.1, October 22, 2009.

Drinking Water Assessment

This drinking water assessment includes a summary of available surface and groundwater monitoring data for tebuconazole. The output for the surface water and groundwater modeling of tebuconazole can be found in **Tables 2, 3, and 5** and in **Appendix 2**.

Exposure Modeling

EFED's current surface water and groundwater model [i.e. Pesticides Water Calculator (PWC (v. 1.5.2)] was used to estimate the EDWCs for tebuconazole's registered uses. The modeling of the surface water and groundwater concentrations followed standard modeling practices outlined in EFED's Input Parameter Guidance (USEPA, 2009) and Offsite Transport Guidance (2013). Parameters for the derivation of surface water and groundwater EDWCs are listed in **Table 1**.

For purposes of streamlining the drinking water assessment, only use patterns with highest application rates, highest usage, and highest percent cropped treated are modeled. Per the 5/14/2019 PLUS report from BEAD, tebuconazole uses with highest application rates are flowering plants, turf, and garlic/onion/shallot. Per the SUUM report from BEAD, uses with highest usage are peanuts, winter wheat and spring wheat. Also per the SUUM report, uses with highest percent crop treated include peanuts, spring wheat, cherries, watermelon, and asparagus.

The EDWCs reported below in **Table 2** vary across the scenarios modeled. These variations are caused by many factors, including, but not limited to: application method, application rate, soil type, and weather. One-in-10-year 24-hour average surface water EDWCs range from 4 ppb to 189 ppb while surface water monitoring detections range up to 3.3 ppb. This indicates that surface water modeling results are appropriately higher than monitoring results but also within one to two orders of magnitude of EDWCs. Monitoring data for tebuconazole is non-targeted, and sampling frequency is irregular. While the available monitoring data provide some characterization of tebuconazole concentrations, it is expected that higher monitoring values would be found if site selection and timing were targeted to high tebuconazole usage areas, and monitoring frequency were increased.

Table 2: PWC Surface Water EDWCs for Selected Registered Uses of Tebuconazole (maximum values are shaded)

Crop	Single Application Rate (lbs. a.i./A)	PWC Scenarios	Initial application date	Number of applications (application interval)	1-in-10 Year 24-hour Average (µg/L)	1-in-10 Year Annual Average (µg/L)	30 Year Annual Average (µg/L)
Peanut	0.205	NC Peanut	25 days post-emergence	4 applications (14 day interval)	18.3	9.98	8.52
Winter Wheat (foliar)	0.113	KS Sorghum	March 15	1	3.68	1.97	1.51

Crop	Single Application Rate (lbs. a.i./A)	PWC Scenarios	Initial application date	Number of applications (application interval)	1-in-10 Year 24-hour Average (µg/L)	1-in-10 Year Annual Average (µg/L)	30 Year Annual Average (µg/L)
Spring Wheat (foliar)	0.113	ND Wheat	50 days post-emergence	1	4.93	3.74	2.95
Cherry	0.225	MI Cherries	May 1	6 applications (7 day interval)	43.9	36.5	25.5
Watermelon (Crop Group 10)	0.222	FL Cucumber	March 21	2 applications (7 day interval)	23.2	5.58	3.63
Asparagus	0.169	MI Asparagus	Emergence	3 applications (14 day interval)	17.6	16.1	10.9
Flowering Plants / Ornamentals	2.40	CA Nursery	March 1	3 applications (42 day interval)	87.9	66.4	27.1
		FL Nursery			189	59.1	36.6
		MI Nursery			95.3	59.7	50.3
		NJ Nursery			134	58.5	42.5
		OR Nursery			44.5	35.3	30.3
		TN Nursery			125	60.4	34.2
Turf / Golf Course	1.36	FL Turf	Emergence	4 applications (21 day interval)	59.3	48.4	39.9
		PA Turf			99.4	93.1	55.6
Garlic / Onion / Shallot	0.577	CA Onion	January 1	3 applications (10 day interval)	26.6	22.9	15.7
		GA Onion			18.6	7.00	4.25

Groundwater modeling was conducted for tebuconazole uses with the highest application rates. All six groundwater scenarios are modelled for each use pattern consistent with a screening level approach, in addition to two non-standard turf scenarios for the turf use pattern. The non-standard scenarios (Delmarva non-ag turf, Florida Central Ridge non-ag turf) are adapted from the corresponding standard scenarios with changes in crop canopy values and soil bulk density, but the most impactful change for this assessment is the change of organic carbon content from 0.144% (Florida Central Ridge) and 0.52% (Delmarva) to 1.0% in both instances. This results in reduced EDWCs when comparing standard and non-standard scenario values. An example of a modified turf scenario can be found in **Appendix 3**. The output from screening level groundwater modeling is presented in **Table 3**. The EDWCs modeled for groundwater exceed those in the surface water models. Tebuconazole breakthrough to groundwater (with a 30-year simulation timeframe) only occurs in six of the 20 scenarios run. Lack of breakthrough in several scenarios is indicative that 100-year simulations should be considered in conjunction with additional refinements and characterizations. Use of a 100-year simulation will result in relatively higher peak EDWC values but are more representative of the full potential of exposure in vulnerable scenarios.

Table 3: Tier 1 PWC Groundwater EDWCs for Selected Registered Uses of Tebuconazole (maximum values are shaded)

Crop	GW Scenarios	Peak (ppb)	Post Breakthrough Avg. (ppb)
Ornamentals/Flower beds (2.4 lbs a.i./A; 3 applications; 42 day MRI)	Delmarva	503	NA**
	Florida, Jacksonville	76.3	NA
	Florida Central Ridge	1,260	1,250
	Georgia Coastal	37.2	NA
	North Carolina Coastal	1,570	1,560
	Wisconsin Sand	270	NA
Turf / Golf Course (1.36 lbs a.i/A; 4 applications; 21 day MRI; last app at 0.33 lb a.i/A)	Delmarva non-ag turf*	159	NA
	Florida non-ag turf*	215	NA
	Delmarva	309	NA
	Florida, Jacksonville	47.1	NA
	Florida Central Ridge	773	767
	Georgia Coastal	23.2	NA
	North Carolina Coastal	961	953
	Wisconsin Sand	169	NA
Cherry 0.225 lb a.i./A; 6 applications; 7 day MRI)	Delmarva	93.7	NA
	Florida, Jacksonville	13.8	NA
	Florida Central Ridge	234	232
	Georgia Coastal	7.16	NA
	North Carolina Coastal	295	293
	Wisconsin Sand	52.0	NA

*Scenarios developed for a previous refined drinking water assessment for a turf use pattern (EPA, 2019)
**Not Applicable – post-breakthrough averages are not applicable in this case because the center of the plume of tebuconazole did not reach the simulated wellhead after 30 years of simulation.

<u>**Groundwater Modeling Refinements**</u>

<u>Use-Specific Organic Carbon Content Refinement</u>

The groundwater EDWCs for ornamental/flower beds presented in Table 4 above are derived based on standard scenarios. The organic carbon content in the top layer of soil in these standard scenarios range as low as 0.14% (Florida Central Ridge). Low organic carbon content in top soil does not reflect typical soil conditions in flower beds. As a result, the Biological and Economic Analysis Division (BEAD) characterized the lower-bound soil organic matter estimate that can be used to evaluate in-field and container ornamental production, flower bed and turf use sites (EPA, 2020).

By reviewing lower-bound baseline levels of soil organic matter (SOM) in surveyed areas representative of the mentioned used sites, along with production and management guidelines, BEAD recommends a 3.5% lower-bound SOM value (or 2.0% organic carbon) for in-field ornamental production and 4% for flower beds. These estimates result from reported lower-bound SOM in areas of interest (2.0 to 2.5%) in addition to recommended soil building cultural practices expected to increase levels of SOM by at least 1.5%. Accordingly, each groundwater scenario for use in refined estimation of flower bed EDWCs is modified to reflect 2.0% organic carbon in the top soil layer (first 10 centimeters of soil depth) to account for the more conservative SOM associated with these use patterns. An example of the scenario modification can be seen in **Appendix 4**.

<u>Aerobic Soil Metabolism Refinement</u>

The groundwater EDWCs presented in Table 4 above are derived based on a single aerobic soil metabolic half-life of 783 days, which results in a model input parameter of 2,349 days, based on the 3X adjustment factor for a single soil. However, the aerobic soil metabolism value does not account for other dissipation processes that occur in field conditions. For instance, tebuconazole degrades via soil photolysis with a half-life of 193 days (MRID 40700958). Soil photolysis is likely the dissipation process most relevant for tebuconazole dissipation in surface soils.

Nine terrestrial field dissipation (TFD) studies are available for tebuconazole representing 11 different sites. These TFD studies can be used to refine the estimate of dissipation represented by the aerobic soil metabolism input parameter (2,349 days per Table 1 above) since no significant leaching occurred in the TFD studies, indicating that dissipation is predominantly due to degradation processes occurring in the top soil layer. More leaching would have likely occurred in these studies if applications and monitoring were performed over subsequent years. The TFD studies most reliable for the determination of an input parameter are those that indicate consistent residue decline for cropped or turf fields that account for all top soil layer residues (*i.e.*, turf layer residues are counted as top soil layer residues).

With these criteria, the five studies summarized in **Table 4** below were used as the dataset to derive a 90th percentile confidence bound of the mean utilized as an aerobic soil metabolism model input parameter. Both the mean TFD half-life and the 90th percentile confidence bound of the mean of TFD half-lives were considered. The 90th percentile confidence bound is intended to account for variability in biotic forms of degradation. However, the mean is potentially appropriate since the dominant dissipation pathway may be abiotic (photodegradation). However, dissipation in TFD and soil photodegradation is limited to top soil layers whereas the soil metabolism input parameter is applied (at a linearly decreasing rate) across the first meter of soil depth. Due to uncertainty in dissipation routes and the associated soil depths to which they are relevant, use of an average for derivation of an input parameter lacks sufficient conservatism, and the 90th percentile confidence bound is used for modeling purposes. The associated refined aerobic soil metabolism input parameter is 532 days. This refined input parameter is lower than the single available aerobic soil metabolism half-life of 783 days.

Table 4: Terrestrial Field Dissipation Data Used to Refine Aerobic Soil Metabolism Input

MRID	Field	Soil type	OM %	Half-life (days)	Leaching below top soil depth
44108310	early season peanut	sand	0.9%	349	The parent was only detected once in the 6- to 12-inch depth above 0.0 1 µg/g, at 0.12 µg/g (single replicate) at 3 days posttreatment, and was not detected below that depth.
44108311	peanut	sand	0.8%	179	Following the fourth application, the parent compound was present (time 0) in the 6- to 12-inch depth at a maximum of 0.14 µg/g at 5 days and was last detected at 0.01 µg/g at 28 days posttreatment.
44108314	grape seedlings	sandy loam	1.2%	857	None noted
44108315	turf	sandy loam	0.9%	163	The parent was ≤0.06 µg/g (single replicate) below the 3-inch depth.
44108316	grass seed	sandy loam	0.9%	216	The parent was detected sporadically in the 6- to 12-inch, 12- to 18-inch, and 18- to 24-inch depths at 50.06 µg/g (individual replicates). Soil samples collected below 24 inches were only analyzed at 300 and 363 days posttreatment; the parent was detected once in the 24- to 36-inch depth at 0.03 µg/g (single replicate) at 363 days posttreatment and was not detected below that depth.

100-year Simulations for the Most Representative Groundwater Scenarios

The groundwater EDWCs presented in Table 4 above are derived based on a standard 30-year simulation. However, for many scenarios across all use patterns, the standard 30-year simulation was not sufficient to achieve breakthrough (*i.e.*, the center of the plume of tebuconazole did not reach the simulated wellhead). In this instance and in conjunction with input parameter and scenario refinement, an extended weather file can be used in PWC to model a 100-year simulation. The two non-standard turf scenarios were selected as most representative for the turf and golf course use pattern because they account for the turf thatch layer and were specifically derived for turf use patterns though all standard scenarios were run for characterization. Standard scenarios are also modeled for the turf and golf course use pattern for characterization but the non-standard scenarios are recommended as representative for the use pattern.

Incorporating the various refinements described above, EFED conducted a second round of groundwater modeling for selected tebuconazole use patterns. Use of refined aerobic metabolism input and soil organic carbon results in relatively lower EDWCs. Use of a 100-year simulation allows for breakthrough to occur in all scenarios and reported EDWCs are therefore relatively higher in some instances. Refined EDWCs are presented below.

Table 5: Refined PWC Groundwater EDWCs for Selected Registered Uses of Tebuconazole Based on a 532 Days Aerobic Soil Metabolism Input Parameter, Refined Flower Bed Organic Carbon Estimate, and 100-Year Simulations (maximum values are shaded)

Crop	GW Scenarios	Peak (ppb)	Post Breakthrough Avg. (ppb)
Ornamentals/ Flower beds (2.4 lbs a.i./A; 3 applications; 42 day MRI)	Delmarva	313	296
	Florida Central Ridge	389	367
	Florida, Jacksonville*	11.4	10.5
	Georgia Coastal	125	116
	North Carolina Coastal	231	216
	Wisconsin Sand	648	620
Turf / Golf Course (1.36 lbs a.i/A; 4 applications; 21 day MRI; last app at 0.33 lb a.i/A)	Delmarva non-ag turf**	279	256
	Florida non-ag turf**	47.8	46.2
	Delmarva	370	341
	Florida Central Ridge	417	392
	Florida, Jacksonville	7.05	6.54
	Georgia Coastal	131	121
	North Carolina Coastal	340***	318***
	Wisconsin Sand	708***	658***
Cherry 0.225 lb a.i./A; 6 applications; 7 day MRI)	Delmarva	112	103
	Florida Central Ridge	126	118
	Florida, Jacksonville	2.06	1.91
	Georgia Coastal	40.0	37.1

Crop	GW Scenarios	Peak (ppb)	Post Breakthrough Avg. (ppb)
	North Carolina Coastal	103	96.6
	Wisconsin Sand	217	202

*Scenario unchanged due to existing high OC 4.2% in top soil layer
**Scenarios developed for a previous refined drinking water assessment for a turf use pattern (EPA, 2019)
***Though these values are higher than from the non-ag turf scenarios, the non-ag turf scenarios are recommended as representative for the use pattern

The recommended EDWCs are derived from modeling with adjusted scenarios, refined aerobic soil metabolism input, and 100-year simulations. Recommended EDWCs for use in the human health dietary assessment are derived from the refined Wisconsin Sand scenario and are 648 µg/L for acute exposure and 620 µg/L for chronic and cancer exposure.

Tebuconazole Monitoring Data Summary

All available monitoring data are considered to characterize the modeling results for tebuconazole in the environment in **Table 6** below. States, tribal organizations, and other government and nongovernment organizations were encouraged to submit additional surface water and groundwater monitoring data for tebuconazole. Below is a summary of currently available monitoring data from publicly available databases and submitted studies. Additional databases were checked for tebuconazole monitoring data but no data were available. The maximum surface water monitoring concentration is 50X to 60X lower than the highest modeled surface water EDWC for ornamentals/flower beds and equivalent to the lowest EDWCs modeled for winter wheat. The maximum groundwater monitoring concentration is more than three orders of magnitude lower than modeled groundwater EDWCs characterized in this assessment. There are multiple factors that contribute to the large differences between monitoring and modeling values. Maximum monitoring concentrations would likely be higher if the data were targeted to tebuconazole use sites. Also, groundwater EDWCs assume continuous use of tebuconazole for the duration of a 30 to 100 year simulation and highest concentrations occur only after 30 years of application in some scenarios. It is unlikely that groundwater sites have been sampled that represent 30 years of continuous tebuconazole use as agricultural usage of the chemical has grown in the last ten years (EPA, 2015).

Table 6. Water Monitoring Results for Tebuconazole

Sites (Dataset Source)	Year	Study Type	Sampling Frequency	Maximum Conc. (µg/L)	Detection frequency (Detects/samples)	Source
Surface Water						
Water Quality Portal	2000 - 2020	General	Irregular	3.3	13% (2,892/21,453)	NAWQA (USGS, 2020)
California (CADPR) SURF	2006-2019	General	Irregular	3.2	1.5% (17/1,143)	(CADPR, 2020)
Groundwater						
Water Quality Portal	2000 - 2020	General	Irregular	0.26	0.08% (6/7,375)	NAWQA (USGS, 2020)

LOQ=Limit of Quantitation

References

California Department of Pesticide Regulation. 2020. Surface Water Database (SURF) https://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm

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Appendix 1: Tebuconazole Application Rates for All Registered Agricultural and Non-agricultural Conventional Uses[1]

Crop	Maximum Single Application Rate (lb a.i./A)	Number of Applications	Maximum Application Rate (Annual or crop cycle)	Re-application Interval	Method of Application
Almonds	0.225	NS	0.9	7	Aerial, Ground
Apple	0.1297	NS	0.4409	7	Ground
Asparagus	0.169	3	0.507	14	Aerial, Ground
Banana	0.09	NS	0.45	14	Aerial, Ground
Barley	0.113	NS	0.113[2]	NA	Aerial, Ground
Barley (seed treatment)	2E-5 lb /lb seed	NA	NA	NA	NA
Beans	0.169	NS	0.677	14	Aerial, Ground
Beans, dry type	0.169	NS	0.338	14	Aerial, Ground
Beets	0.203	NS	0.81	14	Aerial, Ground
Brassica (head and stem vegetables)	0.112	NS	0.45	10	Aerial, Ground
Bulb vegetables	0.164	NS	0.656	10	Aerial, Ground
Cherries	0.225	NS	1.35	7	Aerial, Ground
Cherries	0.0921	NS	0.1828	7	Aerial, Ground
Cherries (fruit cleansing)	0.0045 lb/lb fruit	NS	NS	NS	Ground
Corn (unspecified & sweet)	0.169	NS	0.677	7	Aerial, Ground
Corn (seed treatment)	0.0002 lb/lb seed	NA	NA	NA	NA
Corn, field, pop & sweet	0.0895	NS	0.358	7	Aerial, Ground
Cotton	0.225	NS	0.67	7	Aerial, Ground
Cucurbits	0.225	NS	0.67	10	Aerial, Ground
Filbert (hazelnut)	0.225	NS	0.9	7	Aerial, Ground
Fruiting vegetables	0.225	NS	1.35	7	Aerial, Ground
Garlic	0.169	NS	0.33	10	Aerial, Ground
Garlic (in-furrow)	0.57	NS	0.912	NS	Ground
Golf course turf	1.3 (some have 0.72 w/max of 4.4)	6	4.4	NS	Ground
Grapes	0.11	NS	0.9	7	Aerial, Ground
Grasses grown for seed	0.225	NS	0.45	14	Aerial, Ground
Hops	0.225	NS	0.9	10	Aerial, Ground
Leek	0.169	NS	0.67	10	Aerial, Ground
Melon	0.22	NS	0.44	10	Ground
Nectarine	0.225	NS	1.35	7	Aerial, Ground
Oats, Wheat & Triticale (seed treatment)	2E-5 lb/lb seed	NA	NA	NA	NA
Okra	0.169	NS	0.67	14	Aerial, Ground
Onion	0.169	NS	0.33	10	Aerial, Ground
Onion (in-furrow)	0.57	NS	0.91	NS	Ground
Onions, green	0.169	NS	0.67	10	Aerial, Ground
Ornamentals – tree injection	1.5 lb / see footnote 3	NS	NS	When needed	Injection
Ornamental grasses & Rye (seed treatment)	1.5E-5 lb/lb seed	NA	NA	NA	NA

Crop	Maximum Single Application Rate (lb a.i./A)	Number of Applications	Maximum Application Rate (Annual or crop cycle)	Re-application Interval	Method of Application
Ornamentals	0.0013 lb /plant	4	NS	28	Aerial, Ground
Ornamentals & Roses	6.9 E-6 lb/ plant	NS	NS	7	Ground
Ornamentals[4]	2.6	3	NS	28	Granular
Ornamentals	0.28	4	1.1	14	Ground
Ornamentals	0.84	4	3.36	14	Ground
Peach	0.225	NS	1.35	7	Aerial, Ground
Peanuts	0.203	NS	0.81	14	Aerial, Ground
Pecan	0.225	NS	0.9	10	Aerial, Ground
Pistachio	0.225	NS	0.9	10	Aerial, Ground
Plantain	0.09	NS	0.45	14	Aerial, Ground
Plum, Prune (fruit cleansing)	0.0002 lb/ lb fruit	NS	NS	NS	Ground
Pome fruits	0.225	NS	1.35	7	Aerial, Ground
Shallot	0.169	NS	0.33	10	Aerial, Ground
Shallot (in-furrow)	0.57	NS	0.91	NS	Ground
Soybean	0.11	3	0.33	10	Aerial, Ground
Stone fruit	0.225	NS	1.35	7	Aerial, Ground
Subtropical/tropical fruit	0.169	8	1.35	10	Ground
Sunflower	0.169	NS	0.45	14	Aerial, Ground
Tree nuts	0.225	NS	0.9	7	Aerial, Ground
Turnip (greens)	0.203	NS	0.81	12	Aerial, Ground
Wheat	0.11	NS	0.11	NA	Aerial, Ground

[1] Based on BEAD LUIS report
[2] Some labels do not specify maximum annual/crop cycle rate
[3] If measuring the circumference, divide this number by six (6) to determine the number of capsules needed. If measuring the diameter, divide this number by 2 (two) to determine the number of capsules needed. If the number of capsules results in a fraction, round down to the lower whole number
[4] Based on Reg. No. 92564-66

Appendix 2: Tebuconazole PWC output

Output for highest surface water use (flower beds)

Summary of Water Modeling of tebuconazole and the USEPA Standard Reservoir
Estimated Environmental Concentrations for tebuconazole are presented in Table 1 for the USEPA standard reservoir with the FLnurserySTD_V2 field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Pesticide Water Calculator (PWC), Version 1.52. Critical input values for the model are summarized in Tables 2 and 3.
This model estimates that about 1.9% of tebuconazole applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (98.7% of the total transport) followed by erosion (1.28%).
In the water body, pesticide dissipates with an effective water column half-life of 50.6 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is washout (effective average half-life = 50.6 days).
In the benthic region, pesticide is stable. The vast majority of the pesticide in the benthic region (99.02%) is sorbed to sediment rather than in the pore water.

Table 1. Estimated Environmental Concentrations (ppb) for tebuconazole.

24-hr (1-in-10 yr)	189.
4-day Avg (1-in-10 yr)	183.
21-day Avg (1-in-10 yr)	158.
60-day Avg (1-in-10 yr)	129.
365-day Avg (1-in-10 yr)	59.1
Entire Simulation Mean	36.6

Table 2. Summary of Model Inputs for tebuconazole.

Scenario	FLnurserySTD_V2
Cropped Area Fraction	1.0
Koc (ml/g)	937.5
Water Half-Life (days) @ 25 °C	0
Benthic Half-Life (days) @ 25 °C	0
Photolysis Half-Life (days) @ 40 °Lat	0
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	2349*

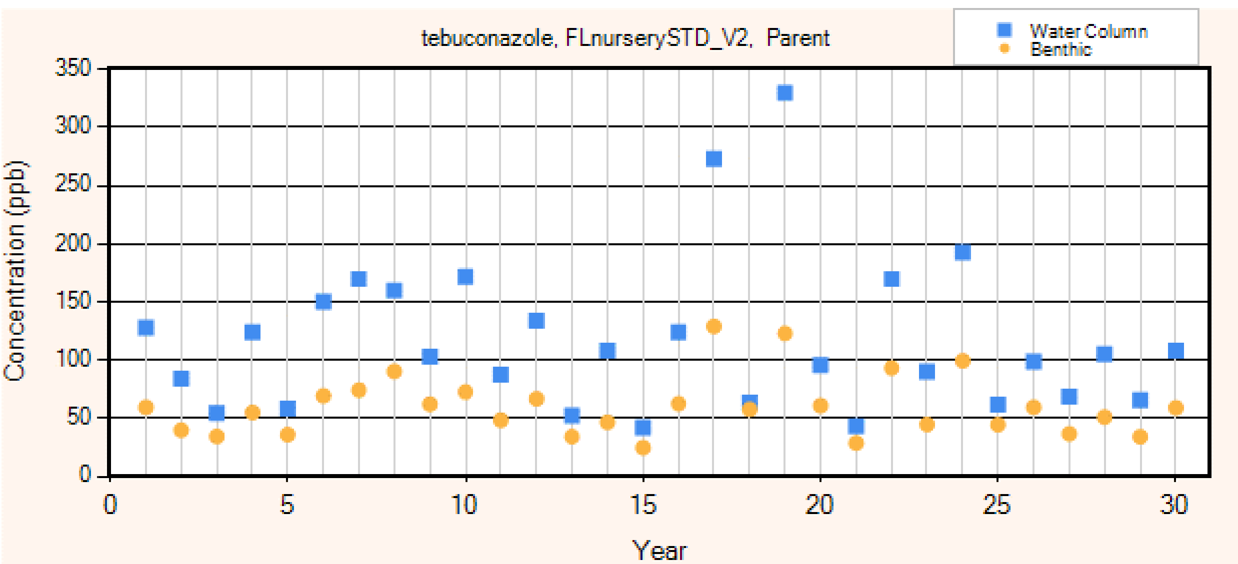
Foliar Half-Life (days)	0
Molecular Weight	307.8
Vapor Pressure (torr)	0.000000013
Solubility (mg/l)	36
Henry's Constant	0.0

*Surface water EDWCs used the unrefined input value of 2349. The groundwater example below utilizes the refined 532 day input parameter.

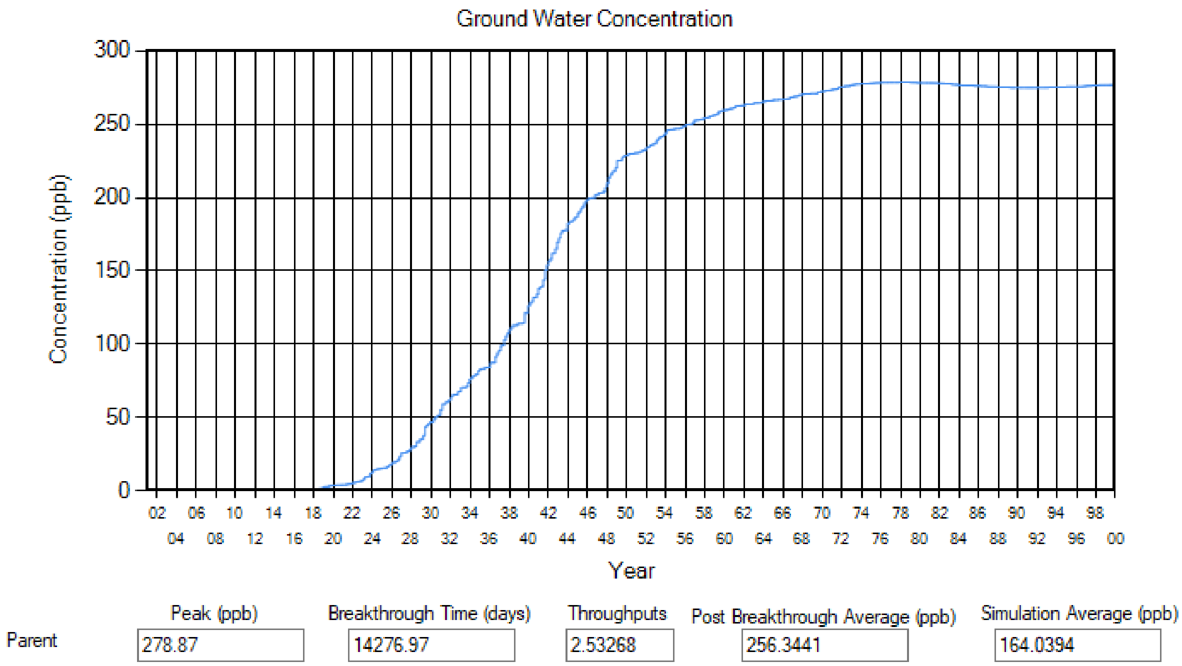
Table 3. Application Schedule for tebuconazole.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
3/1	Ground	2.69	1	0
4/12	Ground	2.69	1	0
5/24	Ground	2.69	1	0

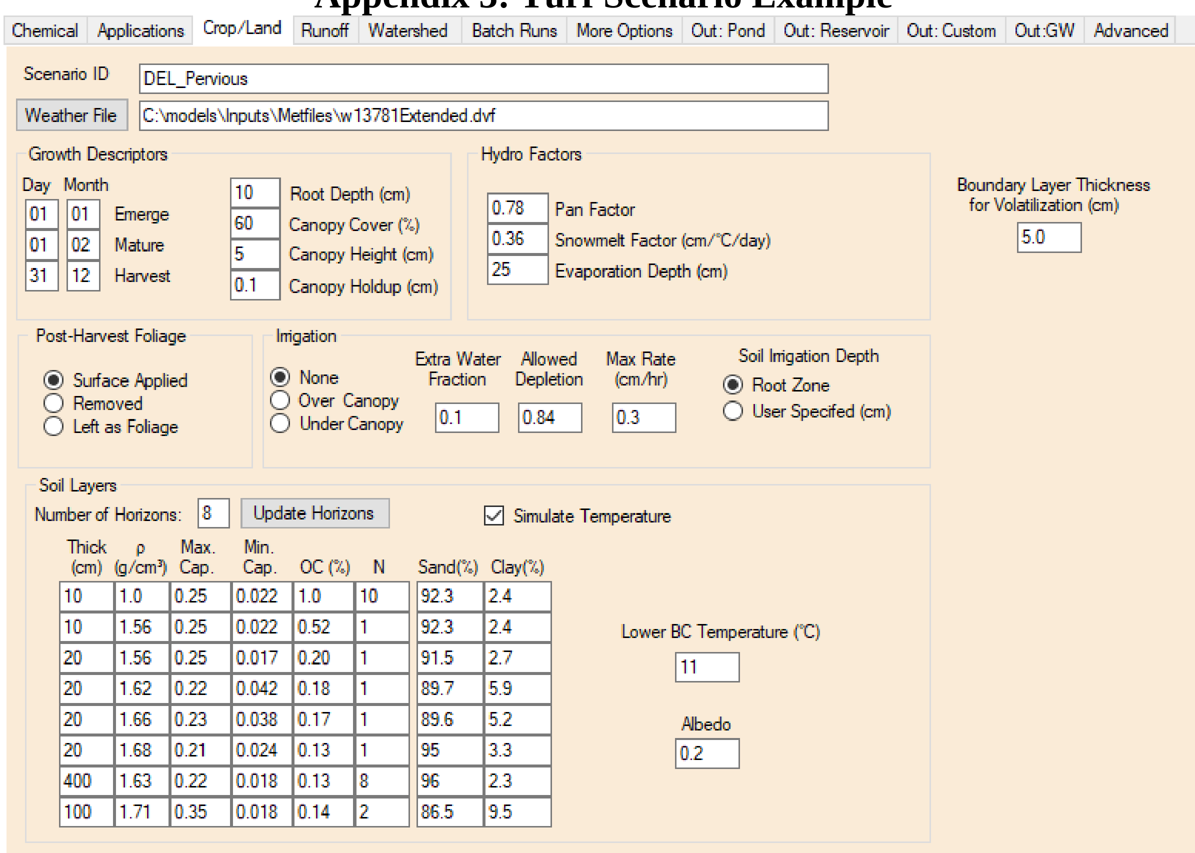
Figure 1. Yearly Peak Concentrations



Chemograph for refined non-ag pervious Delmarva Groundwater scenario



Appendix 3: Turf Scenario Example



Appendix 4: Organic Carbon Change to Standard GW Scenario