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

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code:122305
June 30, 2015

MEMORANDUM

Subject: Section 3 Environmental Fate and Ecological Risk Assessment for Benzovindiflupyr New Chemical Registration for Proposed Uses on Blueberries, Canola, Cereal Crops (oats, wheat, rye, and barley), Corn, Cotton, Cucurbits, Tomatoes, Grapes, Legumes, Peanuts, Pome fruit, Soybeans, Potatoes, Turf Grass, and Nursery crops.

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This memorandum transmits the Environmental Fate and Effects Division's (EFED) screening-level ecological risk assessment for the new fungicide pesticide benzovindiflupyr (aka, solatenol or SYN545192, PC Code 122305). The proposed end use products are emulsifiable concentrate

and water dispersible granule formulations for use as foliar spray (ground, aerial, and chemigation) or soil applications (in-furrow and banded) to various agricultural crops with maximum single application rates ranging from 0.046 to 0.089 lb a.i./A and maximum seasonal application rates up to 0.272 lbs. a.i./A specified. This risk assessment provides EFED's assessment of the environmental fate, terrestrial and aquatic exposure, and ecological risks associated with the proposed uses of benzovindiflupyr including blueberries, canola, cereal crops (oats, wheat, rye, and barley), corn, cotton, cucurbits, tomatoes, grapes, legumes, peanuts, pome fruit, soybeans, potatoes, turf grass, and nursery crops. When estimates of benzovindiflupyr exposure considering all proposed uses in terrestrial and aquatic environments are compared to the available ecotoxicity data, the resulting risk quotients (RQs) for this screening-level assessment indicate a potential for risk to most, but not all aquatic and terrestrial taxa.

For aquatic organisms, acute and chronic risk above established levels of concern to freshwater fish, estuarine/marine fish, freshwater invertebrates, and estuarine/marine invertebrates was identified. Acute risk but not chronic risk was identified for freshwater and estuarine/marine sediment dwelling invertebrates despite benzovindiflupyr's persistence in the environment and its high propensity to bind to sediment. Some chronic risks to aquatic invertebrates may be resolved with establishing 30-ft. spray buffers. In addition, the restriction of applications occurring every few years may potentially resolve some acute risks to both fish and invertebrates. Risks above the level of concern were not identified for aquatic plants (both vascular and non-vascular).

For terrestrial organisms, acute dose-based risk to birds was identified in all size classes of birds. Avian chronic RQs do not exceed the LOC in any scenario so direct chronic risk is presumed to be low though food avoidance demonstrated in the passerine acute dietary study. This may result in decreased fitness through other impacts during sensitive times like during migratory or nesting seasons. There was also LOC exceedences for piscivorous birds (e.g., sandpipers and rails consuming fish contaminated with benzovindiflupyr residues) suggesting risk through this pathway. There was also both acute and chronic dose-based risk identified in all size classes of mammals. There was not any chronic risk identified for dietary-based exposure in mammals or acute risk from the consumption of fish contaminated with benzovindiflupyr residues.

Data gaps for this chemical include acute and chronic toxicity studies submitted for larval bees and chronic feeding studies for adult bees, and additional data on passerine species.

The available data (acute oral and contact toxicity studies for adult bees) suggest that benzovindiflupyr is practically non-toxic to bees and preliminary exposure modeling and RQ analysis suggests that risk to adult bees via the contact and oral exposure pathways is below the level of concern. Studies to other beneficial insects used in the PMRA assessment suggest however that other insects (e.g. the parasitic wasp) have endpoints that are in the range of application rates from the proposed uses of benzovindiflupyr. There are not any acute or chronic toxicity studies submitted for larval bees or chronic feeding studies for adult bees. Furthermore, there is no language on the proposed labels restricting benzovindifluypyr applications when plants are in bloom in the vicinity. Therefore, risks to terrestrial invertebrates is presumed in the

absence of data and given benzonvindiflupyr's potential bioavailability to beneficial insects which may be attracted to treated plants. **EFED recommends the submittal of the additional honey bee toxicity data discussed above.** This will allow EFED to reconsider the presumption of risk to bees. There was not any risk identified to terrestrial plants.

Review of labels indicate that environmental hazard statements, while not pre-empting identified risks, sufficiently address the vulnerable dissipation pathways of benzovindiflupyr to nearby terrestrial and aquatic habitats via runoff of contaminated erodible soil particles. However, there is uncertainty regarding seasonal maximum application rates specified on the label. This risk assessment evaluated one treatment/retreatment cycle of benzovindiflupyr occurring per year. While this is likely the intended use pattern as suggested by resistance management strategies that are recommended on labels**, specification of the seasonal maximum application rates as yearly maximum application rates would eliminate the possibility of multiple treatment/retreatment cycles per year to occur.**

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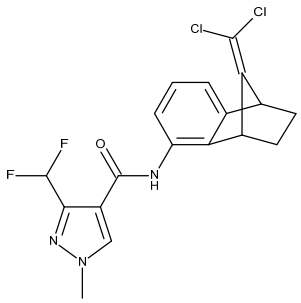
Environmental Fate and Ecological Risk Assessment for Benzovindiflupyr New Chemical Registration for Proposed Uses on blueberries, canola, cereal crops (oats, wheat, rye, and barley), corn, cotton, cucurbits, tomatoes, grapes, legumes, peanuts, pome fruit, soybeans, potatoes, turf grass, and nursery crops.



Chemical Formula: $C_{18}H_{15}Cl_2F_2N_3O$
PC Code: 122305
CAS Number: 1072957-71-1

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Contents

1. EXECUTIVE SUMMARY

1.1 Purpose of Assessment

This screening-level risk assessment examines the potential ecological risks associated with proposed uses of the new pyrazole and amide fungicide chemical benzovindiflupyr (aka solatenol or SYN545192). This risk assessment utilizes the best available scientific information and proposed labels to evaluate the environmental fate and transport, and effects on non-target organisms. The proposed end use products are emulsifiable concentrate and water dispersible granule formulations for use as foliar spray (ground, aerial, and chemigation) or soil applications (in-furrow and banded) to various agricultural crops with maximum single application rates ranging from 0.046 to 0.089 lb a.i./A and maximum seasonal application rates up to 0.272 lbs. a.i./A specified. **The specification of yearly applications would provide further clarity related to seasonal application rates that are currently specified on the proposed labels.** The proposed uses of benzovindiflupyr include blueberries, canola, cereal crops (oats, wheat, rye, and barley), corn, cotton, cucurbits, tomatoes, grapes, legumes, peanuts, pome fruit, soybeans, potatoes, turf grass, and nursery crops.

1.2 Summary of Relevant Environmental Fate, Transport, and Exposure Pathways

When benzovindiflupyr is applied to crops and soil, it may be transported from treated fields to off-site terrestrial habitats, water bodies, and aquatic habitats via spray drift given its proposed spray applications; further, erosion of benzovindiflupyr-ladened soil particles embedded within runoff during rain events after application may occur. Benzovindiflupyr residues had foliar dissipation half-lives ranging between 0.6 – 20 days from turf, barley, peanut, and soybean crops in residues measured in field dissipation studies (MRID Nos. 48604997, 48604998, 48604502, 48604580, and 48604581). However, laboratory studies suggest that benzovindiflupyr is highly persistent in both terrestrial and aquatic environments. Therefore, the longevity for it to be available for runoff will be high after its application with high residence times expected in impacted water bodies and aquatic habitats. Benzovindiflupyr's high persistence was consistently observed in aerobic soil metabolism and anaerobic soil metabolism studies with half-lives which ranged from 635 days – 1,788 days in seven soils[1]. Benzovindiflupyr's high soil-water partition coefficient (K_{oc}) values ranging between 3,829 – 5,221 mL/g (MRID No. 48604505) indicate that benzovindiflupyr would enter surface water bodies and aquatic habitats under a sorbed state with residues bound to eroded soil particles. Once reaching water bodies, benzovindiflupyr's high persistence also was observed in aquatic environments, as it was not observed to degrade at 50°C over a 30 day period in the hydrolysis study (MRID No. 48604506) and its slow biodegradation which occurred with half-lives ranging between 427 – 934 days (MRID Nos. 48604509 and 48604510) under aerobic and anaerobic aquatic conditions. In both

[1] Aerobic soils evaluated include Switzerland Loam Soil (MRID No. 48604492), United Kingdom Sandy Clay Loam Soil (MRID No. 48604493), France Silty Clay Soil (MRID No. 48604493), Switzerland Loam Soil (MRID No. 48604493), California Sandy Loam Soil (MRID No. 48604493), and North Dakota Sandy Clay Loam Soil (MRID No. 48604493). Anaerobic soils evaluated include United Kingdom Sandy Clay Loam Soil (MRID No. 48604494).

aerobic and anaerobic conditions, >83 percent of benzovindiflupyr was still observed in aquatic environments 100 days after the application. While persistent, a large portion of benzovindiflupyr residues present in the water column was observed to sorb to sediment, amounting to between 74 percent and 85 percent of the applied amount, for a period of up to 100 days after the application (MRID Nos. 48604509 and 48604510). Additional mesocosm studies with benzovindiflupyr in water-sediment systems were conducted to further investigate biodegradation of benzovindiflupyr mediated by the presence of algae and macrophytes in the environment (MRID Nos. 48604509, 48604510, and 48604578). However, there were substantial uncertainties related to incomplete accounting of the material balance over the study durations and mode of degradation and dissipation of benzovindiflupyr in water and sediment. Please refer to **Section 6** for a comprehensive discussion on the nature of the uncertainties.

1.3 Summary of Effects and Risk Conclusions

As transformation products remained minimal in soil and water, the stressor of concern to aquatic and terrestrial organisms resulting from benzovindiflupyr application are due to the parent compound alone (see **Section 2.4**, **Appendix F** for environmental fate information, and **Appendix G** for ecological toxicity information on the degradates). When estimates of benzovindiflupyr exposure in terrestrial and aquatic environments are compared to the available ecotoxicity data, the results of the screening-level assessment indicate a potential for risk above the level of concern to both aquatic and terrestrial taxa broadly for all proposed uses of benzovindiflupyr. Please refer to **Table 26** and **Table 27** in the Conclusions Section of this document (**Section 5)** which present the risks of concerns found for all aquatic and terrestrial organisms, respectively, resulting from the proposed uses of benzovindiflupyr specified by crop.

Risk concerns exist for acute and chronic exposures to fish and aquatic invertebrates. The chemical is highly toxic, persistent and RQs for many uses exceed LOCs. Risk is identified for acute exposures to birds and mammals and chronic exposures to mammals. There is considerable uncertainty associated with risk conclusions associated with birds because of the regurgitation based endpoint used to derive acute RQs. Although available information suggest low risk to bees, data gaps associated with critical life stages (i.e., larvae) and chronic exposures to adults prevent concluding that risk is low. **Therefore, the potential bioavailability of benzovindiflupyr to beneficial insects which may be attracted to treated plants serves as rationale for additional data requests for terrestrial invertebrates (see Section 4).** Available information indicate low concern for effects to terrestrial and aquatic plants.

Risks in aquatic ecosystems are predominantly driven by runoff as opposed to spray drift as risk conclusions largely do not change when removing the contribution of spray drift. The implementation of a spray drift buffer of 30 feet from a neighboring water body can reduce the overall chronic risk for only estuarine/marine fish and invertebrates (water column). However, the 30 foot spray drift buffer still would not mitigate risks completely for all proposed benzovindiflupyr uses to other aquatic endpoints including acute freshwater fish, acute freshwater estuarine invertebrates, chronic freshwater fish, or benthic pore water invertebrates (both freshwater and estuarine-marine) endpoints. While spray drift buffers would only resolve

some chronic risks of concern, restrictions on the use of benzovindiflupyr to only every few years potentially can resolve acute risks of concern for aquatic organisms.

2. PROBLEM FORMULATION

The proposed end use products for benzovindiflupyr are emulsifiable concentrate and water dispersible granule formulations for use as foliar spray (ground, aerial, and chemigation) or soil applications (in-furrow and banded) to various agricultural crops with maximum single application rates ranging from 0.046 to 0.089 lb a.i./A and maximum seasonal application rates up to 0.272 lbs. a.i./A specified. This risk assessment provides EFED's assessment of the environmental fate, terrestrial and aquatic exposure, and ecological risks associated with the proposed uses of benzovindiflupyr including blueberries, canola, cereal crops (oats, wheat, rye, and barley), corn, cotton, cucurbits, tomatoes, grapes, legumes, peanuts, pome fruit, soybeans, potatoes, turf grass, and nursery crops.

Benzovindiflupyr belongs to the pyrazole-carboxamides classes of fungicides and is effective against a broad range of fungal diseases. Other pyrazole fungicides currently registered in the United States include, fluxapyroxad, penflufen, penthiopyrad, furamepyr, bixafen, and sedaxane. Benzovindiflupyr is intended to prevent or treat a wide variety of fungal diseases. The proposed mode of action identifies benzovindiflupyr as an inhibitor of the succinate dehydrogenase generation mechanism of the citric acid cycle[2]. This process is a vital energy production step that takes place in the mitochondria of eukaryotic cells.

The active ingredient benzovindiflupyr is a (50:50) racemic mixture. The proposed benzovindiflupyr products consist of either emulsifiable concentrate or water dispersible granule formulations. Emulsifiable concentrate formulations compose of benzovindiflupyr as the single active ingredient (10.27% a.i.) or compose of the following co-formulants: 7.5%:11.25% benzovindiflupyr:difenoconazole, 2.24%:11.25% benzovindiflupyr:difenoconazole, and 7.24%: 12.07% benzovindiflupyr:propiconazole. Water dispersible granule formulations compose of the multiple active ingredients benzovindiflupyr (15% a.i.) and axosystrobin (30% a.i.).

2.1 Use Characterization

Benzovindiflupyr is proposed to be used in conventional ground, aerial, and chemigation spray foliar type of applications on blueberries, canola, cereal crops (oats, wheat, rye, and barley), corn, cotton, cucurbits, tomatoes, grapes, legumes, nursery plants, peanuts, pome fruit, soybeans, potatoes, and turf grass. Furthermore, banded or in-furrow pre-plant soil applications are proposed for peanuts and potatoes. Proposed single maximum application rates of benzovindiflupyr range between 0.046 – 0.089 lbs. a.i./A with the equivalent one to four retreatment intervals at a minimum of seven days between applications specified on the proposed product labels. It should be noted that this is derived from seasonal application rates rather than

[2] Citation: Fungicide Resistance Action Committee Classification on Mode of Action 2011. Accessible on-line: http://www.frac.info/frac/publication/anhang/FRAC%20MoA%20Poster%202011_final_HR.pdf Accessed September 2014.

yearly application rates. The specification of seasonal application rates introduces uncertainty as more than one treatment and re-treatment cycles may occur over multiple seasons. With this uncertainty noted, this assessment evaluates one benzovindiflupyr treatment and re-treatment cycle occurring per year. This is likely the intended use pattern as suggested by resistance management strategies that are recommended on labels The critical use information relevant for outdoor uses of benzovindiflupyr is shown in **Table 1**.

Table 1. Summary of proposed use information for benzovindiflupyr emulsifiable concentrate and water dispersible granules.

CROP USE	MAX. SINGLE APP. RATE (lbs. a.i./A)[1]	MAX. NUMBER OF APPS. and MIN. RETREATMENT INTERVAL	SEASONAL APP. RATE (lbs. a.i./A)[3]	APPLICATION METHOD[2]
Corn	0.068	4 apps., 7 days apart	0.272	Foliar Spray (C, G, A)
Cucurbits				
Tomatoes and Fruiting Vegetables				
Grapes				
Tubers (Potatoes)	0.068	4 apps., 7 days apart	0.272	Foliar Spray (C, G, A) Soil Banded or In-Furrow Application (Pre-plant)
Peanuts	0.089	3 apps., 14 days apart	0.267	Foliar Spray (C, G, A) Soil Banded or In-Furrow Application (Pre-plant)
Nursery Plants, Tomato Transplant, Fruit Transplant, Cucurbit Transplant	0.088	3 apps., 7 days apart	0.264	Foliar Spray (G Only)
Turf Grass	0.088	3 apps., 14 days apart	0.264	Foliar Spray (G Only)
Cotton	0.068	3 apps., 7 days apart	0.204	Foliar Spray (C, G, A)

Table 1. Summary of proposed use information for benzovindiflupyr emulsifiable concentrate and water dispersible granules.				
CROP USE	**MAX. SINGLE APP. RATE (lbs. a.i./A)[1]**	**MAX. NUMBER OF APPS. and MIN. RETREATMENT INTERVAL**	**SEASONAL APP. RATE (lbs. a.i./A)[3]**	**APPLICATION METHOD [2]**
Blueberries	0.068	2 apps., 10 days apart	0.136	Foliar Spray (C, G, A)
Soybeans	0.068	2 apps., 7 days apart	0.136	Foliar Spray (C, G, A)
Legumes				
Cereal (Oats, Barley, and Wheat)	0.068	2 apps., 14 days apart	0.136	Foliar Spray (C, G, A)
Canola	0.068	1 app.	0.068	Foliar Spray (C, G, A)
Pome fruit	0.046	4 apps., 7 days apart	0.184	Foliar Spray (C, G, A)

[1.] Maximum application rate based on product active ingredient density and maximum application rates (specified in fl oz./A) on product labels.

[2] Foliar spray method identifiers: G = Ground spray; A = Aerial Spray; C = Chemigation

[3] Seasonal application rate assumed to be equivalent to a yearly application rate. Further label clarification needed for all crops.

2.2 Environmental Fate and Transport Characterization

Physical and chemical properties of benzovindiflupyr are shown in **Table 2** below. Environmental fate and transport properties of benzovindiflupyr based upon registrant submitted studies or other references are shown in **Table 3** below.

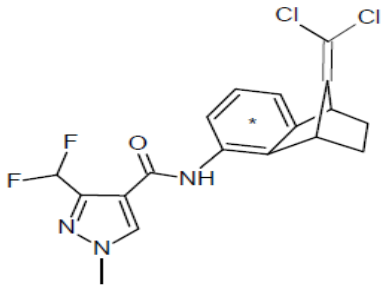
Table 2. Physical and chemical properties of benzovindiflupyr.		
Property	**Value and units**	**MRID or Source**
Structure		MRID 48604402
Chemical Formula	$C_{18}H_{15}Cl_2F_2N_3O$	MRID 48604402
Molecular Weight	398.2 g/mol	MRID 48604402
Vapor Pressure (25°C)	2.40 x 10^{-11} torr	MRID 48604402
Henry's Law Constant	9.75 x 10^{-9} atm·m^3/mol	EpiSuite HENRYWIN v. 3.20
Water Solubility (pH 7, 20°C)	0.98 mg/L	MRID 48604402
Octanol – water partition coefficient (log K_{OW})	4.30	MRID 48604505

Table 3. Summary of benzovindiflupyr environmental fate properties.			
Study/ OCSPP Guideline No.	**Value and unit**	**MRID # or Citation**	**Study Classification, Comment**
Abiotic Hydrolysis (835.2120)	$t_{1/2}$ = Stable (pH 4 at 50°C) $t_{1/2}$ = Stable (pH 5 at 50°C) $t_{1/2}$ = Stable (pH 7 at 50°C) $t_{1/2}$ = Stable (pH 9 at 25°C)	48604506	**Acceptable**
Aqueous Photolysis (835.2240)	$t_{½}$ = 11.2 days (natural water, SFO) $t_{½}$ = 88.4 days (pH 7 buffer solution, SFO)	48604507	**Supplemental** • Environmentally relevant half-life, corrected for dark control • Determination of natural equivalent photoperiod in the study not consistent with current OECD or OCSPP guidance.

Table 3. Summary of benzovindiflupyr environmental fate properties.			
Study/ OCSPP Guideline No.	**Value and unit**	**MRID # or Citation**	**Study Classification, Comment**
Soil Photolysis (835.2410)	Switzerland Loam (Moist): $t_{½}$ = 236 days (SFO) Switzerland Loam (Dry): $t_{½}$ = 492 days (SFO)	48604495	**Supplemental** • Environmentally relevant half-life, corrected for dark control • Determination of natural equivalent photoperiod in the study not consistent with current OECD or OCSPP guidance.
Degradation in air (835.2370)	<u>Reaction with Hydroxyl Radicals</u> $t_{½}$ = 0.237 days	EpiSuite AopWin v. 1.92	NA
Aerobic Soil Metabolism (835.4100)	UK SaCL: $t_{1/2}$ = 1,788 days (SFO) France SiC: $t_{1/2}$ = 1,628 days (SFO) Switzerland L: $t_{1/2}$ = 661 days (SFO) California SaL: $t_{1/2}$ = 1,177 days (SFO) North Dakota SaCL: $t_{1/2}$ = 1,172 days (SFO)	48604493	**Acceptable** • Foreign soils were found to be representative of domestic soils based on soil taxonomy
	Switzerland L: $t_{1/2}$ = 635 days (SFO)	48604492	**Supplemental** • Foreign soil representative of a few localized domestic soils based on soil taxonomy
Anaerobic Soil Metabolism (835.4200)	UK SaCL: $t_{½}$ = 1,339 days (SFO)	48604494	**Acceptable** Foreign soils were found to be representative of domestic soils based on soil taxonomy

Table 3. Summary of benzovindiflupyr environmental fate properties.			
Study/ OCSPP Guideline No.	**Value and unit**	**MRID # or Citation**	**Study Classification, Comment**
Aerobic Aquatic Metabolism (835.4300)	Swiss lake sand sediment: $t_{1/2}$ = 616 - 742 days (n =2, SFO) UK lake silt loam sediment: $t_{1/2}$ = 427 - 502 days (n = 2, SFO)	48604509 & 48604510	**Supplemental** • Study durations insufficient to determine full formation and decline cycle for degradates • Fringe anaerobic conditions (low dissolved oxygen levels, pe +pH <12) present throughout studies
Anaerobic Aquatic Metabolism (835.4400)	Swiss lake sand sediment: $t_{1/2}$ = 767- 934 days (n=2, SFO) UK lake silt loam sediment $t_{1/2}$ = 882 days (DFOP) & $t_{1/2}$ = 620 days (SFO)	48604509 & 48604510	**Supplemental** • Study durations insufficient to determine full formation and decline cycle for degradates
Mobility, unaged leaching, adsorption/ desorption (K_{oc}) (835.1220)	UK SaCL: K_{oc} = 4,414 mL/g; K_d = 123.6 mL/g; OC = 2.8% Fr SiC: K_{oc} = 5,033 mL/g; K_d = 45.3 mL/g; OC = 0.9% Switzerland L: K_{oc} = 3,900 mL/g; K_d = 78 mL/g; OC = 2.0% California SaL K_{oc} = 5,214 mL/g; K_d = 36.5 mL/g ; OC = 0.7 % North Dakota SaL: K_{oc} =3,828 mL/g; K_d = 95.7 mL/g ; OC = 2.5 %	48604505	**Acceptable**
Terrestrial Field Dissipation (Soil Column) (835.6100)	Nebraska, USA Loam/Silty Loam: $t_{1/2}$ = 1,080 days (DFOP)[6] Illinois, USA Clay Loam Soil: $t_{1/2}$ = 2,725 days (SFO)[6] Georgia, USA Sandy Loam Soil: $t_{1/2}$ = 8,190 days (IORE)[6] California, USA Loamy Sand Soil: $t_{1/2}$ = 240 days (DFOP) Manitoba, Canada Loam Soil: $t_{1/2}$ = 196,000 days (IORE)[6] Georgia, USA Loamy Sand Soil: $t_{1/2}$ = 582 days (DFOP)[6] New York, USA Loamy Sand Soil: $t_{1/2}$ =1,610 days (IORE)[6]	48604496 48604497 48604498 48604499 48604502 48604511 48604581	**Acceptable** **Acceptable** **Acceptable** **Acceptable** **Supplemental[4,5]** **Acceptable** **Supplemntal[4]**

Table 3. Summary of benzovindiflupyr environmental fate properties.			
Study/ OCSPP Guideline No.	**Value and unit**	**MRID # or Citation**	**Study Classification, Comment**
Terrestrial Field Dissipation (Foliar Dissipation) (835.6100)	Illinois soybean leaf disks: $t_{1/2}$ = 4 – 10.5 days (IORE, n = 3 applications)	48604497	**Acceptable**
	Georgia whole peanut plant: $t_{1/2}$ = 6.92 days (IORE, n = 1 application)	48604498	**Acceptable**
	Manitoba barley crop: $t_{1/2}$ = 19.3 days (SFO, n = 1 application,)	48604502	**Supplemental**
	California turf grass clippings $t_{1/2}$ = 0.6 – 6.8 days (IORE, n = 4 applications,)	48604580	**Acceptable**
	New York grass clippings $t_{1/2}$ = 11.7 days (SFO, n = 1 application)	48604581	**Supplemental[4,5]**
Fish Bioconcen-tration Factor (BCF) (850.1730)	Bluegill Sunfish Steady State BCF = 116 L/kg (Edible Tissues) Steady State BCF = 695 L/kg (Non-Edible Tissues) Steady State BCF = 405 L/kg (Whole Fish) Time to Steady State = 10 days Depuration $t_{1/2}$ = 0.54 days, 96.9 percent total residues in whole fish were removed after 7 days of depuration.	48604521	**Supplemental** • A large portion of radioactivity was not identified • Only one test concentration was examined
ECM/ILV (850.6100)	**<u>Water</u>** LOQ = 0.05 μg/m^3	48604414 48604415	**Acceptable** • No ILV submitted • Mean Recoveries less than 90 percent but greater than 80.6 percent in all cases
	<u>Soil</u> LOQ = 0.001 mg/kg	48604412, 48604413, 48604457	**Supplemental** • Method evaluation conducted on different soils than evaluated in laboratory studies • Mean Recoveries less than 90 percent but greater than 84 percent in all cases

[1] NA means not applicable.
[2] Half life degradation kinetics scheme determinations:
SFO = Single First Order, IORE = Indeterminate Order Rate Equation, DFOP = Double First Order in Parallel
[3] Soil textural classifications:

Sa: Sand, SaCL: Sandy Clay Loam, SaL: Sandy Loam, LSa: Loamy Sand, SiC: Silty Clay, SiL: Silt Loam, L: Loam, CL: Clay Loam

[4] No discernible degradation of benzovindiflupyr was observed throughout the study duration.

[5] Only two applications were completed in the study amounting to a total load of 0.244 lbs.a.i./A less than the total maximum seasonal load of 0.272 lbs a.i./A.

[6] Very slight to no discernible dissipation observed in the soil plots.

- **Fate and Transport Characteristics of Benzovindiflupyr in Soil and Water**

Benzovindiflupyr when applied to crops and soil may be transported to surface water via erosion of benzovindiflupyr-ladened soil particles concurrent with rain events after application. Benzovindiflupyr residues are expected to be readily washed off from crops as suggested from foliar dissipation half-lives ranging between 0.6 – 20 days from turf, barley, peanut, and soybean crops (MRID Nos. 48604997, 48604998, 48604502, 48604580, and 48604581).

Benzovindiflupyr is very persistent in the terrestrial environment, and therefore the longevity for it to be available for runoff will be high after its application. The total soil half-life in four field dissipation studies were all greater than 2,000 days[3]. The total soil half-life in four other study plots were still highly persistent but to a lesser degree, ranging from between 240 – 1,080 days[4]. The persistence of benzovindiflupyr in the field verified well from laboratory aerobic soil metabolism and anaerobic soil metabolism half-lives which ranged from 635 days – 1,788 days in seven soils[5].

Benzovindiflupyr possesses soil-water partition coefficient (K_{oc}) values ranging between 3,829 – 5,221 mL/g (slightly mobile – immobile, MRID No. 48604505), and a water solubility of 0.98 ppm (MRID No. 48604402). These high K_{oc} and low solubility values suggest that runoff of benzovindiflupyr residues bound to eroded soil particles is expected to most impact surface water bodies. Benzovindiflupyr's low solubility and mobility indicate that it may leach in small quantities. Benzovindiflupyr is not expected to escape from dry or moist soil surfaces or water bodies to the atmosphere via volatilization given its low vapor pressure of 2.4×10^{-11} torr (at 20°C) and low Henry's Law Constant of 9.75×10^{-9} atm·m^3/mol (at 25°C) (MRID No. 48604402).

Once reaching water bodies, benzovindiflupyr is very persistent in aquatic environments as well. Benzovindiflupyr was not observed to degrade at 50°C over a 30 day period in the hydrolysis study (MRID No. 48604506). In both aerobic and anaerobic conditions, >83 percent of benzovindiflupyr was still observed 100 days after the application, and half-lives ranged between

[3] Study plots include Illinois Sandy Clay Loam Soil (MRID No. 48604497), Georgia Sandy Loam Soil (MRID No. 48604998), Manitoba (Canada) Loam Bare Plot (MRID No. 48604502), and Manitoba (Canada) Cropped Plot (MRID No. 48604502).

[4] Study plots include California Loamy Sand Soil (MRID No. 48604499), Nebraska Silty Loam Soil (MRID No. 48604496), Georgia Loamy Sand Soil (MRID No. 48604511), and New York Loamy Sand (MRID No. 48604581).

[5] Aerobic soils evaluated include Switzerland Loam Soil (MRID No. 48604492), United Kingdom Sandy Clay Loam Soil (MRID No. 48604493), France Silty Clay Soil (MRID No. 48604493), Switzerland Loam Soil (MRID No. 48604493), California Sandy Loam Soil (MRID No. 48604493), and North Dakota Sandy Clay Loam Soil (MRID No. 48604493). Anaerobic soils evaluated include United Kingdom Sandy Clay Loam Soil (MRID No. 48604494).

427 – 934 days (MRID Nos. 48604509 and 48604510). While persistent, a large portion of benzovindiflupyr residues present in the water column sorb to sediment. **Figure 1** shows the buildup and equilibration of the benzovindiflupyr material in sediment from the water column overtime from the four aquatic water-sediment systems examined in aerobic and anaerobic aquatic studies. Between 74 percent – 85 percent of applied benzovindiflupyr was observed to sorb to sediment for a period of up to 100 days after the application (MRID Nos. 48604509 and 48604510). It should be noted that quasi-suboxic conditions may have existed in the aerobic aquatic metabolism study given low redox potentials which existed from this study. Please see **Section 4** for further discussion.

It should be noted that additional mesocosym type of studies were conducted for benzovindiflupyr in aquatic environments to further investigate the biodegradation of benzovindiflupyr in the total water-sediment system. These studies modified the guideline aerobic aquatic metabolism guidelines study design to incorporate the impact of algae and macrophytes separately (MRID Nos. 48604509 and 48604510) and collective impacts incorporating both algae and macrophtyes (MRID No. 48604578). Each of these studies were also conducted under conditions with a light-dark cycle using an artificial light source. There were substantial uncertainties in each of these mesocosm studies related to incomplete material balances throughout the total aquatic-sediment system over the study durations. Consequently, the determination of the pathway of degradation in the water column and sediment or dissipation to sediment of the material is also uncertain. Given these uncertainties, the aquatic exposure assessment and the calculated estimated exposure concentrations (EECs) relied on the more definitive results provided in the guideline aerobic aquatic metabolism studies without algae and macrophytes conducted under darkness (MRID Nos. 48604509 and 48604510), and are reflective of environments free of these organisms. It should be noted that the diurnal light-darkness cycles were incorporated into the aquatic exposure analysis and EECs using the existing aqueous photolysis study (MRID No. 48604507). Please refer to **Section 6** for a more comprehensive discussion on the uncertainties related to the mesocosm studies.

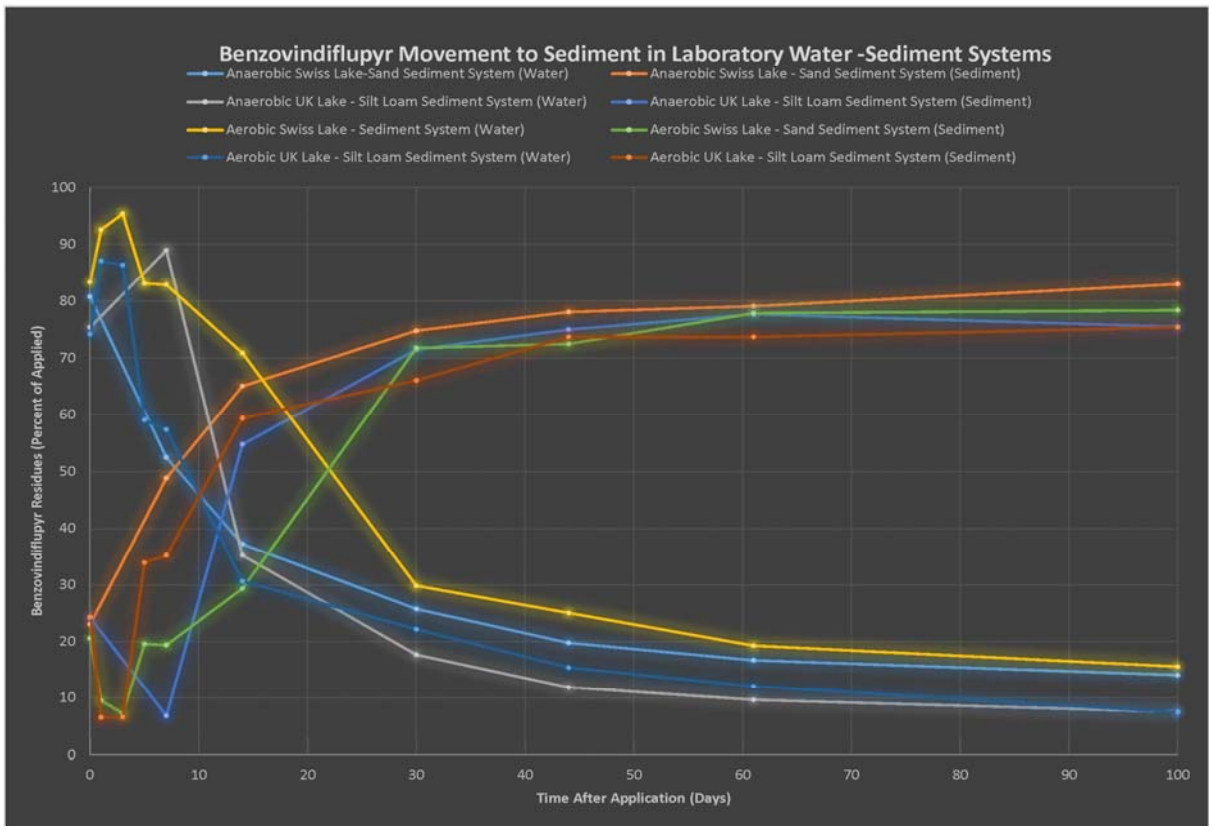


Figure 1. Residues of benzovindiflupyr in water and sediment compartments within the aerobic and anaerobic aquatic laboratory studies (MRID Nos. 48604509 and 48604510).

- **Transformation Products of Benzovindiflupyr in Soil and Water**

Given benzovindiflupyr's persistent properties, small levels of degradates (<< 10 percent of applied) were found in most laboratory studies. The only exception is the aquatic photolysis study where pyrazole acid formed up to 38.6 percent of applied and pyrazole amine formed up to 24.5 percent of applied 15 days after application. However, although these metabolites form in water in the presence of light, this transformation pathway is not expected to be prevalent in the environment given the low occurrence of light penetration in some water bodies nearby agricultural fields as well as adjacent streams and reservoirs given the turbid properties of these water bodies. The formation of benzovindiflupyr's metabolites in soil and water in various environmental fate transformation pathways is shown in **Table F-1** in **Appendix F**.

- **Bioconcentration of Benzovindiflupyr and Degradate Residues in Fish**

Benzovindiflupyr's log K_{ow} value of 4.30 suggests that residues reaching water bodies may partition to fatty tissue in fish. Steady-state BCF values in freshwater fish (bluegill sunfish) between 116 and 695 L/kg from edible tissues, non-edible tissues, and whole fish suggests there is moderately high bioaccumulation potential of benzovindiflupyr residues (MRID No. 48604521). However, the depuration rate of residues is rapid with a half-life of 0.54 days with

96.9 percent of total residues removed by 7 days of depuration. Whether the depuration rate is first-order is unknown because only one test concentration was examined. Given the information on the depuration of total residues within the bluegill sunfish, it appears that accumulation of benzovindiflupyr residues will be minimized in flowing water bodies by its rapid depuration rate. No metabolites of benzovindiflupyr were known to exist in fish from the BCF study, although this is uncertain since a large portion of the material detected was not identified throughout the study. Please refer to **Section 4** for further discussion.

2.3 Ecological Toxicity Characterization

2.3.1 Aquatic Effects

The acute and chronic toxicity values associated with freshwater and estuarine/marine species exposure to benzovindiflupyr are summarized in **Table 4**. Toxicity endpoints shown in bold represent the most sensitive endpoints within a taxonomic grouping (*e.g.*, freshwater fish, freshwater invertebrates, aquatic plants, etc.). These endpoints are termed the "toxicity reference values" which are used for this quantitative risk assessment. Aquatic toxicity studies were also submitted with various degradation products of parent benzovindiflupyr that were detected in small quantities in the environmental fate studies. Since benzovindiflupyr is the main stressor of concern in this risk assessment and because transformation products are not as toxic as the parent chemical (see **Section 2.4** below), toxicological endpoints from the studies on the degradation products are not used in the risk assessment. However, they are summarized in **Table G-1** of **Appendix G.**

Table 4. Toxicity Reference Values For Aquatic Organisms Exposed to Benzovindiflupyr.

Acute Freshwater Fish						
Species	**Study Type**	**Test Substance (Purity)**	**LC_{50} (µg a.i/L) (95% CL; slope)**	**Endpoints Affected**	**Toxicity Classification MRID**	**Acceptability**
Fathead minnow *Pimephales promelas*	96-hr, flow-through	TGAI (98.3%)	4.7 (3.6-6.2; N/A)	Mortality and Sublethal effects	Very highly toxic 48604519	Acceptable
Rainbow trout *Onchorhynchus mykiss*	96-hr, flow-through	TGAI (98.3%)	9.1 (7.6-10.8; N/A)	Mortality and Sublethal effects	Very highly toxic 48604518	Acceptable
Carp *Cyprinus carpio*	96-hr, flow-through	TGAI (98.3%)	3.5 (2.6 - 4.9; N/A)	Mortality and Sublethal effects	Very highly toxic 48604562	Acceptable

Chronic Freshwater Fish						
Species	**Study Type**	**Test Substance (Purity)**	**NOAEC; LOAEC (µg a.i/L)**	**Endpoints Affected**	**MRID**	**Acceptability**
Fathead minnow *Pimephales promelas*	32-d Early Life Stage	98.30%	0.95 ; 1.8	Growth	48604520	Acceptable
Acute Freshwater Invertebrates						
Species	**Study Type**	**Test Substance (Purity)**	**EC_{50} (µg a.i/L) (95% CL; slope)**	**Endpoints Affected**	**Toxicity Classification MRID**	**Acceptability**
Water flea *Daphnia magna*	48-hr, static	TGAI 98.3%)	**85** (71-103)	Immobility	Very Highly toxic 48604522	Acceptable
Chronic Freshwater Invertebrates						
Species	**Study Type**	**Test Substance (Purity)**	**NOAEC; LOAEC (µg a.i/L)**	**Endpoints Affected**	**MRID**	**Acceptability**
Water flea *Daphnia magna*	21-day Life Cycle	TGAI (98.3%)	**5.6 ; 15**	Time to first brood	48604523	Acceptable
Acute Saltwater Fish						
Species	**Study Type**	**Test Substance (Purity)**	**EC_{50} (µg a.i/L) (95% CL; slope)**	**Endpoints Affected**	**Toxicity Classification MRID**	**Acceptability**
Sheepshead minnow *Cyprinodon variegatus*	96-hour, flow-through	TGAI 98.3%)	28 (22-36; NA)	Mortality and sublethal effects	Very highly toxic 48604534	Acceptable

Chronic Saltwater Fish						
Species	**Study Type**	**Test Substance (Purity)**	**NOAEC; LOAEC (µg a.i/L)**	**Endpoints Affected**	**MRID**	**Acceptability**
Sheepshead minnow *Cyprinodon variegatus*	32-d Early Life Stage	TGAI 98.3%)	**5.66; 10.77**	Determined through acute to Chronic ratio	Not Applicable	Not Applicable
Acute Saltwater Invertebrates						
Species	**Study Type**	**Test Substance (Purity)**	**EC_{50} (µg a.i/L) (95% CL; slope)**	**Endpoints Affected**	**Toxicity Classification MRID**	**Acceptability**
Eastern oyster *Crassostrea virginica*	96-hour, flow-through	TGAI (97%)	160 (135-192; NA)	Shell Deposition	Highly toxic 48604537	Acceptable
Saltwater mysid *Americamysis bahia*	96-hour, flow-through	TGAI (99%)	**47** (36-61; NA)	Mortality	Very highly toxic 48604535	Acceptable
Chronic Saltwater Invertebrates						
Species	**Study Type**	**Test Substance (Purity)**	**NOAEC; LOAEC (µg a.i/L)**	**Endpoints Affected**	**Endpoints MRID**	**Acceptability**
Saltwater mysid *Americamysis bahia*	28-d Life Cycle	TGAI (97%)	**7.4 ; 15**	Reproduction	Reproduction 48604536	Acceptable
Freshwater Chronic Sediment Invertebrate Toxicity Tests						
Species	**Study Type**	**Test Substance (Purity)**	**Sediment NOAEC / LOAEC (mg a.i/kg sediment)**	**Pore water NOAEC (mg a.i/L)**	**MRID**	**Acceptability**
Freshwater midge *Chironomus tentans*	56-day, whole sediment	TGAI (97 %)	2.8 ; 6.7 Percent emerged	0.069 ; 0.22 Percent emerged	48604525	Acceptable

Estuarine/Marine Chronic Sediment Invertebrate Toxicity Tests						
Species	**Study Type**	**Test Substance (Purity)**	**Sediment NOAEC / LOAEC (mg a.i/kg sediment)**	**Pore water NOAEC (mg a.i/L)**	**MRID**	**Acceptability**
Estuarine amphipod *Leptocheirus plumulosus*	28-day, whole sediment	TGAI (97 %)	4.1 ; 8.7 Survival	0.098 ; 0.12 Survival	48604583	Acceptable
Aquatic Plant Toxicity Tests						
Species	**Study Type**	**Test Substance (Purity)**	**EC_{50} (ug a.i./L) (95% CL) and NOAEC (ug a.i./L)**	**Endpoints Affected**	**MRID**	**Acceptability**
Marine diatom (*Skeletonema costatum*)	96-hr, static	TGAI (97%)	**240 (185-309) NOAEC = 50**	Cell density	48604550	Acceptable
Freshwater green algae (*Pseudokirchneriella subcapitata*)	96-hr, static	TGAI (98.3%)	**> 890 ; N/A; NOAEC= 420**	Cell yield	48604524	Acceptable
Duckweed (*Lemna gibba*)	7-day static renewal	TGAI (97%)	**> 880 ; N/A; NOAEC = 430**	Growth rate	48604526	Acceptable

* EC_{05} used for estimation of risk to endangered aquatic plant in the event the NOAEC is non-definitive.
Bolded values refer to the most sensitive endpoint for a given taxa to be used in quantitative risk assessment.

- **Freshwater Fish**

Acute toxicity studies with technical-grade benzovindiflupyr were available for three species of freshwater fish: fathead minnow (*Pimephales promelas*), rainbow trout (*Oncorhynchus mykiss)* and carp (*Cyprinus carpio*) All studies were conducted on TGAI with 98.3% purity. In the fathead minnow study (MRID 48604519) the mean-measured concentrations were <LOQ (<0.019, negative and solvent controls), 0.54, 1.1, 2.2, 4.4, and 9.4 µg a.i/L. At 96 hours, mortality was 43 and 100% in the 4.4 and 9.4 µg/L (mean measured) treatment groups,

respectively, the two highest treatment concentrations tested. The LC_{50} was 4.7 µg a.i/L classifying benzovindiflupyr as very highly toxic. Sublethal effects included fish being observed on the bottom of the test vessel and complete loss of equilibrium in the 4.4 µg a.i/L group at 96 hours. In the 9.4 µg a.i/L group, fish were observed with complete loss of equilibrium, fish on the bottom of the test vessel, and dark in coloration. This study was classified as acceptable.

In the rainbow trout study (MRID 48604518) the mean-measured concentrations were <LOQ (<0.061, negative and solvent controls), 1.5, 2.3, 4.7, 9.8, and 18 µg a.i/L. At 96 hours, mortality was 57 and 100% in the 9.8 and 18 µg a.i/L (mean measured) treatment groups, respectively, the two highest treatment concentrations tested. The LC_{50} 9.1 µg a.i/L classifying benzovindiflupyr as very highly toxic. Sublethal effects included partial loss of equilibrium and dark in coloration in the 4.7 µg a.i/L group at 72 and 96 hours. In the 9.8 µg a.i/L group, fish were observed with complete loss of equilibrium, fish on the bottom of the test vessel, and dark in coloration. This study was classified as acceptable.

In the carp study (MRID 48604562), the mean-measured concentrations were <LOQ (<0.022, negative and solvent controls), 0.61, 1.1, 2.3, 5.4, and 10 µg a.i/L. At 96 hours, mortality was 14, 100, and 100% in the negative control, 5.4, and 10 µg a.i/L groups, respectively. The LC_{50} was 3.5 µg a.i/L classifying benzovindiflupyr as very highly toxic. Sublethal effects included loss of equilibrium, dark in coloration, lethargic, and fish on the bottom of the test vessel in the 5.4 µg a.i/L group throughout the test. In the 10 µg a.i/L group, fish were observed with complete loss of equilibrium and on the bottom of the test vessel. This study was classified as acceptable.

Based on the available data, TGAI benzovindiflupyr is classified as very highly toxic to fish and the carp LC_{50} of 3.5 µg a.i/L will be used for estimating risk to this taxa.

There were two additional acute freshwater fish toxicity studies submitted with degradation products of benzovindiflupyr. Both studies were conducted with the rainbow trout. In one study conducted with 98% purity of degradation product SYN546039 (MRID 48604545), the mean-measured concentrations were <LOQ (<0.0544, negative control), 0.19, 0.41, 0.87, 1.9, 3.9, and 7.2 mg a.i/L. At 96 hours, mortality was 14, 100 and 100% in the 1.9, 3.9, and 7.2 mg a.i/L groups, respectively. Sublethal effects included fish lying on side or back on bottom, strong ventilation, and tumbling during swimming in the 3.9 mg a.i/L group at 4 and 24 hours. In the 1.9 mg a.i/L group, one fish at 48 hours was observed mainly on the bottom of the test vessel. The 96 hour LC_{50} based on mean-measured concentrations was 2.5 mg a.i/L. This study was classified as acceptable and suggests this metabolite is moderately toxic to rainbow trout. In the other study conducted with 99.2% purity of degradation product M700F001 (MRID 47923726), the limit test used a mean-measured concentration was 88.1 mg/L under static conditions. The 96-h LC_{50} was >88.1 mg/L and there were not any mortalities or sublethal effects observed during the 96 hour test. This study was classified as acceptable and suggests that M700F001 is slightly to practically non-toxic to rainbow trout.

In a chronic early life stage test with a freshwater fish (fathead minnow, MRID 48604520)

conducted with TGAI benzovindiflupyr (98.3% purity), fertilized eggs/embryos (120/level, 6 hours old) of fathead minnows were exposed to mean measured concentrations of ≤0.021 µg/L (negative and solvent controls), 0.29, 0.49, 0.95, 1.8, and 3.6 µg a.i/L. There were no treatment-related effects for pre-hatch survival and times to hatch. Larval survival at 28 days post-hatch was significantly reduced at the 3.6 µg a.i/L (mean measured) treatment concentration. The total length and dry weight were significantly reduced at ≥ the 1.8 µg a.i/L (mean measured) treatment concentration. The 32-day NOAEC and LOAEC based on mean measured concentrations were 0.95 and 1.8 µg a.i/L, respectively for mean dry weight and mean length. . This study was classified as acceptable and for risk assessment purposes, a chronic toxicity of 0.95 µg a.i/L will be used for estimating chronic risk quotients for freshwater fish.

- **Freshwater Invertebrates**

An acute toxicity study conducted with TGAI benzovindiflupyr (98.3%) on freshwater invertebrates was available for *Daphnia magna* (MRID 4864522). The mean-measured concentrations were <0.74 µg/L (<LOQ; negative and solvent controls), 8.5, 21, 56, 130, and 330 µg a.i/L. Immobilization was 0% in the controls and ≤56 µg/L treatment groups, 100% in the 130 µg a.i/L and 330 µg a.i/L treatment groups. All surviving daphnids were lethargic in the 56 µg a.i/L treatment group at 48 hours. The 48-hr EC_{50} values was and 85 µg a.i/L indicating that benzovindiflupyr is very highly toxic to freshwater invertebrates. This study is classified as acceptable and 85 µg a.i/L will be used for estimating acute risk quotients for freshwater invertebrates.

There were two additional acute freshwater invertebrate toxicity studies submitted with degradation products of benzovindiflupyr, both conducted with *Daphnia magna*. One study was conducted with the degradation product of both benzovindiflupyr and fluxapyroxad (another pyrazole fungicide as indicated in Section 2). The degradate M700F001 had a purity 99.2% (MRID 47923732). The mean-measured concentrations were <LOQ (<0.05, negative control), 9.37, 17.4, 38.9, 54.6, and 98.2 mg a.i/L. No treatment-related mortality or immobility was observed in the control and all treatment groups. The 48-hr EC_{50} was >98.2 mg a.i/L suggesting that this degradate is practically non-toxic to freshwater invertebrates. This study was classified as acceptable. The other study was conducted with the degradate SYN546039 that had a purity of 98% (MRID 48604546). The mean-measured concentrations were <LOQ (<0.0544, negative control), 0.40, 0.87, 1.9, 3.9, and 8.1 mg a.i/L. Immobilization was 0% in the controls and ≤1.9 mg/L treatment groups, 10% in the 3.9 mg a.i/L treatment group, and 100% in the 8.1 mg a.i/L treatment group. Daphnids were observed with reduced swimming activity in the 3.9 and 8.1 mg a.i/L treatment groups. The 48-hr EC_{50} values was 5.2 mg a.i/L suggesting that this metabolite is moderately toxic to freshwater invertebrates. This study was classified as acceptable.

A freshwater invertebrate (*Daphnia magna*) lifecycle test with benzovindiflupyr TGAI (98.3%) was submitted and found to be supplemental / reliable with restrictions (MRID 48604523). The 21-day chronic toxicity was studied under static renewal conditions. Daphnids (<24 hours old; 20 per level) were exposed to benzovindiflupyr at mean measured concentrations were ≤0.059 µg a.i/L (≤LOQ; negative and solvent controls), 0.88, 2.7, 5.6, 15, 34, and 95 µg/L. Treatment-

related reductions from the negative control were observed for parental survival at 95 µg a.i/L (mean measured, the highest treatment concentration tested and where there was complete mortality), and dry weight at 0.88 µg a.i/L (mean measured, the lowest treatment concentration); the number of live offspring was unaffected by treatment up to 15 µg a.i/L and no offspring were produced at 34 µg a.i/L. There were no effects on parental length up to the 34 µg a.i/L (mean measured) treatment concentration, although data from the 95µg a.i/L treatment concentration were excluded due to complete mortality in that treatment concentration. There was also a significant increase in the average time to first brood at the 15 µg a.i/L level relative to the negative control (Day 9). The NOAEC and LOAEC 5.6 µg/L and 15 µg a.i/L based on an increase in time to first brood as compared to the negative control. This study was classified as acceptable due to the non-definitive endpoint and the NOAEC of 5.6 µg/L will be used for estimating chronic risk quotients for freshwater invertebrates.

- **Estuarine/Marine Fish**

One acute toxicity study was submitted conducted with TGAI benzovindiflupyr (98.3% purity) to the sheepshead minnow, *Cyprinodon variegates* (MRID 48604534). The mean-measured concentrations were <LOQ (<0.3, negative and solvent controls), 8.7, 16, 32, 70, and 150 µg a.i/L and ranged from 64-75% of nominal values. At 96 hours, mortality was 71, 100, and 100% in the 32, 70, and 150 µg a.i/L (mean measured) treatment groups, respectively, the three highest treatment concentrations tested. In the 32 µg a.i/L group, sublethal effects were observed throughout the test and included lethargic fish, complete loss of equilibrium, and fish on the bottom of the test vessel. Sublethal effects included lethargic fish and complete loss of equilibrium in the 70 µg a.i/L group at 24 hours. The 96 hour LC_{50}, based on mean-measured concentrations, were 28 µg a.i/L suggesting that benzovindiflupyr is very highly toxic to estuarine/marine fish. This study was classified as acceptable and this endpoint will be used with assessing acute risk to estuarine/marine fish.

There was not an estuarine/marine chronic fish early life stage test conducted with benzovindiflupyr. The NOAEC and LOAEC determined through examining the acute to chronic ratios of the fathead minnow were 5.66 µg a.i/L and 10.77 µg a.i/L respectively.

- **Estuarine/Marine Invertebrates**

Acceptable acute toxicity studies were available for two species of estuarine/marine invertebrates: the eastern oyster (*Crassotrea virginica*; MRID 48604537, and the mysid shrimp (*Americamysis bahia*; MRID 48604535). The oyster study examined reduction in shell deposition under flow- through conditions with TGAI of 97% purity. At test termination, mean shell growth in the control and solvent control was 2.8 and 3.2 mm, respectively. Mean shell growth in the 22, 35, 67, 140 and 240 µg a.i./L treatment levels was 2.8, 2.7, 2.4, 1.5 and 0.9 mm, respectively. The percent reduction of shell growth at the 22, 35, 67, 140 and 240 µg a.i./L treatment levels was 5, 9, 19, 50 and 68%, respectively. Based on mean measured concentrations, the 96-hour EC_{50} was 160 µg a.i./L, indicating that benzovindiflupyr was highly toxic to the eastern oyster.

The mysid shrimp test was conducted with TGAI of 99% purity with mean measured treatment concentrations of control, and solvent control, 7.4, 17, 48, 120, 250 µg a.i./L. Following 24 hours of exposure, 100% mortality was observed among mysids exposed to the 250 µg/L (mean measured) treatment level, the highest treatment level tested. At test termination (96 hours), 10, 35 and 100% mortality was observed in mysids exposed to the 17, 48 and 120 µg a.i/L (mean measured) treatment levels, respectively, the three highest treatment levels tested. Several surviving mysids exposed to the 48 µg a.i/L treatment level were observed to be lethargic at test termination. Mortality of 5% was observed in mysids exposed to the solvent control. No mortality or adverse effects were observed for mysids exposed to the remaining treatment level tested (7.4 µg a.i/L) or the dilution water control. Based on mean measured concentrations, the 96-hour LC_{50} was estimated to be 47 µg a.i/L indicating that that benzovindiflupyr is very highly toxic to saltwater mysids. This study was classified as acceptable and this endpoint will be used to assess the acute risk to estuarine/marine invertebrates.

An estuarine/marine invertebrate (*Americamysis bahia*) lifecycle test with benzovindiflupyr TGAI (97 %) (MRID 48604536) exposed mysids to mean-measured concentrations were <0.24 (<LOQ, control), 1.9, 3.5, 7.4, 15, and 31 µg ai/L throughout their life cycle. The number of offspring per female averaged 25.5 for the control group, and 20.7, 20.0, 21.6, 17.0, and 0.7 for the mean-measured 1.9, 3.5, 7.4, 15, and 31 µg ai/L levels, respectively. This endpoint was significantly reduced ($p<0.05$) compared to the controls at 15 and 31 µg ai/L. The NOAEC and LOAEC values for reproduction were 7.4 and 15 µg ai/L, respectively, based upon mean-measured concentrations. This endpoint will be used to assess chronic risk to estuarine/marine invertebrates. The NOAEC and LOAEC for F0 female dry weight, F0 male dry weight, F0 male length, F0 survival post-pairing, were 15 and 31 µg ai/L respectively. This study was classified as acceptable.

- **Benthic (Sediment Dwelling) Invertebrates**

The effect of benzovindiflupyr on freshwater benthic invertebrates is available from one study utilizing a 56 day exposure via spiked sediment to the midge *Chironomous tentans* (MRID 48604525). Midges were exposed to mean-measured sediment concentrations were <0.28 (<LOQ, controls), 2.8, 6.7, 12, 24, and 48 mg ai/kg and mean-measured pore-water concentrations were <LOQ (controls), 0.069, 0.22, 0.28, 0.67, and 1.15 mg a.i/L. The most sensitive endpoints that were affected included percent emerged and number eggs per emerged female. There were reductions in emergence from control of 19.4% and 17.7% in the 12 and 48 mg a.i/kg sediment level. Statistical analysis determined significant effects in emergence ($p<0.05$) at the three highest treatment concentrations (12, 24, and 48 mg a.i/kg sediment). A 42% reduction from control in number of eggs per emerged female at the 6.7 mg a.i/kg sediment was not identified as significant ($p>0.05$. However, the study reviewer determined that a 42% reduction from control for this endpoint is biologically meaningful and therefore the NOAEC and LOAEC for number of eggs per emerged female were determined to be 2.8 and 6.7 mg a.i/kg sediment, respectively and 0.069 and 0.22 mg a.i./L porewater respectively.

One 28-day sediment toxicity test on an estuarine/marine amphipod *Leptocheirus plumulosus* is available (MRID 48604583). Amphipods were exposed to 0 (negative and solvent control), 2.1, 4.1 8.7, 17, 37 and 68 mg a.i. /kg dry weight sediment. Concentrations of Benzovindiflupyr remained mainly with the sediment throughout the duration of the test. The porewater concentrations were 0.020, 0.046, 0.11, 0.22, 0.42 and 0.76 mg a.i./L. There were not any sublethal or behavioral effects that were observed in any of the treatment levels. Survival was 88 and 80 percent for the negative and solvent controls, respectively and 83%, 88%, 56%, for 2.1, 4.1 and 8.7 treatment levels respectively. There was 100% mortality in the three highest test concentrations. The NOAEC and LOAEC were determined to be 4.1 and 8.7 mg a.i. / kg sediment and 0.098 and 0.12 mg a.i./L porewater based on effects to survival. This study was classified as acceptable.

- **Vascular and Non-vascular Aquatic Plants**

Two non-vascular aquatic plant studies (algae) (MRIDs 48604550,48604524) were submitted along with one vascular aquatic plant study (MRID 48604526) for the parent benzovindiflupyr. One algal study was submitted for the metabolite SYN46039 (MRID 48604547).

In an acceptable study with the marine diatom *Skeletonema costatum* (MRID 48604550), TGAI benzovindiflupyr (purity 97%) cultures were exposed to mean measured concentrations of <0.0020 (<LOQ, negative and solvent controls), 0.047, 0.10, 0.20, 0.40, and 0.72 mg/L mg a.i/L to cultures. After 96 hours, the NOAEC and EC_{50} values based on yield were 0.05 and 0.24 mg a.i./L, respectively. No abnormalities were noted. Percent growth inhibition based on cell density in the treated algal culture as compared to the negative control ranged from 14 to 89%. This study was classified as acceptable. In an acceptable study with the freshwater green alga, *Pseudokirchneriella subcapitata* (MRID 48604524), TGAI benzovindiflupyr (purity 98.3%), cultures were exposed to a two concentration limit test with mean measured concentrations of 420 and 890 µg a.i/L. The EC_{50} and NOAEC were >890 µg a.i/L and 420 µg a.i/L respectively. This study was classified as acceptable.

In the aquatic vascular plant toxicity study, *Lemna gibba* (duckweed) was exposed to mean measured treatment concentrations of 58, 110, 230, 430 and 880 µg a.i./L. The EC_{50} and NOAEC after the seven day exposure was >880 and 430 ug a.i./L respectively for biomass yield and growth rate based on biomass. This study was classified as acceptable.

In another study (MRID 48604547) conducted with *Pseudokirchneriella subcapitata,* the benzovindiflupyr degradate (SYN46039, 98% purity) was exposed to cultures at mean measured concentrations of <0.0544 (<LOQ, negative control), 0.21, 0.41, 0.90, 1.9, 4.0, and 6.4 mg a.i./L under static conditions. The highest concentration represented the limit of water solubility. After 96 hours, the most sensitive NOAEC and EC_{50} values were 0.41 and 15.8 mg a.i./L, respectively, based on area under the curve (AUC). No abnormalities were noted. Percent growth inhibition based on cell density in the treated algal culture as compared to the negative control ranged from -4.4 to 26.7%. This study was classified as acceptable.

2.3.2 Terrestrial Effects

All toxicity reference values used to assess the potential acute and chronic risks of benzovindiflupyr exposure to birds, mammals, and invertebrates were obtained from acceptable or supplemental studies using benzovindiflupyr TGAI (**Table 5).**

Table 5. Toxicity Reference Values For Terrestrial Organisms Exposed To Benzovindiflupyr.

Exposure Scenario	% A.I.	Species	Dur.	Toxicity Reference Value (std dev; slope)	Endpoints Affected	MRID; Classification	Acceptability
Birds							
Acute	TGAI (97%)	Bobwhite quail (*Colinus virginianus*)	14 d	LD_{50} : 1373 (1047-1978; NA) mg/kg bw	Mortality, body weight, and sub-lethal effects	Slightly toxic 48604512	Acceptable
	TGAI (98.3%)	Bobwhite quail (*Colinus virginianus*)	14 d	LD_{50}: >1014(N/A; N/A) mg/kg bw	NA	Slightly toxic 48604598	Acceptable
	TGAI (97%)	Zebra Finch (*Taeniopygia guttata*	14 d	14-d LD_{50} = 10 (N/A; N/A) mg/kg bw	Regurgitation equates to mortality in the absence of better data	Highly toxic 48604513	Supplemental
Acute Dietary	TGAI (97%)	Zebra Finch (*Taeniopygia guttata*	5 d	LD_{50}: < 562 (N/A; N/A) mg/kg bw	≥70% mortality at all treatment levels	49383802	Supplemental
Sub-Acute Dietary	TGAI (97%)	Bobwhite Quail *Colinus virginianus*	8 d	8-d LC_{50} : > 6390 mg a.i/kg diet (N/A; N/A)	Mortality, body weight, and food consumption	Practically nontoxic 48604515	Acceptable
	TGAI (97%)	Mallard duck (*Anas platyrhynchos*)	8 d	LC_{50}: >6390 mg a.i/kg diet (95% CI not available)	Mortality, body weight, and food consumption	Practically nontoxic 48604514	Acceptable
Chronic Reproduc -tion	TGAI (97%)	Mallard Duck *Anas platyrhynchos*	20 weeks	NOAEC=59.4 mg a.i/kg diet LOAEC=202 mg a.i/kg diet	hatchling weight, 14-day survival weight, mean food	48604516	Acceptable

Table 5. Toxicity Reference Values For Terrestrial Organisms Exposed To Benzovindiflupyr.							
Exposure Scenario	**% A.I.**	**Species**	**Dur.**	**Toxicity Reference Value (std dev; slope)**	**Endpoints Affected**	**MRID; Classification**	**Acceptability**
					consumption, female weight gain		
	TGAI (97%)	Bobwhite Quail *Colinus virginianus*	20 weeks	NOAEC= 610 mg a.i/kg diet LOAEC= >610 mg a.i/kg diet	NA	48604517	Acceptable
Mammals							
Acute	TGAI 97%	Rat *(Rattus norvegicus)*	14 d	**LD_{50} = 66.3 mg ai/kg bw (females)**	Mortality	48604427	Acceptable
Chronic	TGAI 97%	Rat *(Rattus norvegicus)*	2 gen	**NOAEL = 8.2 mg/kg/day (females)** **LOAEL = 19.4 mg/kg/day**	Decreased body weight/weight gain and decreased food consumption in parental males	48604449	Acceptable
Nontarget Insects - Bees							
Acute	TGAI 98.3%	Honeybee *Apis mellifera* (Acute contact toxicity)	48 h	LD_{50}: > 100 ug ai/bee (95% CI N/A)	NA	Practically non-toxic 48604527	Acceptable
	TGAI 98.3%	Honeybee *Apis mellifera* (Oral toxicity study)	48 h	LD_{50}: > 109 ug ai/bee (95% CI N/A)	NA	Practically non-toxic 48604527	Acceptable

Table 5. Toxicity Reference Values For Terrestrial Organisms Exposed To Benzovindiflupyr.							
Exposure Scenario	**% A.I.**	**Species**	**Dur.**	**Toxicity Reference Value (std dev; slope)**	**Endpoints Affected**	**MRID; Classification**	**Acceptability**
Other Non-target Terrestrial Organisms							
Acute	TGAI 94.7%	Earthworm (*Eisenia fetida*)	14 d	LC_{50}: 463 mg a.i/kg dw soil NOAEC (body weight): 125 mg a.i/kg soil	• Mortality was significantly higher in two highest concentrations • Body weight was significantly reduced ($p<0.05$) at the three highest concentrations	PMRA 2255438,2255478 Supplemental	Supplemental
				NOAEC (mortality): 250 mg a.i/kg soil			
Acute	SYN545 192 EC (synonym: A17056F) Guarantee: 150 g/L benzovindiflupyr	Parasitic Wasp *Aphidus rhopalosiphi*	13 d	2-d LR_{50} = 578 mL product/ha (86.7 g a.i./ha) (95% CL 507 – 667 mL product/ha)2-d NOER [mortality] = 208.3 mL product/ha (31.25 g a.i./ha) 11-d NOER [reproduction]: 416.5 mL product/ha (62.5 g a.i./ha)	Effects on non-target terrestrial arthropods on artificial substrate	IIA 8.8.1.1/01 PMRA-2307584 (Word doc) and PMRA-2255447 (PDF)	Supplemental
Acute	SYN545 192 EC (synonym: A17056F) Guarantee: 150 g/L	Predatory mite *Typhlodromus pyri*	14 d	7-d LR50: > 833.33 mL product/ha (> 125 g a.i./ha) 7-d NOER [mortality]: 833.33 mL product/ha	Effects on non-target terrestrial arthropods on artificial substrate	IIA 8.8.1.2/01 PMRA-2307583 (Word doc) and PMRA-2255451 (PDF)	Supplemental

Table 5. Toxicity Reference Values For Terrestrial Organisms Exposed To Benzovindiflupyr.							
Exposure Scenario	**% A.I.**	**Species**	**Dur.**	**Toxicity Reference Value (std dev; slope)**	**Endpoints Affected**	**MRID; Classification**	**Acceptability**
	benzovindiflupyr			(125 g a.i./ha)14-d NOER [reproduction]: 3333 mL product/ha (500 g a.i./ha)			
Acute	Benzovindiflupyr EC (synonym: A15457FH) Guarantee: 100 g/L SYN545192	*Parasitic Wasp Aphidus rhopalosiphi*	13 d	2-d LR_{50}: 2650 mL product/ha (C.L. 2102 – 3482 mL product/ha)[265 (C.L. 210 – 348) g a.i./ha]2-d NOER [mortality]:750 mL product/ha (75 g a.i./ha)11-d NOER [reproduction]: 1500 mL product/ha (150 g a.i./ha)	Effects on non-target terrestrial arthropods in extended laboratory tests	IIA 8.8.2.1/01 PMRA-2307606 (Word doc) and PMRA-2255555 (PDF)	Supplemental
Acute	Benzovindiflupyr EC (synonym: A15457FH) Guarantee: 100 g/L SYN545192	Predatory mite *Typhlodromus pyri*	14 d	7-d LR50: > 6000 mL product/ha (> 600 g a.i./ha) – highest test conc. 7-d NOER [mortality]:3000 mL product/ha (300 g a.i./ha)14-d NOER [reproduction]: 6000 mL product/ha (600 g a.i./ha)	Effects on non-target terrestrial arthropods in extended laboratory tests	IIA 8.8.2.2/01PMRA-2307607 (Word doc) and PMRA-2255551 (PDF)	Supplemental

Bolded values refer to the most sensitive endpoint for a given taxa to be used in quantitative risk assessment.
*Regurgitation guidance (referenced in the effects section) states that the endpoint is the highest

- **Birds (Acute and Sub-Acute Toxicity)**

Three acute oral studies are available of three avian species (northern bobwhite quail, mallard duck, zebra finch) and two subacute dietary toxicity studies are available for two avian species (northern bobwhite quail, mallard duck).

The first acute study with bobwhite quail (exposed birds via oral gavage to concentrations of 0 (vehicle control) 292, 486, 810, 1350, and 2250 mg ai/kg-bw. On Day 14, there was 0, 0, 10, 0, 60, and 80% mortality in the 0 (vehicle control) 292, 486, 810, 1350, and 2250 mg ai/kg-bw groups, respectively. Sub-lethal effects were observed at all treatment levels and included one or more of the following characteristics: ruffled appearance, lethargy, loss of coordination, lower limb weakness, prostrate posture, loss of righting reflex, hyper-excitability, lower limb rigidity, sporadic movement about cage, sporadic head movement, and depression. Treatment-related effects were observed for overall body weight gain and feed consumption. The 14-day acute oral LD_{50} for northern bobwhites exposed to SYN545192 (Benzovindiflupyr) was 1373 mg a.i./kg-bw. This would classify Benzovindiflupyr as slightly toxic to the northern bobwhite quail on an acute oral basis. This study was classified as acceptable.

The second acute study with bobwhite quail exposed birds via oral gavage to a four stage sequential testing design with concentrations in stage 1 of 0 (vehicle control) or 2000 mg /kg-bw; stage 2 at concentrations of 392, 497, 630, 800, 1014, 1286, 1632, 2070, 2625, and 3330 mg/kg-bw; Stage 3 at concentrations of 889, 1129, 1433, 1819, and 2309 mg/kg-bw; stage 4 at concentrations of 1025, 1301, 1652, 2097, and 2662 mg/kg-bw. Sub-lethal effects were observed at all treatment levels during all stages. Body weight reductions were reported for 28 of 29 surviving birds from Days 0 to 3, and a majority of birds continued to lose weight from Days 3 to 7, and overall weight loss was observed for Days 0 to 14. The 14-day acute oral LD_{50} for Northern bobwhites exposed to SYN545192 (Benzovindiflupyr) was estimated as >1014 mg a.i./kg-bw. This study was classified as acceptable.

The third study with zebra finch exposed birds to benzovindiflupyr using a two stage test via oral gavage. Regurgitation was observed at all treatment levels in Stages 1 and 2. During stage 1, ten (5/sex/group) birds were exposed once to the test material at concentrations of 0 (vehicle control), 259, and 432 mg ai/kg-bw. Two males dosed at 259 mg ai/kg-bw and three males dosed at 432 mg ai/kg-bw were observed for 14 days post-dosing (mortality only). During stage 2, up to 18 (9 male and 9 female) birds were exposed once to the test material at concentrations of 0 (vehicle control), 10, 32, 100, and 320 mg ai/kg-bw. Ten (5/sex/group) birds that did not regurgitate in the 10 and 32 mg ai/kg-bw doses were observed for 14 days post-dosing. On Day 14, there was 0, 0, 0, 0, 50, and 33.3% mortality in the 0 (vehicle control 1), 0 (vehicle control 2), 10, 32, 259, and 432 mg ai/kg-bw groups, respectively. No treatment-related effects were observed for body weight or feed consumption. This study is classified as supplemental, as it does not fully satisfy the guideline requirement for acute oral toxicity study a passerine species due to the high degree of regurgitation throughout the study. The observation of regurgitation at all but the lowest treatment levels precluded the ability to derive a meaningful LD_{50} from this study that could be used in risk assessment as it is unclear what dose the birds actually received.

EFED guidance[6] indicates to use the highest value below which regurgitation did occur as the acute endpoint for this study. Based on this the LD_{50} is 10 mg/kg bw and categorizes benzovindiflupyr as highly to very highly toxic to the zebra finch.

An additional acute dietary toxicity test was submitted for zebra finch to try to better understand the toxic effects of solatenol on passerine species (MRID 49383802). This study exposed birds to nominal doses of 0 (negative control), 562, 1000, 1780, 3160, and 5620 mg ai/kg bw of diet in a 5 day test. A reliable LC_{50} could not be determined due to ≥70% mortality at all treatment levels and survival data possibly being confounded by food avoidance and resulting starvation. This study could not be used to derive an endpoint but indicates that solatenol is toxic to the zebra finch in the doses that were administered.

There were two subacute studies submitted for the northern bobwhite quail (MRID 48604515) and mallard duck (MRID 48604514), both categorizing benzovindiflupyr practically non-toxic on a sub-acute basis. In the northern bobwhite quail study, birds were exposed to mean-measured concentrations were <50 (<LOQ, control), 588, 959, 1780, 3130, and 6390 mg ai/kg-diet, respectively. Mortality was limited to one bird in the control group and one bird in the 6390 mg ai/kg-diet (mean measured) treatment group, the highest concentration tested. The LC_{50} based on mean-measured concentrations was >6390 mg ai/kg-diet. This study was classified as acceptable. In the mallard duck study, birds were exposed to mean-measured concentrations of <50 (<LOQ, control), 588, 959, 1780, 3130, and 6390 mg ai/kg-diet. There was not any treatment-related mortality during the study. Slight lethargy was reported on days 4 and 5 but all birds appeared normal on days 6-8. The 8-day acute dietary LC_{50} based on mean-measured concentrations was >6390 mg ai/kg-diet. This study was classified as acceptable. For risk assessment purposes, a subacute dietary LC_{50} of > 6390 ppm in the diet) will be used qualitatively to evaluate potential acute effects to birds (*i.e.*, a lower bound of 6390 ppm will be assumed as a screen for acute effects).

- **Birds (Chronic Toxicity)**

Two studies were submitted that examined the chronic toxicity of benzovindiflupyr to avian species. In the mallard duck study (MRID 48604516) 22 week old birds were exposed to mean-measured concentrations were <25 (<LOQ, control), 59.4, 202, and 598 mg ai/kg diet. Based upon treatment-related effects on adult female body weights and offspring body weights (hatchling weight and 14-d survivor weight) at the 202 and 598 mg ai/kg diet levels, the overall NOAEC and LOAEC were 59.4 and 202 mg ai/kg bw, respectively. There were no treatment-related effects noted for any treatment level regarding adult survival, clinical signs of toxicity, food consumption, or gross pathological findings. Data for male body weight gain were very

[6] Citation: (http://www.epa.gov/pesticides/science/efed/policy_guidance/team_authors/terrestrial_biology_tech_team/rr_regurg_acute_passerine.pdf)

highly variable (%CV over 300 for treatment concentrations) and so while no significant effects were observed ($p<0.05$), percent reductions from control were 34.5, 12.6, and 136.8% for the 59.4, 202, and 598 mg a.i/kg/diet treatment concentrations, respectively. There was a decreasing dose-dependent trend for female body weight gain. The body weight gain of females was significantly reduced from control ($p<0.05$) at the 202 and 598 mg ai/kg-diet levels. No treatment-related effects on reproduction were evident at the 59.4 mg ai/kg diet treatment level. At the 598 mg ai/kg diet level, the reviewer's analysis detected a significant reduction in egg production ($p=0.022$), relative to the control. Additionally, there were dose-dependent treatment reductions upon offspring body weights at the 202 and 598 mg ai/kg diet levels, with statistically-significant differences indicated for both hatchlings and 14-day old chicks ($p<0.05$; William's test). This study was classified as acceptable.

In the bobwhite quail study (MRID 48604517), birds were exposed to mean-measured concentrations of <25 (<LOQ, control), 60.0, 200, and 610 mg ai/kg diet, There was a slight, but significant dose-dependent reduction in the ratio of live 3-week embryos to viable embryos at the 200 and 610 mg ai/kg treatment levels ($p<0.005$; Jonckheere-Terpstra). However, the reduction in this reproductive endpoint did not exceed 1% of control and there were no other reproductive treatment-related effects noted in the study. There were no treatment-related effects on adult survival, clinical signs of toxicity, food consumption, adult body weight, or gross pathological findings. While statistically significant ($p<0.05$) effects on male body weight gain were attributed to high variation in the data and not related to treatment as a stimulatory effect on body weight gain was observed in females. Based on these findings, the NOAEC and LOAEC were determined to be 610 and >610 mg ai/kg diet, respectively. This study was classified as acceptable.

- **Mammals (acute toxicity)**

The acute oral toxicity for mammals, as conducted with formulated benzovindiflupyr (10.2% w/w or 99.6g/L) in an up-down study using treatment concentrations of 17.5, 55, 175 mg/kg using young adult rats (MRID 48604427). Benzovindiflupyr caused mortalities at 175 mg/kg bw (3/3) and at 55 mg/kg bw (1/4). Clinical signs included decreased activity (3/3), prone position (3/3), incoordination (3/3), piloerection (3/3), dyspnoea (3/3), decreased respiratory rate (1/3), clonic convulsion (1/3), decreased body temperature (3/3) and mortality (3/3) at a dose level of 175 mg/kg bw and decreased activity (4/4), dyspnoea (4/4), incoordination (4/4), hunched back (1/4), mortality (1/4) at 55 mg/kg. There were no adverse signs observed in the animal dosed at 17.5 mg/kg bw. The reviewer calculated LD_{50} was 66.3 mg/kg will be used for estimating acute RQs in mammals. This study was classified as acceptable.

- **Mammals (chronic toxicity)**

There was an acceptable chronic two-generation reproduction study conducted with the Norway rat submitted in support of benzovindiflupyr using dietary levels of 0, 25, 100, 250, 600 ppm (MRID 48604449). Food consumption in both the P and F1 generation were statistically lower in the highest two dietary levels but unaffected in the lower three concentrations. Body weights

in both the generations demonstrated the same trends as food consumption. Hepatocellular glycogen deposits were decreased in females at 100 and 250 ppm. The NOAEC calculated by ToxSAC for this study is 8.2 mg/kg/day for females, since the lowest LOAEL was 19.4 mg/kg/day in the matching females (which were consistently the most sensitive gender). **The NOAEC of 8.2 mg/kg/day will be used for estimating the acute RQs in mammals.**

- **Non-target Beneficial Insects**

One study examined acute oral and contact exposure of bees (*Apis mellifera*) to benzovindiflupyr (98.3% a.i) for 48 hours (MRID 48604527). The bees were exposed to nominal limit dose of 100 µg a.i/bee, as well as negative and solvent controls. By 48 hours in the contact and oral tests, no mortality occurred in the controls or treatment group. No LD_{50} values could be determined since cumulative mortality was <50% during both the contact and oral tests. The LD_{50} was >100 µg a.i/bee for the contact test, and the LD_{50} based on actual intake was >109 µg ai/bee for the oral test. As a result, Benzovindiflupyr is categorized as practically non-toxic to honey bees on an acute contact basis. This study was classified as acceptable.

- **Other Non-target Terrestrial Organisms**

An acute toxicity study was submitted that exposed TGAI benzovindiflupyr to the earthworm (*Eisenia fetida*, PMRA 2255438). Earthworms were exposed to nominal concentrations of 62.5, 125, 250, 500 and 1000 mg a.i./kg soil dry weight in addition to negative control. No mortality (0 %) occurred in the control group. The mortalities were 0, 2.5, 12.5, 70 and 95% in the 62.5, 125, 250, 500 and 1000 mg/kg treatments. The increase in mortality was significantly different than the control group in the two highest test substance concentrations: 500 and 1000 mg/kg. Thus, the NOEC for mortality was 250 mg/kg. The reviewer-calculated 14-day LC_{50} for mortality was 406.4 mg/kg with 95% confidence limits of 352.4 – 469.5 mg/kg. No abnormal behavior or toxic symptoms of the worms were observed at test concentrations up to and including 500 mg a.i./kg soil d.w. or in the control group during the test. At a concentration of 1000 mg a.i./kg soil d.w., the worm body was deformed with one or more constrictions visible. Thus the NOEC for sub-lethal signs of toxicity was visually determined to be 500 mg/kg. In the control group, the mean biomass changed by -5.7% (negative value denoting an overall decrease). The biomass changes in the 62.5, 125, 250, 500 and 1000 mg/kg treatments were -5.1, - 6.4, - 11.6, -15.9, and - 27.3%. Due to the lack of effects at the 50% level, an EC_{50} value for biomass decrease could not be calculated. The extent of the biomass decrease was significantly different than the control group in the three highest test substance concentrations: 250, 500 and 1000 mg/kg (Williams Multiple Sequential t-test Procedure, $\alpha = 0.05$). Thus, the NOEC for biomass decrease was determined by the reviewer to be 250 mg a.i.//kg soil d.w. This study was scientifically sound but was not designed to fulfill any current OCSPP guideline requirement and is therefore classified as supplemental.

In a 13-day acute toxicity study, the parasitic wasp (*Aphidius rhopalosiphi*) was exposed to benzovindiflupyr in the formulated product SYN545192 EC (150) [referred to in the study report by its product code: A17056F]. This end-use product has a guarantee of 150 g/L SYN545192 (benzovindiflupyr – BZV). At 48 h in the definitive test, the mortality in the control treatment

was 0.0%, whereas mortalities of 0, 0, 2.5, 17.5 and 77.5 were observed in the 52.1, 104.1, 208.3, 416.5, and 833 mL/ha treatment rates, respectively. The 416 and 833 mL/ha treatment rates differed significantly from the control (Fisher's Exact Test, $\alpha = 0.05$). The LR_{50} value calculated by the PMRA reviewer was 578 mL product/ha with 95% confidence limits of 507 and 667 mL product/ha. The LR_{50} value was used in the Canadian assessment. The NOER for mortality was 208.3 mL/ha. This study was acceptable and satisfies Canadian guideline requirements for a laboratory study with the parasitic wasp (*Aphidius rhopalosiphi*).
For EFED risk description this study was scientifically sound but was not designed to fulfill any current OCSPP guideline requirement and is therefore classified as supplemental.

In a 14-day acute toxicity study, the predatory mite (*Typhlodromus pyri*) was exposed to benzovindiflupyr in the formulated product SYN545192 EC (150) [referred to in the study report by its product code: A17056F]. This end-use product has a guarantee of 150 g/L SYN545192 (benzovindiflupyr – BZV). The corrected mortality was observed to be 16, 14, 27, 41 and 92% in the 420, 833.33, 1667, 3333, and 6667 mL/ha (63, 125, 250, 500 and 1000 g a.i./ha) treatments. Based on statistical comparison with the control, the no-observed-effects rate (NOER) for mortality was determined to be 833.33 mL A17056F/ha. Therefore the ER_{50} for mortality was empirically determined to be > 833.33 mL A17056F/ha. The reductions in fecundity in the 420, 833.33, 1667 and 3333 mL/ha treatments were equivalent to 25.5, 37.6, 30.7 and 17.7% relative to the control. When compared statistically, no test-item treatment differed significantly from the control (ANOVA, $\alpha = 0.05$) and the NOER was determined to be 3333 mL/ha (the highest concentration evaluated for reproduction, and the second highest concentration in the overall dose-response test). Canada determined that this study was acceptable and satisfied the Canadian guideline requirements for a laboratory study with the predatory mite (*Typhlodromus pyri*).
For EFED risk description this study was scientifically sound but was not designed to fulfill any current OCSPP guideline requirement and is therefore classified as supplemental.

In a 13-day acute toxicity study, the parasitic wasp (*Aphidius rhopalosiphi*) was exposed to the formulated product benzovindiflupyr EC (100) [referred to in the study report by its product code: A15457H]. This end-use product has a guarantee of 100 g/L SYN545192 (benzovindiflupyr – BZV). Treatments and controls were applied to pots of seedling barley (*Hordeum vulgare*) with a lab track sprayer that was used to deliver spray at a volume rate equivalent to 400 L/ha. Once the barley plants were dry, they were enclosed within cylindrical, ventilated collars. In addition to mortality and reproduction, the apparent repellence of the product was examined by observing settling behavior of the wasps. At 48 h in the definitive test, the mortality in the control treatment was 0.0%, whereas in the 375, 750, 1500, 3000 and 6000 mL/ha treatment rates, the observed mortalities were 0, 16.7, 20, 50 and 80, respectively. The 1500, 3000 and 6000 mL/ha treatment rates differed significantly from the control (Fisher's Exact Test, $\alpha = 0.05$). Therefore the NOER for mortality was 750 mL/ha. The LR_{50} was calculated by the reviewer to be 2650 mL product/ha with confidence limits of 2102 – 3482 mL product/ha. The mean reproductive output was 41.7 mummies produced per surviving female in the controls, compared with values of 46.5, 36.3 and 27 in the 750, 1500 and 3000 mL product/ha treatment rates, respectively. This represents a -11.4 (negative value indicating an increase), 12.9 and 35.3% change relative to the controls. The reproductive performance of

surviving wasps was significantly affected 3000 mL product/ha treatment rate (i.e. 35.3% reduction). Therefore, the NOER for reproduction was 1500 mL product/ha. Due to the nature of the response data (lack of effects beyond 35%), it was not possible to calculate an ER_{50} value for reproduction. Canada considered this study acceptable and it satisfied Canadian guideline requirements for a laboratory study with the parasitic wasp (*Aphidius rhopalosiphi*). For EFED risk description this study was scientifically sound but was not designed to fulfill any current OCSPP guideline requirement and is therefore classified as supplemental.

In a 14-day acute toxicity study, the predatory mite (*Typhlodromus pyri*) was exposed to benzovindiflupyr in the formulated product SYN545192 EC (100) [referred to in the study report by its product code: A15457H]. This end-use product has a guarantee of 100 g/L SYN545192 (benzovindiflupyr – BZV). Treatments and controls were applied to leaf discs taken from French bean plants (*Phaseolus vulgaris* L.) using a lab track sprayer to deliver spray at a volume rate equivalent to 200 L/ha. After the leaf discs had dried, they were placed into test chambers with their treated surface facing upwards. Mite mortality was 0% in the control and was observed to be 0, 7, 0, 2, 2 and 15% in the 375, 750, 1500, 3000 and 6000 mL/ha (37.5, 75, 150, 300 and 600 g a.i./ha) treatments. Based on statistical comparison with the control, the no-observed-effects rate (NOER) for mortality was determined to be 3000 mL A17056F/ha. A reliable ER_{50} for mortality could not be calculated due to lack of effects greater than 15%. Thus, the LR_{50} for mortality was empirically determined to be > 6000 mL A17056F/ha. The reductions in fecundity in the 375, 750, 1500, 3000 and 6000 mL/ha (37.5, 75, 150, 300 and 600 g a.i./ha) treatments were equivalent to -10.4% (negative value denoting an increase relative to controls), 11.5, 6.8, 28.1 and 12.9% relative to the controls. When compared statistically, no test-item treatment differed significantly from the control (ANOVA, $\alpha = 0.05$) and the NOER was determined to be 6000 mL/ha (the highest test concentration). Canada considered this study acceptable and it satisfied Canadian guideline requirements for a laboratory study with the predatory mite (*Typhlodromus pyri*). For EFED risk description this study was scientifically sound but was not designed to fulfill any current OCSPP guideline requirement and is therefore classified as supplemental.

- **Terrestrial Plants**

Toxicity reference values for terrestrial plants exposed to benzovindiflupyr is shown in **Table 6**.

Table 6. Toxicity Reference Values for Terrestrial Plants Exposed to Benzovindiflupyr.

Crop	Species Common name	EC_{25} (lbs a.i./A)	NOAEL (lbs a.i./A)	MRID Acceptability
Seedling Emergence (formulated benzovindiflupyr)				
Monocots	Corn	>0.089	0.089	48604538 Supplemental
	Wheat	>0.089	0.089	
	Onion	>0.089	0.089	
	Ryegrass	>0.089	0.089	
Dicots	Cabbage	>0.089	0.089	
	Lettuce	>0.089	0.089	
	Sugar beet	>0.089	0.089	
	Tomato	>0.089	0.089	
	Radish	>0.089	0.089	
	Soybean	>0.089	0.089	
Vegetative Vigor (formulated benzovindiflupyr)				
Monocots	Corn	NC	0.09	48604599 Acceptable
	Wheat	NC	0.09	
	Onion	NC	0.09	
	Ryegrass	NC	0.09	
Dicots	Cabbage	NC	0.09	
	Lettuce	NC	0.09	
	Sugarbeet	NC	0.09	
	Tomato	NC	0.09	
	Radish	NC	0.09	
	Soybean	NC	0.09	

NC: Not calculated

A seedling emergence and vegetative vigor study (Table 6) were submitted with TEP benzovindiflupyr (purity is 148 g/L; 14.6% a.i) (MRIDs 48604538 and 48604599, respectively). In the seedling emergence study, seeds were exposed to mean measured concentrations ranging from 0.0011 to 0.089 lb a.i./A depending on the species for 21 days. The NOAEC for monocots and dicots was 0.089 lbs a.i/A (which is equivalent to 100 g/Ha). There was however uncertainty in this endpoint. Six of the 10 species (onion, ryegrass, sugarbeet, cabbage, lettuce, and tomato) had treatment levels that were statistically different from controls, and NOAECs derived from these species ranged from 0.003 to 0.029 lbs a.i./A. But in each case there was very poor statistical power and the responses were not treatment related. The lack of trends in any of the data sets and the NOAEC at the highest tested concentration make any of the EC_{25} values determined uncertain. The EC_{25} is therefore set at greater than the highest concentration tested which is 0.089 lbs a.i/A. As a result, this study partially fulfils the guideline requirement for a Tier II Seedling Emergence study and is classified as supplemental but indicates that solatenol is not likely to have adverse impacts on plants.

The effect of benzovindiflupyr on the vegetative vigor of monocots and dicots was studied at measured concentrations of <LOQ (control) and 0.090 lb ai/A. In the vegetative vigor test, survival, plant dry weight, and plant height were not affected by the test material. The most sensitive monocot and dicot species could not be determined due to a lack of toxicity in this study. The overall NOAEC value was 0.090 lb ai/A (equivalent to 101 g ai/ha). Chlorosis, necrosis, wilt, and insect damage were observed in the cabbage controls; however, the treated plants were unaffected. There was complete mortality in a single treated lettuce plant; however, no other plants were affected. Leaf curl and necrosis were observed in the treated radish plants, but the effects were very slight and not attributable to the test material. In conclusion, there were no compound-related phytotoxic effects.

2.4 Conceptual Model and Risk Hypothesis

Benzovindiflupyr is considered to be the primary stressor in this risk assessment. Given benzovindiflupyr's persistent properties, small levels of degradates are expected under environmentally relevant conditions as demonstrated with environmental fate and terrestrial field dissipation studies (see **Appendix F**). Furthermore, measured comprehensive toxicity data on two of these degradates for freshwater fish, freshwater invertebrates, and aquatic plants indicate that parent benzovindiflupyr is between 3 and 4 orders of magnitude more toxic for freshwater fish and invertebrates and one order of magnitude for non-vascular aquatic plants than the degradates (see **Appendix G** for the endpoint values of the ecological toxicological studies for the degradates). Therefore, this risk assessment will only evaluate adverse impacts from parent benovindiflupyr considering the limited formation of transformation products and its high relative toxicity compared to the degradates.

The identification of relevant environmental exposure pathways to benzovindiflupyr applications for this risk assessment evaluating impact to non-target organisms are discussed below:

- **Dietary Exposure**: Direct dietary exposure to non-target terrestrial organisms (birds and mammals) is possible due to the direct deposition of benzovindiflupyr sprays on to crop foliage, enabling the bioavailability of benzovindiflupyr. Furthermore, indirect dietary exposure may result from the impact of benzovindiflupyr's resulting aquatic exposure (discussed further below) with fish. Piscivorous birds and mammals feeding on contaminated fish may potentially be exposed. Bioaccumulation of benzovindiflupyr residues is possible in fish given benzovindiflupyr's Log K_{ow} value of 4.30 and steady-state BCF values in fish of up to 405 L/Kg (MRID No. 48604521).

- **Aquatic Exposure**: The overall persistence of benzovindiflupyr in the environment and its potential to be transported to water bodies and aquatic habitat mainly in a sorbed state to erodible soil particles embedded within runoff or its deposition into water bodies via spray drift indicates that aquatic exposure is another relevant pathway associated with benzovindiflupyr applications. Freshwater and estuarine marine fish and invertebrates as well as aquatic plants in the water column may be impacted. In addition, benthic organisms residing in the bottoms of water bodies may also be impacted given the

benzovindiflupyr's tendency to bind to sediment to a large extent as shown in **Figure 1**.

- **Terrestrial plants:** Terrestrial plants may be impacted from benzovindiflupyr applications given the potential for residues to runoff off-site from treated fields to adjacent lands covered with non-targeted vegetation. Furthermore, off-site deposition of benzovindiflupyr due to spray drift may also adversely impact non-target terrestrial plants. However, the NOAEC for terrestrial plants are equivalent to the highest application rate (see **Table 6**). Therefore, adverse impacts are not expected. Nonetheless, the risk analysis will be conducted for terrestrial plants to confirm this.

- **Terrestrial invertebrates:** Dietary and contact exposure to terrestrial invertebrates are possible pathways with benzovindiflupyr applications. Crops treated with benzovindiflupyr may potentially attract terrestrial invertebrates (e.g., beneficial insects) resulting in dietary and contact exposure.

Drinking water and inhalation exposure to terrestrial animals are <u>not</u> expected to be of concern as verified by results of the Screening Imbibition Program (SIP version 1.0, 6/15/2010) and the Screening Tool for Inhalation Risk (STIR version 1.0; 11/23/2010), respectively. SIP is available publically at: http://www.epa.gov/oppefed1/models/terrestrial/sip/sip_user_guide.html. STIR may be accessed on-line at: http://www.epa.gov/oppefed1/models/terrestrial/stir/stir_user_guide.html.

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). For benzovindiflupyr, the following ecological risk hypothesis is being employed for this risk assessment:

> *Given the proposed ground and aerial foliar spray uses of benzovindiflupyr and its environmental fate properties, there is a likelihood of exposure to non-target terrestrial and aquatic organisms.*
>
> *When used in accordance with the label, benzovindiflupyr results in potential adverse effects upon the survival, growth, and reproduction of non-target terrestrial and aquatic organisms.*

2.5 Analysis Plan

The primary method used to assess risk in this screening-level assessment is the risk quotient (RQ) and follows the methods outlined in the EPA Overview Document (EPA, 2004). The RQ is the primary risk value for the screening-level 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 LD_{50} or NOAEC. The RQ is calculated as a ratio of the estimated environmental concentration (EEC) to an effect level (*e.g.*, LC_{50}, LD_{50} or NOAEC) using the

effect level as a denominator. The resulting RQ is then compared to a specified level of concern (LOC), which represents a point of departure for concern. For example, if the RQ exceeds the LOC, then there is the potential for risk. In general, the higher the RQ, the more certain the potential risks. However, the risk quotients are not necessarily a true estimate of risk since there is no estimated probability of effect. Risk presumptions, along with the corresponding RQs and LOCs, are summarized in **Appendix A**.

Generation of robust risk quotients is dependent on the quality of data from both fate and toxicological studies. The adequacy of the submitted data is evaluated relative to Agency guidelines. For benzovindiflupyr, the available environmental fate data ecological effects data is determined to be sufficient in evaluating the ecological risk to terrestrial and aquatic organisms as a result of the proposed uses.

2.5.1 Measures of Exposure

To estimate risks of benzovindiflupyr exposures in aquatic and terrestrial environments, all exposure modeling and resulting risk conclusions will be based on maximum application rates and methods cited in **Table 1** and will be estimated for each use of benzovindiflupyr. Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EEC) of benzovindiflupyr. Aquatic exposure in surface waters, benthic pore water, and sediment for proposed benzovindiflupyr applications are estimated using The Surface Water Concentration Calculator interface (SWCC version 1.106, dated June 6, 2014). The SWCC is available on-line at: http://www.epa.gov/oppefed1/models/water/#swcc. The standard farm pond scenario will be used to estimate the aquatic EECs. The model used to predict terrestrial EECs on food items is the Terrestrial Residue Exposure (T-REX) publically available at: http://www.epa.gov/oppefed1/models/terrestrial/trex/t_rex_user_guide.htm. The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant accessible publically at: http://www.epa.gov/oppefed1/models/terrestrial/terrplant/terrplant_user_guide.html. The model used to derived EECs relevant to drift is AgDrift (version 2.1.1). These models are parameterized using relevant reviewed environmental fate data and ecological toxicity studies from registrant submissions and the literature; model input values will be consistent with the most recent version of the input parameter guidance (citation: http://www.epa.gov/oppefed1/models/water/input_parameter_guidance.htm).

Since benzovindiflupyr is a new active ingredient, there are no environmental monitoring data available. Therefore, exposure will only be quantified using EECs calculated from the models described above.

2.5.2 Measures of Effects

Measures of ecological effects are obtained from a suite of registrant-submitted guideline studies conducted with a limited number of surrogate species. 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. Although monitoring data may also be used to provide supporting lines of evidence for the risk characterization, monitoring data is not available for this new chemical. Commonly used laboratory-derived toxicity values include estimates of acute mortality (such as LD_{50}, LC_{50}, or EC_{50}) and estimates of effects due to longer term, chronic exposures (such as the NOAEC or NOAEL). In addition, effects other than survival, reproduction, and growth may be considered, (such as changes in biochemical, cellular, organ-level responses) but are typically used qualitatively to characterize risks since, in many cases, the relationship between these effects and higher-order processes is prone to more uncertainty. The latter can reflect changes seen in mortality, reproduction, or growth. In general, for a given assessment endpoint, the lowest relevant measure of effect is used in calculating the risk quotient.

3. RISK ANALYSIS AND CHARACTERIZATION

Risk characterization is the integration of exposure and effects characterization to determine the ecological risk from the use of benzovindiflupyr and the likelihood of effects on aquatic life, wildlife, and plants based on varying pesticide-use scenarios. The risk characterization provides estimation and a description of the exposure and resulting risk; articulates risk assessment assumptions, limitations, and uncertainties; synthesizes an overall conclusion; and provides the risk managers with information to make regulatory decisions.

3.1 Exposure Estimation

3.1.1 Aquatic Exposure Estimation

The fate parameters and use-specific input parameters for the SWCC aquatic exposure modeling used to estimate upper-bound EECs due to benzovindiflupyr applications are shown in **Table 7** (chemical specific input parameters) and **Table 8** (crop use specific input parameters). Broadcast aerial applications are only evaluated in this screening level risk assessment for all uses except turf and nursery plants since this is considered to be the application method resulting in the most conservative exposure scenario as compared to ground applications and localized banded and in-furrow soil applications. Only ground spray applications are evaluated for turf and nursery since aerial applications are not proposed on the product labels. EECs are calculated considering scenarios possessing the most vulnerable environmental conditions for all benzovindiflupyr proposed uses nationwide. The EECs of benzovindiflupyr in the surface water column, benthic pore water, and sediment are shown for aerial and ground applications in **Table 9**. A sample SWCC output file is provided in **Appendix E.**

Table 7. SWCC chemical property input parameter values for benzovindiflupyr aquatic exposure estimation.

SWCC Input Parameter	Input Value and Unit	Source
Physical Chemical Properties		
Molecular Weight (g/mol)	398.2	MRID 48604402
Vapor Pressure (torr)	2.40×10^{-11}	MRID 48604402
Solubility in Water (mg/L)	0.98	MRID 48604402
Soil-Water Partition Coefficient (K_{oc}) (mL/g)	4,478	MRID 48604505 EFED Input Parameter Guidance Mean value from batch equilibrium studies (n = 5 soils)
Environmental Fate Properties		
Hydrolysis at pH7 ($t_{1/2}$)	Stable	MRID 48604506
Aerobic soil metabolism ($t_{1/2}$) and Reference Temperature	1,460 days @ 20°C	MRID 48604492 & 48604493 EFED Input Parameter Guidance Upper 90^{TH} percentile confidence interval (n = 5 soils)[1]
Aerobic aquatic metabolism ($t_{1/2}$) and	2,920 days @ 20°C	MRID 48604509 & 48604510

Table 7. SWCC chemical property input parameter values for benzovindiflupyr aquatic exposure estimation.		
SWCC Input Parameter	**Input Value and Unit**	**Source**
Reference Temperature		EFED Input Parameter Guidance Supplemental aerobic aquatic metabolism study available. Conservative default of 2 x aerobic soil metabolism half-life used (2 x 1,460 days).
Anaerobic aquatic metabolism ($t_{1/2}$) and Reference Temperature	907 days @ 20°C	MRID 48604494 EFED Input Parameter Guidance Upper 90th percentile confidence interval (n = 4 soil-water sediment systems)[1].
Aqueous Photolysis ($t_{1/2}$) and Reference latitude	88.4 days @ 45°N	MRID 48604507
Foliar Extraction	0.5	Default assumption for foliar applications

[1] The upper 90th percentile half life calculated as follows: $t_{1/2\ input} = \overline{t_{1/2}} + \frac{(t_{90,\ n-1} \times \sigma)}{n^{1/2}}$

where $\overline{t_{1/2}}$ is the mean of the set of half lives from each study, $t_{90,\ n-1}$ is the one-sided t value for the 90th percentile level, σ is the standard deviation of the set of half lives determined from each study, and n is the sample size of the set of half lives determined from each study.

Table 8. SWCC crop scenario and application methods input parameter values for benzovindiflupyr aquatic exposure estimation.

Crop Use	SWCC Application Method and Crop Scenario Input Parameters						
	Representative Vulnerable SWCC Scenario and Weather Station[1]	Application Rate (kg a.i./ha)[2]	Number of Applications and Retreatment Interval[2]	First Application Date[3]	Application Methods[4]	Application Efficiency[5]	Spray Drift Fraction[6]
Corn	MS Corn 03940.dvf (Jackson, MS)	0.076	4 apps., 7 days apart	Apr. 10	Foliar - Aerial	0.95	0.125
Cucurbits	FL Cucumbers 12844.dvf (West Palm Beach, FL)			Oct. 25			
Tomatoes and Fruiting Vegetables	FL Tomato 12844.dvf (West Palm Beach, FL)			May 1			
Grapes	NY Grape 14860.dvf (Erie, PA)			Sept. 15			
Tubers (Potatoes)	ME Potato 14607.dvf (Caribou, ME)			Aug. 15			
Peanuts	NC Peanuts 13722.dvf (Raleigh, NC)	0.1	3 apps., 14 days apart	Aug. 1			
Nursery Plants, Tomato Transplant, Fruit Transplant, Cucurbit Transplant	NJ Nursery 93730.dvf (Atlantic City, NJ)		3 apps., 7 days apart	Aug. 5	Foliar - Ground	0.99	0.062
Turf Grass	FL Turf 12834.dvf (Daytona Beach, FL)		3 apps., 14 days apart	Oct. 5			
Cotton	MS Cotton 03940.dvf (Jackson, MS)	0.076	3 apps., 7 days apart	May 15	Foliar – Aerial	0.95	0.125

Table 8. SWCC crop scenario and application methods input parameter values for benzovindiflupyr aquatic exposure estimation.

Crop Use	SWCC Application Method and Crop Scenario Input Parameters						
	Representative Vulnerable SWCC Scenario and Weather Station[1]	Application Rate (kg a.i./ha)[2]	Number of Applications and Retreatment Interval[2]	First Application Date[3]	Application Methods[4]	Application Efficiency[5]	Spray Drift Fraction[6]
Blueberries	NY Grape 14860.dvf (Erie, PA)	0.076	2 apps., 10 days apart	Sept. 15	Foliar – Aerial	0.95	0.125
Soybeans & Legumes	MS Soybean 03940.dvf (Jackson, MS)	0.076	2 apps., 7 days apart	May 15			
Cereal (Oats, Barley, and Wheat)	ND Wheat 14914.dvf (Fargo, ND)	0.076	2 apps., 14 days apart	Jun. 20			
Canola	ND Canola 24013.dvf (Minot, ND)	0.076	1 app.	Aug. 15			
Pome fruit	CA Fruit 93193.dvf (Fresno, CA)	0.052	4 apps., 7 days apart	Feb. 10			

1 Selected crop scenarios possessing most vulnerable environmental conditions for all benzovindiflupyr uses. Refer to **Table 1** for information on maximum application rates specified on the label for proposed uses which was partially considered to select crop scenarios.

2 Maximum single application rate specified on product labels (**Table 1**).

3 Selected based on maximum rainfall climatological date at meteorological station after crop emergence date specified in PRZM crop scenario based on expected pest pressure.

4 The most conservative application method evaluated based on crop uses specified on product labels.

5 EFED input parameter guidance for aerial and ground applications.

6 Spray drift fraction for aerial and ground applications from Table 2 of EPA, 2013, "Guidance on Modeling Offsite Deposition of Pesticides via Spray Drift".

Table 9. SWCC estimated upper bound concentrations in the surface water column, pore water, and sediment (ppb) for aerial application of benzovindiflupyr at the highest application rate for proposed crop uses.

Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	Surface Water Column EECs (µg/L)			Pore Water EECs (µg/L)		Sediment EECs (µg/Kg dry wt.)	
	Peak	21-day	60-day	Peak	21-day	Peak	21-day
Corn (MS Corn, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	8.13	7.11	6.76	6.42	6.41	1,149	1,147
Cucurbits (FL Cucumber, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	5.66	4.49	4.24	3.88	3.88	695	695
Grapes (NY Grape, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	6.85	5.94	5.61	5.38	5.38	963	963
Nursery Crops (NJ Nursery , 0.088 lbs. a.i./A, 3 apps. 7 days apart)	3.83	3.24	3.01	2.85	2.85	510	510
Peanuts (NC Peanuts, , 0.089 lbs. a.i./A, 3 apps. 7 days apart)	4.52	3.93	3.69	3.43	3.43	614	614
Tubers (Potatoes) (ME Potatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**8.71**	**8.17**	**7.91**	**7.77**	**7.77**	**1,391**	**1,391**
Tomatoes and Fruiting Vegetables (FL Tomatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	5.62	4.52	4.15	3.78	3.77	677	675
Turf Grass (FL Turf, 0.088 lbs. a.i./A, 3 apps. 14 days apart)	1.09	0.881	0.842	0.730	0.729	131	130
Cotton (MS Cotton, 0.068 lbs. a.i./A, 3 apps. 7 days apart)	5.30	4.55	4.28	3.98	3.97	712	711
Blueberries (NY Grape, 0.068 lbs. a.i./A, 2 apps. 10 days apart)	3.40	3.06	2.93	2.82	2.82	505	505

Table 9. SWCC estimated upper bound concentrations in the surface water column, pore water, and sediment (ppb) for aerial application of benzovindiflupyr at the highest application rate for proposed crop uses.

Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	Surface Water Column EECs (µg/L)			Pore Water EECs (µg/L)		Sediment EECs (µg/Kg dry wt.)	
	Peak	21-day	60-day	Peak	21-day	Peak	21-day
Soybeans and Legumes (MS Soybeans, 0.068 lbs. a.i./A, 2 apps. 7 days apart)	2.84	2.46	2.23	2.05	2.05	367	367
Cereal Crops (ND Wheat, 0.068 lbs. a.i./A, 2 apps. 14 days apart)	2.86	2.53	2.42	2.28	2.27	408	406
Canola (ND Canola, 0.068 lbs. a.i./A, 1 app.)	1.36	1.12	1.00	0.928	0.928	166	166
Pome fruit (CA Fruit, 0.046 lbs. a.i./A, 4 apps. 7 days apart)	1.42	1.19	1.04	0.910	0.909	163	163

***Bold** text indicate maximum values.
EECs are not one-in-ten year return frequency values due to accumulation in the pond.

3.1.2 Terrestrial Exposure Estimation

In order to estimate risks of benzovindiflupyr exposures in terrestrial environments, all exposure modeling and resulting risk conclusions will be based on maximum application rates for a given use. Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of benzovindiflupyr.

- ***Wildlife Dietary Exposure Estimation***

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived from using the T-REX model (Version 1.5, released 03/2012). This model incorporates the Kenaga nomogram, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph (Hoerger and Kenaga, 1972) was developed using the upper 90th percentile confidence bound of foliar dissipation half-life values from actual field measurements. The Fletcher *et al.* (1994) modifications to the Kenaga nomograph are based on field measured field residues from 249 published papers, including information on 118 species of plants, 121 pesticides, and 17 chemical classes. The environmental (foliar dissipation) half-life of 10.9 days was derived 90th percentile value from the foliar dissipation half-lives of submitted studies and was used to estimate EECs in lieu of the T-REX default half-life of 35 days[7]. **Table 10** and **Table 11** show

[7] Please refer to data presented for terrestrial field dissipation studies in Table 3 (MRID Nos. 48604498, 48604502, 48604580, 48604581).

the estimated environmental dose-based concentrations (EECs) for the three weight classes of birds and mammals, respectively. **Table 12** shows the estimated dietary-based concentrations (EECs) for both birds and mammals. These EECs were combined with the most sensitive endpoints to generate risk quotients described in the risk characterization section. The T-REX sample input file is provided in **Appendix B.**

Table 10. Terrestrial food item residue estimates for birds with proposed crop uses of benzovindiflupyr (environmental dose mg/kg-bw).

	20 g "Small" Bird						100 gram "Medium" Bird						1000 gram "Large" Bird					
Crop Use	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds
Corn, cucurbits, fruit and tomatos, grapes, tubers	43.0	19.7	24.2	2.7	16.8	0.6	24.5	11.2	13.8	1.5	9.6	0.3	11.0	5.0	6.2	0.7	4.3	0.2
Peanuts	38.4	17.6	21.6	2.4	15.0	0.5	21.9	10.0	12.3	1.4	8.6	0.3	9.8	4.5	5.5	0.6	3.8	0.1
Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant	49.3	22.6	27.8	3.1	19.3	0.7	28.1	12.9	15.8	1.8	11.0	0.4	12.6	5.8	7.1	0.8	4.9	0.2
Turf grasses	38.0	17.4	21.4	2.4	14.9	0.5	21.7	9.9	12.2	1.4	8.5	0.3	9.7	4.4	5.5	0.6	3.8	0.1
Cotton	38.1	17.5	21.4	2.4	14.9	0.5	21.7	10.0	12.2	1.4	8.5	0.3	9.7	4.5	5.5	0.6	3.8	0.1
Blueberries	28.4	13.0	16.0	1.8	11.1	0.4	16.2	7.4	9.1	1.0	6.3	0.2	7.3	3.3	4.1	0.5	2.8	0.1
Soybeans, Legumes	30.5	14.0	17.2	1.9	11.9	0.4	17.4	8.0	9.8	1.1	6.8	0.2	7.8	3.6	4.4	0.5	3.0	0.1
Cereal (Oats, Barley, and Wheat)	26.2	12.0	14.7	1.6	10.3	0.4	15.0	6.9	8.4	0.9	5.9	0.2	6.7	3.1	3.8	0.4	2.6	0.1
Canola	18.6	8.5	10.5	1.2	7.3	0.3	10.6	4.9	6.0	0.7	4.2	0.1	4.7	2.2	2.7	0.3	1.9	0.1
Pome fruit	29.1	13.3	16.4	1.8	11.4	0.4	16.6	7.6	9.3	1.0	6.5	0.2	7.4	3.4	4.2	0.5	2.9	0.1

Table 11. Terrestrial food item residue estimates for mammals with proposed crop uses of benzovindiflupyr (environmental dose mg/kg-bw).																		
	15 gram "Small" Mammal						35 gram "Medium" Mammal						1000 gram "Large" Mammal					
Crop Use	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds
Corn, cucurbits, fruit and tomatos, grapes, tubers	36.0	16.5	20.3	2.3	14.1	0.5	24.9	11.4	14.0	1.6	9.7	0.3	5.8	2.6	3.2	0.4	2.3	0.1
Peanuts	32.2	14.7	18.1	2.0	12.6	0.4	22.2	10.2	12.5	1.4	8.7	0.3	5.2	2.4	2.9	0.3	2.0	0.1
Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant	41.3	18.9	23.2	2.6	16.2	0.6	28.5	13.1	16.1	1.8	11.2	0.4	6.6	3.0	3.7	0.4	2.6	0.1
Turf grasses	31.8	14.6	17.9	2.0	12.5	0.4	22.0	10.1	12.4	1.4	8.6	0.3	5.1	2.3	2.9	0.3	2.0	0.1
Cotton	31.9	14.6	18.0	2.0	12.5	0.4	22.1	10.1	12.4	1.4	8.6	0.3	5.1	2.3	2.9	0.3	2.0	0.1
Blueberries	23.8	10.9	13.4	1.5	9.3	0.3	16.4	7.5	9.3	1.0	6.4	0.2	3.8	1.7	2.1	0.2	1.5	0.1
Soybeans, Legumes	25.5	11.7	14.4	1.6	10.0	0.4	17.6	8.1	9.9	1.1	6.9	0.2	4.1	1.9	2.3	0.3	1.6	0.1
Cereal (Oats, Barley, and Wheat)	21.9	10.1	12.3	1.4	8.6	0.3	15.2	7.0	8.5	0.9	5.9	0.2	3.5	1.6	2.0	0.2	1.4	0.0
Canola	15.6	7.1	8.8	1.0	6.1	0.2	10.8	4.9	6.0	0.7	4.2	0.1	2.5	1.1	1.4	0.2	1.0	0.0
Pome fruit	24.4	11.2	13.7	1.5	9.5	0.3	16.8	7.7	9.5	1.1	6.6	0.2	3.9	1.8	2.2	0.2	1.5	0.1

Table 12. Terrestrial food item residue estimates for birds and mammals with proposed crop uses of benzovindiflupyr (dietary concentration ppm).					
Crop Use	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods
Corn, cucurbits, fruit and tomatos, grapes, tubers	37.8	17.3	21.2	2.4	14.8
Peanuts	33.7	15.5	19.0	2.1	13.2
Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant	43.3	19.9	24.4	2.7	17.0
Turf grasses	33.4	15.3	18.8	2.1	13.1
Cotton	33.5	15.3	18.8	2.1	13.1
Blueberries	25.0	11.4	14.0	1.6	9.8

Table 12. Terrestrial food item residue estimates for birds and mammals with proposed crop uses of benzovindiflupyr (dietary concentration ppm).					
Crop Use	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods
Soybeans, Legumes	26.8	12.3	15.1	1.7	10.5
Cereal (Oats, Barley, and Wheat)	23.0	10.6	12.9	1.4	9.0
Canola	16.3	7.5	9.2	1.0	6.4
Pome fruit	25.6	11.7	14.4	1.6	10.0

- ***Terrestrial Plant Exposure Estimation***

The model used to predict terrestrial and wetland plants is TerrPlant (version 1.2.2, released 12/2006). EECs for terrestrial plants inhabiting dry and wetland areas are derived using this model which utilizes the solubility of pesticide in runoff and in spray drift. Additionally, TerrPlant derived EECs factor in application rate and minimum incorporation depth. **Table 13** summarizes the EECs resulting from the proposed uses of benzovindiflupyr. The sample TerrPlant model output file is presented in **Appendix D.**

Table 13. TerrPlant derived EECs for dry and semi-aquatic areas resulting from proposed benzovindiflupyr crop uses.		
Crop Uses	**Description of Area**	**EEC (lbs a.i/A)**
Pome fruit	Runoff to Dry areas	0.00046
	Runoff to semi-aquatic areas	0.0046
	Spray drift	0.00046
	Total for dry areas	0.00092
	Total for semi-aquatic areas	0.00506
Corn Cucurbits Tomatoes and Fruiting Vegetables Grapes Tubers (Potatoes) Cotton Blueberries Soybeans and Legumes Cereal Crops (Oats, Barley, and Wheat) Canola	Runoff to Dry areas	0.00068
	Runoff to semi-aquatic areas	0.0068
	Spray drift	0.00068
	Total for dry areas	0.00136
	Total for semi-aquatic areas	0.00748

Table 13. TerrPlant derived EECs for dry and semi-aquatic areas resulting from proposed benzovindiflupyr crop uses.		
Crop Uses	**Description of Area**	**EEC (lbs a.i/A)**
Peanuts Nursery Plants Tomato Transplant, Fruit Transplant, and Cucurbit Transplant Turf Grass	Runoff to Dry areas	0.00089
	Runoff to semi-aquatic areas	0.0089
	Spray drift	0.00089
	Total for dry areas	0.00178
	Total for semi-aquatic areas	0.00979

- ***Terrestrial Organism Exposure to Residues in Aquatic Food Items***

The KABAM model (KOW based Aquatic BioAccumulation Model) version 1.0 was used to evaluate the potential exposure and risk of direct effects to birds and mammals via bioaccumulation and biomagnification in aquatic food webs. KABAM is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic ecosystems and risks to mammals and birds consuming aquatic organisms which have bioaccumulated these pesticides. The bioaccumulation portion of KABAM is based upon work by Arnot and Gobas (2004) who parameterized a bioaccumulation model based on PCBs and some pesticides (*e.g.*, lindane, DDT) in freshwater aquatic ecosystems (Arnot and Gobas, 2004). KABAM relies on a chemical's octanol-water partition coefficient (KOW) to estimate uptake and elimination constants through respiration and diet of organisms in different trophic levels. Pesticide tissue residues are calculated for different levels of an aquatic food web. The model then uses pesticide tissue concentrations in aquatic animals to estimate dose- and dietary-based exposures and associated risks to mammals and birds (surrogate for amphibians and reptiles) consuming aquatic organisms. Seven different trophic levels including phytoplankton, zooplankton, benthic invertebrates, filter feeders, small-sized (juvenile) forage fish, medium-sized forage fish, and larger piscivorous fish, are used to represent an aquatic food web. Input parameters from the modeled scenarios are presented in **Table 14**. Example output from the bioaccumulation model is provided in **Appendix C.**

Table 14. Benzovindiflupyr input parameter values for KABAM.		
Parameter	**Input Value**	**Source**
Pesticide Name	Benzovindiflupyr	
Log K_{OW}	4.3	MRID 48604402
K_{OC}	4,478 L/kg_{OC}	MRIDs 48604505
Use patterns	Acute Concentration in sediment pore water (ppb)	Acute Concentration in water column (ppb)
Corn	6.41	7.11
Cucuribits	3.88	4.49
Grapes	5.38	5.94
Nursery Crops	2.85	3.24
Peanuts	3.43	3.93
Tubers	7.77	8.17
Tomatos	3.78	4.52
Cotton	3.97	4.55
Blueberries	3.98	3.06
Soybeans and legumes	2.05	2.46
Cereal Crops	2.27	2.53
Canola	0.928	1.12
Pome fruits	0.909	1.19
Turf grass	0.729	0.881

Based on KABAM results, estimated concentrations of benzovindiflupyr residues in the tissue of organisms in the different trophic levels following application on the proposed uses of benzovindiflupyr range from 817 to 9,055 µg/kg (**Table 15**).

Table 15. Predicted Acute Concentrations of Benzovindiflupyr in Aquatic Organism Tissues at Different Trophic Levels (µg/kg).							
Crop Uses	**Phytoplankton**	**Zooplankton**	**Benthic Invertebrates**	**Filter Feeders**	**Small Fish**	**Medium Fish**	**Large Fish**
Corn	6603	4884	5348	3517	7079	7347	7877
Cucuribits	4170	3085	3371	2217	4462	4631	4973
Grapes	5517	4081	4469	2939	5915	6139	6581
Nursery Crops	3650	2700	2952	1941	3907	4055	4353
Peanuts	4170	3085	3429	2255	4535	4709	4986

Table 15. Predicted Acute Concentrations of Benzovindiflupyr in Aquatic Organism Tissues at Different Trophic Levels (μg/kg).							
Crop Uses	**Phytoplankton**	**Zooplankton**	**Benthic Invertebrates**	**Filter Feeders**	**Small Fish**	**Medium Fish**	**Large Fish**
Tubers	7588	5613	6161	4052	8154	8463	9055
Tomatos	4198	3105	3388	2228	4485	4655	5005
Cotton	5517	4081	4469	2939	5915	6139	6581
Blueberries	2842	2102	2304	1515	3050	3165	3391
Soybeans and legumes	2842	2102	2304	1515	3050	3165	3391
Cereal Crops	2350	1738	1903	1251	2518	2614	2803
Canola	1040	769	839	552	1111	1153	1240
Pome fruits	1105	818	889	585	1177	1221	1317
Turf grass	817	605	660	434	873	906	974

3.2 Risk Estimation – Integration of Exposure and Effects Data

Risks of adverse effects on non-target species are assessed using RQs based on exposure and toxicity data for mortality, growth and reproduction. For the assessment of benzovindiflupyr risks, the risk quotient method is used to compare exposure and measured toxicity values (refer to **Appendix A**). Estimated environmental concentrations are divided by the most sensitive acute and chronic toxicity values. The RQs are then compared to the Agency's levels of concern. These LOCs, summarized in **Appendix A**, are the Agency's interpretive policy and are used to analyze potential risk to non-target organisms and the need to consider regulatory action. These criteria are used to indicate when a pesticide's use as directed on the label has the potential to cause adverse effects on non-target organisms.

3.2.1 Non-target Aquatic Animals and Plants

To assess risk of benzovindiflupyr to non-target aquatic animals and plants, surface water, pore water and sediment EECs for benzovindiflupyr were obtained from the SWCC based on its proposed uses (**Table 9**). EECs were compared to the most sensitive toxicological endpoints for aquatic organisms as shown in **Table 4**.

- ***Fish (Acute and Chronic)***

Maximum acute and chronic RQs for freshwater and estuarine/marine fish are determined from the peak and 60-d average EECs, respectively (**Table 9**) and the most sensitive toxicity reference values (**Table 4**). **Table 16** summarizes the acute and chronic RQs for freshwater and estuarine/marine fish in the water column.

Benzovindiflupyr was classified as very highly toxic to all three species of freshwater fish tested on an acute basis. The most acutely sensitive species, *Cyprinus carpio,* had an LC50 of 3.5 ug a.i. /L (MRID 48604562). The acute RQs for freshwater fish derived from this endpoint and the peak EECs presented in **Table 16**, ranged from 0.3 for turf to 2.4 for potatoes. RQs exceeded the LOC for acute listed (LOC = 0.05) for every use. The RQ exceeded the acute LOC for nonlisted species (LOC = 0.5) in eleven out of the fourteen proposed uses, with the canola, pome fruit, and turf uses below the acute level of concern for non-listed species. This suggests that there is acute risk concern for freshwater fish over a broad range of uses. The chronic NOAEC for freshwater fish was calculated through the ACR with the fathead minnow data was 0.73 ug a.i./L. This value increased the calculated RQs 33 percent over the endpoint from fathead minnow (0.95 ug a.i./L). Utilizing the 60 day EECs presented in **Table 9**, chronic RQs for freshwater fish ranged from 1.2 to 9.3 (**Table 16**). RQs exceeded the chronic LOC (1.0) in all the proposed uses indicating there is chronic risk concern to freshwater fish from a broad range of uses.

Benzovindiflupyr was also classified as very highly toxic to estuarine/marine fish on an acute basis (LC50 = 28 ug a.i./L, MRID 48604534). The acute RQs derived from this endpoint and the peak EECs presented in **Table 9** ranged from less than 0.01 for turf to 0.3 for potatoes. RQs in thirteen of the fourteen proposed uses exceeded the LOCs for acute listed species, with the turf use below the acute LOC, indicating a risk concern for listed species over a broad range of uses. No proposed use exceeded the acute LOC for non-listed species. The NOAEC for estuarine / marine fish (sheepshead minnow) was calculated with the acute to chronic ratio from the acute and chronic toxicity endpoints from the freshwater fathead minnow. The NOAEC for sheepshead minnow was calculated to be 5.66 ug a.i./L. EFED recommends that when there is a data gap such as there was for the chronic toxicity study for estuarine/marine fish, the ACR be calculated using the most sensitive species from the parallel studies (in this case the freshwater acute and chronic fish studies) and using the same species. Since there was not any chronic studies conducted with carp, the fathead minnow was selected since the toxicity endpoints were within 2 ug ai /L and an acceptable chronic study was submitted for fathead minnow. The calculation of ACR provides an unbounded estimate of toxicity has uncertainties inherent with it. The RQs derived with this value and the 60 day EECs presented in **Table 9** ranged from 0.5 and 1.4. The chronic LOC of 1.0 was exceeded for only three proposed uses including potatoes, corn, and grapes (**Table 16**).

Table 16. RQs for freshwater and estuarine/marine fish for the proposed uses of benzovindiflupyr.[1,2]				
Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	**Freshwater Fish**		**Estuarine / Marine Fish**	
	Acute RQ	**Chronic RQ**	**Acute RQ**	**Chronic RQ**
Corn (MS Corn, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**2.3**	**9.3**	**0.29**	**1.2**
Cucurbits (FL Cucumber, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**1.6**	**5.8**	**0.20**	0.7
Grapes (NY Grape, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**1.9**	**7.7**	**0.24**	**1.0**
Nursery Crops (NJ Nursery , 0.088 lbs. a.i./A, 3 apps. 7 days apart)	**1.3**	**4.1**	**0.16**	0.7
Peanuts (NC Peanuts, , 0.089 lbs. a.i./A, 3 apps. 7 days apart)	**1.3**	**5.1**	**0.16**	0.6
Tubers (Potatoes) (ME Potatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**2.4**	**10.8**	**0.30**	**1.4**
Tomatoes and Fruiting Vegetables (FL Tomatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**1.6**	**5.6**	**0.20**	0.7
Turf Grass (FL Turf, 0.088 lbs. a.i./A, 3 apps. 14 days apart)	**0.30**	**1.2**	<0.01	0.1
Cotton (MS Cotton, 0.068 lbs. a.i./A, 3 apps. 7 days apart)	**1.47**	**5.9**	**0.19**	0.8
Blueberries (NY Grape, 0.068 lbs. a.i./A, 2 apps. 10 days apart)	**0.94**	**4.01**	**0.12**	0.5
Soybeans and Legumes (MS Soybeans, 0.068 lbs. a.i./A, 2 apps. 7 days apart)	**0.79**	**3.1**	**0.10**	0.4
Cereal Crops (ND Wheat, 0.068 lbs. a.i./A, 2 apps. 14 days apart)	**0.79**	**3.3**	**0.10**	0.4
Canola (ND Canola, 0.068 lbs. a.i./A, 1 app.)	**0.38**	**1.4**	**0.05**	0.2
Pome fruit (CA Fruit, 0.046 lbs. a.i./A, 4 apps. 7 days apart)	**0.39**	**1.4**	**0.05**	0.2

*Acute Listed Species LOC = 0.05; Non-listed species LOC 0.5; Chronic LOC = 1.0.

****Bolded** values indicate LOC exceedence.

1 Please refer to **Table 9** for the acute (peak) and chronic (60-day average) SWCC water column EECs for

each crop use utilized in RQs.

2 Most sensitive endpoints for benzovindiflupyr utilized in RQs:

Acute Freshwater Fish: Carp LC_{50} = 3.6 µg a.i./L (MRID No. 48604562)

Chronic Freshwater Fish: Carp ACR NOAEC = 0.73 µg a.i./L based on Fathead minnow data. Utilizing the Carp ACR rather than the fathead minnow chronic data of 0.95 µg a.i./L (MRID No. 48604520) increased the freshwater chronic RQs by 33 percent.

Acute Estuarine/Marine Fish: Sheepshead Minnow EC_{50} = 28 µg a.i./L (MRID No. 48604534)

Chronic Estuarine/Marine Fish: Sheepshead Minnow NOAEC = 5.66 µg a.i./L (Acute to Chronic Ratio using values from Fathead minnow)

- ***Aquatic Invertebrates - Water Column (Acute and Chronic)***

Benzovindiflupyr was classified as very highly toxic to both freshwater invertebrates (EC_{50} = 85 ug a.i./L; MRID 48604522) and estuarine/marine invertebrates (EC_{50} = 47 ug a.i./L; MRID 48604535). Acute RQs for freshwater invertebrates ranged from less than 0.01 to 0.1 with eight out of fourteen proposed uses (corn, cucurbits, grapes, nursery crops, peanuts, potatoes, tomatoes, and cotton) exceeding the LOC for acute listed species (LOC = 0.05), and no proposed uses exceeding for acute non-listed species (LOC = 0.5). Acute RQs for estuarine/marine invertebrates ranged from 0.02 to 0.18 with all but three proposed uses (turf, canola, and pome fruit) exceeding the LOC for acute listed species and no exceedances for non-listed species.

Both freshwater and estuarine invertebrates demonstrated sensitivity to benzovindiflupyr on a chronic basis with NOAECs of 5.6 ug a.i./L (MRID 48604523) and 7.4 ug a.i./L (MRID 48604536), respectively. Using the NOAEC of 5.6 ug a.i/L, the chronic RQs for freshwater invertebrates are predicted to range from at least 0.2 to 1.5 (**Table 17)**. Three proposed uses for freshwater invertebrates exceeded the chronic LOCs. The chronic RQs for estuarine/marine invertebrates ranged from 0.1 to 1.1 with only one proposed use (potatoes) exceeding the chronic LOC. From this data, there is risk concern from chronic exposure for both freshwater and estuarine/marine invertebrates but the risk is less prevalent than those observed for fish.

Table 17. RQs for freshwater and estuarine/marine aquatic invertebrates in the water column for the proposed uses of benzovindiflupyr.[1,2]

Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	Freshwater Invertebrates		Estuarine / Marine Invertebrates	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Corn (MS Corn, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**0.10**	**1.3**	**0.17**	0.9
Cucurbits (FL Cucumber, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**0.07**	0.8	**0.12**	0.6
Grapes (NY Grape, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**0.08**	**1.1**	**0.15**	0.8

Table 17. RQs for freshwater and estuarine/marine aquatic invertebrates in the water column for the proposed uses of benzovindiflupyr.[1,2]				
Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	Freshwater Invertebrates		Estuarine / Marine Invertebrates	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Nursery Crops (NJ Nursery , 0.088 lbs. a.i./A, 3 apps. 7 days apart)	**0.05**	0.6	**0.10**	0.5
Peanuts (NC Peanuts, , 0.089 lbs. a.i./A, 3 apps. 7 days apart)	**0.05**	0.7	**0.09**	0.5
Tubers (Potatoes) (ME Potatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**0.10**	**1.5**	**0.18**	**1.1**
Tomatoes and Fruiting Vegetables (FL Tomatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	**0.06**	0.8	**0.12**	0.6
Turf Grass (FL Turf, 0.088 lbs. a.i./A, 3 apps. 14 days apart)	<0.01	0.2	0.02	0.1
Cotton (MS Cotton, 0.068 lbs. a.i./A, 3 apps. 7 days apart)	**0.06**	0.8	**0.11**	0.6
Blueberries (NY Grape, 0.068 lbs. a.i./A, 2 apps. 10 days apart)	0.04	0.5	**0.07**	0.4
Soybeans and Legumes (MS Soybeans, 0.068 lbs. a.i./A, 2 apps. 7 days apart)	0.03	0.4	**0.06**	0.3
Cereal Crops (ND Wheat, 0.068 lbs. a.i./A, 2 apps. 14 days apart)	0.03	0.5	**0.06**	0.3
Canola (ND Canola, 0.068 lbs. a.i./A, 1 app.)	0.02	0.2	0.03	0.1
Pome fruit (CA Fruit, 0.046 lbs. a.i./A, 4 apps. 7 days apart)	0.02	0.2	0.03	0.1

*Acute Listed Species LOC = 0.05; Non-listed species LOC 0.5; Chronic LOC = 1.0.

****Bolded** values indicate LOC exceedence.

[1]Please refer to **Table 9** for the acute (peak) and chronic (60-day average) SWCC water column EECs for each crop use utilized in RQs.

[2]Most sensitive endpoints for benzovindiflupyr utilized in RQs:

Acute Freshwater Invertebrates: Water Flea LC_{50} = 85 µg a.i./L (MRID No. 48604522)
Chronic Freshwater Fish: Water Flea NOAEC 5.6 µg a.i./L (MRID No. 48604523)
Acute Estuarine/Marine Fish: Eastern Oyster EC_{50} = 47 µg a.i./L (MRID No. 48604535)
Chronic Estuarine/Marine Fish: Saltwater Mysid NOAEC = 7.4 µg a.i./L (MRID No. 48604536)

- ***Benthic Invertebrates (Acute and Chronic)***

Comparisons of EECs and sediment toxicity endpoints are provided below to supplement risk estimation to water column organisms. The evaluation of toxic risk to the benthic organisms was approached by assuming equilibrium partitioning benzovindiflupyr between the sediment and the pore water (the water found between particulates in the sediment). Risk to benthic organisms was assessed using three approaches, two for chronic risk and one for acute risk. Approach 1 (chronic risk with sediment exposure): 21-day ECs for sediment were model-generated (SWCC) and compared to the toxicity value as reported for sediment exposure (NOAEC) in the sediment toxicity tests (normalized to organic carbon). Approach 2 (chronic risk from porewater exposure): 21-day EECs for pore water were model-generated (SWCC) and compared to the toxicity value as reported for pore water (NOAEC) in the sediment toxicity tests. Approach 2 (acute risk from porewater exposure): Peak EECs for pore water were model-generated (SWCC) and compared to the acute toxicity value as reported water column invertebrates.

There was one 56-day chronic sediment toxicity test for freshwater invertebrates (Sediment NOAEC = 2.8 mg a.i./kg; MRID 48604525) and one 28-day chronic sediment toxicity test for estuarine/marine invertebrates (Sediment NOAEC 4.1 mg a.i./kg; MRID 48604583). The RQs were derived from the 21-day sediment EECs and porewater EECs (**Table 9**) and the respective sediment and pore water endpoints in **Table 4**). The RQs derived from both pore water and sediment values did not exceed the chronic LOC of 1.0 for any of the proposed uses (**Table 18**). There were however LOC exceedances when comparing peak porewater concentrations with the acute toxicity endpoints of both freshwater and estuarine/marine invertebrates indicating potential risk. The acute RQs of freshwater sediment invertebrates exceeded the acute listed species LOC in five of the fourteen proposed uses while the acute RQs for estuarine/marine invertebrates exceeded the acute listed species LOC in nine of the fourteen proposed uses. The only uses that exceeded the restricted use LOC were corn, grapes, and tubers. The RQs indicate that there is acute risk concern for both freshwater and estuarine/marine benthic invertebrates from a broad range of uses but no chronic risk exceeding levels of concern in both freshwater and estuarine marine environments.

Table 18. Chronic RQs for benthic invertebrates for the proposed uses of benzovindiflupyr.[1,2]						
Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	Chronic Pore Water		Chronic Sediment		Acute Porewater	
	Freshwater	Estuarine/ Marine	Freshwater	Estuarine/ Marine	Freshwater	Estuarine/ Marine
Corn (MS Corn, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	0.09	0.07	0.41	0.28	**0.08**	**0.14**
Cucurbits (FL Cucumber, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	0.06	0.04	0.25	0.17	**0.05**	**0.08**
Grapes (NY Grape, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	0.08	0.05	0.34	0.24	**0.06**	**0.11**
Nursery Crops (NJ Nursery , 0.088 lbs. a.i./A, 3 apps. 7 days apart)	0.04	0.03	0.18	0.12	0.03	**0.06**
Peanuts (NC Peanuts, , 0.089 lbs. a.i./A, 3 apps. 7 days apart)	0.05	0.04	0.22	0.15	0.04	**0.07**
Tubers (Potatoes) (ME Potatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	0.11	0.08	0.50	0.34	**0.09**	**0.17**
Tomatoes and Fruiting Vegetables (FL Tomatoes, 0.068 lbs. a.i./A, 4 apps. 7 days apart)	0.05	0.04	0.24	0.17	0.04	**0.08**
Turf Grass (FL Turf, 0.088 lbs. a.i./A, 3 apps. 14 days apart)	0.01	0.01	0.05	0.03	0.01	0.02
Cotton (MS Cotton, 0.068 lbs. a.i./A, 3 apps. 7 days apart)	0.06	0.06	0.25	0.17	**0.05**	**0.08**
Blueberries (NY Grape, 0.068 lbs. a.i./A, 2 apps. 10 days apart)	0.04	0.04	0.18	0.12	0.03	**0.06**

Table 18. Chronic RQs for benthic invertebrates for the proposed uses of benzovindiflupyr.[1,2]						
Crop Use (SWCC Scenario, App. Rate, Number of Apps., App. Interval)	Chronic Pore Water		Chronic Sediment		Acute Porewater	
	Freshwater	Estuarine/ Marine	Freshwater	Estuarine/ Marine	Freshwater	Estuarine/ Marine
Soybeans and Legumes (MS Soybeans, 0.068 lbs. a.i./A, 2 apps. 7 days apart)	0.03	0.03	0.13	0.09	0.02	0.04
Cereal Crops (ND Wheat, 0.068 lbs. a.i./A, 2 apps. 14 days apart)	0.03	0.03	0.15	0.10	0.03	0.05
Canola (ND Canola, 0.068 lbs. a.i./A, 1 app.)	0.01	0.01	0.06	0.04	0.01	0.02
Pome fruit (CA Fruit, 0.046 lbs. a.i./A, 4 apps. 7 days apart)	0.01	0.01	<0.01	<0.01	0.01	0.02

Chronic LOC = 1.0; Acute risk listed species = 0.05;Acute non-listed species LOC = 0.5.
Bolded values indicate LOC exceedence
****Bolded** values indicate LOC exceedence.
[1]Please refer to **Table 9** for acute (peak) and chronic (21-day average) SWCC pore water and sediment EECs for each crop use utilized in RQs.
[2]Most sensitive endpoints for benzovindiflupyr utilized in RQs:
Chronic Freshwater Invertebrates (Pore Water):
Freshwater Midge NOAEC = 69 µg a.i./L (MRID No. 48604525)
Chronic Estuarine/Marine Invertebrates (Pore Water):
Estuarine Amphipod NOAEC = 98 µg a.i./L (MRID No. 48604583)
Chronic Freshwater Invertebrates (Sediment):
Freshwater Midge NOAEC = 2.8 mg/kg dry wt. (MRID No. 48604525)
Chronic Estuarine/Marine Invertebrates (Sediment):
Freshwater Midge NOAEC = 4.1 mg/kg dry wt. (MRID No. 48604583)

- ***Aquatic Plants***

RQs were estimated for non-listed and listed vascular (EC_{50} >880, NOAEC = 430 ug a.i./L; MRID 48604526) and non-vascular (algae) plants (EC_{50} = 240 ug a.i./L, NOAEC = 50 ug a.i./L utilizing the EECs presented in **Table 9**. The EC_{50} values were used to determine the RQs for non-listed species while the NOAECs were used to determine the RQs for listed species. There were no RQs that exceeded the non-listed and listed LOC of 1.0 in any scenario for either nonvascular plants or vascular plants. RQs for nonvascular plants ranged from <0.01 to 0.04 for non-listed species and from 0.02 to 0.17 for listed species. RQs for vascular plants ranged from <0.01 to 0.02 for listed species and from less than 0.01 to 0.01 for non-listed species. Based on these RQs, there is risk below the level of concern determined for vascular and non-vascular aquatic plants for all proposed benzovindiflupyr uses.

3.2.2 Non-target Terrestrial Animals and Plants

- ***Acute and Chronic Risk to Birds***

T-REX provides acute dose based RQs for three size classes of birds as well as acute and chronic dietary based RQs resulting from ingestion of six different food items exposed to benzovindiflupyr. **Table 19** below summarizes the acute dose-based RQs to birds for proposed uses of benzovindiflupyr. The acute endangered species LOC (0.1) was exceeded for small birds eating short grass, tall grass, broadleaf plants, fruits/pods and arthropods for all proposed uses. The acute endangered species LOC (0.1) was also exceeded in one of the 10 use groups when eating seeds. The acute endangered species LOC (0.1) was exceeded for medium birds eating short grass, tall grass, broadleaf plants for all proposed uses as well as when eating arthropods for all uses except turf grass. For medium sized birds, there were not any exceedances when eating seeds. For large sized birds feeding on short grass, tall grass, and broadleaf plants, the RQs exceeded the acute listed species LOC for all uses (**Table 19**). There were not any listed or non-listed LOC exceedances for large birds eating fruits/pods, arthropods, or seeds (**Table 19**). LOC exceedances in every size class of bird for both listed (LOC = 0.1) and non-listed (LOC-0.5) species suggest that there is acute concern for birds from a broad range of uses and application rates.

Table 20 presents the chronic dietary based RQs for birds resulting from ingestion of five different food items exposed to benzovindiflupyr. The acute dietary based RQs were all less than or equal to 0.01 and are not presented here as they were not higher than any LOCs. The chronic dietary based RQs also did not exceed the chronic LOC of 1.0 and ranged from 0.28 o 0.73 for short grass to 0.02 to 0.06 for fruits/pods.

Table 19. Acute dose-based RQs for birds due to exposure to proposed uses of benzovindiflupyr.

Crop Use	Small						**Medium**						**Large**					
	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds
Corn, cucurbits, fruit and tomatos, grapes, tubers	**4.0**	**1.8**	**2.3**	**0.3**	**1.6**	**0.1**	**1.8**	**0.8**	**1.0**	**0.1**	**0.7**	<0.1	**0.6**	**0.3**	**0.3**	<0.1	<0.1	<0.1
Peanuts	**3.6**	**1.7**	**2.0**	**0.2**	**1.4**	**0.1**	**1.6**	**0.7**	**0.9**	**0.1**	**0.6**	<0.1	**0.5**	**0.2**	**0.3**	<0.1	<0.1	<0.1
Ornamentals (Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant)	**4.6**	**2.1**	**2.6**	**0.3**	**1.8**	**0.1**	**2.1**	**0.9**	**1.2**	**0.1**	**0.8**	<0.1	**0.7**	**0.3**	**0.4**	<0.1	<0.1	<0.1
Turf grasses	**3.6**	**1.6**	**2.0**	**0.2**	**1.4**	**1.6**	**0.7**	**0.9**	0.1	**0.6**	0.02	<0.1	**0.5**	**0.2**	**0.3**	<0.1	<0.1	<0.1
Cotton	**3.6**	**1.6**	**2.0**	**0.2**	**1.4**	**0.1**	**1.6**	**0.7**	**0.9**	**0.1**	**0.63**	<0.1	**0.5**	**0.2**	**0.3**	<0.1	<0.1	<0.1
Blueberries	**2.7**	**1.2**	**1.5**	**0.2**	**1.0**	<0.1	**1.2**	**0.5**	**0.7**	**0.1**	**0.47**	<0.1	**0.4**	**0.2**	**0.2**	<0.1	<0.1	<0.1
Soybeans, Legumes	**2.9**	**1.3**	**1.6**	**0.2**	**1.1**	<0.1	**1.3**	**0.6**	**0.7**	**0.1**	**0.50**	<0.1	**0.4**	**0.2**	**0.2**	<0.1	<0.1	<0.1
Cereal (Oats, Barley, and Wheat)	**2.5**	**1.1**	**1.4**	**0.2**	1.0	<0.1	**1.1**	**0.5**	**0.6**	**0.1**	**0.43**	<0.1	**0.3**	**0.2**	**0.2**	<0.1	<0.1	<0.1
Canola	**1.7**	**0.8**	**1.0**	**0.1**	0.7	<0.1	**0.8**	**0.4**	**0.4**	**0.1**	**0.31**	<0.1	**0.2**	**0.1**	**0.1**	<0.1	<0.1	<0.1
Pome fruit	**2.7**	**1.3**	**1.5**	**0.2**	1.1	<0.1	**1.2**	**0.6**	**0.7**	**0.1**	**0.48**	<0.1	**0.4**	**0.2**	**0.2**	<0.1	<0.1	<0.1

Acute listed species LOC = 0.1;; Non-listed animals acute LOC = 0.5

Table 20. Chronic dietary-based RQs for birds due to exposure to proposed uses of benzovindiflupyr.

Crop Use	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods
Corn, cucurbits, fruit and tomatos, grapes, tubers	0.64	0.29	0.36	0.04	0.25
Peanuts	0.57	0.26	0.32	0.04	0.22
Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant	0.73	0.33	0.41	0.05	0.29
Turf grasses	0.56	0.26	0.32	0.04	0.22
Cotton	0.56	0.26	0.32	0.04	0.22
Blueberries	0.42	0.19	0.24	0.03	0.16
Soybeans, Legumes	0.45	0.21	0.25	0.03	0.18
Cereal (Oats, Barley, and Wheat)	0.39	0.18	0.22	0.02	0.15
Canola	0.27	0.13	0.15	0.02	0.11
Pome fruit	0.43	0.20	0.24	0.03	0.17

Chronic LOC = 1.0

- ***Acute and Chronic Risk to Mammals***

T-REX provides acute and chronic dose- based RQs for three size classes of mammals as well as chronic dietary based RQs resulting from ingestion of six different food items exposed to benzovindiflupyr. **Table 21** below summarizes the acute dose-based RQs to mammals for all proposed use of benzovindiflupyr. For small mammals the acute listed species LOC was exceeded for all ten use groups eating short grass, and for two, five, and one of the use groups eating tall grass, broadleaf plants and arthropods respectively **(Table 21)**. For medium sized animals, the acute listed species LOC was exceeded for nine of the ten use groups for short grass and for one and four of the use groups for both tall grass and broadleaf plants. For large sized mammals, only three of the ten use groups exceeded the acute listed species LOC when eating shortg rass. Overall acute RQs ranged from 0.01 to 0.28 and no dietary item from any use group exceeded the LOCs for non-listed species.

Table 22 summarizes the chronic dose-based RQs to mammals for all proposed uses. Chronic RQs ranged from 0.01 to 2.29. For small mammals the chronic LOC of 1.0 was exceeded in nine of ten use groups from consumption of short grass while the chronic LOC was exceeded from consuming tall grass and broadleaf plants in one and two of the use groups respectively. For medium sized mammals, the chronic LOC was exceeded in nine of ten use groups when consuming short grass and two of ten use groups when consuming broadleaf plants. There were only two LOC exceedances for large sized mammals consuming short grass (**Table 22**).

The dietary based RQs did not exceed the chronic LOC of 1.0 for any dietary item in any of the ten proposed use groups for benzovindiflupyr (**Table 23**). RQs ranged 0.01 when consuming fruits/pods to 0.26 when consuming short grass. Based on this there is predicted to be low chronic risk from dietary items in **Table 23**.

Table 21. Acute dose based RQs for mammals for benzovindiflupyr uses.																		
Crop Use	Small						Medium						Large					
	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods	Seeds
Corn, cucurbits, fruit and tomatoes, grapes, tubers	**0.25**	**0.11**	**0.14**	0.02	**0.10**	<0.1	**0.21**	**0.10**	**0.12**	0.01	0.08	<0.1	**0.11**	0.05	0.06	0.01	0.04	<0.1
Peanuts	**0.22**	**0.10**	**0.12**	0.01	0.09	<0.1	**0.19**	0.09	**0.11**	0.01	0.07	<0.1	**0.10**	0.05	0.06	0.01	0.04	<0.1
Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant	**0.28**	**0.13**	**0.16**	0.02	**0.11**	<0.1	**0.24**	**0.11**	**0.14**	0.02	0.09	<0.1	**0.13**	0.06	0.07	0.01	0.05	<0.1
Turf grasses	**0.22**	**0.10**	**0.12**	0.01	0.09	<0.1	**0.19**	0.09	**0.10**	0.01	0.07	<0.1	**0.10**	0.05	0.06	0.01	0.04	<0.1
Cotton	**0.22**	**0.10**	**0.12**	0.01	0.09	<0.1	**0.19**	0.09	**0.11**	0.01	0.07	<0.1	**0.13**	0.06	0.07	0.01	0.05	<0.1
Blueberries	**0.16**	0.07	0.09	0.01	0.06	<0.1	**0.14**	0.06	0.08	0.01	0.05	<0.1	**0.10**	0.05	0.06	0.01	0.04	<0.1
Soybeans, Legumes	**0.18**	0.08	**0.10**	0.01	0.07	<0.1	**0.15**	0.07	0.08	0.01	0.06	<0.1	0.08	0.04	0.05	0.01	0.03	<0.1
Cereal (Oats, Barley, and Wheat)	**0.15**	0.07	0.08	0.01	0.06	<0.1	**0.13**	0.06	0.07	0.01	0.05	<0.1	0.07	0.03	0.04	<0.1	0.03	<0.1
Canola	**0.11**	0.05	0.06	0.01	0.04	<0.1	0.09	0.04	0.05	0.01	0.04	<0.1	0.05	0.02	0.03	<0.1	0.02	<0.1
Pome fruit	**0.17**	0.08	0.09	0.01	0.07	<0.1	**0.14**	0.07	0.08	0.01	0.06	<0.1	0.08	0.04	0.04	<0.1	0.03	<0.1

Acute listed species LOC = 0.1;; Non-listed animals acute LOC = 0.5

Table 22. Chronic dose based RQs for mammals due to exposed to proposed uses of benzovindiflupyr.

	Small						Medium						Large					
Crop Use	**Short Grass**	**Tall Grass**	**Broadleaf Plants**	**Fruits/pods**	**Arthropods**	**Seeds**	**Short Grass**	**Tall Grass**	**Broadleaf Plants**	**Fruits/pods**	**Arthropods**	**Seeds**	**Short Grass**	**Tall Grass**	**Broadleaf Plants**	**Fruits/pods**	**Arthropods**	**Seeds**
Corn, cucurbits, fruit and tomatos, grapes, tubers	**2.0**	0.9	**1.1**	0.1	0.8	<0.1	**1.7**	0.8	1.0	0.1	0.7	<0.1	0.9	0.4	0.5	0.1	0.4	<0.1
Peanuts	**1.8**	0.8	**1.0**	0.1	0.7	<0.1	**1.5**	0.7	0.9	0.1	0.6	<0.1	0.8	0.4	0.5	0.1	0.3	<0.1
Ornamentals (Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant)	**2.3**	**1.1**	**1.3**	0.1	0.9	<0.1	**2.0**	0.9	**1.1**	0.1	0.8	<0.1	**1.1**	0.5	0.6	0.1	0.4	<0.1
Turf grasses	**1.8**	0.8	1.0	0.1	0.7	<0.1	**1.5**	0.7	0.9	0.1	0.6	<0.1	0.8	0.4	0.5	0.1	0.3	<0.1
Cotton	**1.8**	0.8	1.0	0.1	0.7	<0.1	**1.9**	0.9	**1.1**	0.1	0.8	<0.1	**1.0**	0.5	0.6	0.1	0.4	<0.1
Blueberries	**1.3**	0.6	0.7	0.1	0.5	<0.1	**1.1**	0.5	0.6	0.1	0.4	<0.1	0.6	0.3	0.3	<0.1	0.2	<0.1
Soybeans, Legumes	**1.4**	0.7	0.8	0.1	0.6	<0.1	**1.2**	0.6	0.7	0.1	0.5	<0.1	0.7	0.3	0.4	<0.1	0.3	<0.1
Cereal (Oats, Barley, and Wheat)	**1.2**	0.6	0.7	0.1	0.5	<0.1	**1.0**	0.5	0.6	0.1	0.4	<0.1	0.6	0.3	0.3	<0.1	0.2	<0.1
Canola	0.9	0.4	0.5	0.1	0.3	<0.1	0.7	0.3	0.4	0.1	0.3	<0.1	0.4	0.2	0.2	<0.1	0.2	<0.1
Pome	**1.4**	0.6	0.8	0.1	0.5	<0.1	**1.2**	0.5	0.7	0.1	0.5	<0.1	0.6	0.3	0.4	<0.1	0.2	<0.1

Chronic LOC = 1.0

Table 23. Chronic dietary based RQs for mammals due to exposed to proposed uses of benzovindiflupyr.					
Crop Use	Short Grass	Tall Grass	Broadleaf Plants	Fruits/pods	Arthropods
Corn, cucurbits, fruit and tomatos, grapes, tubers	0.23	0.11	0.13	0.01	0.09
Peanuts	0.21	0.09	0.12	0.01	0.08
Ornamentals (Nursery Plants, Tomato Transplant, Fruit Transplant, Curcubit Transplant)	0.26	0.12	0.15	0.02	0.10
Turf grasses	0.20	0.09	0.11	0.01	0.08
Cotton	0.20	0.09	0.11	0.01	0.08
Blueberries	0.15	0.07	0.09	0.01	0.06
Soybeans, Legumes	0.16	0.07	0.09	0.01	0.06
Cereal (Oats, Barley, and Wheat)	0.14	0.06	0.08	0.01	0.05
Canola	0.10	0.05	0.06	0.01	0.04
Pome fruit	0.16	0.07	0.09	0.01	0.06

Chronic LOC = 1.0

- ***Terrestrial Invertebrates and Beneficial Insects***

Benzovindiflupyr is classified as practically non-toxic to honeybee (acute contact LD_{50} >100 ug a.i/bee; MRID 48604527) and was shown to be non-toxic at a dose of 109 µg a.i/bee in an acute oral exposure study (MRID 48604527). RQs were determined utilizing the equations in the *Guidance for Assessing Pesticide Risks to Bees* (US EPA, 2014). For risk through acute contact on individual survival the exposure was estimated by multiplying the maximum application rate by 2.7 µg a.i./bee and then comparing it to the acute contact LD_{50}. Oral exposure was determined by multiplying the maximum application rate by 110 µg a.i./g multiplied by 0.292 g/day (page 17 of guidance). The RQs for acute contact and oral exposures were <0.01 and 0.03 respectively and were below the LOC of 0.4 for bees. Therefore, while the potential exists via exposure pathways such as foliar sprays, the low application rates and lack of toxicity suggest that there is low risk concern to bees. One important caveat to this is that, as part of the aforementioned guidance document, the Agency now requires studies on acute oral toxicity to larval honey bees, chronic oral toxicity to adult honey bees, and chronic oral toxicity larval honey bees in addition to the acute contact toxicity to adult honey bees and acute oral toxicity to adult honey bees. These additional studies would reduce uncertainty about benzovindiflupyr's effect on other life stages of the honey bee.

- ***Terrestrial Plants***

Utilizing the data that was submitted, there was not any risk identified to terrestrial plants from any application of benzovindiflupyr. Seedling emergence and vegetative vigor studies are available for benzovindiflupyr but there remains uncertainty with several species that were tested in the seedling emergence study (see the ecological effects section for discussion of these species. The estimates of exposure generated by TerrPlant and described in **Section 3.1.2** were compared to estimates of toxicity to estimate RQ for listed and non-listed plants in dry and semi aquatic areas and from spray drift. At the highest application rate modeled (0.089 lb a.i/A) there were not any exceedences of the LOC of 1.0 with RQs ranging from <0.1 in dry areas to 0.11 in semi-aquatic areas. However, there are uncertainties related to these risk conclusions related to the seedling emergence of plants and vegetative vigor. These uncertainties are discussed and characterized in **Sections 3.3 and 4**.

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- ***Risks Resulting from Bioaccumulation in the Food Web***

KABAM was used to calculate risk quotients from a bioaccumulation pathway for aquatic food items that may be consumed by birds and mammals (**Table 24**). There were not any mammalian wildlife species modeled that exceeded either the acute or chronic LOCs when consuming fish contaminated by benzovindiflupyr and are not presented here. The RQs modeled for avian wildlife species only exceeded the LOC for acute dose based exposure. The acute dietary based exposure and chronic based exposure (both dose based and dietary based) did not exceed any LOCs and are not presented. The acute dose based RQs exceeded the acute listed species LOC

in 11 of 14 scenarios modeled for sandpipers and in 8 of 14 scenarios modeled for rails. The acute dose-based based RQs for sandpipers ranged from 0.13 (cereal crops) to 0.42 (tubers) and from 0.16 (cotton) to 0.23 (tubers) for rails (**Table 24**). There were not any LOC exceedances for chronic exposure of avian species consuming fish contaminated with benzovindiflupyr. Likewise risk to avian species on a chronic basis also appears to be low as evidenced by no LOC exceedances in any scenario. On an acute dose basis, there does appear to be risk to federally listed birds consuming fish contaminated with benzovindiflupyr as seen in listed LOC exceedances for two species of birds and in 11 of the 14 proposed uses of benzovindiflupyr. However, if this model uses the LD50 for bobwhite quail (1373 mg/kg-bw), there would not be any LOC exceedances for either sandpipers or rails. Furthermore, given the uncertainty with the passerine study and the regurgitation driving the endpoint, there is uncertainty in the risk conclusions using the passerine endpoint.

Table 24. Calculation of RQ values for birds consuming fish contaminated by benzovindiflupyr.

Crop Use	Dose Based Acute Avian RQs					
	sandpipers	cranes	rails	herons	small osprey	white pelican
Corn	**0.37**	0.02	**0.20**	0.03	0.05	0.02
Cucuribits	**0.23**	0.01	**0.12**	0.02	0.03	0.01
Grapes	**0.31**	0.02	**0.16**	0.03	0.04	0.02
Nursery Crops	**0.20**	0.01	**0.11**	0.02	0.03	0.01
Peanuts	**0.23**	0.01	**0.13**	0.02	0.03	0.01
Tubers	**0.42**	0.02	**0.23**	0.04	0.06	0.03
Tomatos	**0.23**	0.01	**0.13**	0.02	0.03	0.01
Cotton	**0.31**	0.02	**0.16**	0.03	0.04	0.02
Blueberries	**0.16**	0.01	0.09	0.01	0.02	0.01
Soybeans and legumes	**0.16**	0.01	0.09	0.01	0.02	0.01
Cereal Crops	**0.13**	0.01	0.07	0.01	0.02	0.01
Canola	0.06	<0.01	0.03	0.00	0.01	<0.01
Pome fruits	0.06	<0.01	0.03	0.01	0.01	<0.01
Turf grass	0.05	<0.01	0.02	<0.01	0.01	<0.01

*Acute listed species LOC = 0.1;; Non-listed animals acute LOC = 0.5
Chronic LOC = 1.0
****Bolded** Red Values Indicate LOC exceedence

3.3 Risk Description

3.3.1 Aquatic Organisms

The proposed benzovindiflupyr applications are predicted to adversely impact both freshwater and estuarine/marine fish on both an acute and a chronic basis. The proposed applications also adversely impact both freshwater and estuarine/marine water column invertebrates on an acute and chronic basis. **S**ediment invertebrates are expected to have low exposures to benzovindiflupyr with RQs being less than the LOC for fish and invertebrates in the water column since the relevant endpoints for benthic invertebrates are less sensitive effects. **Table 26** in **Section 5** below lists the expected adverse impacts by aquatic organism for each proposed use.

Exceedances of LOCs appear to be driven by benzovindiflupyr's high toxicity and high persistence despite its low application rate. In addition, aquatic exposure for the benzovindiflupyr proposed uses appear to be driven by runoff. Therefore, the ability to mitigate risk to water column organisms by eliminating spray drift is minimal. Modeling with the SWCC shows that RQs would decrease by *ca.* 30% (range 29 -33%) by eliminating spray drift to water bodies but would not change the risk conclusions, particularly for acute exposure for freshwater fish, chronic freshwater fish, and chronic exposure to water column freshwater invertebrates. The implementation of spray drift buffers can only mitigate risk for all benzovindiflupyr uses related to chronic impacts estuarine/marine fish and estuarine/marine invertebrates (water column) including proposed uses on potato, corn, and grapes with these taxa. For example, the chronic estuarine/marine fish RQ from the highest exposure scenario (ME potatoes) decreases from 1.4 to slightly below the LOC threshold without drift. The Tier 1 AgDrift model (version 2.1.1) indicates that a 30 ft spray drift buffer would effectively mitigate risk with all benzovindiflupyr proposed uses for chronic estuarine/marine invertebrates (water column) and chronic estuarine/marine fish. However, it is still important to note that spray drift buffers would not resolve the risks anticipated to adverse impacts expected for acute freshwater fish, acute freshwater estuarine invertebrates, chronic freshwater fish for all of the proposed benzovindiflupyr uses collectively.

Given benzovindiflupyr's persistence in aquatic environments, residue build up in the water column and sediment is possible and can result in higher aquatic EECs than depicted in this assessment given the finite timeframe (30 years) simulated to calculate EECs with the SWCC. However, the proposed seasonal treatment schedules of benzovindiplupyr, its slow degradation observed in aquatic environments in the aquatic metabolism studies, and its tendency to equilibrate relatively rapidly in sediment and the water column (see **Figure 1**) all indicate that steady state concentrations of benzovindiflupyr would be expected to be reached within a 30-year window of time. This is evident from time series produced by the SWCC for all of the aquatic scenarios modeled (sample from the ME Potatoes scenario shown in **Figure 2**). Annual average SWCC estimated concentration in the water column and benthic pore water indicate that steady state is reached with *ca.* 20 years of steady labeled application of benzovindiflupyr. Since

steady state concentrations are reached within the simulation time in this evaluation, uncertainties in EECs due to continual buildup of residues over time are expected to be minimal.

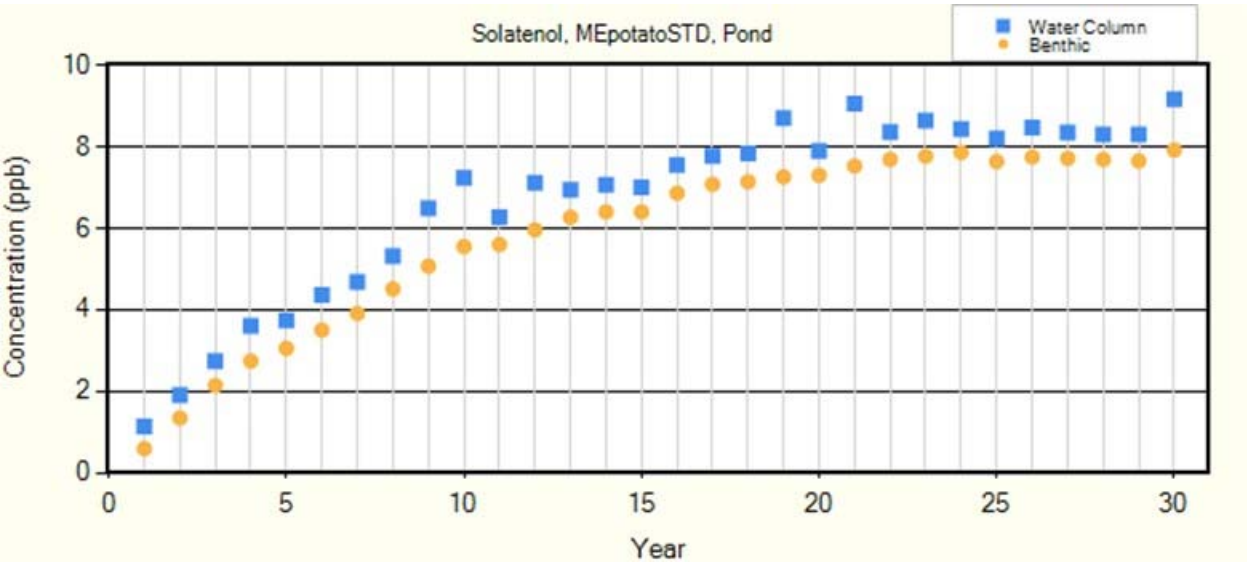

Figure 2. Time series of SWCC annual average concentrations predicted in the water column (blue squares) and benthic pore water (yellow dots). Sample results from SWCC Maine potato application scenario.

Regardless of benovindiflupyr's high persistence, restrictions on the use of benzovindiflupyr to only every few years potentially can resolve acute risks of concern for aquatic organisms. While long-term concentrations, as shown in **Figure 2** would not change chronic exposure risks of concern, short-term pulses entering waterways associated with benzovindiflupyr applications can be reduced with sparser applications of benzovindiflupyr applications every few years.

3.3.2 Terrestrial Organisms

For dietary exposure, there are risks of concern for both birds and mammals related to acute dose-based impacts for all of the proposed uses of benzovindiflupyr. The direct deposition of benzovindiflupyr residues on treated crops are expected to result in toxicologically adverse impacts considering the maximum single application rates, number of applications, and application intervals for the proposed uses of benzovindiflupyr as shown in **Table 1**. It should be noted that risk of concern are likely driven from a conservative endpoint from the passerine oral toxicity study (MRID No. 48604513) due to the frequency of regurgitation at all but the lowest treatment group precluded the determination at a definitive endpoint. The conservative endpoint was estimated according to EFED guidance (EPA 2012; also online at http://www.epa.gov/pesticides/science/efed/policy_guidance/team_authors/terrestrial_biology_tech_team/rr_regurg_acute_passerine.pdf) on the basis of the highest dose concentration below which regurgitation occurred. Given the conservative nature of this endpoint, the risk conclusions utilizing this endpoint would likely be protective. If the endpoint for bobwhite quail is used (LD50 = 1373 mg/kg-bw), there would not be any acute risk identified for birds for any

use of solatenol. Additional studies submitted for passerine birds may enable for the determination of an oral LD_{50} that would likely yield a less conservative depiction of the actual lethal dose. The dietary study that was received indicated that benzovindiflupyr was toxic with 70 percent mortality occurring at the lowest dose tested and precluded determination of an appropriate endpoint. For chronic impacts to birds, there are no impacts expected for any of the proposed uses of benzovindiflupyr based on dietary-based RQs.

Dietary-based RQs do not exceed any of the LOCs for mammals as well. In general, chronic exposure is anticipated to be minimized by the small total loadings of benzovindiflupyr (up to 0.272 lbs. a.i./A) considering all proposed uses. Furthermore, chronic exposures to benzovindiflupyr crop residues on turf grass, barley, peanuts, and soybeans are not expected to be prevalent given foliar dissipation half-lives between 0.6 – 19.3 days have been determined from the field dissipation plant residue module (MRID Nos. 48604497, 48604498, 48604502, 48604502, 58604580, and 48604581, refer to **Table 3**). The foliar dissipation half-lives from these submitted studies were used the in exposure modeling the risk quotient calculations. While chronic dietary-based exposures are not expected to mammals, chronic dosed-based exposures may occur. The dosed-based exposure can more capture the longer-term exposure via benzovindiflupyr residues for mammals which feed more consistently within treated fields leading to repeat exposure. However, in cases where mammals are more transient in their dietary habits with feedings which may occur off the treated field, the dietary-based RQs may be a more relevant depiction of risk. In any case, the chronic dose-based risk of concern to mammals is not discountable given the on-field non-transient exposure scenario for mammalian habitats described above.

There is risk concern related to the indirect dietary exposure pathway of piscivorous birds consuming fish containing benzovindiflupyr residue and related impacts resulting from the food web at lesser trophic levels, as indicated by KABAM modeling and LOC exceedances for two species of birds modeled for 11 of the 14 proposed uses of benzovindiflupyr. While benzovindiflupyr's bioavailability within fish tissues is limited from a combination of low application rates and moderately high depuration rates, the predicted toxicity to birds, particularly from the passerine oral toxicity study with a likely highly conservative endpoint given the regurgitation limitations with the study, make this route of exposure an area of concern. As noted for the results of the TREX generated RQs, the RQs decrease significantly (to below the agencies LOCs) if the LD50 used was from the bobwhite quail study (LD50 =1373 (quail) vs LD50 = 10 (passerine species). Benzovindiflupyr's expected accumulation as suggested by its log K_{ow} = 4.3, BCF values appear to be moderated by benzovindiflupyr's overall rapid depuration with total residue half-lives of < 1 day measured in the *bluegill sunfish* BCF study (MRID No. 4864521, refer to **Table 3**). The demonstrated bioconcentration potential found in benzovindiflupyr BCF study is similar to those used in KABAM modeling with the BCF values generated by KABAM being 2.4 times greater than those measured in the BCF study (MRID 48604521) suggesting that the model estimates represent a reasonable assessment of risk from consumption of fish from contaminated water bodies. Evaluating the reduction of the accumulation of benzovindiflupyr on fish tissues due to metabolism were not found to impact the overall risk conclusions.

Risks to terrestrial invertebrates (beneficial insects) are not expected via the contact or oral route on an acute basis. This is primarily due to that exposure to benzovindiflupyr residues which are directly deposited on to treated crop foliage from spray applications are not expected to be in high enough quantities to exceed the level of concern based on EEC calculations from the existing honeybee contact toxicity study (acute contact LD_{50} >100 ug a.i/bee; MRID 48604527), and acute oral toxicity study (non-toxic finding at a dose of 109 µg a.i/bee, MRID 48604527). However, there is uncertainty for terrestrial invertebrates. The LR50 for the parasistic wasp is equivalent to 0.077 lbs a.i. per acre. The application rates for benzovindiflupyr range from 0.68 to 0.088 lbs a.i. per acre suggesting that benzovindiflupyr may adversely impact terrestrial invertebrates. Additionally, there is uncertainty related to adverse impacts to larval honey bees via the oral exposure route (acute and chronic) as well as chronic adverse impacts to adult honey bees via the oral route as no studies have been submitted. There is no language on the proposed labels restricting benzovindifluypyr applications when plants are in bloom in the vicinity. Furthermore, chronic adverse impacts to bees and terrestrial invertebrates are possible especially considering the risks of concern identified with aquatic invertebrates. Therefore, at this time, EPA presumes risk to terrestrial invertebrates and will re-visit this risk finding upon submission of the acute and chronic larval oral toxicity studies and chronic adult bee contact toxicity study.

Based on vegetative vigor and seedling emergence toxicity studies submitted for benzovindiflupyr and Terrplant EECs, there are not any LOC exceedances from proposed applications. The NOAEC for the ***seedling emergence study*** (MRID 48604538) was 0.089 lbs./A for monocots and dicots. The NOAEC for the ***vegetative vigor study*** (MRID 48604599) was 0.09 lbs a.i./A for all monocots and dicots tested. The EC_{25} values are used to calculate the RQs for non-listed species suggesting that there is uncertainty with these RQs due to non-definitive EC_{25} values. The RQs ranged from <0.1 for monocots to 0.11 for listed dicots in semi-aquatic areas. While there is uncertainty in risk due to non-definitive endpoints, the results suggest there is low risk to plants.

Please refer to **Table 27** in **Section 5** below which breaks down the expected adverse impacts by terrestrial organism for each proposed use.

3.4 Review of Incident Data and Environmental Monitoring Data

As benzovindiflupyr has not been previously approved for use in the United States, there are no incident reports or environmental monitoring data for this chemical.

4. 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 required by FFDCA section 408(p), benzovindifluypyr 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[8] 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.

Benzovindifluypyr is not on the first or second list. The second list represents the next set of chemicals for which EPA intends to issue test orders/data call-ins in the near future. 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.[9]

[8] See http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074 for the final second list of chemicals.

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

5. LISTED SPECIES

In November 2013, the EPA, along with the U.S. Fish & Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS) (collectively, the Services), and the U.S. Department of Agriculture (USDA) released a summary of their joint Interim Approaches for assessing risks to listed species from pesticides. The Interim Approaches were developed jointly by the agencies in response to the National Academy of Sciences' (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. The NAS report 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 Endangered Species Act (ESA) and FIFRA.

The joint Interim Approaches were released prior to a stakeholder workshop held on November 15, 2013. In addition, the EPA presented the joint Interim Approaches at the December 2013 Pesticide Program Dialogue Committee (PPDC) and State-FIFRA Issues Research and Evaluation Group (SFIREG) meetings, and held a stakeholder workshop in April 2014, allowing additional opportunities for stakeholders to comment on the Interim Approaches. As part of a phased, iterative process for developing the Interim Approaches, the agencies will also consider public comments on the Interim Approaches in connection with the development of upcoming Registration Review decisions. The details of the joint Interim Approaches are contained in the white paper "Interim Approaches for National-Level Pesticide Endangered Species Act Assessments Based on the Recommendations of the National Academy of Sciences April 2013 Report," dated November 1, 2013.

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 preliminary risk assessment for benozvindiflupyr does not contain a complete ESA analysis that includes effects determinations for specific listed species or designated critical habitat. Although EPA has not yet completed effects determinations for specific species or habitats, for this preliminary assessment, EPA conducted a screening-level assessment for all taxa of non-target wildlife and plants that assumes for the sake of the assessment that listed species and designated critical habitats may be present in the vicinity of the application of benzovindiflupyr. This screening level assessment will allow 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. This screening-level risk assessment for benzovindiflupyr indicates potential risks of direct effects to listed mammals, birds, terrestrial invertebrates, fish, and aquatic invertebrates on all of its registered use sites. Listed species of aquatic and terrestrial plants may also be affected through indirect effects because of the potential for direct effects on listed and non-listed species upon which such species may rely. Potential direct effects on listed mammals, birds, terrestrial invertebrates, fish, and aquatic invertebrates from the use of benzovindiflupyr may be associated with modification of Primary Constituent Elements (PCEs) of designated critical habitats, where such designations have been made. Once the agencies have fully developed and implemented the scientific

methods necessary to complete risk assessments for endangered and threatened (listed) species and their designated critical habitats, these methods will be applied to subsequent analyses for benzovindiflupyr as part of completing this registration review.

6. UNCERTAINTIES, LIMITATIONS, AND IDENTIFICATION OF DATA GAPS

- ***Labels and Proposed Uses***

There is uncertainty regarding seasonal maximum application rates specified on the label. This risk assessment evaluated one treatment and retreatment cycle of benzovindiflupyr occurring per year. While this is likely the intended use pattern, specification of seasonal maximum application rates potentially enables multiple series of benzovindiflupyr treatment and retreatment cycles throughout the year. Therefore, specifying seasonal maximum application rates as yearly maximum application rates would address this uncertainty, which exists for all proposed crop uses.

The Executive Summary (Section 1.1) re-iterates the need for providing this clarification on labels to address this uncertainty related to treatment and re-treatment application cycles of benzovindiflupyr which may occur throughout the course of the year.

- ***Aquatic Exposure Assessment***

The main uncertainty in the aquatic exposure assessment for benzovindiflupyr concerns a major deficiency in the aerobic aquatic studies (MRID Nos. 48604509 and 48604510). The aerobic aquatic metabolism half-life is one critical parameter impacting acute and chronic aquatic EECs. Conditions in these studies were fringe anaerobic (suboxic) as the criteria for aerobic conditions taking into account redox potential and pH was not satisfied[10]. However, benzovindiflupyr is very persistent in all environmental media with half-lives in the range of 620 – 1,788 days in soil and water. So, it is unlikely that benzovindiflupyr would degrade exceptionally faster in water under aerobic conditions. In lieu of the aerobic aquatic studies available, this uncertainty is addressed in this risk assessment by utilizing the conservative default of doubling the soil metabolism half-life to represent the aquatic environmental biodegradation in the modeling. However, given that benzovindiflupyr is persistent as it is, aquatic EECs would not be impacted unless aerobic aquatic metabolism half-lives much lower in magnitude than other degradation pathways, which is not likely given the appearance of the persistent moiety of benzovindiflupyr in the environment.

In addition related to aerobic degradation of benozvindiflupyr in water-sediment environments, photosynthetically active organisms may provide an additional mode of degradation for benzovindiflupyr. To investigate this, additional mesocosym type of studies were conducted by th for benzovindiflupyr in aquatic environments. These mesocosm studies modified the guideline aerobic aquatic metabolism guidelines study design to incorporate the impact of algae and macrophytes separately (MRID Nos. 48604509 and 48604510) and collective impacts incorporating both algae and macrophtyes (MRID No. 48604578). Each of these studies were also conducted under conditions with a light-dark cycle using an artificial light source. The

[10] The criteria for aerobic conditions is pe + pH >12 where pe = redox potential/59.2 (Sposito, 1989).

registrant calculated half-lives for benzovindiflupyr in the range between 52 – 85 days with algae cultures, 19 – 39 days with macrophyte cultures, and 15 – 56 days with combined algae and macrophyte cultures. However, there were substantial uncertainties in each of these mesocosm studies related to incomplete material balances throughout the total aquatic-sediment system over the study durations. In summary, there were instances where at least 30 percent of the overall material balance was not known, and in some cases such was the case well in exceedance of this amount in the total water-sediment system. Furthermore, in most cases, the degradates detected in the mesocosm studies were less than 10 percent total of the material balance. Therefore,, there are a lot of uncertainities with the environmental context of the registrant calculated half-lives in the mesocosm studies, and the pathway of degradation in the water column and sediment or dissipation to sediment of the material is also uncertain. Given these uncertainties, the aquatic exposure assessment and the calculated estimated exposure concentrations (EECs) relied on the more definitive results provided in the guideline aerobic aquatic metabolism studies without algae and macrophytes conducted under darkness (MRID Nos. 48604509 and 48604510), and are reflective of environments free of these organisms. It should be noted that the diurnal light-darkness cycles were incorporated into the aquatic exposure analysis and EECs using the existing aqueous photolysis study (MRID No. 48604507).

One other limitation related to aquatic exposure in this screening risk assessment is that surface water aquatic exposure EECs presented for the proposed nationwide uses of benzovindiflupyr are based on a finite collection of application scenarios associated with the SWCC model. While finite, the application scenarios for crops were selected based on the combination of the highest application rates proposed for crops, application methods, and environmental conditions across the country which would result in upper-bound exposure out of all of the proposed uses for benzovindiflupyr consistent with the screening approach to this risk assessment. For instance, first, only aerial applications are evaluated for surface water for all application scenarios except where only ground spray applications are proposed for turf and ornamental uses. Aerial applications result in upper-bound EDWCs since the spray drift contribution with these applications most impact water bodies. Furthermore, broadcast aerial applications would result in higher EECs than banded and in-furrow soil applications also proposed for potatoes and peanuts since these soil applications would be a more localized application rather than a broadcast application. Secondly, while all proposed uses were evaluated in this risk assessment, only one crop scenario per use site is presented in the surface water exposure assessment. These presented crop scenarios were selected based on the SWCC scenario which produces the highest runoff and resulting exposure out of all regional crop scenarios developed across the country. With this stated, the maximum EECs identified in **Table 9** is considered the upper-bound EECs for the entire collection of proposed crops for benzovindiflupyr, considering all of the decision points related to application rates, application methods, and environmental regional variations discussed above.

Despite the uncertainties described above, the dataset of environmental fate studies and ecological toxicity studies for the aquatic exposure assessment is complete for benzovindiflupyr. The submission of additional studies to address the various deficiencies noted above would not change the risk conclusions presented in **Section 3.2** and **Section 5**

below. Therefore, no data to support future aquatic exposure assessments for benzovindiflupyr are requested at this time.

- ***Terrestrial Exposure Assessment***

The exposure assessment for terrestrial organisms in this risk assessment relies on the best available estimates of environmental fate and physicochemical properties, maximum application rate of benzovindiflupyr, maximum number of applications, and the shortest interval between applications. However, several uncertainties and model limitations are noted and should be considered in interpreting the results of this terrestrial risk assessment.

When effects data are available, dose-based and dietary-based acute RQs should be provided to risk managers. The dose-based approach assumes that the uptake and absorption kinetics of a gavage toxicity study approximate the absorption associated with uptake from a dietary matrix. Toxic response is a function of duration and intensity of exposure. Absorption kinetics across the gut and enzymatic activation/deactivation of a toxicant may be important and are likely variable across chemicals and species. For many compounds, a gavage dose represents a very short-term, high intensity exposure, whereas dietary exposure may involve a more prolonged exposure period. The dietary-based approach assumes that animals in the field are consuming food at a rate similar to that of confined laboratory animals. Energy content in food items differs between the field and the laboratory as do the energy requirements of wild and captive animals. The Wildlife Exposure Factors Handbook can provide insights into energy requirements of animals in the wild as well as energy content of their diets (USEPA, 1993).

The typical 21-week avian reproduction study does not define the true exposure duration needed to elicit the observed responses. The study protocol was designed to establish a steady-state tissue concentration for bioaccumulative compounds. For other pesticides, it is entirely possible that steady-state tissue concentrations are achieved earlier than the 21-week exposure period. Moreover, pesticides may exert effects at critical periods of the reproduction cycle; therefore, long-term exposure may not be necessary to elicit the effect observed in the 21-week protocol. The EFED screening-level risk assessment uses the single-day maximum estimated EEC as a conservative approach. The degree to which this exposure is conservative cannot be determined by the existing reproduction study.

In the risk assessment, RQs were only calculated for the most sensitive dietary class relevant to the organisms assessed. For most organisms, not enough data is available to conclude that birds or mammals may not exclusively feed on a dietary class for at least some time period. However, most birds and mammals consume a variety of dietary items and thus the RQ will overestimate risk to those organisms. Additionally, some organisms will not feed on all of the dietary classes. For example, many amphibians would only consume insects and not any plant material.

In addition, there are a couple of uncertainties to note related to the potential bioaccumulation of benzovindiflupyr residues in the tissues of fish which may be bioavailable to piscivorous birds. The uncertainties are all related to the existing BCF study on the bluegill sunfish (MRID No. 48604521). First, only one test concentration of benzovindiflupyr was evaluated in the study.

The test concentration of 0.26 µg a.i./L in the study was on the lower bound of the range of aquatic EECs for benzovindiflupyr. Despite this uncertainty, BCFs calculated in KABAM, which served as the basis of exposure dose concentrations for piscivorous birds and based on upper-bound aquatic EECs, were similar in magnitude to BCFs determined in the study, with a magnitude departure of less than 2.4 in all cases. Secondly, only a small amount of benzovindiflupyr was detected throughout the study. However, it was found that depuration of total residues was rapid, with a depuration half-life of 0.54 days and that the vast majority of total residues were removed from whole fish after 7 days of depuration. This suggests that the residence time of any toxic residue, including benzovindiflupyr, in fish tissues is similarly short in a flowing water body, but not in a static pond.

Considering the discussion above, the ecological toxicity database is largely complete. **However, the following are a list of exceptional data gaps applicable to the terrestrial assessment: 1.) Honeybee toxicity studies**: The available data (acute oral and contact toxicity studies for adult bees) suggest that benzovindiflupyr is practically non-toxic to bees and preliminary exposure modeling and RQ analysis suggests that risk to adult bees via the contact and oral exposure pathways is low. However, there are no acute or chronic toxicity studies submitted for larval bees or chronic feeding studies for adult bees. There is no language on the proposed labels restricting benzovindifluypyr applications when plants are in bloom in the vicinity. Therefore, risks to terrestrial invertebrates is presumed in the absence of data and given benzonvindiflupyr's potential bioavailability to beneficial insects which may be attracted to treated plants. This presumption of risk finding for terrestrial invertebrates will be re-considered contingent upon the submission of these honeybee toxicity studies. **The Executive Summary (Section 1.3) re-iterates the need for the additional bee toxicity data at this time including acute and chronic larval-stage bee toxicity studies and chronic feeding toxicity studies for adult bees to address the potential risks to different life stages of terrestrial invertebrates not assessed with the currently available data. 2.) Passerine study**: As of the time of this assessment, the existing passerine study (MRID 48604513) was considered supplemental. In the currently available passerine study, the frequency of regurgitation at all but the lowest treatment group precluded the determination at a definitive endpoint. EFED guidance (EPA 2012; also online at http://www.epa.gov/pesticides/science/efed/policy_guidance/team_authors/terrestrial_biology_tech_team/rr_regurg_acute_passerine.pdf) indicates to "use the highest value below which regurgitation did occur as the acute endpoint for that study". Therefore, the risk conclusions utilizing this endpoint would likely be protective considering the uncertainty that regurgitation introduces. An additional passerine study that has been requested to address this uncertainty has not been submitted as of the time of this assessment**.**

- ***Other General Uncertainties for Screening Risk Assessments***

Routes of Exposure

The screening assessment does not consider benzovindiflupyr dermal exposure to terrestrial organisms. The Agency is actively pursuing modeling techniques to account for dermal exposure

via direct application of spray and by incidental contact with contaminated vegetation, soil and water.

Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. The screening risk assessment acute toxicity data for fish are collected on juvenile fish and aquatic invertebrate acute testing is performed on recommended immature age classes. Similarly, acute dietary testing with birds is also performed on juveniles, with mallard being 5-10 days old and quail at 10-14 days of age.

Testing of juveniles may overestimate the toxicity of direct acting pesticides in adults. As juvenile organisms do not have fully developed metabolic systems, they may not possess the ability to transform and detoxify xenobiotics equivalent to the older/adult organism. The screening risk assessment has no current provisions for a generally applied method that accounts for this uncertainty. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, the risk assessment uses the most sensitive life-stage information as the conservative screening endpoint.

Lack of Effects Data for Amphibians and Reptiles

Currently, toxicity studies on amphibians and reptiles are not required for pesticide registration. Since these data are lacking, the Agency uses fish as surrogates for aquatic phase amphibians and birds as surrogates for terrestrial phase amphibians and reptiles. If other species are more or less sensitive to benzovindiflupyr than the surrogates, risks may be under- or overestimated, respectively. The Agency is not limited to a base set of surrogate toxicity information in establishing risk assessment conclusions. The Agency also considers toxicity data on non-standard test species when available. Further research is needed to determine whether, in general, reptiles and terrestrial-phase amphibians are suitably represented by bird species in assessing risks for benzovindiflupyr and fish are an appropriate surrogate for aquatic-phase amphibians.

Use of the Most Sensitive Species Tested

Although the screening risk assessment relies on a selected toxicity endpoint from the most sensitive species tested, it does not necessarily mean that the selected toxicity endpoints reflect sensitivity of the most sensitive species existing in a given environment. The relative position of the most sensitive species tested in the distribution of all possible species is a function of the overall variability among species to a particular chemical. The relationship between the sensitivity of the most sensitive tested species versus wild species (including listed species) is unknown and a source of significant uncertainty. In addition, in the case of listed species, there is uncertainty regarding the relationship of the listed species' sensitivity and the most sensitive species tested.

Sublethal Effects

When assessing acute risk, the screening risk assessment relies on the acute mortality endpoint as well as a suite of sublethal responses to the pesticide, as determined by the testing of species response to chronic exposure conditions and subsequent chronic risk assessment. Consideration of additional sublethal data in the effects determination is exercised on a case-by-case basis and only after careful consideration of the nature of the sublethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sublethal endpoint) and the assessment endpoints. However, the full suite of sublethal effects from valid open literature studies is considered for the characterization purposes.

To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of benzovindiflupyr on listed species may be underestimated.

7. CONCLUSIONS

The risk hypothesis identified in the problem formulation (**Section 2.4**) stated,
"Based on the application methods, mode of action, fate and transport, and the sensitivity of non-target aquatic and terrestrial species, benzovindiflupyr has the potential to reduce survival, reproduction, and/or growth in non-target terrestrial and aquatic organisms when used in accordance with the current label.

After reviewing the most recent environmental fate and effects data for benzovindiflupyr, the screening-level assessment concludes that registered uses of the fungicide may result in risk to both listed and non-listed species of aquatic and terrestrial animals and wildlife.

When estimates of benzovindiflupyr exposure in terrestrial and aquatic environments are compared to the available ecotoxicity data, the results of the screening-level assessment indicate a potential for risk to both aquatic and terrestrial taxa. Environmental fate modeling and risk quotient determination indicate potential adverse effects on aquatic animal taxa. Acute and chronic risk to freshwater fish, estuarine/marine fish, freshwater invertebrates, and estuarine/marine invertebrates was identified. Chronic RQs for sediment dwelling invertebrates did not exceed LOCs and did not identify any chronic risk to sediment dwelling invertebrates. Acute RQs derived from comparing peak porewater concentrations to acute water column toxicity endpoints did however predict acute risk concerns to sediment dwelling invertebrates. Risk above the level of concern was not identified for aquatic plants (both vascular and non-vascular). Acute dose based risk to birds was identified in all size classes of birds. There was also LOC exceedences for sandpipers and rails consuming fish contaminated with benzovindiflupyr suggesting risk through this pathway. Avian chronic RQs did not exceed the LOC in any scenario so chronic risk is presumed to be low. There was also acute and chronic dose-based risk identified in all size classes of mammals. There was not any chronic risk identified for dietary based exposure in mammals or acute risk from the consumption of fish contaminated with benzovindiflupyr. The available data suggest that benzovindiflupyr is practically non-toxic to bees and preliminary modeling and RQ analysis suggests that acute risk to bees via the contact exposure route is low. However, chronic risk and acute dietary risk to terrestrial invertebrates remain an uncertainty due to lack of toxicity data. There was not any risk identified to terrestrial plants.

The overall risk conclusions for aquatic and terrestrial taxa broken down by each proposed use of benzovindiflupyr are presented below in **Table 26 and Table 27,** respectively. Collectively for all proposed uses of benzovindiflupyr, no risks to listed terrestrial plant species are anticipated. Risks for direct and indirect effects to all terrestrial and aquatic listed species are expected. The exceptions are chronic impacts to listed benthic estuarine/marine and freshwater invertebrates.

Table 26. Summary of adverse impacts for aquatic organisms expected from the proposed uses of benzovindiflupyr.

Proposed Use	Adverse Impacts Expected for Aquatic Organisms? (No/Yes: A = Acute, C=Chronic)							
	Freshwater Fish	Estuarine/Marine Fish	Freshwater Invertebrates (Water Column)	Estuarine/ Marine Invertebrates (Water Column)	Freshwater and Saltwater Benthic Invertebrates (Sediment)	Freshwater Benthic Invertebrates (Pore water)	Saltwater Benthic Invertebrates (Pore water)	Aquatic Plants
Corn	**Yes**[A,C]	**Yes**[A,C]	**Yes**[A,C]	**Yes**[A]	No	**Yes**[A]	**Yes**[A]	No
Cucurbits	**Yes**[A,C]	**Yes**[A]	**Yes**[A]	**Yes**[A]	No	No	**Yes**[A]	No
Tomatoes and Fruiting Vegetables	**Yes**[A,C]	**Yes**[A]	**Yes**[A,C]	**Yes**	No	No	**Yes**[A]	No
Grapes	**Yes**[A,C]	**Yes**[A,C]	**Yes**[A]	**Yes**[A]	No	**Yes**[A]	**Yes**[A]	No
Tubers (Potatoes)	**Yes**[A,C]	**Yes**[A,C]	**Yes**[A]	**Yes**[A,C]	No	**Yes**[A]	**Yes**[A]	No
Peanuts	**Yes**[A,C]	**Yes**[A]	**Yes**[A,C]	**Yes**[A]	No	No	**Yes**[A]	No
Nursery Plants, Tomato Transplant, Fruit Transplant, Cucurbit Transplant	**Yes**[A,C]	**Yes**[A]	**Yes**[A]	**Yes**[A]	No	No	**Yes**[A]	No
Turf Grass	**Yes**[A,C]	No	No	No	No	No	No	No
Cotton	**Yes**[A,C]	**Yes**[A]	**Yes**[A]	**Yes**[A]	No	No	**Yes**[A]	No

Table 26. Summary of adverse impacts for aquatic organisms expected from the proposed uses of benzovindiflupyr.

Proposed Use	Adverse Impacts Expected for Aquatic Organisms? (No/Yes: A = Acute, C=Chronic)							
	Freshwater Fish	Estuarine/Marine Fish	Freshwater Invertebrates (Water Column)	Estuarine/ Marine Invertebrates (Water Column)	Freshwater and Saltwater Benthic Invertebrates (Sediment)	Freshwater Benthic Invertebrates (Pore water)	Saltwater Benthic Invertebrates (Pore water)	Aquatic Plants
Blueberries	**Yes**[A,C]	**Yes**[A]	No	**Yes**[A]	No	No	**Yes**[A]	No
Soybeans & Legumes	**Yes**[A,C]	**Yes**[A]	No	**Yes**[A]	No	No	No	No
Cereal (Oats, Barley, and Wheat)	**Yes**[A,C]	**Yes**[A]	No	**Yes**[A]	No	No	No	No
Canola	**Yes**[A,C]	**Yes**[A]	No	No	No	No	No	No
Pome fruit	**Yes**[A,C]	**Yes**[A]	No	No	No	No	No	No

Risk duration identifiers:
A = Acute
C = Chronic

Table 27. Summary of adverse impacts for terrestrial organisms expected from the proposed uses of benzovindiflupyr.						
Proposed Use	**Adverse Impacts Expected for Terrestrial Organisms? (No/Yes: A = Acute, C=Chronic)**					
	Birds	**Mammals**	**Piscivorous Birds**	**Piscivorous Mammals**	**Terrestrial Plants**	**Terretrial Invertebrates[1]**
Corn	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Cucurbits	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Tomatoes and Fruiting Vegetables	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Grapes	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Tubers (Potatoes)	**Yes[A]**	**Yes[A,C]**	**Yes[A,]**	No	No	**Yes[A,C]**
Peanuts	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Nursery Plants, Tomato Transplant, Fruit Transplant, Cucurbit Transplant	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Turf Grass	**Yes[A]**	**Yes[A,C]**	No	No	No	**Yes[A,C]**
Cotton	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Blueberries	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Soybeans & Legumes	**Yes[A]**	**Yes[A,C]**	**Yes[A]**	No	No	**Yes[A,C]**
Cereal (Oats, Barley, and Wheat)	**Yes[A]**	**Yes[A,C]**	No	No	No	**Yes[A,C]**
Canola	**Yes[A]**	**Yes[A]**	**Yes[A]**	No	No	**Yes[A,C]**
Pome fruit	**Yes[A]**	**Yes[A,C]**	No	No	No	**Yes[A,C]**

Risk duration identifiers:
A = Acute
C = Chronic

[1] Risk presumed in the absence of acute and chronic oral laraval-stage bee toxicity studies and chronic contact adult bee toxicity study.

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162-1 Aerobic soil metabolism

MRID	Citation Reference
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MRID	Citation Reference
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MRID	Citation Reference

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835.2120 Hydrolysis of parent and degradates as a function of pH at 25 C

MRID	Citation Reference
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835.2210 Direct photolysis rate in water by sunlight

MRID	Citation Reference
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MRID	Citation Reference
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835.2410 Photodegradation of parent and degradates in soil

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835.4100 Aerobic soil metabolism

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835.4300 Aerobic aquatic metabolism

MRID	Citation Reference
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835.4400 Anaerobic aquatic metabolism

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MRID	Citation Reference
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MRID	Citation Reference
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MRID	Citation Reference
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MRID	Citation Reference
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850.1350 Mysid chronic toxicity test

MRID	Citation Reference
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MRID	Citation Reference
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850.1730 Fish BCF

MRID	Citation Reference
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MRID	Citation Reference
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MRID	Citation Reference
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850.2300 Avian reproduction test

MRID	Citation Reference
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MRID	Citation Reference
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850.4400 Aquatic plant toxicity test using Lemna spp. Tiers I and II

MRID	Citation Reference
48604526	Softcheck, K. (2011) SYN545192 - 7-Day Toxicity Test with Duckweed (Lemna gibba): Final Report. Project Number: TK0002658/OCR, 1781/6749. Unpublished study prepared by Smithers Viscient Laboratories. 70p.

850.5400 Algal toxicity, Tiers 1 and II

MRID	Citation Reference
48604524	Softcheck, K. (2010) SYN545192 - 96-Hour Toxicity Test with the Freshwater Green Alga, Pseudokirchneriella subcapitata: Final Report. Project Number: T001181/08/OCR, 1781/6725. Unpublished study prepared by Springborn Smithers Laboratories. 61p.
48604547	Liedtke, A. (2012) SYN546039 - Toxicity to Pseudokirchneriella subcapitata in a 96-Hour Algal Growth Inhibition Test: Final Report. Project Number: TK0054002/OCR, D46480. Unpublished study prepared by Harlan Laboratories Ltd. 56p.
48604550	Softcheck, K. (2011) SYN545192 - 96-Hour Toxicity Test with the Marine Diatom, Skeletonema costatum: Final Report. Project Number: TK0058664/OCR, 1781/6805. Unpublished study prepared by Smithers Viscient Laboratories. 66p.

850.6200 Earthworm subchronic toxicity test

MRID	Citation Reference
48604532	Friedrich, S. (2011) SYN545192 - Sublethal Toxicity to the Earthworm Eisenia fetida in Artificial Soil with 5% Peat: Final Report. Project Number: TK0058663/OCR, 11/10/48/069/S. Unpublished study prepared by Biochem Agrar, Labor fuer Biologische und Chemische. 36p.

48604533	Friedrich, S. (2008) CSCD465008 - Sublethal Toxicity to the Earthworm Eisenia fetida: Final Report. Project Number: T000614/08/OCR, 08/10/48/025/S. Unpublished study prepared by Biochem Agrar, Labor fuer Biologische und Chemische. 25p.

850.7100 Data reporting for environmental chemistry methods

MRID	Citation Reference
48604557	Amic, S. (2012) SYN545192 - Independent Laboratory Validation of Residue Method GRM042.02A for the Determination of SYN545192 in Soil: Method Validation. Project Number: TK0002570/OCR, S11/03840, GRM042/02A. Unpublished study prepared by ADME Bioanalyses. 46p.
48604560	Braid, S.; Wiesner, F.; Breyer, N. (2012) SYN545192 - Analytical Method GRM042.05A for the Determination of SYN545192 and its Metabolite SYN546206 in Soil. Project Number: T001407/08/OCR, GRM042/05A. Unpublished study prepared by Jealott''s Hill Res. Station. 80p.

850.1735 Whole sediment: acute freshwater invertebrates

MRID	Citation Reference
48604583	Picard, C. (2012) SYN545192 - 28-Day Toxicity Test Exposing Estuarine Amphipods (Leptocheirus plumulosus) to Spiked Sediment: Final Report. Project Number: TK0053449/OCR, 1781/6806. Unpublished study prepared by Smithers Viscient Laboratories. 92p.
48286201	Benyon, K. (2010) SYN545192: Toxicity Test with Sediment-Dwelling Midges (Chironomus riparius) Under Static Conditions, Using Spiked Sediment. Project Number: TK0013014, 1781/6759, 090110/OECD/MIDGE/SPIKED/SEDIMENT. Unpublished study prepared by Springborn Smithers Laboratories. 12 p.

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48286301	Benyon, K. (2010) Syn545192 - 28-Day Toxicity Test Exposing Estuarine Amphipods (Leptocheirus plumulosus) to a Test Substance Applied to Sediment Following EPA Test Methods. Project Number: 101008/EPA/28/D/LEPTOCHEIRUS. Unpublished study prepared by Springborn Smithers Laboratories. 12 p.
48415801	Hubbard, P. (2011) SYN545192- An Acute Oral Toxicity Study with the Canary using a Sequential Testing Procedure: Protocol. Project Number: Syngenta Study Number, 582/021811/CLD/Seq/SUB528. Unpublished study prepared by Wildlife International, Ltd. 23
48604529	Fallowfield, L. (2011) SYN545192 EC (A17056F) - A Rate-Response Laboratory Bioassay of the Effects of Fresh Residues on the Predatory Mite, Typhlodromus pyri (Acari - Phytoseiidae): Final Report. Project Number:

	TK0013029/OCR, SYN/11/7. Unpublished study prepared by Mambo-Tox Ltd. 30p.
48604541	Peffer, R.; Hofstra, A.; Parsons, P. (2012) Solatenol (SYN545192): Document M-II, Section 3: Toxicological Studies. Unpublished study prepared by Syngenta Crop Protection, LLC. 508p.
48604569	Stevens, J. (2012) Benzovindiflupyr EC (A15457H) A Rate-Response Extended Laboratory Bioassay of the Effects of Fresh Residues on the Parasitic Wasp Aphidius rhopalosiphi (Hymenoptera, Braconidae): Final Report. Project Number: TK0013057/OCR, SYN/12/14. Unpublished study prepared by Mambo-Tox Ltd. 38p.
48640917	Ueckermann, A. (2012) A15457B: Details of SYN545192 Solo Formulations Used in Regulatory Studies Submitted in NAFTA Joint Review Benzovindiflupyr Dossier (November 2012). Project Number: A15457B/50090/OCR. Unpublished study prepared by Syngenta Crop Protection, LLC. 5p.
49070301	Ueckermann, A.; Rezaaiyan, R.; Sanchez, U. (2013) Syngenta Response to COFEPRIS, EPA and PMRA Deficiencies Noted During Completeness Check for NAFTA Joint Review of Benzovindiflupyr Technical and Seven Associated End-Use Products - A15457TO Fungicide, A15457 Fungicide, Mural Fungicide, A18126 Fungicide, A18993 Fungicide, A19334 Fungicide and Ascenity Fungicide. Project Number: TK0180690. Unpublished study prepared by Syngenta Crop Protection, LLC. 56p.
49070501	Lorez, C. (2013) Solatenol (SYN545192) - Toxicological and Metabolism Studies and Their Use in Determination of the ADI. Project Number: TK0180689/OCR. Unpublished study prepared by Syngenta Crop Protection, AG. 11p.

MRID	Citation Reference
D417315	Stevens, J. (2011) SYN545192 EC (A17056F) - A Rate-Response Laboratory Bioassay of the Effects of Fresh Residues on the Parasitic Wasp Aphidius rhopalosiphi (Hymenoptera, Braconidae): Final Report. Project Number: TK0013031/OCR, SYN/11/8. Unpublished study prepared by Mambo-Tox Ltd. 30p.

Appendix A. The Risk Quotient Method and Levels of Concern

The Risk Quotient Method is the means by which the Environmental Fate and Effects Division (EFED) integrates the results of exposure and ecotoxicity data. In this method, both acute and chronic risk quotients (RQs) are calculated by dividing exposure estimates by the most sensitive ecotoxicity values or toxicity endpoints derived from the studies. Calculated RQs are then compared to OPP's levels of concern (LOCs). The LOCs are the criteria used by OPP to indicate potential risk to non-target organisms and the need to consider regulatory action. EFED has defined LOCs for acute risk, potential restricted use, and for endangered species. Risk presumptions, along with the corresponding RQs and LOCs are summarized in the table below.

These LOCs are criteria used by EFED to indicate potential risk to non-target organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on non-target organisms. LOCs currently address the following risk presumption categories: (1) acute – potential for acute risk is high, regulatory action may be warranted in addition to restricted use classification (2) acute restricted use - potential for acute risk is high, but this may be mitigated through restricted use classification (3) acute endangered species – the potential for acute risk to endangered species is high, regulatory action may be warranted, and (4) chronic risk - the potential for chronic risk high, regulatory action may be warranted. Currently, EFED does not perform assessment for chronic risk to plants, acute or chronic risks to non-target insects or chronic risks from granular/bait formulations to mammalian or avian species.

The ecotoxicity test values (*i.e.*, measurement endpoints) used in the acute and chronic risk quotients are derived from the results of required studies. Examples of ecotoxicity values derived from results of short-term laboratory studies that assess acute effects are (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC_{50} (aquatic plants and aquatic invertebrates, and (4) EC_{25} (terrestrial plants). An example of a toxicity test effect level derived from the results of a long-term laboratory study that assesses chronic effects is (1) NOAEC (birds, fish, and aquatic invertebrates).

Risk Presumption	RQ	LOC
Birds		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Mammals		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Aquatic Animals		
Acute Risk	EEC/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1
Terrestrial and Semi-Aquatic Plants		
Acute Risk	EEC/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1
Aquatic Plants		
Acute Risk	EEC/EC_{50}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1

Appendix B. Output of T-REX

Example from Corn

Chemical Name:	**Solatenol**		
Use	**1**		
Formulation	**0**		
Application Rate		**0.068**	**lbs a.i./acre**
Half-life		**10.9**	**days**
Application Interval		**7**	**days**
Maximum # Apps./Year		**4**	
Length of Simulation		**1**	**year**
Variable application rates?		**no**	

Endpoints			
Avian	**zebra finch**	**LD50 (mg/kg-bw)**	**10.00**
	Bobwhite quail	**LC50 (mg/kg-diet)**	**6390.00**
	Bobwhite quail	**NOAEL(mg/kg-bw)**	**0.00**
	Mallard duck	**NOAEC (mg/kg-diet)**	**59.40**
Mammals		**LD50 (mg/kg-bw)**	**66.30**
		LC50 (mg/kg-diet)	**0.00**
		NOAEL (mg/kg-bw)	**8.20**
		NOAEC (mg/kg-diet)	**164.00**

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	37.77
Tall Grass	17.31
Broadleaf plants	21.25
Fruits/pods/seeds	2.36
Arthropods	14.79

Avian Class	Body Weight (g)	Ingestion (Fdry) (g bw/day)	Ingestion (Fwet) (g/day)	% body wgt consumed	FI (kg-diet/day)
Small	20	5	23	114	2.28E-02
Mid	100	13	65	65	6.49E-02
Large	1000	58	291	29	2.91E-01
Granivores	20	5	5	25	5.06E-03
	100	13	14	14	1.44E-02
	1000	58	65	6	6.46E-02

Avian Body Weight (g)	Adjusted LD50 (mg/kg-bw)
20	10.67
100	13.58
1000	19.18

Dose-based EECs (mg/kg-bw)	Avian Classes and Body Weights (grams)		
	small	mid	large
	20	100	1000
Short Grass	43.02	24.53	10.98
Tall Grass	19.72	11.24	5.03
Broadleaf plants	24.20	13.80	6.18
Fruits/pods	2.69	1.53	0.69
Arthropods	16.85	9.61	4.30
Seeds	0.60	0.34	0.15

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	4.03	1.81	0.57
Tall Grass	1.85	0.83	0.26
Broadleaf plants	2.27	1.02	0.32
Fruits/pods	0.25	0.11	0.04
Arthropods	1.58	0.71	0.22
Seeds	0.06	0.03	0.01

Dietary-based RQs (Dietary-based EEC/LC50 or NOAEC)	RQs	
	Acute	Chronic
Short Grass	0.01	0.64
Tall Grass	0.00	0.29
Broadleaf plants	0.00	0.36
Fruits/pods/seeds	0.00	0.04
Arthropods	0.00	0.25

Mammalian Class	Body Weight	Ingestion (Fdry) (g bwt/day)	Ingestion (Fwet) (g/day)	% body wgt consumed	FI (kg-diet/day)
Herbivores/ insectivores	15	3	14	95	1.43E-02
	35	5	23	66	2.31E-02
	1000	31	153	15	1.53E-01
Grainvores	15	3	3	21	3.18E-03
	35	5	5	15	5.13E-03
	1000	31	34	3	3.40E-02

Mammalian Class	Body Weight	Adjusted LD50	Adjusted NOAEL
Herbivores/ insectivores	15	145.72	18.02
	35	117.90	14.58
	1000	51.00	6.31
Granivores	15	145.72	18.02
	35	117.90	14.58
	1000	51.00	6.31

Dose-Based EECs (mg/kg-bw)	Mammalian Classes and Body weight (grams)		
	15	35	1000
Short Grass	**36.01**	**24.89**	**5.77**
Tall Grass	**16.50**	**11.41**	**2.64**
Broadleaf plants	**20.26**	**14.00**	**3.25**
Fruits/pods	**2.25**	**1.56**	**0.36**
Arthropods	**14.10**	**9.75**	**2.26**
Seeds	**0.50**	**0.35**	**0.08**

Dose-based RQs (Dose-based EEC/LD50 or NOAEL)

	Small mammal 15 grams		Medium mammal 35 grams		Large mammal 1000 grams	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short Grass	0.247128	1.998121	0.211095	1.706782	0.113155	0.914902
Tall Grass	0.113267	0.915805	0.096752	0.782275	0.051863	0.41933
Broadleaf plants	0.13901	1.123943	0.118741	0.960065	0.06365	0.514633
Fruits/pods	0.015446	0.124883	0.013193	0.106674	0.007072	0.057181
Arthropods	0.096792	0.782597	0.082679	0.66849	0.044319	0.358337
Seeds	0.003432	0.027752	0.002932	0.023705	0.001572	0.012707

Dietary-based RQs (Dietary-based EEC/LC50 or NOAEC)	Mammal RQs	
	Acute	Chronic
Short Grass	**#DIV/0!**	**0.23**
Tall Grass	**#DIV/0!**	**0.11**
Broadleaf plants	**#DIV/0!**	**0.13**
Fruits/pods/seeds	**#DIV/0!**	**0.01**
Arthropods	**#DIV/0!**	**0.09**

Appendix C. Kow (based) Aquatic Bioaccumulation Model Output using Corn scenario

Table C-1. Estimated concentrations of Solatenol in ecosystem components.

Ecosystem Component	Total concentration (µg/kg-ww)	Lipid normalized concentration (µg/kg-lipid)	Contribution due to diet (µg/kg-ww)	Contribution due to respiration (µg/kg-ww)
Water (total)*	7	N/A	N/A	N/A
Water (freely dissolved)*	7	N/A	N/A	N/A
Sediment (pore water)*	6	N/A	N/A	N/A
Sediment (in solid)**	1,148	N/A	N/A	N/A
Phytoplankton	6,603	330168	N/A	6,603.36
Zooplankton	4,884	162816	32.11	4,852.36
Benthic Invertebrates	5,348	178278	88.18	5,260.16
Filter Feeders	3,517	175856	56.82	3,460.30
Small Fish	7,079	176973	346.88	6,732.03
Medium Fish	7,347	183675	662.91	6,684.10
Large Fish	7,877	196923	1,229.40	6,647.50

* Units: µg/L; **Units: µg/kg-dw

Table C-2. Total BCFand BAF values of Solatenol in aquatic trophic levels.

Trophic Level	Total BCF (µg/kg-ww)/(µg/L)	Total BAF (µg/kg-ww)/(µg/L)
Phytoplankton	959	929
Zooplankton	683	687
Benthic Invertebrates	742	752
Filter Feeders	488	495
Small Fish	955	996
Medium Fish	955	1033
Large Fish	959	1108

Table C-3. Lipid-normalized BCF, BAF, BMF and BSAF values of Solatenol in aquatic trophic levels.				
Trophic Level	**BCF (µg/kg-lipid)/(µg/L)**	**BAF (µg/kg-lipid)/(µg/L)**	**BMF (µg/kg-lipid)/(µg/kg-lipid)**	**BSAF (µg/kg-lipid)/(µg/kg-OC)**
Phytoplankton	47931	46437	N/A	12
Zooplankton	22774	22900	0.49	6
Benthic Invertebrates	24744	25074	1.10	6
Filter Feeders	24414	24734	1.08	6
Small Fish	23868	24891	1.04	6
Medium Fish	23868	25833	1.03	6
Large Fish	23986	27697	1.07	7

Table C-4. Calculation of EECs for mammals and birds consuming fish contaminated by Solatenol.						
Wildlife Species	**Biological Parameters**				**EECs (pesticide intake)**	
	Body Weight (kg)	**Dry Food Ingestion Rate (kg-dry food/kg-bw/day)**	**Wet Food Ingestion Rate (kg-wet food/kg-bw/day)**	**Drinking Water Intake (L/d)**	**Dose Based (mg/kg-bw/d)**	**Dietary Based (ppm)**
Mammalian						
fog/water shrew	0.02	0.140	0.585	0.003	3.131	5.35
rice rat/star-nosed mole	0.1	0.107	0.484	0.011	2.573	5.32
small mink	0.5	0.079	0.293	0.048	2.156	7.35
large mink	1.8	0.062	0.229	0.168	1.684	7.35
small river otter	5.0	0.052	0.191	0.421	1.404	7.35
large river otter	15.0	0.042	0.157	1.133	1.238	7.88
Avian						
sandpipers	0.0	0.228	1.034	0.004	5.5144	5.33
cranes	6.7	0.030	0.136	0.211	0.7373	5.42
rails	0.1	0.147	0.577	0.010	3.5885	6.21
herons	2.9	0.040	0.157	0.120	0.9994	6.35

Table C-4. Calculation of EECs for mammals and birds consuming fish contaminated by Solatenol.						
Wildlife Species	**Biological Parameters**				**EECs (pesticide intake)**	
	Body Weight (kg)	**Dry Food Ingestion Rate (kg-dry food/kg-bw/day)**	**Wet Food Ingestion Rate (kg-wet food/kg-bw/day)**	**Drinking Water Intake (L/d)**	**Dose Based (mg/kg-bw/d)**	**Dietary Based (ppm)**
small osprey	1.3	0.054	0.199	0.069	1.4654	7.35
white pelican	7.5	0.029	0.107	0.228	0.8407	7.88

Table C-5. Calculation of toxicity values for mammals and birds consuming fish contaminated by Solatenol.				
	Toxicity Values			
	Acute		**Chronic**	
Wildlife Species	**Dose Based (mg/kg-bw)**	**Dietary Based (mg/kg-diet)**	**Dose Based (mg/kg-bw)**	**Dietary Based (mg/kg-diet)**
Mammalian				
fog/water shrew	115.49	N/A	16.38	156
rice rat/star-nosed mole	78.35	N/A	11.11	156
small mink	51.65	N/A	7.33	156
large mink	36.52	N/A	5.18	156
small river otter	28.29	N/A	4.01	156
large river otter	21.50	N/A	3.05	156
Avian				
sandpipers	15.07	6390.00	N/A	59.4
cranes	36.04	6390.00	N/A	59.4
rails	18.18	6390.00	N/A	59.4
herons	31.79	6390.00	N/A	59.4

Table C-5. Calculation of toxicity values for mammals and birds consuming fish contaminated by Solatenol.				
	Toxicity Values			
	Acute		Chronic	
Wildlife Species	Dose Based (mg/kg-bw)	Dietary Based (mg/kg-diet)	Dose Based (mg/kg-bw)	Dietary Based (mg/kg-diet)
small osprey	28.02	6390.00	N/A	59.4
white pelican	36.66	6390.00	N/A	59.4

Table C-6. Calculation of RQ values for mammals and birds consuming fish contaminated by Solatenol.				
	Acute		Chronic	
Wildlife Species	Dose Based	Dietary Based	Dose Based	Dietary Based
Mammalian				
fog/water shrew	0.027	N/A	0.191	0.034
rice rat/star-nosed mole	0.033	N/A	0.232	0.034
small mink	0.042	N/A	0.294	0.047
large mink	0.046	N/A	0.325	0.047
small river otter	0.050	N/A	0.350	0.047
large river otter	0.058	N/A	0.406	0.050
Avian				
sandpipers	**0.366**	0.001	N/A	0.090
cranes	0.020	0.001	N/A	0.091
rails	**0.197**	0.001	N/A	0.105
herons	0.031	0.001	N/A	0.107
small osprey	0.052	0.001	N/A	0.124
white pelican	0.023	0.001	N/A	0.133

Appendix D. Terrplant.

Table 1. Chemical Identity.	
Chemical Name	
PC code	122305
Use	Cucurbits
Application Method	
Application Form	
Solubility in Water (ppm)	2.1

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	0.068	y
Incorporation	I	1	none
Runoff Fraction	R	0.01	none
Drift Fraction	D	0.01	none

Table 3. EECs for . Units in y.		
Description	Equation	EEC
Runoff to dry areas	(A/I)*R	0.00068
Runoff to semi-aquatic areas	(A/I)*R*10	0.0068
Spray drift	A*D	0.00068
Total for dry areas	((A/I)*R)+(A*D)	0.00136
Total for semi-aquatic areas	((A/I)*R*10)+(A*D)	0.00748

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
	Seedling Emergence		Vegetative Vigor	
Plant type	EC_{25}	NOAEC	EC_{25}	NOAEC
Monocot	0.089	0.089	x	0.09
Dicot	0.089	0.089	x	0.09

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	<0.1	<0.1
Monocot	listed	<0.1	<0.1	<0.1
Dicot	non-listed	<0.1	<0.1	<0.1
Dicot	listed	<0.1	<0.1	<0.1
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix E. Sample SWCC Output File

Summary of Water Modeling of Solatenol and the USEPA Standard Pond

Estimated Environmental Concentrations for Solatenol are presented in Table 1 for the USEPA standard pond with the MEpotatoSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 4.1% of Solatenol applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by erosion (43.4% of the total transport), followed by spray drift (30.4%) and runoff (26.2%).

In the water body, pesticide dissipates with an effective water column half-life of 4638.4 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 metabolism (effective average half-life = 6781.9 days) followed by photolysis (14682.8 days) and volatilization (2.905305E+07 days).

In the benthic region, pesticide dissipation is negligible (2106.6 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 2106.6 days). The vast majority of the pesticide in the benthic region (99.79%) is sorbed to sediment rather than in the pore water.

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

Peak (1-in-10 yr)	8.71
4-day Avg (1-in-10 yr)	8.46
21-day Avg (1-in-10 yr)	8.17
60-day Avg (1-in-10 yr)	7.91
365-day Avg (1-in-10 yr)	7.71
Entire Simulation Mean	5.71

Table 2. Summary of Model Inputs for Solatenol.

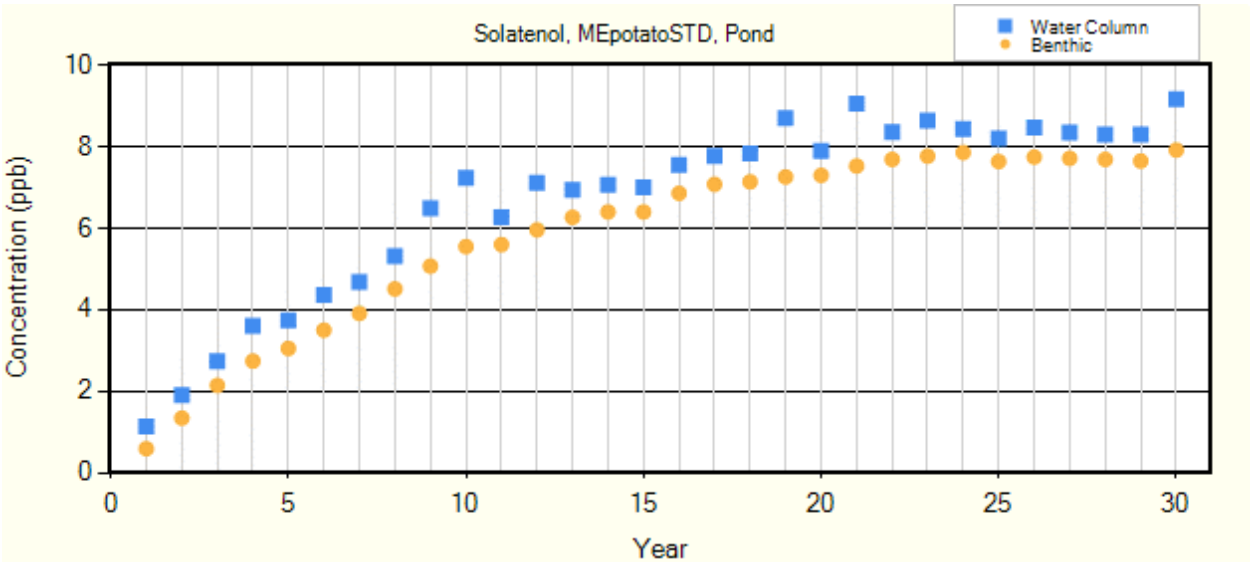
Scenario	MEpotatoSTD
Cropped Area Fraction	1
Koc (ml/g)	4478
Water Half-Life (days) @ 20 °C	2920
Benthic Half-Life (days) @ 20 °C	907
Photolysis Half-Life (days) @ 45 °Lat	88.4
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 20 °C	1460
Foliar Half-Life (days)	0
Molecular Wt	398.2
Vapor Pressure (torr)	2.4e-11

Solubility (mg/l)	0.98

Table 3. Application Schedule for Solatenol.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
8/15	Foliar	0.076	0.95	0.125
8/22	Foliar	0.076	0.95	0.125
8/29	Foliar	0.076	0.95	0.125
9/5	Foliar	0.076	0.95	0.125

Figure 1. Yearly Peak Concentrations



Appendix F. Formation of Benzovindiflupyr Transformation Products in Environmental Fate Studies

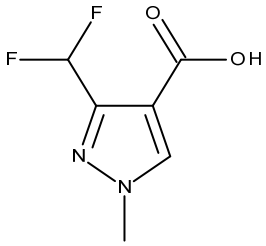
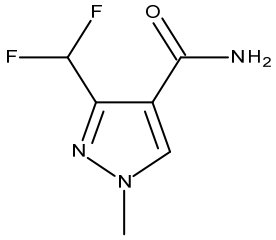
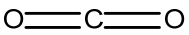
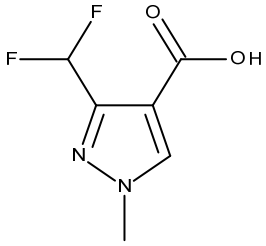
Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
Hydrolysis (MRID No. 48604506)			
None – Stable at pH 4, 5, 7, and 9			
Aquatic Photolysis (MRID No. 48604507)			
Pyrazole Acid (NOA449410, CSAA798670; CA4312)		8.9% at 15 days (pH7 solution) 38.6% at 15 days (natural water)	Study terminated at 15 days.
Pyrazole Amine (SYN508272, CSCC210616)		2.6% at 15 days (pH7 solution) 24.5% at 15 days (natural water)	Study terminated at 15 days.
Carbon Dioxide		6.9% at 15 days (natural water) 25.7% at 15 days (natural water)	Study terminated at 15 days.
Soil Photolysis (MRID No. 48604495)			
Pyrazole Acid (NOA449410, CSAA798670; CA4312)		2.9% at 30 days	Study terminated at 30 days.

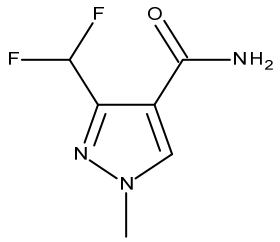
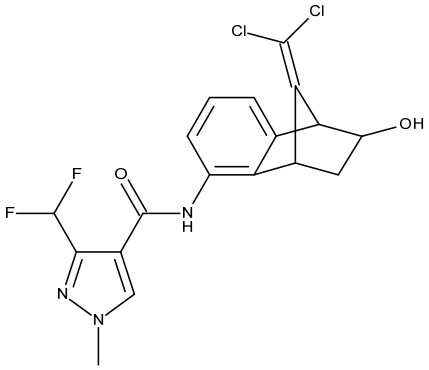
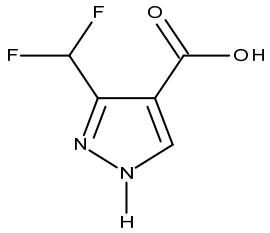
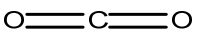
Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
Pyrazole Amine (SYN508272, CSCC210616)		6.5% at 30 days	Study terminated at 30 days.
SYN546039 (CSCD695908)		7.0% at 30 days	Study terminated at 30 days.
SYN545720 (CSCD465008)		0.7% at 30 days	Study terminated at 30 days.
Carbon Dioxide		2.2% at 30 days	Study terminated at 30 days.

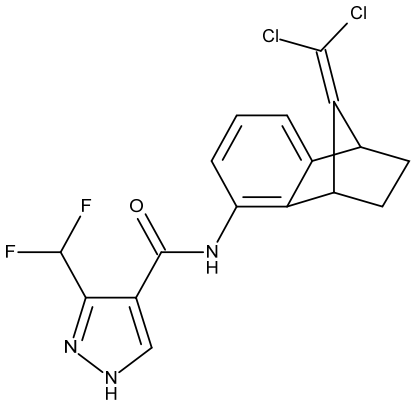
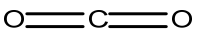
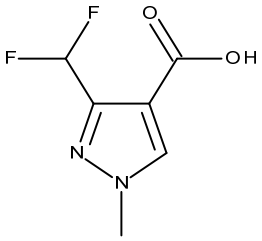
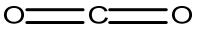
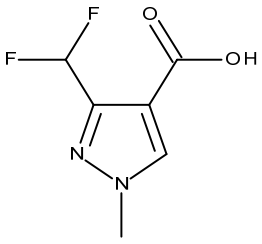
Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
Aerobic Soil Metabolism (MRID Nos. 48604492 and 48604493)			
SYN546206 (CSCD711742)		5.6% at 365 days	Study terminated at 365 days.
Carbon Dioxide		6.0% at 365 days.	Study terminated at 365 days.
Anaerobic Soil Metabolism (MRID Nos. 48604494)			
Pyrazole Acid (NOA449410, CSAA798670; CA4312)		2.4% at 120 days.	Study terminated at 120 days.
Carbon Dioxide		0.4% at 120 days.	Study terminated at 120 days.
Aerobic Aquatic Metabolism (MRID Nos. 48604509 and 48604510)			
Pyrazole Acid (NOA449410, CSAA798670; CA4312)		3.1% at 102 days	Study terminated at 102 days.

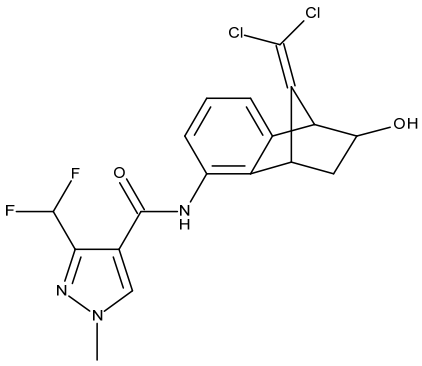
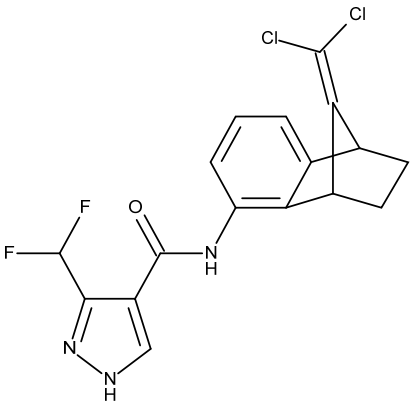
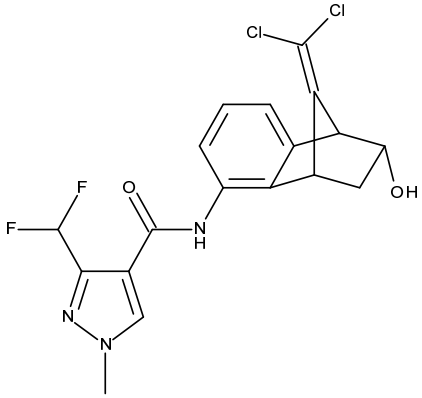
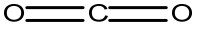
Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
SYN546039 (CSCD695908)		0.4% at 29 days	Study terminated at 102 days.
SYN546206 (CSCD711742)		1.4% at 60 days	Study terminated at 102 days.
SYN546040 (CSCD696468)		0.1% at 61 days	Study terminated at 100 days.
Carbon Dioxide		0.3% at 100 days	Study terminated at 100 days.

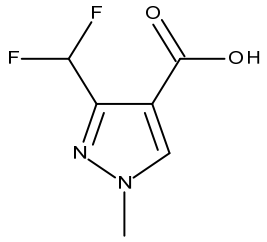
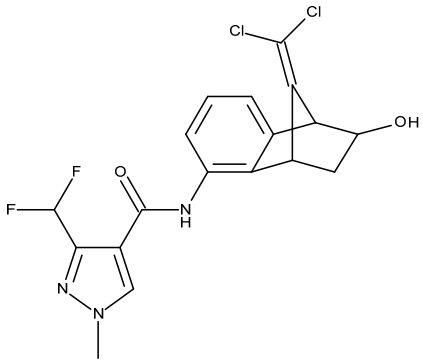
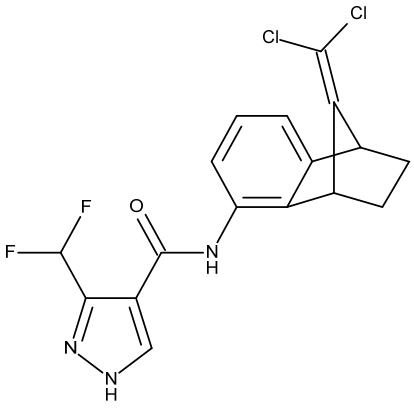
Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
Anaerobic Aquatic Metabolism (MRID Nos. 48604509 and 48604510)			
Pyrazole Acid (NOA449410, CSAA798670; CA4312)		3.0% at 102 days	Study terminated at 100 days.
SYN546039 (CSCD695908)		0.2% at 59 days	Study terminated at 100 days.
SYN546206 (CSCD711742)		1.7% at 30 days	Study terminated at 100 days.

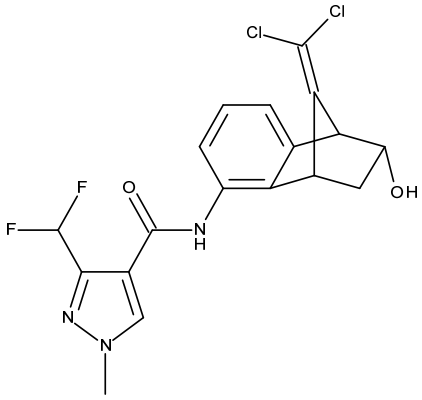
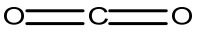
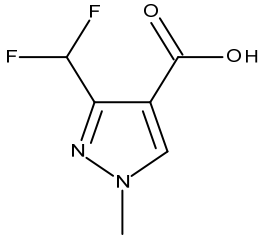
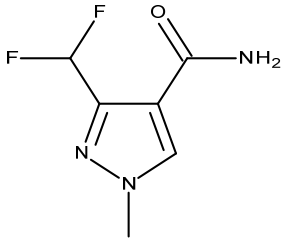
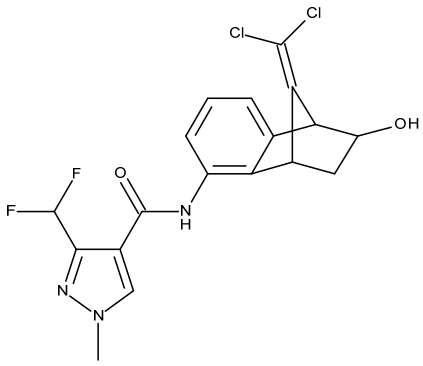
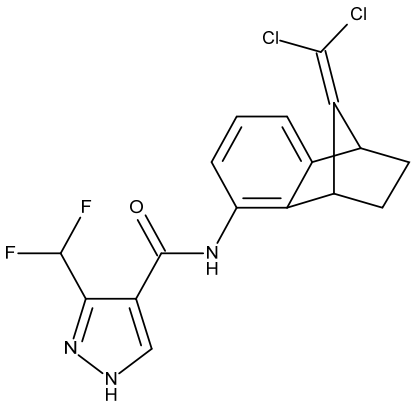
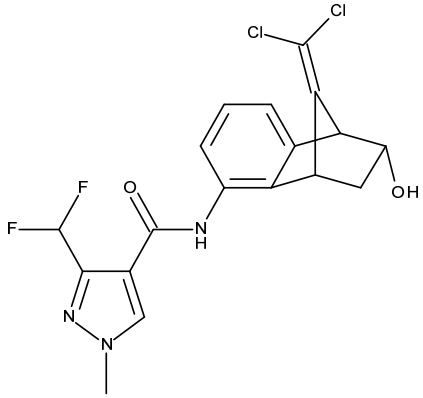
Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
SYN546040 (CSCD696468)		0.6% at 61 days	Study terminated at 100 days.
Carbon Dioxide		0.3% at 100 days	Study terminated at 100 days.
Terrestrial Field Dissipation (MRID Nos. 48604498, 48604502, and 48604511)			
Pyrazole Acid (NOA449410, CSAA798670; CA4312)		0.77% at 29 days after 2nd application 0.5% at 7 days after 1st application	Manitoba Loam Soil, Bare Plot (MRID No. 48604502) Georgia Loamy Sand (MRID No. 48604511)
Pyrazole Amine (SYN508272, CSCC210616)		2.0% at 7 days after 1st application	Georgia Loamy Sand (MRID No. 48604511)

Table F-1. Benzovindiflupyr degradation products identified in environmental fate studies.			
Degradate Identity	**Structure**	**Max% of Applied and Days Post Application**	**Comments**
SYN546039 (CSCD695908)		1.2% at 34 days after 3rd application 1.5% at 63 days after 1st application	Georgia Peanut Plants (MRID No. 48604498) Georgia Loamy Sand Soil (MRID No. 48604511)
SYN546206 (CSCD711742)		1.8% at 148 days after 1st application	Georgia Loamy Sand Soil (MRID No. 48604511)
SYN546040 (CSCD696468)		0.6% at 91 days after 1st application	Georgia Loamy Sand Soil (MRID No. 48604511)

Appendix G. Ecological Toxicity Data for Transformation Products for Benzovindiflupyr Transformation Products

Table G-1. Toxicity Reference Values For Aquatic Organisms Exposed to Degradation Products of Benzovindiflupyr.

Species	Study Type	Test Substance (Purity)	LC_{50} (µg a.i/L)[1,2,3] (95% CL; slope)	Endpoints Affected	Toxicity Classification (MRID)
Acute Freshwater Fish Test with Benzovindiflupyr Metabolite M700F001					
Rainbow trout (*Oncorhynchus mykiss)*	96-hour, flow-through	TGAI (99.2 %)	>88100	None	slightly to practically non-toxic (47923926)
Acute Freshwater Fish with Benzovindiflupyr MetaboliteSYN46039					
Rainbow trout (*Oncorhynchus mykiss)*	96-hour, flow-through	TGAI (98 %)	2500 (2000-3000; NA)	Mortality and Sublethal effects	Moderately toxic (48604545)
Acute Freshwater Invertebrate Test with Benzovindiflupyr Metabolite M700F001					
Species	**Study Type**	**Test Substance (Purity)**	**LC_{50} (µg a.i/L)[1,2,3] (95% CL; slope)**	**Endpoints Affected**	**Toxicity Classification (MRID)**
Water flea (*Daphnia magna*)	48-hr, static	TGAI (99.2%)	>98200	None	practically non-toxic (47923732)
Acute Freshwater Invertebrate test with Benzovindiflupyr MetaboliteSYN46039					
Species	**Study Type**	**Test Substance (Purity)**	**LC_{50} (µg a.i/L)[1,2,3] (95% CL; slope)**	**Endpoints Affected**	**Toxicity Classification (MRID)**
Water flea (*Daphnia magna*)	48-hr, static	TGAI (98%)	**5450 (4790 - 6190; NA)**	immobility	Moderately toxic (48604546)
Aquatic Plant Test with Benzovindiflupyr Metabolite SYN46039					

Species	Study Type	Test Substance (Purity)	**LC_{50}** (µg a.i/L)[1,2,3] **(95% CL; slope)**	Endpoints Affected	Toxicity Classification (MRID)
Species	**Study Type**	**Test Substance (Purity)**	**EC_{50}** (ug a.i./L) **(95% CL)[1,2]**	**Endpoints Affected**	**(MRID)**
Freshwater green algae (*Pseudokirchneriella subcapitata*)	96-hr, static	TGAI (98%)	**> 6400 ; N/A**	Growth Rate	(48604547)