Appendix B. Case Study for Integrating a Distributional Approach to Using Percent Crop Area (PCA) and Percent Crop Treated (PCT) into Drinking Water Assessment

1. Executive Summary

Drinking water assessments (DWA) follow a tiered process that is used to distinguish pesticides that that do not pose a potential risk from pesticides that may require a detailed and more in-depth analysis. The Percent Cropped Area (PCA)/Percent Crop Treated (PCT) project provides an approach to apply use and usage data to refine estimated drinking water concentrations (EDWCs) in higher-tier assessments for agricultural and non-agricultural uses individually or in combinations. The goal of the PCA and PCT refinements are to generate EDWCs that are appropriate for human health risk assessment that reduce the magnitude of overestimation due to variability in crops and actual pesticide usage. The background and concepts of the PCA/PCT project are presented in the PCA/PCT White Paper while this case study provides an example of employing these new methods in a highly refined DWA on a Hydrologic Unit Code (HUC-2) basis.

This case study first provides a high-level summary of the scoping and problem formulation process for a pesticide called "pest1", including the fate properties and use patterns, as well as the results of the Tier 2 DWA for HUC-2 Regions 03, 04 and 05. The subsequent sections of the case study describe the application of the new PCA and PCT methods as a Tier 3 refinement. For this case study, after applying the new PCA method, the EDWCs in HUC-04 are all expected to be below the level of concern, while the results for HUC-03 and HUC-05 indicate the need for further PCT refinements. After applying the new PCT method, in HUC-03, PCT refinement had a minimal impact on the EDWCs due to the lack of PCT data for non-agricultural uses. PCT refinements in HUC-05 reduced the number of watersheds with Drinking Water Level of Comparison (DWLOC) exceedances by 37%.

This case study focuses specifically on applying this new approach to utilize PCA and PCT in Tier 3 DWA refinements to the EDWC in surface water for pest1, and not on the DWA process up to that point which has been already completed. A description of the entire tiered DWA process can be found in the Draft *Framework for Conducting Pesticide Drinking Water Assessments for Surface Water* (DWA Framework) (USEPA, 2019).

2. Scoping and Problem Formulation

The DWA Framework describes the problem formulation and scoping process prior to, and during, the conduct of a DWA. This involves a holistic look at the pesticide to be assessed, what is known about the potential and actual use, the underlying environmental fate and human health hazard data (*i.e.*, DWLOC), and the results of previous risk assessments.

a. Use Characterization

Pest1 is a nationally registered insecticide with 80 uses in terrestrial food and feed crops, terrestrial non-food crops, greenhouse food/non-food, and non-agricultural indoor and outdoor crops. The spatial distribution of the average agricultural usage data in lbs pest1/agricultural acre between 2008-2012 are presented in **Figure 1**.

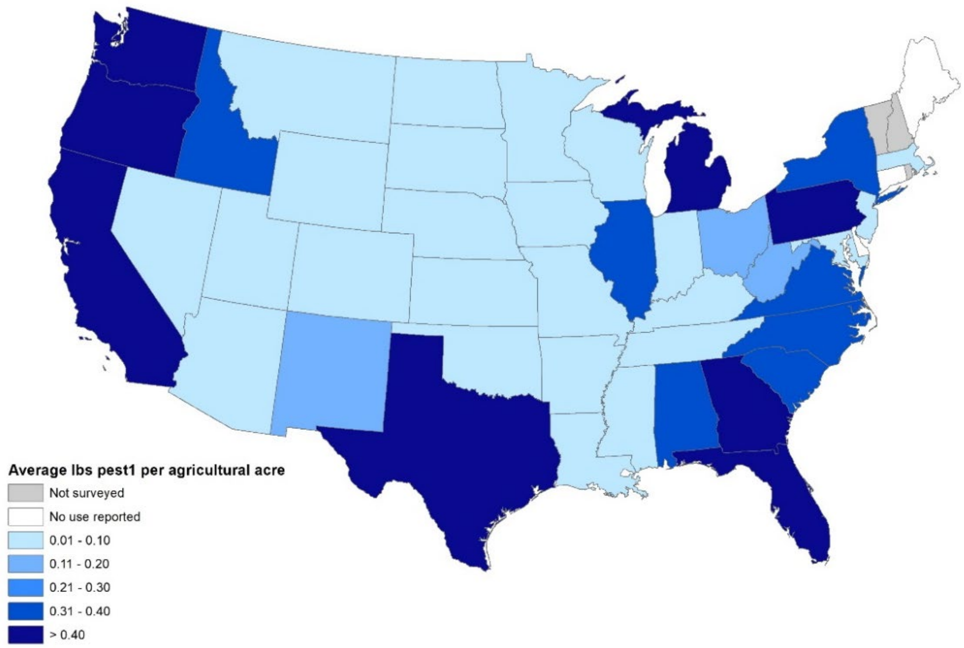

Figure 1. Spatial Distribution of Pest1 Agricultural Use (2008-2012)

Based on yearly average usage data from 2004 to 2013 provided by the Biological and Economic Analysis Division (BEAD), approximately 7.2 million pounds of pest1 are used each year for agricultural purposes in the United States. Approximately 21% and 19% of the total volume of pest1 used in the United States each year is applied to soybeans (1.5 million lbs) and corn (1.4 million lbs), respectively. On average only 5% of total soybean acreage and about 2.5% of total corn acreage is treated with pest1 each year. Other crops with relatively high usage of pest1 (at least 100,000 lbs/year) include alfalfa, almonds, apples, apricots, cotton, grapes, oranges, peanuts, pecans, sugar beets, walnuts and wheat. A large fraction, at least 40%, of the total acreage planted with apples, asparagus, broccoli, onions, and walnuts, is treated with pest1. Agricultural usage has declined every year from 1992 – 2012 as shown in **Figure 2**.

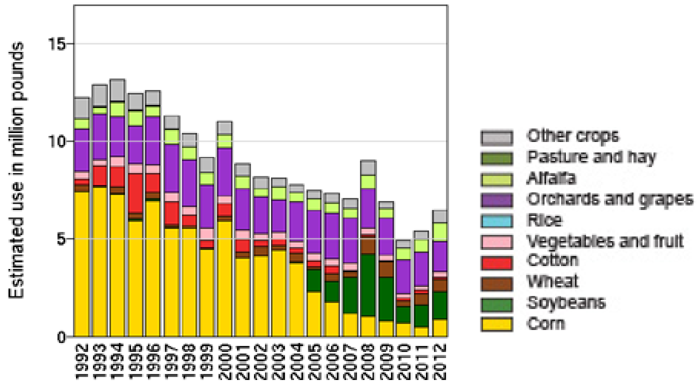

Figure 2. Pest1 Use by Year per Crop (1992 – 2012)

No national-level pest1 usage data are available for registered non-crop use sites, including turf, golf courses, mosquito control, and ornamental sites and indoor/outdoor pest control. Pest1 is also used as wood protection treatment for fence posts, utility poles, lumber and railroad ties, *etc*.). Finally, pest1 may be used for general outdoor (*i.e.*, wide areas) treatment to control ants and other miscellaneous pests.

b. Exposure Characterization

Pest1 will initially enter the environment via direct application (*e.g.*, liquid spray and granular) to use sites (*e.g.*, soil, foliage, seed treatments, non-ag surfaces). It may move off-site via spray drift, volatilization (primarily following foliar applications), and runoff (generally by soil erosion rather than dissolution in runoff water). Pest1 is expected to be persistent for several months in the environment with aerobic soil and aerobic aquatic metabolism being the primary routes of transformation. Major routes of dissipation include spray drift, volatilization and runoff via dissolved phase and eroded sediment.

Table 1. Summary of Environmental Fate and Transport Characteristics of Pest1

Parameter (time)	Test System Name or Characteristics	Half-life Values
Hydrolysis half-life (days)	pH 7, 25°C	72
Aqueous photolysis half-life (days)	pH 7, 25°C	29.6
Soil photolysis half-life (days)	--	Stable
Air photolysis half-life (hours)	Indirect	2
	Direct	6
Aerobic Soil Metabolism half-life (days)	25°C	19 - 297 (n=8)
Aerobic Aquatic Metabolism half-life (days) (kinetic model)	25 ˚C	30.4 (SFO)
Anaerobic Soil Metabolism half-life (days)	25 ˚C	78 - 171 (n=2)
Anaerobic Aquatic Metabolism half-life (days) (kinetic model)	25 ˚C	50.2 – 125 (IORE)

c. Previous Assessments

As described above, this case study builds on a DWA completed up to Tier 2 consistent with the DWA Framework (USEPA, 2019). The previous Tier 2 DWA for pest1 produced EDWCs that covered maximum label rates for all uses using standard modeling scenarios. It included consideration of typical rates and regional (HUC-2 scale) PCA adjustment factors.

At the Tier 2 assessment level, many use scenarios resulted in concentrations above the DWLOC even when considering regional use patterns (*i.e.*, maximum regional percent cropped area) and when assuming non-agricultural uses had minimal influence on the overall exposure profile. The range of Tier 2 EDWC by use site are shown graphically on **Figure 3**.

The results of the Tier 2 DWA for pest1 indicates that further refinements consistent with Tier 3 of the DWA Framework (USEPA, 2019) are needed.

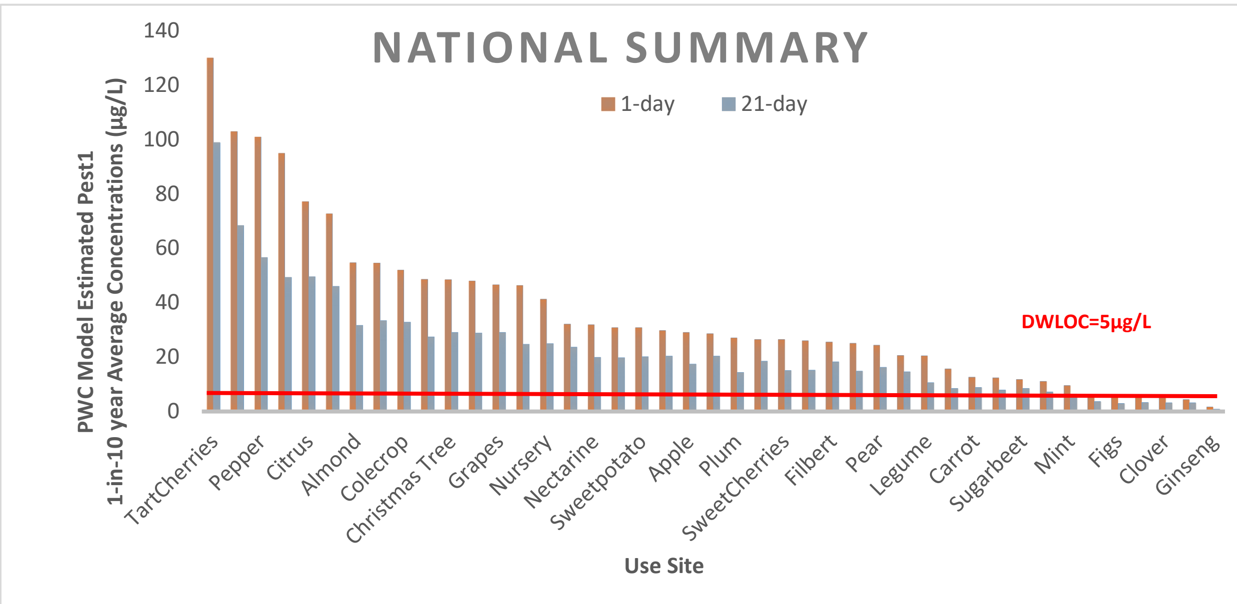

Figure 3. National Screening Level Estimated Concentrations for the Case Study Pest1 Resulting from Maximum Labeled (single and 21-day rolling average) Rates and Minimum Retreatment Intervals for Uses on Agricultural Sites and Non-Agricultural Sites

d. Current Assessment

This case study lays out an example of how PCA and PCT refinements as described in the PCA/PCT White Paper can be incorporated into a Tier 3 DWA using pest1 as an example. In order to demonstrate the proposed approach for incorporating the full distribution of CWS watershed PCAs and PCTs, this case study begins with the results from the regional Tier 2 level assessment and focuses on three, HUC-2 Regions 03, 04 and 05 as summarized in the sub-sections below. Simplifications of the use profile and other factors have been made for each region for brevity of the case study. In addition, for the purposes of this case study only the

4838 quality assured delineated drinking water intake watersheds are considered[1]. This method will ultimately be extended to all delineated CWS watersheds and the HUC-12 surrogates described in the *Development of Community Water System Drinking Water Intake Percent Cropped Area Adjustment Factors for use in Drinking Water Exposure Assessments: 2014 Update* (USEPA, 2014). Also, this case study uses a 21-day average DWLOC of 5 µg/L.

3. Tier 2 Analysis

a. Introduction

Consistent with the DWA Framework (USEPA, 2019) Tier 2 considers maximum use rate data and regional PCAs as described in the DWA Framework. This section describes the results for the three representative HUC-2 Regions chosen for this case study which inform the transition to Tier 3 and the application of the distributional PCA and PCT refinements to EDWC values for pest1 in three representative HUC-2 Regions: regions 03, 04, and 05.

b. PCA and Watershed Descriptions

i. South Atlantic-Gulf (HUC-2 Region 03)

The South Atlantic-Gulf region (HUC-2 Region 03) encompasses several states including Florida, Georgia, North Carolina, South Carolina, and Alabama, parts of Mississippi, Louisiana and Virginia. There are roughly 470 known surface water intakes used to supply drinking water in the region. In the South Atlantic-Gulf region, pest1 may be applied to orchard crops including apples and cherries as well as non-agricultural setting (*i.e.*, wide area use) but not in residential areas (*i.e.,* turf). This region includes use sites with high labeled use rates (4 lbs ai/A per year). The maximum regional all-agricultural and non-agricultural land PCA is 1 for all CWS watersheds. Based on Tier 2 modeling and maximum label rates, the 1-in-10 year 21-day average concentrations for the South Atlantic-Gulf region are 17.5, 49.6, and 55.6 µg/L for apple, citrus, and non-agricultural, respectively. Therefore, EDWCs for pest1 resulting from maximum label rates are above the DWLOC of 5 µg/L in the South Atlantic-Gulf region and more refinements need to be considered.

ii. Great Lakes (HUC-2 Region 04)

The Great Lakes region (HUC-2 Region 04) encompasses primarily Michigan with overlap with small portions of Ohio, Indiana, Pennsylvania, and New York. There are 150 known surface water intakes used to supply drinking water in the region. The Great Lakes region has a diverse range of crops to which pest1 may be applied. This region includes use sites with high labeled use rates (4 lb a.i./A/yr on orchards). The maximum regional all-agricultural and non-agricultural land PCA is 0.92 for all CWS watersheds. Based on Tier 2 modeling and maximum label rates, the 1-in-10 year 21-day average concentrations for region 04 are 90.9, 16.1, 42.4, 9.8, and 7.8 µg/L for cherries, apples, corn, soybeans, and sugar beets, respectively. Therefore,

[1] Details on development of the CWS PCA and their use as a DWA refinement may be found in the PCA/PCT White Paper and Development of Community Water System Drinking Water Intake Percent Cropped Area Adjustment Factors for use in Drinking Water Exposure Assessments: 2014 Update (USEPA, 2014)

EDWCs for pest1 resulting from maximum label rates are above the DWLOC of 5 µg/L in the Great Lakes region and more refinements need to be considered.

iii. Ohio (HUC-2 Region 05)

The Ohio Region (HUC-2 Region 05) encompasses Ohio, and parts of Pennsylvania, West Virginia, Indiana and Kentucky. There are over 600 known surface water intakes used to supply drinking water in this region. HUC-2 05 has a diverse range of crops to which pest1 may be applied. This area contains use sites with high labeled use rates (4 lbs ai/A per year on orchards). The maximum regional all-agricultural and non-agricultural land PCA is 0.89 for all CWS watersheds. Based on Tier 2 modeling and maximum label rates, the 1-in-10 year 21-day average concentrations for region 05 are 87.9, 15.6, 41.0, 9.5, and 22.1 µg/L for cherries, apples, corn, soybeans, and alfalfa, respectively. Therefore, EDWC for pest1 resulting from maximum label rates are above the DWLOC of 5 µg/L in the Ohio Region and more refinements need to be considered.

iv. Tier 2 Summary

Results of the Tier 2 DWA for pest1 in HUC-2 Regions 03, 04, and 05 demonstrate that each HUC-2 EDWCs are above the DWLOC. While not proposed for Tier 2, the application of the full suite of PCA's for each HUC-2 indicates most of the watersheds require additional refinement.

Table 2. Summary of Tier 2 Results by HUC-2 Region

Region	Use Sites [a]	Highest Estimated 21-day Average	Total Number of CWS[b]
South Atlantic-Gulf (HUC-2 Region 03)	**non-agricultural**, citrus, and apple	55.6	468
Great Lakes (HUC-2 Region 04)	**cherries**, apples, corn, soybean, and alfalfa	90.9	151
Ohio (HUC-2 Region 05)	**cherries**, apples, corn, soybeans, and alfalfa	87.9	626

[a] **Bold** use site indicates use pattern with maximum EDWC
b based on the 4838 delineated CWS watersheds only

4. Tier 3 Analysis

As described in the PCA/PCT White Paper and consistent with the DWA Framework (USEPA, 2019), after considering standard Tier 2 refinements, our proposed Tier 3 DWA considers additional data to further refine EDWCs including using the full distribution of individual CWS watershed PCAs where the EDWCs exceed the DWLOC followed by pesticide specific usage data (*i.e.*, Percent Crop Treated, or PCT data). It is important to note that, because the PCA data are readily available within EFED and the data are generic to all pesticides, application of PCA refinements is often easier than PCT refinements. Usage data provided by BEAD is pesticide specific and must be generated on a case by case basis. For pest1, pesticide usage data including PCT is available from previous assessments which included information on typical application rates and dates of application. Usage information including typical application rates and application timing is integrated in this case study with incorporation of regionally specific modeling scenarios for HUC-2 Regions 03, 04, and 05.

a. Percent Cropped Area Analysis

There are several potential Tier 3 PCA refinement options to better understand the exposure potential of pest1 as described in the White Paper. The PCA refinements applied in this case study are summarized below and the results are presented by HUC-2 Region.

1. **APPLY USE PATTERN SPECIFIC PCA.** The use pattern specific PCA is the PCA value for the combination of crops/groups of crops specific to the registered uses of a pesticide. This captures the area of the watershed allocated to proposed or registered use sites, rather than using the default all-agricultural land PCA as is typically applied at Tier 2 when there are multiple crop uses or Tier 1 when non-agricultural uses are under consideration, understanding that both options can overestimate the use footprint. An example is the orchard PCA being applied to cherries or apples, but not both.

2. **EXAMINE FULL DISTRIBUTION OF WATERSHED PCA VALUES.** Instead of only using the maximum national/regional PCA value, the Tier 3 PCA analysis considers all watershed PCAs within each HUC-2 Region to identify the percentage of watersheds that have PCA adjusted EDWCs that exceed the DWLOC and whether the pest1 specific use sites (*e.g.*, cherries) occur in the respective watersheds.

3. **CALCULATE THE CRITICAL PCA AND PERCENT OF WATERSHEDS WITH PCA VALUES LARGER THAN THE CRITICAL PCA.** The Critical PCA, the ratio between the unrefined EDWC and the DWLOC, is the PCA value that would generate a refined EDWC equal to the DWLOC. The Critical PCA quickly identifies the percentage of watersheds within each region with exposure concerns and is applied to each use alone and in the aggregate.

4. **COMPARE OVERLAP OF WATERSHEDS WITH PCAS LARGER THAN THE CRITICAL PCA WITH USE SITE FOOTPRINT.** PCA values for groups of crops (*i.e.*, orchards, vegetables) are derived from generalized crop data layers based on the National Land Cover Database (NLCD) and Census of Agriculture (Ag Census). This approach has the potential to overestimate the percent of a given watershed with the noted use site (*e.g.*, planted with a single crop). For instance, an individual CWS watershed with an orchard PCA of 20% may very well have little or no cherries grown within the watershed. Spatial overlap helps further identify CWS watersheds with potential exposure concerns.

5. **DEVELOP AGGREGATED ESTIMATED DRINKING WATER CONCENTRATIONS**. Prior to this step, EDWCs are based on the highest EDWC of all uses determined using modeling scenarios for individual uses or generalized crop groups, however, the relative contributions of each modeled use site can be determined by adding the contribution concentrations (*i.e.*, EDWCs*PCA) based on relative contribution within each CWS watershed. This is the sum of the crop-specific PCA adjusted EDWC values for each registered crop/group of crops within each watershed. This aggregation step is actually

a two-step process. The first step is to aggregate individual 1 in 10 year EDWCs for each use site in a region without regard to timing (calendar day). For CWS watersheds that continue to exceed the DWLOC a second step can be employed where individual time-series (*e.g.*, chemographs) from each modeled use (*e.g.*, cherries and turf) can be added together on a calendar day basis. This process of aggregating chemographs can be performed manually or can be automated (in this case study the process was performed manually). This second step captures the temporal variability across uses with different application timing and weather.

i. South Atlantic-Gulf (HUC-2 Region 03)

In the South Atlantic-Gulf region, non-agricultural uses are permitted, including wide-area mosquito adulticide use. As such, in the Tier 2 DWA, a PCA of 1 for all CWS watersheds is used when there are agricultural and non-agricultural (*e.g.*, rights of way, perimeter treatment) uses. As a first step, a use pattern (*i.e.*, non-agricultural and orchard) specific PCA was calculated by subtracting out the cropped area that does not correlate to uses (*i.e.*, corn, wheat, soybean, cotton, and vegetable) permitted in the HUC-2 Region from the maximum all-agriculture/non-agricultural PCA of 1 used in Tier 2. Using this approach for HUC-2 Region 03 the maximum refined PCA for the registered uses for pest1 is 0.65. This PCA includes non-agricultural uses sites including institutional turf (e.g. sports fields) and wide-area uses. The distribution of EDWCs for the South Atlantic-Gulf region are shown in **Figure 4** for all CWS watersheds. Applying this use-site specific PCA, for pest1 use on apples, 92% of CWS watersheds have EDWCs below the DWLOC while for non-agricultural and citrus uses of pest1 less than 18% of watersheds have EDWCs below the DWLOC. EDWCs for pest1 resulting from maximum label rates for all three uses remain above the DWLOC of 5 µg/L in the South Atlantic-Gulf region when the use-site specific PCA is applied. As such, more refinements needed to be considered for all uses.

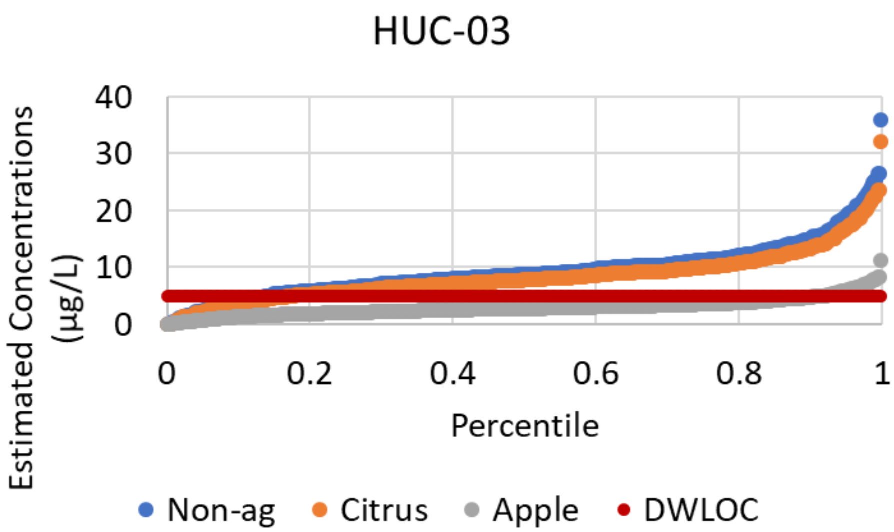

Figure 4. Estimated 1-in-10 Year 21-Day Average Concentrations Adjusted for the Individual Watershed PCAs for the pest1 Resulting from Maximum Labeled (single and yearly) Rates and Minimum Retreatment Intervals for Uses in HUC-2 Region 03

Usage data were examined, and EDWC were updated as a next step in the refinement process for those watersheds and uses that have EDWCs above the DWLOC. **Table 3** lists the EDWCs of pest1 in HUC-2 Region 03 based on the typical use rates provided by BEAD. Note that no typical use information is available for the non-agricultural uses permitted in HUC-2 Region 03; therefore, the maximum label rates continue to be used for non-agricultural uses.

Table 3. Summary of Estimated Pest1 Concentrations Considering Maximum Regional (HUC-2 Region 03) Percent Cropped Area Adjustment Factors

Use	Maximum Regional PCA	Estimated 21-day Average Concentration	Refined Regional Use Pattern Specific Maximum PCAs	Typical Use Number of Applications; Rate (lb/A)	1-in-10 Year Estimated 21-day Average Concentration (Typical Rate)[a,b]	1-in-10 Year Refined Regional Adjusted 21-day Average Concentration[b]
	Tier 2		Tier 3			
Apple	1.0	17.5	0.65[b]	1; 4	7.0	4.55 (NR)
Citrus		49.6		1; 2.8	17.5	**11.14**
Non-ag		55.6		Unknown	55.6	**36.01**

NR No more Refinement needed, EDWC<DWLOC; bolded values more refinement needed for the uses.
[a] Value is model output and does not reflect PCA adjustment
[b] Concentrations reflect consideration of regionally representative scenario, typical application rate and date, and regional relevant percent cropped areas adjustment factor

The distribution of EDWCs based on typical use for the South Atlantic-Gulf region for all CWS watersheds are shown in **Figure 5**. EDWCs for pest1 resulting from typical rates are above the DWLOC of 5 µg/L in the South Atlantic-Gulf region for non-agricultural and citrus use. However, concentrations of pest1 for applications to apples is below the DWLOC. Examination of the full distribution PCAs identifies what percentage of watersheds within a HUC-2 Region have a use pattern-specific PCA-refined EDWC value that still exceeds the DWLOC. In this refinement step, the Critical PCA, which is defined as the PCA value which when applied to a refined EDWC will be below the DWLOC, is identified. The Critical PCA value for the pesticide is calculated from the DWLOC and EDWC (PCA unadjusted value) using **Equation 1**.

Equation 1 $$\textbf{Critical PCA} = \textbf{DWLOC}/\textbf{EDWC}_{max}$$

Where:

Critical PCA =	PCA value below which the PCA-adjusted EDWC is less than the DWLOC
$EDWC_{max}$ =	Maximum EDWC for a given crop or use pattern
DWLOC =	Drinking water level of concern

Based on this analysis in HUC-2 Region 03, the critical PCA is 0.09 and 0.29 for non-agricultural use and citrus crops, respectively. Applying these PCAs to each individual CWS watershed in this region indicates that roughly 14% (non-agricultural) and 92% (citrus) of watersheds have refined EDWC below the DWLOC for this region. This is illustrated in **Figure 5**.

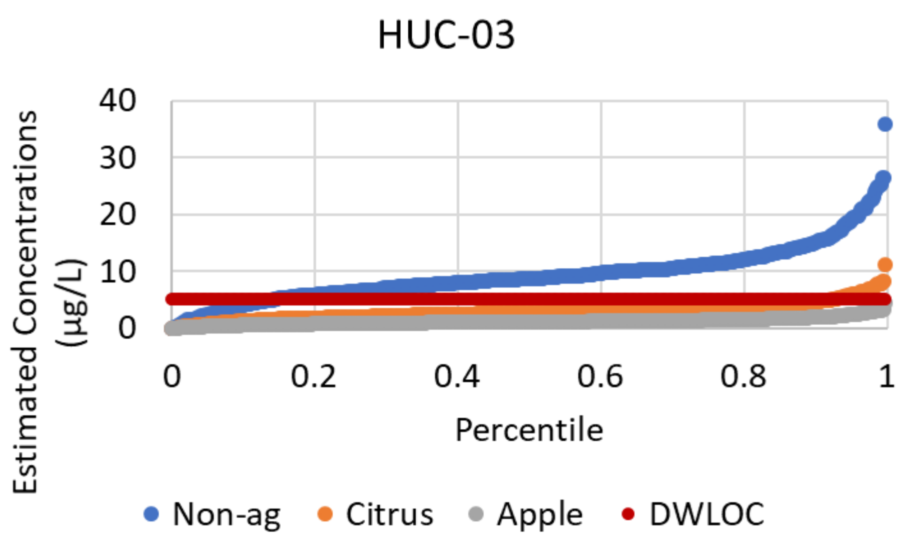

Figure 5. Distribution of Estimated 1-in-10 Year 21-Day Average Concentrations Adjusted for the Individual Watershed PCAs for the pest1 Resulting from Typical Applications in HUC-2 Region 03

The next refinement is to compare the overlap of the CWS watersheds area and use site specific land cover area where the PCAs are above the Critical PCAs. In the previous step an assumption is made using generalized PCA data layers (*e.g.*, orchards) which were derived using the National Land Cover Database (NLCD) All-Ag data layer and generalized acreage data from the Census of Agriculture (Ag Census) as described in the original CWS PCA documentation (USEPA, 2014). For example, specific orchard crops (*e.g.*, citrus) are represented by a generalized orchard data layer.

The previous analysis has the potential to overestimate the percent of a given watershed that is planted with a specific orchard crop. Therefore, an additional step is employed where an overlap analysis is conducted which compares individual CWS watersheds with crop specific information from the Ag Census with the goal to exclude CWS watersheds where the specific crop is not likely to be present. For CWS watersheds with no acreage being reported in Ag Census as being present for a specific crop (*e.g.*, apples), it is assumed that no use would be present and thus no exposure from that use would be possible and the CWS watershed can be excluded from further refinements. Conversely, a county where Ag Census suggests a crop may be present, even in cases where no explicit acreage is reported, the county is assumed to have the use and the EDWCs are considered present. This is done because it is not uncommon for data to be censored in order to protect grower confidentiality. The results of this analysis are shown in **Figure 6**. This figure shows that citrus growing counties overlap with watersheds with PCAs above the Critical PCA in central Florida. These areas may also have non-agricultural uses of pest1.

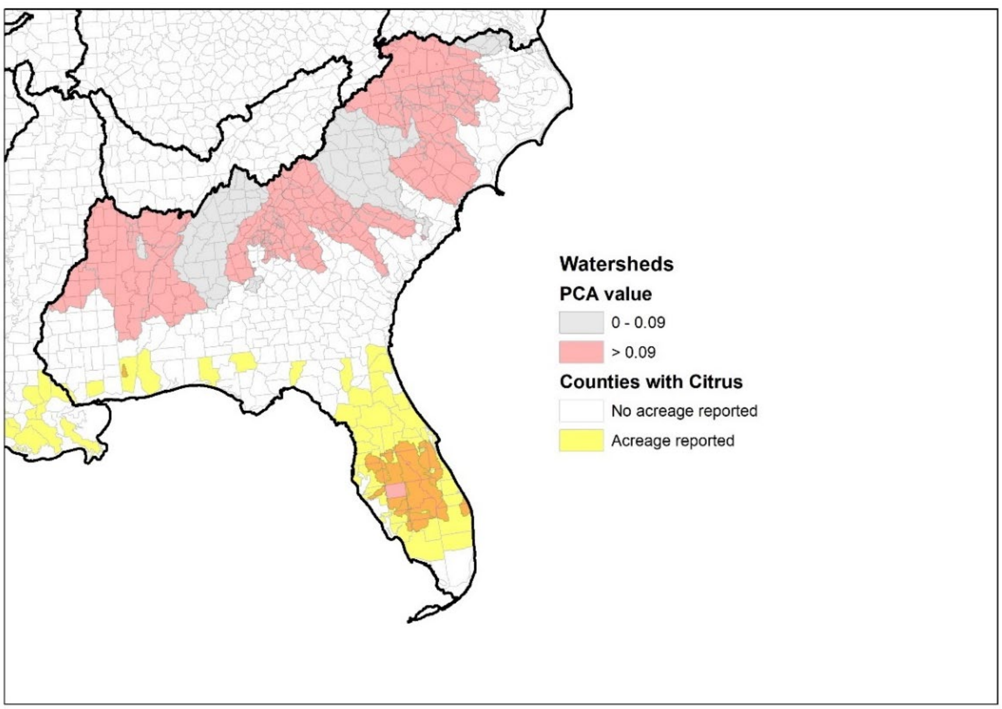

Figure 6. Community Water System Watersheds where Watershed PCA ≥ Critical PCA of 9% for HUC-2 Region 03 Overlaid with Orchard crop footprint (shown in pink and gray) and county level Citrus acreage (shown in yellow).

For the watersheds and uses that have EDWCs above the DWLOC, the next step in the refinement process is aggregation of relevant uses to generate a more realistic EDWC. This moves away from the assumption that the entire area of the watershed is entirely planted with the crop that leads to the highest EDWC by weighting the EDWCs using watershed landcover data (*i.e.*, PCA) on a crop-specific basis. Instead aggregation allows for the relative contributions of each use within the watershed to be considered in the EDWC as shown in **Equation 2**. The White Paper outlines a two-step approach for developing an aggregated EDWCs. The first approach uses the 1-in-10 year concentration while the second approach uses the individual time series for each simulation to develop a new time series of data for each CWS watershed which a 1-in-10 year concentrations can be estimated. The first step is expected to be a conservative approach as the 1-in-10 year concentrations are not expected to occur on the same days for all uses under consideration. The second approach adds the individual PCA adjusted chemographs together to create a new chemograph. Note that only one chemograph for each available PCA (*i.e.*, use category) must be selected for the aggregation process (*e.g.*, apples or cherries but not both). The 1-in-10 year concentration is calculated from the new aggregated chemograph and compared to the DWLOC. This second approach allows for consideration of the temporal aspect of exposure which can differ due to timing or application among other factors occuring within a watershed.

Equation 2

$$(\mathbf{CWS\ crop\ specific\ (n)PCA\ x\ crop\ specific(n)\ EDWC}) + (\mathbf{CWS\ crop\ specific\ (n+1)PCA\ x\ crop\ specific\ (n+1)EDWC}) = \mathbf{aggregated\ EDWC}$$

Where:

CWS crop specific PCA =	Community water system specific percent cropped area adjustment factor
Crop specific EDWC =	Crop or crop group specific estimated concentration
Aggregated EDWC	Aggregated estimated drinking water concentration

In HUC-03, n represents non-ag use while n+1 represents orchard use in the above equation. As a first step, the 1-in-10 year concentration for each use site (*i.e.*, non-agricultural and orchard) can be adjusted by the CWS specific PCA for each crop or crop group and then be added together to generate an aggregated EDWC. This approach suggests that roughly 67 CWS watersheds of the total 468 CWS watersheds have pest1 concentrations below the DWLOC. Refining further using the entire time series of estimated concentrations suggests that many of the roughly 67 CWS watersheds still have concentrations below the DWLOC and additional refinements need to be considered. This is because non-ag use of pest1 is driving the aggregate exposure estimates in this example.

Table 4. Summary of Estimated Pest1 EDWC using Maximum Crop-Watershed Specific PCAs Relevant to High Orchard Production in HUC-2 Region 03

Use	Typical Use Number of Applications; Rate (lb/A)	Estimated 21-day Average Concentration (μg/L)	Maximum Crop-Watershed Specific PCA	Refined PCA Adjusted Individual Concentrations (μg/L)	Aggregated Estimated Concentration (μg/L)
HUC-03					
Non-ag	Unknown	55.6	0.65	36.4	38.2
Apple	1; 4	17.5[a]	0.12	2.1[a]	
Citrus	1; 2.8	7.0	NR	NR	
a. Used maximum concentration from all orchard uses.					

b. NR in this table to show aggregation process but citrus is considered in appropriate watersheds.

ii. Great Lakes (HUC-2 Region 04)

As was done for HUC-2 Region 03, a use pattern specific PCA that accounts for orchards, corn, soybean, and sugar beets was calculated by subtracting out the cropped area that does not correlate to uses (*i.e.*, wheat, cotton, rice and vegetable) permitted in HUC-04 from the maximum all-agriculture for each respective watershed. This approach functionally develops a miscellaneous agricultural PCA for crops for which PCAs have not been specifically developed, in this case, sugar beets. The maximum PCA for miscellaneous agriculture for HUC-04 is 0.50. The highest use site (*i.e.*, orchard, corn, soybean, and miscellaneous) specific PCA calculated is 0.85. The distribution of EDWCs for the Great Lakes region are shown in **Figure 7** for all CWS watersheds. EDWCs for pest1 resulting from maximum label rates are above the DWLOC of 5 µg/L in the Great Lakes region and more refinements needed to be considered for all uses.

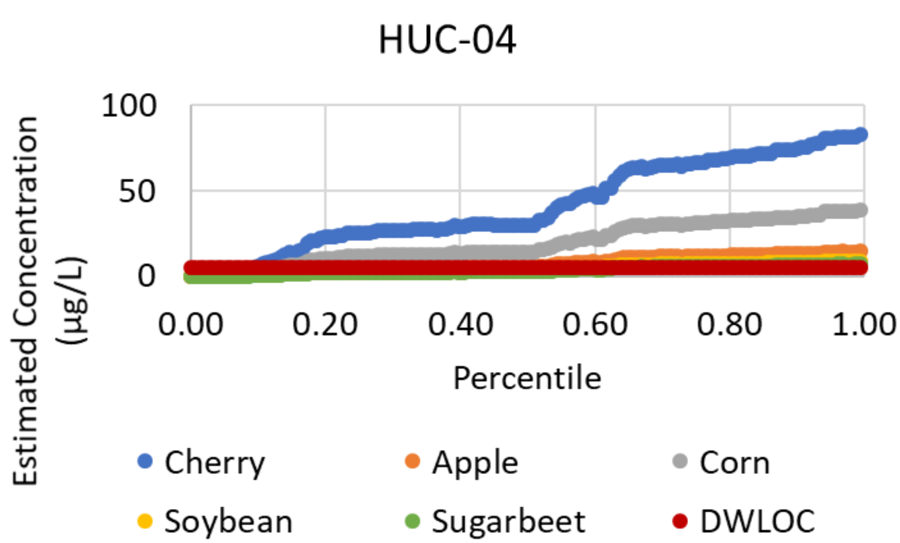

Figure 7. Estimated 1-in-10 Year 21-Day Average Concentrations Adjusted for the Individual Watershed PCAs for the pest1 Resulting from Maximum Labeled (single and yearly) Rates and Minimum Retreatment Intervals for Uses in HUC-2 Region 04

Usage data were integrated, and model estimates were updated including use of regionally specific PCAs (*e.g.*, cherry represented by HUC-2 Region 04 orchard PCA) as a next step in the refinement process. **Table 5** lists the EDWCs of pest1 in HUC-2 Region 04 based on the typical use rates provided by BEAD in combination with the use site specific PCA adjusted concentrations. These refined EDWCs are below the DWLOC for pest1 use on corn, soybean, and sugar beet in HUC-2 Region 04. Additional refinements are necessary for cherry and apple.

Table 5. Summary of Estimated Pest1 Concentrations Considering Maximum Regional (HUC-04) Percent Cropped Area Adjustment Factors

Use	Estimated 21-day Average Concentration	Maximum Regional PCA	Refined Regional Use Pattern Specific Maximum PCAs	Typical Use Number of Applications; Rate (lb/A)	1-in-10 Year Estimated 21-day Average Concentration (Typical Rate)[a]	1-in-10 Year Refined Regional Adjusted 21-day Average Concentration[b,c]
	Tier 2		Tier 3			
Cherry	90.9	0.92	0.84	1; 2	**31.4**	**26.4**
Apple	42.4			1; 2.8	**44.0**	**37.0**
Corn, Field	16.1			1; 1	3.8 (NR)	NR
Soybean	9.8			1; 1.1	4.2 (NR)	NR
Sugar beet	7.8			1; 1.2	4.7 (NR)	NR

NR No more Refinement needed, EDWC<DWLOC; bolded values more refinement needed for the uses.
[a] Concentrations reflect consideration of regionally representative scenario, typical application rate and date
[b] Concentrations reflect consideration of regional relevant percent cropped areas adjustment factor
[c] PCA for miscellaneous crop area was calculated taking the maximum agricultural PCA and subtracting out cropped areas for known crop groups (*e.g.*, corn, wheat, soybean, cotton, vegetable).

In HUC-2 Region 04, the critical PCA is 0.11 and 0.16 for apple and cherry, respectively. This indicates that roughly 87% and 83% of watersheds have refined EDWC above the DWLOC. This equates to 131 and 125 of the total 151 CWS watersheds with EDWC above the DWLOC. This is illustrated in **Figure 8**.

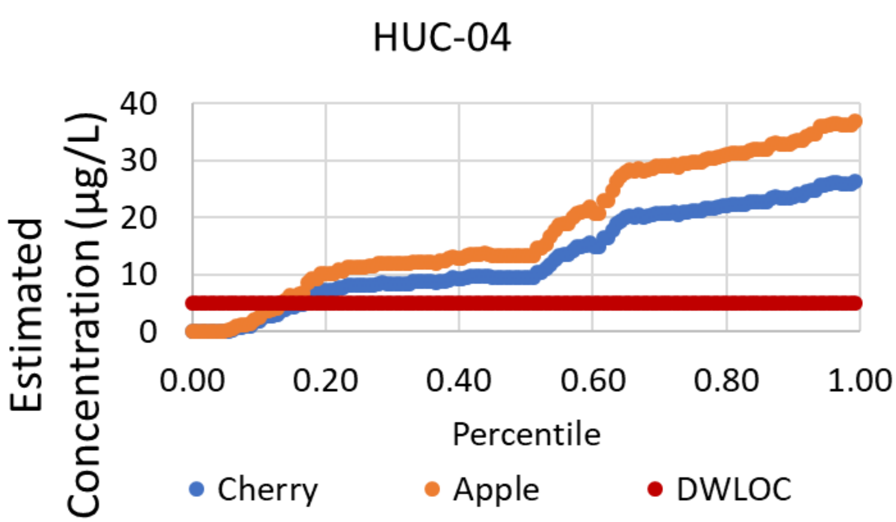

Figure 8. Distribution of Estimated 1-in-10 Year 21-Day Average Concentrations Adjusted for the Individual Watershed PCAs for the pest1 Resulting from Typical Applications in HUC-2 Region 4

As done for HUC-2 Region 3, a comparison of the watersheds with PCAs equal to or greater than the Critical PCAs with Ag Census acreage data for cherries and apple is shown in **Figure 6**. Overlap analysis for HUC-2 Region 04 shows that CWS watersheds with orchard PCAs greater than the critical PCA for a given crop/group of crops overlap with cherry and apple acreage.

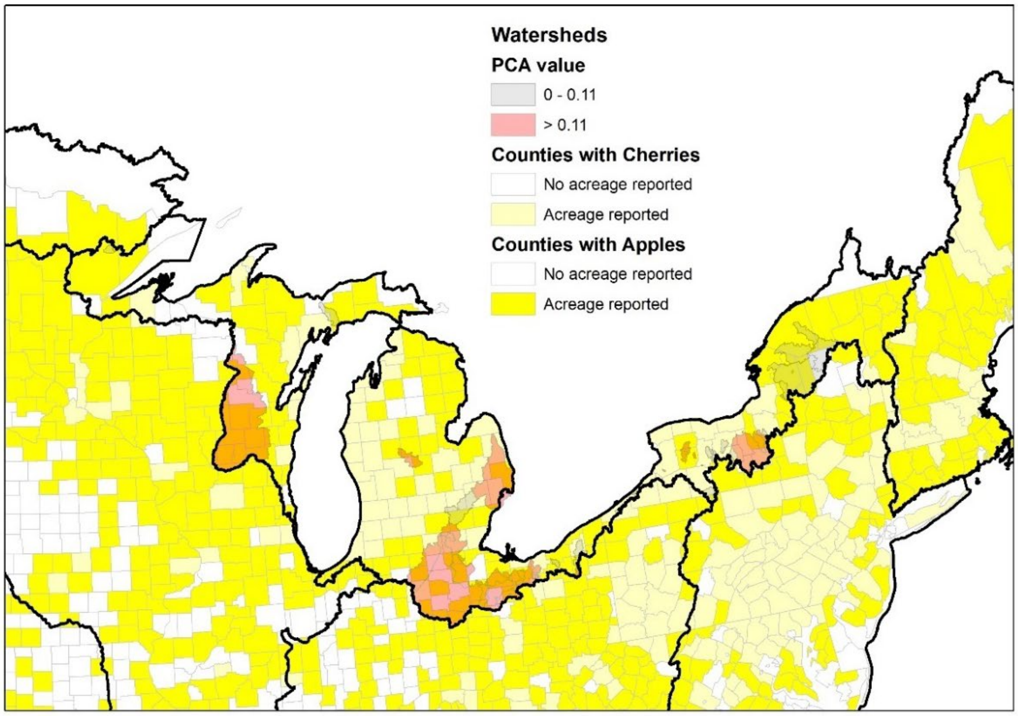

Figure 9. Community Water System Watersheds where Watershed PCA ≥ Critical PCA OF 11% for HUC-2 Region 04 Overlaid with Orchard crop footprint

As a next step, aggregated EDWCs were developed which considers contributions from all crop uses for the overlapping watersheds. The 1-in-10 year 21-day average concentration from manually aggregated chemographs[2] (*i.e.*, sum of PCA-adjusted chemographs and recalculation of 1-in-10 year 21-day average concentration) are not expected to be higher than the DWLOC. As such, no additional refinements are necessary for pest1 uses in HUC-2 Region 4.

iii. Ohio (HUC-2 Region 05)

Like done for HUC-2 Region 4, a use pattern specific PCA for orchard, corn, soybean, and miscellaneous (for alfalfa) was calculated by subtracting out the cropped area that does not correlate to uses (*i.e.*, wheat, cotton, rice and vegetable) permitted in HUC-04 from the maximum all-agriculture PCA for each respective watershed. Like sugar beets in HUC-03, the

[2] When the PCA/PCT project is fully implemented the process of aggregating modeled chemographs will be automated.

approach functionally develops a miscellaneous agricultural PCA for crops for which PCAs have not been specifically developed. In this case, for alfalfa. The maximum PCA for miscellaneous agriculture for HUC-2 Region 4 is 0.78. The highest use site (*i.e.*, orchard, corn, soybean, and miscellaneous) specific PCA calculated is 0.88. The distribution of individual watershed PCA adjusted EDWCs for the Ohio region are shown in **Figure 10** for all CWS watersheds. EDWCs for pest1 resulting from maximum label rates are above the DWLOC of 5 µg/L in the Great Lakes region and more refinements needed to be considered for all uses.

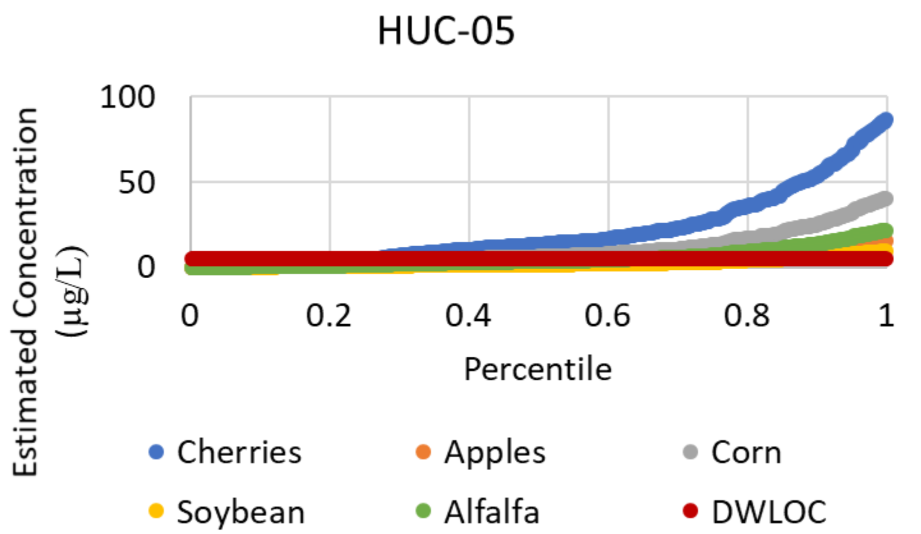

Figure 10. Estimated 1-in-10 Year 21-Day Average Concentrations Adjusted for the Individual Watershed PCAs for the Case Study Pesticide Resulting from Maximum Labeled (single and yearly) Rates and Minimum Retreatment Intervals for Uses in HUC-2 Region 05

Usage data (*e.g.*, typical rates and application timing) were incorporated into modeling along with regionally specific modeling scenarios for both individual crops (*e.g.*, cherries) and generic crop groups (*e.g.*, orchard) as a next step in the refinement process. **Table 6** lists the EDWCs of pest1 in HUC-2 Region 05 based on the typical use rates provided by BEAD. In combination with the use site specific PCA, concentrations are expected to be below the DWLOC for pest1 use on alfalfa; however, all the other uses result in pest1 concentrations above the DWLOC.

Table 6. Summary of Estimated Pest1 Concentrations Considering Maximum Regional (HUC-05) Percent Cropped Area Adjustment Factors

Use	Estimated 21-day Average Concentration	Maximum Regional PCA	Refined Regional Use Pattern Specific Maximum PCAs	Typical Use Number of Applications; Rate (lb/A)	1-in-10 Year Model Estimated 21-day Average Concentration (Typical Rate)[a]	Refined Regional PCA Adjusted 1-in-10 Year 21-day Average Concentration[b,c]
	Tier 2		Tier 3			
Cherry	87.9	0.92	0.85[c]	1; 3	15.3	**13.5**
Apple	15.6			1; 2.8	14.3	**12.6**
Corn	41.0			1; 4[a]	17.4	**15.3**
Soybean	9.5			1; 1.1	12.8	**11.2**
Alfalfa	22.1			1; 1	4.5 (NR)	NR

NR No more Refinement needed, EDWC<DWLOC; bolded values more refinement needed for the uses.
[a] Concentrations reflect consideration of regionally representative scenario, typical application rate and date
[b] Concentrations reflect consideration of regional relevant percent cropped areas adjustment factor
[c] PCA for miscellaneous crop area was calculated taking the maximum agricultural PCA and subtracting out cropped areas for known crop groups (*e.g.*, corn, wheat, soybean, cotton, vegetable).

In HUC-2 Region 05, the critical PCAs are 0.29, 0.33, 0.35, and 0.39 for corn, cherry, apple, and soybean, respectively. Applying these PCAs to each individual CWS watershed in this region indicates that for all uses roughly 80% of watersheds are below the DWLOC. This equates to roughly 513 community water systems of the 626 total systems have pest1 concentrations below the DWLOC in HUC-2 Region 05. This is illustrated in **Figure 11**.

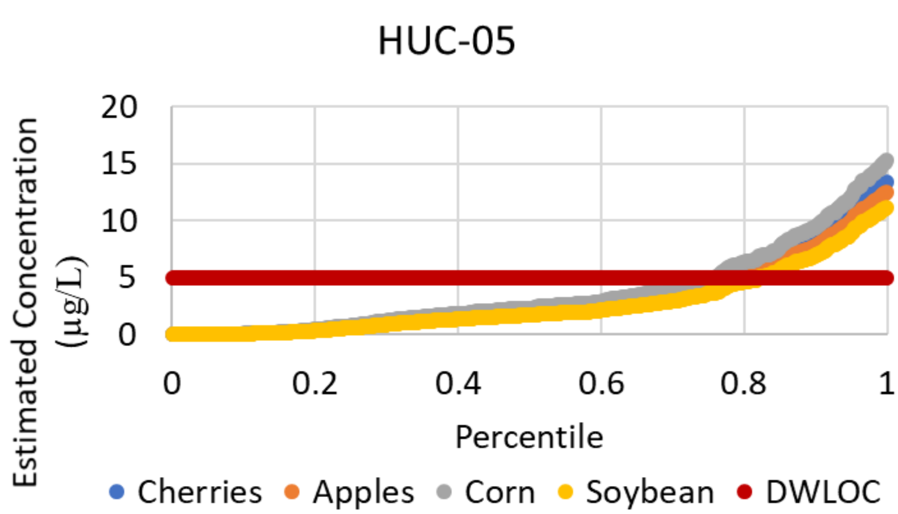

Figure 11. Distribution of Estimated 1-in-10 Year 21-Day Average Concentrations Adjusted for the Individual Watershed PCAs for the Case Study Pesticide Resulting from Typical Applications in HUC-2 Region 05

A comparison of the watersheds with PCAs equal to or greater than the Critical PCAs with landcover data is shown in **Figure 12** which indicates wide spread overlap and that additional refinements are necessary.

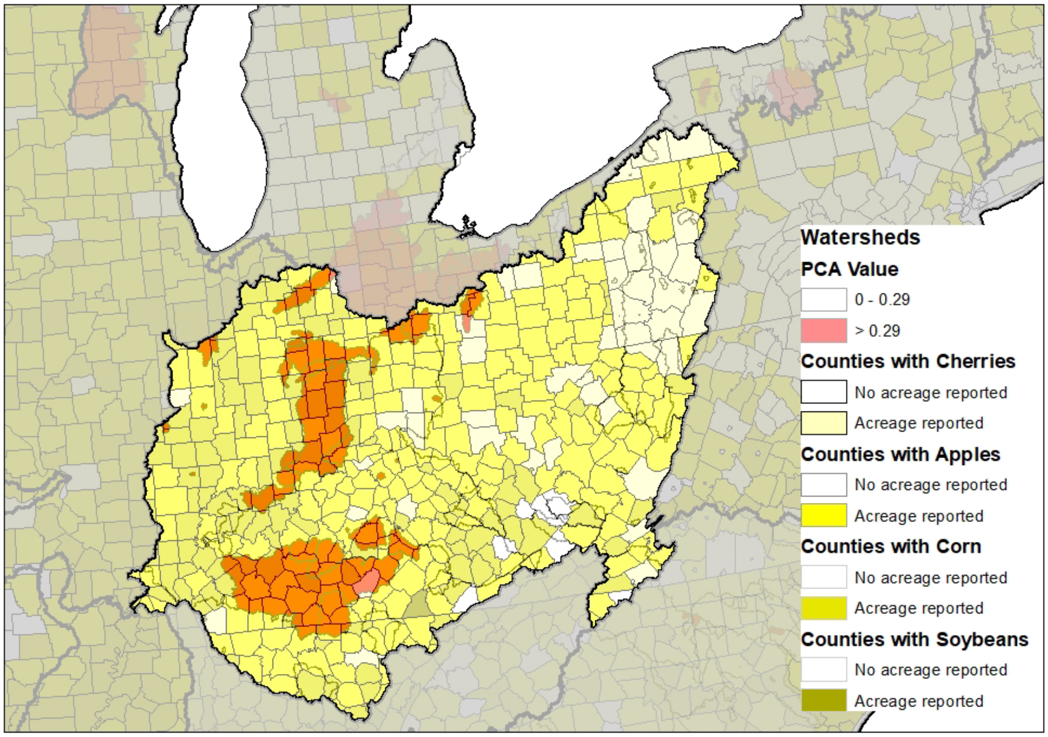

Figure 12. Community Water System Watersheds where Watershed PCA ≥ Critical PCA of 29% for HUC-2 Region 05 Overlaid with Orchard Crop Footprint

Aggregated EDWCs suggest there are still a number of watersheds with concentrations above the DWLOC in HUC-2 Region 05. The 1-in-10 year 21-day average aggregated concentrations are shown in **Table 7** for simplicity; however, similar results were obtained when aggregated chemographs were considered and the 1-in-10 year 21-day average was calculated. The similarity between aggregated individual EDWC and aggregated chemograph derived EDWC is likely due to overlap in rainfall events across scenarios driving runoff events.

Table 7. Summary of Estimated Pest1 EDWC using Maximum Crop-Watershed Specific PCAs Relevant to Use Sites in HUC-2 Region 05

Use	Typical Use Number of Applications; Rate (lb/A)	Estimated 21-day Average Concentration (µg/L)	Maximum Crop-Watershed Specific PCA	Refined PCA Adjusted Individual 21-day Average Concentrations (µg/L)	Aggregated 21-day Average Estimated Concentration (µg/L)
HUC-05					
Cherry	1; 3	15.3	0.034	0.52	13.3
Apple	1; 2.8	14.3	--	--	
Corn	1; 4[a]	17.4	0.51	8.9	

Use	Typical Use Number of Applications; Rate (lb/A)	Estimated 21-day Average Concentration (µg/L)	Maximum Crop-Watershed Specific PCA	Refined PCA Adjusted Individual 21-day Average Concentrations (µg/L)	Aggregated 21-day Average Estimated Concentration (µg/L)
Soybean	1; 1.1	12.8	0.58	7.4	
Alfalfa	1; 1	4.5	0.76	3.4	

-- Only the maximum EDWC orchard crop was included in the aggregate EDWC calculation

a. Used maximum concentration from all orchard uses.

b. Since no PCA is available for sugar beet a surrogate PCA is calculated by subtracting all the individual crops/crop groups from the all-Ag PCA.

i. Summary of PCA Analysis

Considering PCA refinements along with typical use and regionally representative scenarios, there are more than 100 watersheds in HUC-2 Region 03 and HUC-2 Region 05 where concentrations may still exceed the DWLOC. For HUC-2 Region 03, pest1 use in non-agricultural areas is driving the exposure conclusions while in HUC-2 Region 05 contributions from multiple crop uses are resulting in EDWCs greater than the DWLOC. Overlays of the CWS watersheds with the land cover data and aggregate EDWC values suggest the EDWCs in HUC-2 Region 04 are below the DWLOC for all CWS within the region.

b. Percent Cropped Treated Analysis

As described in the PCA/PCT White Paper there are several ways to integrate PCT data and allocate or distribute the acres treated across a CWS watershed. Regardless of the method chosen, the same series of steps are used to calculate the total treated acreage and distribute it to the individual watersheds. This case study focused on examples using maximum PCT and the upper and uniform distribution methods to demonstrate how the process would work. The PCT refinements steps in this case study are summarized below and the results are presented for HUC-2 Regions 03 and 05.

1. **CALCULATE THE MAXIMUM STATE-LEVEL TREATED ACREAGE FOR EACH CROP BASED ON THE MAXIMUM PCT VALUES AND CAG.** USEPA Biological and Economic Analysis Division (BEAD) provided the PCT values for each crop based on 5 years of survey data. From the 5 years of data BEAD will provide a maximum PCT, minimum PCT, and an average of the 5 years of PCT for each state covered by the labeled uses for pest1. The surface water EDWC for CWS watersheds exceeding the DWLOC after consideration of PCA refinements consistent with the PCA/PCT White Paper will be further refined by considering the Base Acres Treated (BAT) within those watersheds. Consistent with the White Paper, the selected PCT value (*e.g.*, maximum) will be used to calculate the BAT for each registered use by state.

2. **ALLOCATE TREATED ACREAGE TO EACH CWS WATERSHED.** Once a BAT is derived, there are three proposed methods to distribute the treated acres across each CWS using the upper, uniform, and lower distribution methods, as appropriate. This case study only considers the upper and uniform distribution methods, as the lower distribution resulted in no treated acres allocated to the watersheds.

3. **CALCULATE THE TREATED AREA SCALING PERCENTAGES (TASP) FOR EACH WATERSHED/PCT/DISTRIBUTION METHOD COMBINATION.** The TASP, the ratio of the treated acreage within the watershed to the total area of the watershed, is the multiplicative scaling factor used to adjust the unmodified EDWC values based on the treated acreage within the watershed. It is similar to the PCA, but factors in both percent cropped area and percent crop treated into a single value. Every watershed/crop/PCT/distribution method will have a unique TASP.

4. **CALCULATE THE AGGREGATE TASP-ADJUSTED EDWC FOR EACH WATERSHED.** Similar to the aggregate PCT-adjusted EDWC, the relative contributions of each use site can be determined by adding the contribution concentrations (*i.e.*, EDWCs*TASP) based on the relative contribution for each CWS watershed. This is the sum of the TASP adjusted EDWC values for each registered crop/group of crops within each watershed.

5. **COMPARE ADJUSTED EDWC TO DWLOC.** The new aggregate EDWC values for each watershed are compared to the DWLOC to determine how many watersheds have EDWCs that are expected to exceed the DWLOC.

i. South Atlantic-Gulf (HUC-2 Region 03)

There is very limited PCT data available for non-agricultural pesticide use, which limits the applicability of PCT refinements to Pest1. In the absence of reliable PCT data, the method assumes 100% crop treated. Since the non-agricultural use pattern of pest1 is the major contributor to the EDWC, PCT refinements will have a minimal impact on the EDWC values. While non-agricultural PCT data are not available for pest1, a non-agricultural PCT value of 9% would be needed for concentrations to be below the DWLOC. This analysis points out the importance of usage data for non-agricultural uses and the development of means to approximate non-agricultural use when usage data is not available.

ii. Ohio (HUC-2 Region 05)

For purposes of this case study, the Ohio PCT is assumed to represent the entire HUC-2 Region 05. For this example, this assumption is reasonable given that the bulk of HUC-2 Region 05 is within Ohio. However, when fully implemented the PCT data for all states spanning each HUC-2 would be allocated proportionally relative to the percentage of each state overlap with the entire HUC-2 Region using an automated process.

Table 8 below presents the statistics for average annual acres grown and PCT for the uses of pest1 within HUC-2 Region 05 (as represented by Ohio) compiled by BEAD. The treated acreage for each crop within the state is the product of the average annual acres grown and the maximum PCT value. Between the years of 2010 to 2014, the crop with the largest treated acreage was soybeans (55,400 acres treated), followed by field corn (37,100 acres treated). These represent the maximum number of treated acres that can be allocated to a watershed for each crop.

Table 8. Average Annual Acres Grown and Percent Crop Treated in Ohio.

Crop or Use	Ohio (HUC-2 Region 05)		
	Average Annual Acres Grown	Maximum PCT	Maximum BAT
Alfalfa	264,000	7	18,480
Apples	4,709	43	2,024
Corn, field	3,710,002	1	37,100
Corn, sweet	16,020	48	7,690
Soybean	2,769,996	2	55,400

To account for the uncertainty in the location of the treated acreage throughout the state, this case study considers two of the three treated acreage allocation methods described in the White Paper for PCA and PCT Refinements: upper and uniform distribution. These examples will illustrate how the acreage was allocated to the representative example watershed, described in the following sections. However, this methodology can be applied to all watersheds with EDWC that remain above the DWLOC at any point after the Tier 3 distributional PCA approach has been utilized. Similar to the aggregation of PCA adjusted EDWC in previous sections, the consideration of PCT methods in regional and national DWA will require automated processes to efficiently implement. In this case study the consideration of PCT methods has been done manually.

The sample watershed is a 310,245-acre watershed located within HUC-2 Region 05. The watershed-scale PCA values and cropped area for the target crops of pest1 are shown in **Table 9**. The PCA value for orchards in the example watershed is zero, therefore orchards will not contribute to the EDWCs in the watershed and are excluded from the subsequent analysis. The aggregate PCA-refined EDWC of pest1 in the example watershed is 5.26 µg/L, which exceeds the DWLOC of 5 µg/L

Table 9. Example Watershed Characteristics

Watershed area (A)	Watershed PCA Value				Cropped Area Within Watershed (A)			
	Alfalfa	Corn	Soybeans	Orchard	Alfalfa	Corn	Soybeans	Orchard
310,245	0.045	0.27	0.22	0.0	13,961	84,061	67,879	0

The upper distribution assumes that all the treated acres for each individual crop are allocated to the example watershed, up to a maximum of the PCA adjusted area of the watershed for each crop. Therefore, the treated acreage within the watershed is the lower value of either the state-level treated acreage or the cropped area within the watershed (**Table 10**). In the example watershed, the maximum PCT state-level treated acreage was greater than the cropped area for alfalfa and thus no adjustment to the EDWC is warranted for alfalfa. Conversely, for corn and soybeans, the max PCT state-level treated acreage is less than the number of acres grown in the watershed, therefore the PCT refinement will reduce the EDWCs for both crops. If the cropped area of the watershed was less than PCT treated acreage for all crops, then the PCT refinement would not alter the EDWCs and further refinement would need to be considered.

Table 10. Comparison of State-Level Treated Acreage and Watershed Cropped Area to Determine Upper Distribution Treated Acreage

Crop or Use	Ohio (HUC-2 Region 05)		
	Maximum PCT Treated Acreage	**Cropped Area of Watershed (A)**	**Upper Distribution Treated Acreage**
Alfalfa	18,480	13,961	**13,961**
Corn, (field+sweet)	44,790	84,061	**44,790**
Soybean	55,400	67,879	**55,400**

The uniform distribution assumes the treated acres are distributed evenly through the state where the crop and watershed are located. For each crop, the treated area within a watershed= (acres within the watershed that overlaps with the land cover class)*(state-level PCT), up to a maximum of the total treated acres within the state. The acres within a watershed that overlap with the land cover class = (watershed area)*(land cover class PCA). Combining the two equations gives the formula for calculating the uniform distribution treated acreage within a watershed (**Equation 3**).

Equation 3

$$\boldsymbol{Treated\ Area} = (\boldsymbol{watershed\ area})\boldsymbol{x}(\boldsymbol{land\ cover\ class\ PCA})\ \boldsymbol{x}\ (\boldsymbol{land\ cover\ class\ PCT})$$

The PCA, PCT and uniform distribution treated acreage for each relevant landcover are given in **Table 11**. The calculated uniform distribution treated acreages are 977 A, 1005 A, and 1365 A for alfalfa, corn, and soybeans, respectively. These values are all less than the total treated acres within the state from **Table 10**, thus, represent the total treated acreage within the example watershed based on the uniform distribution method.

Table 11 Uniform Distribution Treated Acreage Values for the Example Watershed

Crop or Use	Watershed Area (A)	Land Cover Class PCA	State-level Land Cover Class Maximum PCT	Uniform Distribution Treated Acreage
Alfalfa	310,245	0.045	0.07	**977**
Corn, (field+sweet)		0.27	0.012	**1005**
Soybean		0.22	0.02	**1365**

The Treated Area Scaling Percentage (TASP) is the multiplicative scaling factor for each crop that is used to refine the EDWC values based on the treated area of the watershed. It is equal to the (watershed treated area)/(total watershed area). Separate TASP values are calculated for every combination of watershed, PCT value, and treated acreage distribution method. The TASP values for the maximum and uniform treated acreage distribution methods are shown in **Table 12**. For the upper distribution of treated acreage in the example watershed, the TASP for alfalfa is equal to the alfalfa PCA because the total treated acreage allocated to the watershed was equal to the total area of the land cover class in the watershed (*i.e.*, 100% PCT). The other TASP values are all lower than the PCA values for their respective crops, indicating that the PCT refined EDWC values will be lower than the PCA refined values. The uniform distribution TASP values are 1-2 orders of magnitude lower than the upper distribution.

Table 12. Calculated TASP Values for the Example Watershed Based on the Maximum PCT and Upper and Uniform Treated Acreage Distributions

Crop or Use	Watershed Area (A)	Land Cover Class PCA	Upper Distribution Method		Uniform Distribution Method	
			Treated Area (A)	TASP	Treated Area (A)	TASP
Alfalfa	310,245	0.045	13,961	**0.045**	977	**0.0032**
Corn, (field+sweet)		0.27	44,790	**0.14**	1005	**0.0032**
Soybean		0.22	55,400	**0.18**	1365	**0.0044**
Treated Area Scaling Percentage (TASP)						

The refined EDWC values for each land cover class are calculated by multiplying the unmodified EDWCs and the TASP for each PCT/treated acreage distribution combination. The aggregate TASP-adjusted EDWCs are the sum of the refined individual crop EDWCs (**Table 13** and **Table 14**). The TASP-refined EDWCs for the watershed are 3.39 and 0.12 µg/L for the upper and uniform treated acreage distributions, respectively. The refined EDWC using both the upper and uniform distribution methods are below the DWLOC of 5 µg/L, therefore, no further refinements are necessary for the watershed.

Table 13. Summary of Estimated Upper Distribution TASP-Refined Pest1 Concentrations in the Example Watershed

Use	Estimated 21-day Average Concentration	Upper Distribution TASP	Refined TASP Adjusted Individual Concentrations	Aggregated Estimated Concentration
Alfalfa	17.4	0.045	0.78	
Corn	12.8	0.14	1.79	3.39
Soybean	4.5	0.18	0.81	
Treated Area Scaling Percentage (TASP)				

Table 14. Summary of Estimated Uniform Distribution TASP-Refined Pest1 Concentrations in the Example Watershed

Use	Estimated 21-day Average Concentration	Uniform Distribution TASP	Refined TASP Adjusted Individual Concentrations	Aggregated Estimated Concentration
Alfalfa	17.4	0.0032	0.056	
Corn	12.8	0.0032	0.041	0.12
Soybean	4.5	0.0044	0.020	
Treated Area Scaling Percentage (TASP)				

TASP-refined EDWCs were calculated for the full set of CWS watersheds in HUC-2 Region 05 for the maximum PCT and both the upper and uniform treated acreage distribution methods. Based on a maximum state-level PCT and the upper treated acreage distributions, pest1 EDWCs are above the DWLOC in 66 of 626 watersheds (**Figure 13**). This represents a 37% reduction in the number of watersheds where the EDWC would exceed the DWLOC from the number focused only on the distributional PCA options.

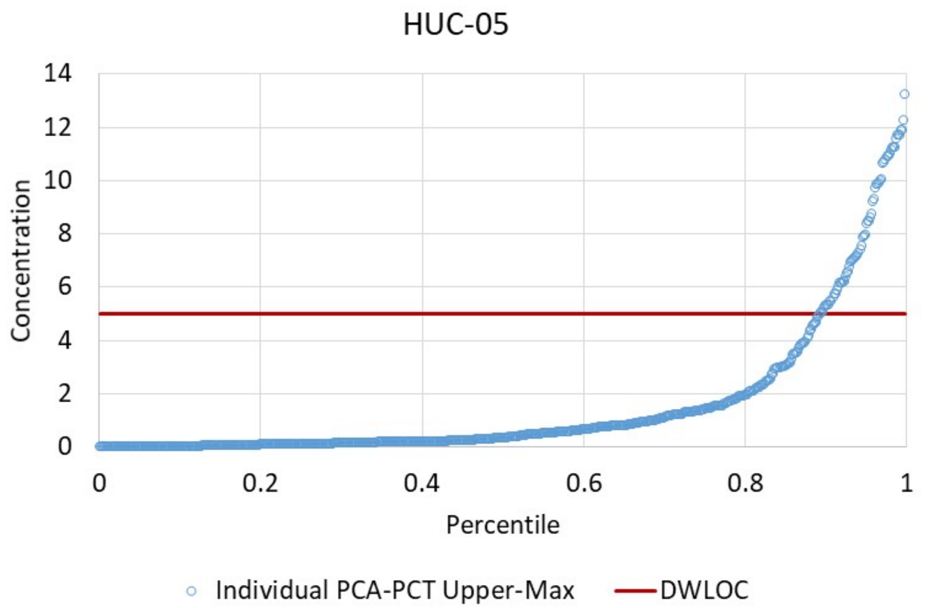

Figure 13. Distribution of Pest1 Concentrations for Aggregated Use Scenarios in Assuming a Maximum PCT with Maximum Distribution of Treated Crops within Each Individual Community Water System Watershed

Using a maximum state-level PCT and the uniform treated acreage distributions none of 626 watersheds are expected to have pest1 EDWC above the DWLOC (**Figure 14**). Based on the maximum PCT/uniform distribution, no further refinements would be needed.

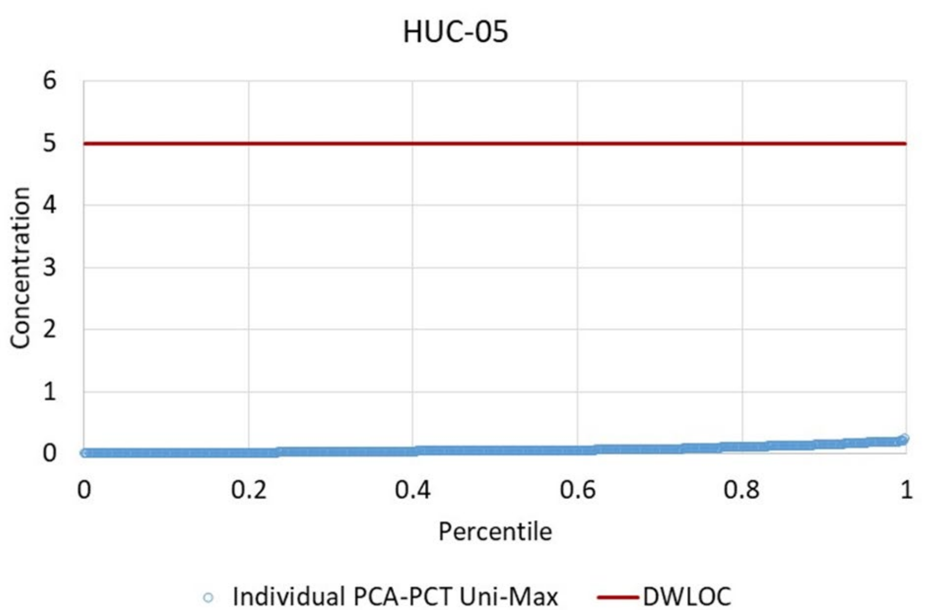

Figure 14. Distribution of Pest1 Concentrations for Aggregated Use Scenarios in HUC-05 Assuming a Maximum PCT with a Uniform Distribution

iii. Summary of PCT Analysis

After applying PCT refinements, several watersheds in HUC-2 Region 03 still have concentrations that may be above the DWLOC. However, this conclusion is uncertain due to the lack of available usage data for non-agricultural use of pest1. Concentrations in roughly 10% of CWS watersheds in HUC-2 Region 05 exceed the DWLOC when an upper-max PCT analysis is considered; however, when a uniform max PCT analysis is considered no CWS are predicted to exceed the DWLOC.

When interpreting application of PCT using the methods describe above consideration must be given to the strengths, weaknesses and uncertainty associated with the available usage data and methods to distribute state and national level usage data to watersheds within a state. Similarly, for watersheds that span multiple states PCT data will be allocated proportionally from multiple states to the watershed.

For pest1 in this case study a clear distinction is seen between the Upper and Uniform distribution methods for PCT where the difference in EDWC is between 1 and 2 orders of magnitude. The differences between results in this case study point to a significant source of uncertainty. While it is unlikely that all pesticide use will occur in all watersheds simultaneously without specific information on where pest pressure is occurring, it cannot be ruled out that some concentration of use is possible across all watersheds in a region. The likely scenario is that some concentration of pesticide use is going to occur but not across all watersheds at the same time. This points to the potential that some intermediate method of distributing usage (e.g. only 90% of treated acreage is in a given watershed) may provide a more realistic representation of where EDWC are likely to occur above the DWLOC.

Ultimately, the decision whether a specific set of CWS watersheds remain above the DWLOC after consideration of the full distribution of PCA and the matrix of options for considering PCT will have to weigh the strengths, weaknesses, and uncertainty associated with the underlying data sets.

5. Conclusion

This case study illustrates the application of full distribution PCA refinements and PCT refinements to EDWCs for the Tier 3 drinking water assessments of pest1 in HUC-2 Regions 03, 04, and 05 consistent with USEPAS OPP's DWA Framework (USEPA, 2019) and the methods described in the PCA/PCT White Paper.

The scoping exercise for pest1 indicated that after completing a Tier 2 DWA analyses, there were still DWLOC exceedances for several uses for the three regions considered in this case study. After completing a Tier 3 level of assessment including integration of additional PCA and PCT refinements the following results were obtained:

- For HUC-2 Region 03, there are roughly 15% of CWS watersheds where concentrations may be above the DWLOC after considering PCA refinements. There is not enough PCT data on non-agricultural uses to apply PCT refinements to the pest1 EDWC values.

However, it was possible to determine what amount of usage would be needed to exceed the DWLOC. Based on the aggregate EDWC value, non-agricultural PCT value of <9% would lead to pest1 EDWC values less than the DWLOC. Additional non-agricultural usage data would help further refine the pest1 EDWCs in the region.

- For HUC-2 Region 04, there are no CWS where concentrations are expected to be above the DWLOC after considering PCA refinements along with cropland overlap analysis and development of aggregated EDWCs (no PCT analysis was needed).
- For HUC-2 Region 05, roughly 10% of CWS have EDWC values that exceed the DWLOC after considering PCA refinements and where using the maximum PCT with maximum distribution of treated acres. Based on the maximum PCT with a uniform distribution of treated acres there were no CWS watersheds where the EDWC values exceeded the DWLOC.

The approaches outlined above represent a high level of refinement consistent with Tier 3 of USEPA's DWA Framework (USEPA, 2019). This case study provides representative examples of how a step wise approach to successive refinements using the full suite of CWS watershed PCA and state level PCT data (national level for non-ag uses) can be utilized to focus DWA refinements on groups of CWS watersheds most likely to be of concern. For those locations where there are differences in exceedances of the DWLOC depending on the state level PCT value (*e.g.*, maximum vs average) chosen and the PCT distribution method (*e.g.*, upper vs. uniform) a Weight of Evidence (WoE) approach that considers the strengths, weaknesses and uncertainty in the usage data should be considered for determining further refinement options and/or mitigation options. Subsequent refinements at Tier 4 can be conducted consistent with the DWA Framework and should focus on factors relevant to the groups of CWS watersheds that continue to have EDWC greater than the DWLOC after consideration of the methods presented in the PCA/PCT White Paper illustrated in this case study.

6. References

USEPA. 2014 *Development of Community Water System Drinking Water Intake Percent Cropped Area Adjustment Factors for use in Drinking Water Exposure Assessments: 2014 Update*. 9/9/14. Environmental Fate and Effects Division. Office of Chemical Safety and Pollution Prevention. U.S. Environmental Protection Agency. Available at https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/development-community-water-system-drinking-water.

USEPA, 2019. Draft *Framework for Conducting Pesticide Drinking Water Assessments for Surface Water*. Office of Pesticides Programs, U.S. Environmental Protection Agency. August 22, 2019. Available at https://www.regulations.gov/document?D=EPA-HQ-OPP-2019-0417-0006