Response to Eastern Equine Encephalitis Virus Mosquito Control Aerial Spray Events 2020: A Summary of the Surface Water Quality Sampling Operations

Massachusetts Department of Environmental Protection
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Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environment

Martin Suuberg, Commissioner
Department of Environmental Protection

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Background

The Massachusetts Department of Public Health's (DPH) Arbovirus Surveillance Program (Program) collects mosquito population data statewide on Eastern Equine Encephalitis virus (EEEv), West Nile and other mosquito borne arboviruses from spring to fall of each year in order to detect, predict, prevent, deter, and contain their spread. From the data collected in 2019 and 2020, the Program issued a determination on August 4, 2020 that there was an elevated risk of EEEv in parts of southeastern Massachusetts. Throughout the state, surveillance results for arbovirus infected mosquitos were fewer in 2020, likely due in part to cooler spring temperatures and drought conditions. Thus, there were fewer cases of EEEv and considerably less spraying in 2020 than in 2019 (MassDEP 2020a). The final number of human EEEv cases in 2020 totaled four and West Nile Virus cases totaled seven, far less than 2019.

Despite unfavorable weather conditions, in mid-July the southeastern communities of Carver and Middleborough in Plymouth County experienced more typical EEEv activity for that region. By early August 26, EEE-positive mosquito pools were found in these communities, prompting DPH to raise the EEEv risk level from high to critical.

Based on the elevated public-health risk and a confirmed human case of EEEv, on August 8, 2020, DPH issued a "*Certification of Public Health Hazard that Requires Pesticide Application to Protect Public Health"* for Bristol and Plymouth Counties. The certification affirmed that aerial intervention application was necessary to protect the public, and the State Reclamation and Mosquito Control Board (SRMB) held an emergency meeting on the same day to approve aerial spray to reduce the abundance of adult mosquitoes infected with EEEv and other arboviruses.

Following DPH's certification of public health hazard, the SRMB, operating within the Massachusetts Department of Agricultural Resources, and in collaboration with regional Mosquito Control Districts and Projects, and the Massachusetts Department of Public Health planned and implemented an aerial mosquito control spray operation and coordinated communication between agencies. The Massachusetts Department of Environmental Protection (MassDEP) conducted monitoring of public water supplies and surface water bodies following the spraying, which was conducted on the evening of August 10-11, 2020.

The pesticide Anvil 10+10 ULV, currently used for aerial spraying in Massachusetts, contains the active ingredients d-phenothrin (Sumithrin) and the synergist piperonyl butoxide (PBO).

In late August 2020, the presence of poly and perfluoroalkyl substances (PFAS) in Anvil 10+10 was brought to MassDEP's attention. Although this was not known when the 2020 mosquito control aerial spray event was conducted earlier that month, once it was brought to MassDEP's attention, MassDEP responded quickly to sample the formulation and coordinate with the U.S. EPA to investigate this issue. For more information on MassDEP's multipronged approach to address PFAS contamination go to: https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas#pesticide-products/mosquito-control.

Mosquito Control Aerial Spraying

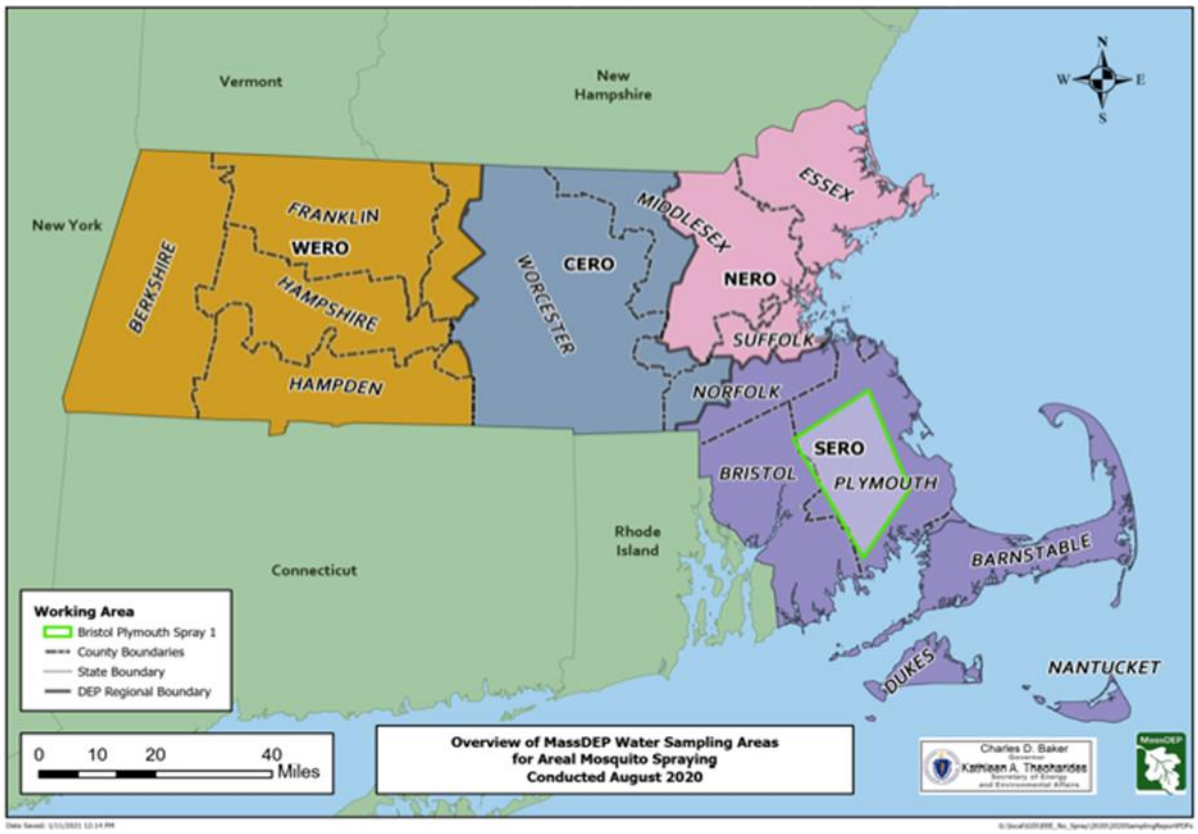
Dynamic Aviation conducted the aerial spraying and provided the associated GIS services. The emergency mosquito response began at 8 pm on August 10, 2020 and ended at approximately 2 am on August 11, 2020. Three planes covered the entire spray area, which totaled 178,823 acres, in one night. The pilots were instructed to follow a 500 ft exclusion (no spray) zone around public water supplies that are surface waters as identified by GIS maps. In addition, other exclusion zones included the entirety and buffers of mapped organic farms and endangered species habitat.

Twenty-five towns in two counties (Figure 1) were either fully or partially in the spray area, including:

Bristol County: Acushnet, Easton, Raynham, Taunton

Plymouth County: Bridgewater, Carver, Duxbury, East Bridgewater, Halifax, Hanover, Hanson, Kingston, Lakeville, Marion, Mattapoisett, Middleborough, Norwell, Pembroke, Plymouth, Plympton, Rochester, Rockland, Wareham, West Bridgewater, Whitman

Figure 1: 2020 MassDEP Water Sampling Map for Aerial Mosquito Spraying



MassDEP's Water Quality Sampling Effort in 2020

In response to the aerial spraying, MassDEP conducted water sampling, with the assistance of public water suppliers who collected samples from their water systems, to ensure that public water supplies were safe for human consumption and that surface waters were safe for public use based on U.S. EPA benchmarks: the Human Health Drinking Water Criteria and the Aquatic Life Benchmark Concentrations for fish and invertebrates, respectively, for the short-lived Sumithrin pesticide and piperonyl butoxide synergist.

Building on the 2019 sampling effort (MassDEP 2020a), MassDEP's Office of Research and Standards (ORS) updated the *Mosquitocide Aerial Spraying Water Resources Sampling Guidance* in consideration of the Department's current QA/QC standards for field sampling and laboratory analysis (MassDEP 2020b and Appendices 1a and 1b). The guidance procedures were implemented by the public water suppliers, MassDEP staff, and University of Massachusetts Pesticide Analysis Lab (MPAL) in Amherst.

Description of Water Quality Sampling Operation and COVID Overlay Safety Guidance

Due to the COVID -19 pandemic (MassDEP 2020c), MassDEP developed a *Safety Guidance for Field Sampling Operations Following Aerial Spraying for Mosquito Control During the COVID-19 Pandemic* to protect MassDEP, public water supply and laboratory staff, and the public prior to and following the water quality sampling effort. Appropriate personal protective equipment (PPEs), supplies and other safety measures/features were also provided to staff before sampling began to avoid infection and cross contamination. Consequently, no COVID-related health issues occurred as a result of the sampling effort.

The water quality sampling was conducted on August 11, 2020. Due to the rapid degradation of the pesticide and PBO once exposed to light and air, MassDEP staff and the water suppliers made every effort to mobilize quickly and collect samples by approximately 8:00 am after the previous night's aerial spray operation.

The public water suppliers conducted the sampling at their treatment plants and MassDEP staff sampled select non-public water systems' (PWS) surface waters to determine if the spray event resulted in risks to ecological receptors. Selected water bodies close to, but outside, the spray zones were sampled to serve as controls or comparisons.

A total of 26 samples were collected from 12 locations as shown in Figure 2, page 5. Four public water suppliers collected 14 raw and finished water samples at their water treatment plants. They were:

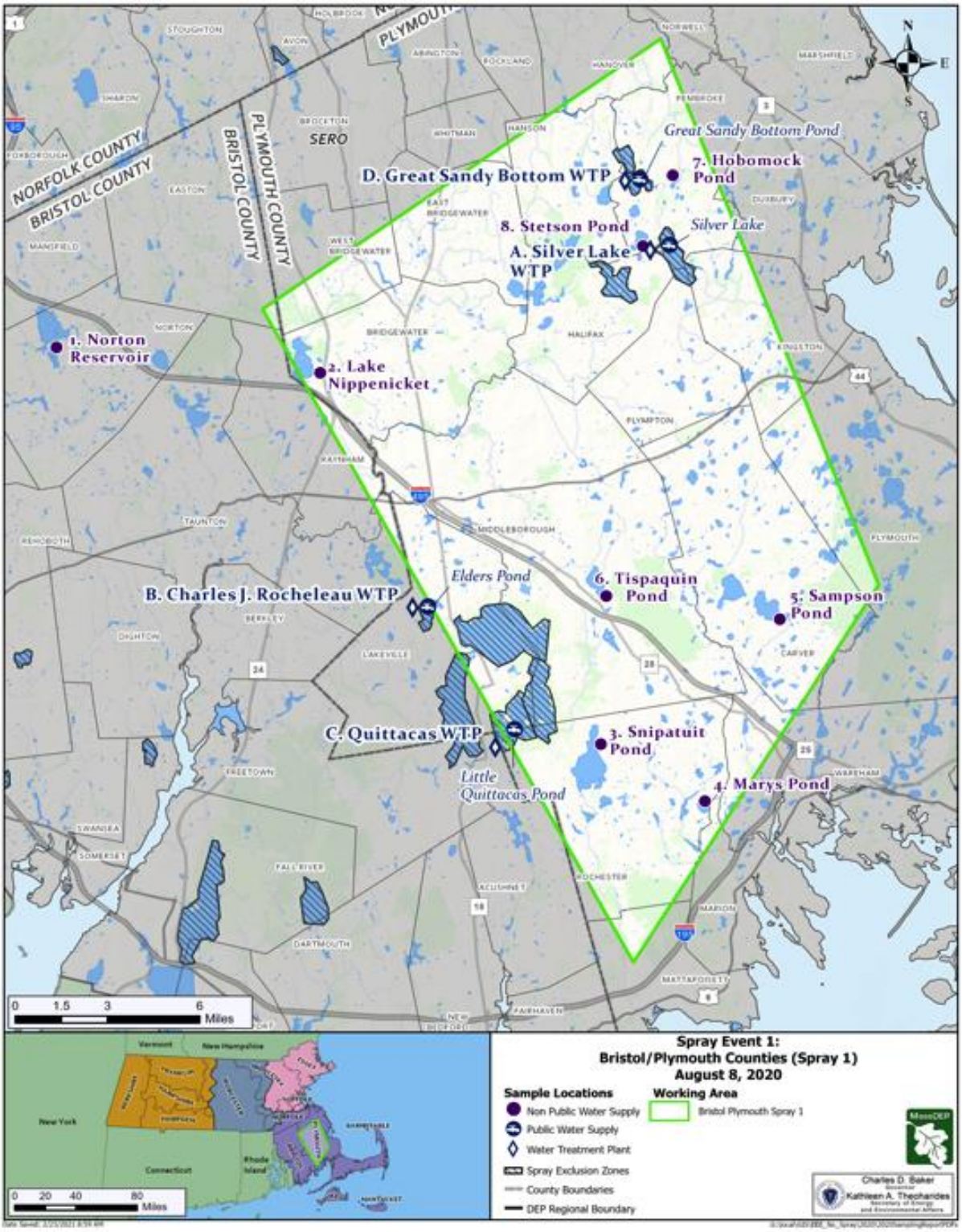
A. Brockton Water Commission's Silver Lake Water Treatment Plant (WTP)
B. Taunton Water Division's Charles J. Rocheleau WTP

C. New Bedford Department of Public Infrastructure (DPI) Water Division's Quittacas WTP
D. Abington-Rockland Joint Waterworks' Great Sandy Bottom WTP (collected in early afternoon on 8/11/2020)

MassDEP's field sampling staff also collected twelve samples from eight non-PWS water bodies. The samples include two duplicate samples, two blank samples and a control site (outside the spray area) sample. These samples were collected from the following water bodies:

1. Norton Reservoir, Norton (control site)
2. Lake Nippenicket, Bridgewater
3. Snipatuit Pond, Rochester
4. Mary's Pond, Rochester
5. Sampson's Pond, Carver
6. Tispaquin Pond, Middleborough
7. Hobomock Pond, Pembroke
8. Stetson Pond, Pembroke

Figure 2: Sampling Locations for August 8, 2020 Spray Event



Summary of the Anvil 10+10 Water Sampling Results

Post-spray samples were analyzed by MPAL in Amherst and resulting data were forwarded to MassDEP's ORS for assessment of potential human and ecological risks. (See Appendix 2 for detailed information about samples analyzed by MPAL as well as samples results.) ORS evaluated the analytical data to determine if any concentrations of Sumithrin (the pesticide) and piperonyl butoxide (PBO, the synergist that amplifies its effectiveness) were of public health concern or posed risks to aquatic animals based on U.S. EPA benchmarks as noted earlier, the Human Health Drinking Water Criteria and the Aquatic Life Benchmark Concentrations for fish and invertebrates, respectively.

Sumithrin was not detected in any of the raw and finished samples collected from the public water systems. The synergist PBO was detected at a very low concentration (0.079 ug/L) in the raw sample from the pond at the Great Sandy Bottom treatment plant but was not detected after treatment (Table 1) or in any other public water system. This concentration was thousands of times below the U.S. EPA and MassDEP PBO Guidance Levels for Human Health (Table 2). Thus, the reported concentrations would not present a risk to public health from use of drinking water. PWSs participating in the sampling are required to provide information on any results in their Drinking Water Consumer Confidence Report. More information is available at https://www.mass.gov/info-details/consumer-confidence-reports.

Table 1. PBO and Sumithrin Detections by Water Treatment Plant (ug/L)1

Public Water System/ Location	PBO		SUMITHRIN	
	RAW	FINISH	RAW	FINISH
Taunton Water Department/ Charles J. Rocheleau WTP	<LOQ[2]	<LOQ	<LOQ	<LOQ
Abington-Rockland/ Great Sandy Bottom Pond WTP	0.079	<LOQ	<LOQ	<LOQ
New Bedford Water Division/ Quittacas WTP	<LOQ	<LOQ	<LOQ	<LOQ
Brockton Water Department/ Silver Lake WTP	<LOQ	<LOQ	<LOQ	<LOQ

[1]ug/L means micrograms per liter (also equal to parts per billion (ppb).
[2]LOQ = Limit of Quantitation; The LOQ for both Sumithrin and PBO is 0.04 ug/L (ppb).

Table 2. U.S. EPA Guidance Levels for Human Health

COMPOUND	Chronic Criteria (ug/L)[1]			Acute Criteria (ug/L)[1]		
	general population	child	lactating woman	child	female (13-49 years)	lactating woman
Sumithrin	40	23	26		800	557
Piperonyl Butoxide	992	206	575	42,000		117,000

[1]ug/L means micrograms per liter (also equal to parts per billion (ppb).

Sumithrin was not detected in any of the samples collected from the surface water bodies that do not serve as drinking water sources (non-PWS water samples). The synergist PBO was detected and quantified in five of the eight non-PWS surface water bodies sampled (Table 3). The highest concentration of PBO in a non-PWS water body was 0.132 ug/L, reported in a sample from Lake Nippenicket, in Bridgewater, MA. This concentration was far below the U.S. EPA Aquatic Life Benchmark Concentrations for fish and invertebrates (Table 4). Thus, the concentrations found in these water bodies would not be expected to present a significant risk to fish and invertebrates.

Table 3. PBO and Sumithrin Detections by Non-PWS Waterbody (ug/L)1

Non-PWS Waterbody	PBO	Sumithrin
Tispaquin Pond - Middleborough	0.078	<LOQ
Sampsons Pond - Carver	0.06	<LOQ
Lake Nippenicket - Bridgewater	0.132	<LOQ
Snipatuit Pond - Rochester	0.125	<LOQ
Mary's Pond - Rochester	0.041	<LOQ
AVERAGE	**0.087**	**---**
MINIMUM	**0.041**	**---**
MAXIMUM	**0.132**	**---**

[1]ug/L means micrograms per liter (also equal to parts per billion (ppb)).
[2]LOQ = Limit of Quantitation; The LOQ for both Sumithrin and PBO is 0.04 ug/L (ppb).

Table 4. U.S. EPA Aquatic Life Benchmark Concentrations

COMPOUND	Chronic Criteria (ug/L)[1]		Acute Criteria (ug/L)[1]	
	Fish	Invertebrates	Fish	Invertebrates
Sumithrin	1.1	0.47	7.9	2.2
Piperonyl Butoxide	40	30	950	255

[1]ug/L means micrograms per liter (also equal to parts per billion (ppb)).

References

Massachusetts Department of Environmental Protection, 2020a. Response to Eastern Equine Encephalitis Virus Mosquito Control Aerial Spray Events 2019: A Summary of the Surface Water Quality Sampling Operations (https://www.mass.gov/doc/response-to-eastern-equine-encephalitis-virus-mosquito-control-aerial-spray-events-2019/download)

Massachusetts Department of Environmental Protection, 2020b. Mosquitocide Aerial Spraying Water Resources Sampling Guidance

Massachusetts Department of Environmental Protection, 2020c. Safety Guidance for Field Sampling Operations Following Aerial Spraying for Mosquito Control During the COVID-19 Pandemic

Appendix 1:
Highlights of MassDEP's 2020 Mosquitocide Aerial Spraying Water Resources Sampling Guidance

Appendix 1a:
Summary of Sample Collection Procedure for Mosquitocide Aerial Spraying
Water Resources Sampling Guidance

Water Quality Samples within Aerial Spray Zone	Day before Aerial Spraying	Morning After (Day 1) Aerial Spraying (By 8 AM)	Second Day After (Day 2) Aerial Spraying (24 hrs after 1st sample)
All Water Suppliers	None	1 Raw Water Intake Sample without preservative 1 Finished Water Sample with L-ascorbic acid (preservative) 1 Finished Water Sample without preservative **3 Total Samples to be collected in 1L bottles**	None If spraying in the vicinity of a PWS reservoir takes more than one day to complete, then additional sets of Morning After (Day 1) samples will be collected until spraying in that vicinity is complete.
One selected Water Supplier	None	1 Raw Water Intake Sample without L-ascorbic acid (preservative) 1 Finished Water Sample with L-ascorbic acid (preservative) 1 Finished Water Sample without preservative 1 Duplicate Finished Water Sample with L-ascorbic acid (preservative) 1 Duplicate Finished Water Sample without preservative **5 Total Samples to be collected in 1L bottles**	None If spraying in the vicinity of a PWS reservoir takes more than one day to complete, then additional sets of Morning After (Day 1) samples will be collected until spraying in that vicinity is complete.

Water Quality Samples within Aerial Spray Zone	Day before Aerial Spraying	Morning After (Day 1) Aerial Spraying (By 8 AM)	Second Day After (Day 2) Aerial Spraying (24 hrs after 1st sample)
DEP Field Crew	None	1 surface water sample per location (up to 6 locations per day) 1 Duplicate sample* and 1 Blank per sampling day 1 Control Site sample from outside the spray area per spray event No preservative is necessary for non-PWS samples **Samples to be collected in 1L bottles**	None

*One surface water location to be randomly selected for collection of a duplicate sample by the DEP Regional Office

Appendix 1b:
Modification to Sampling and Analysis Protocols as described in MassDEP's 2020 Mosquitocide Aerial Spraying Water Resources Sampling Guidance

A review of the sampling and analytical protocols used in 2019 and previous years to monitor water resources following aerial spraying resulted in some changes to these protocols in 2020. A revision in the number and type of samples was made based on observation of past results and a focus on the best use of laboratory and other resources to obtain the most relevant data. In addition, a review of the analytical methodology used by the University of Massachusetts Pesticide Analysis Laboratory (MPAL) by MassDEP's Wall Experiment Station (WES), initiated to incorporate standard measures of quality assurance and quality control (QA/QC) into the methodology, also resulted in some other modifications to the method to reflect standard practice for this type of evaluation. The collective changes to these protocols are described in an updated guidance document, the 2020 Mosquitocide Aerial Spraying Water Resources Sampling Guidance (hereafter referred to as the 2020 Sampling Guidance). A list of the important changes and the reason for the change are listed below.

- **PRE- AND POST-DAY SAMPLES** - Collection of both pre-spray samples (collected the day before spraying), as well as post-spray samples (collected in the day or days following the day of spraying), was not conducted in 2020, as past experience with these samples in previous years indicated that the results of these samples were largely "Non-Detect" (ND).
- **SAMPLE BOTTLE PREPARATION** - In keeping with standard practice for this kind of analysis, several preservatives were recommended for addition to the 1-L sample bottles, including L-ascorbic acid (as a dechlorinator for chlorinated samples), EDTA (ethylenediaminetetraacetic acid) trisodium salt (as an inhibitor of metal hydrogen) and potassium dihydrogen citrate (as a microbial inhibitor) trisodium salt.
- **SAMPLE COLLECTION TECHNIQUE -** While past protocols specified filling bottles completely and leaving no headspace, the 2020 protocol specifies that there should be some space between the shoulder and cap of the bottle to allow for mixing of the sample at the laboratory.
- **DUPLICATES** - In contrast to the large number of duplicate raw water samples collected in 2019, in 2020 only one of the PWS and one of the non-PWS each took a duplicate of the finished water per day of sampling.
- **FIELD BLANKS** – As for the duplicates, in 2020, one of the PWS and one of the non-PWS each prepared a field blank per day of sampling.
- **FILTRATION OF SAMPLES BEFORE ANALYSIS** - While in previous sampling events, water samples were filtered prior to analysis, and in 2019, a large number of additional PWS and non-PWS duplicate raw water samples were taken with the intent to do a study to quantify analyte differences in filtered versus unfiltered samples, for the 2020 spraying event, requirements regarding filtration of samples prior to analysis were clearly specified: Finished drinking water samples were not filtered as these samples contain little to no

suspended material; however, for any finished drinking water with a high particulate content that the lab determined had to be filtered, the lab was required to report, in consultation with MassDEP, the total quantity of analytes in water including any removed through filtration. Raw drinking water samples were only filtered if they contained high level of suspended particulates and non-drinking water surface waters were generally filtered.

- **ANALYTICAL REPORTING LIMIT** - In 2019, the limit of detection (LOD) was used as the reporting limit for the analytical results, whereas in 2020 the reporting limit was changed to the limit of quantitation (LOQ). The LOD is the lowest concentration of an analyte that can be reliably seen or detected in a sample but not reliably quantitated. The LOQ is the lowest concentration of an analyte that can be reliably quantitated. Conventional analytical protocol specifies that analytical results that fall above the LOD but below the LOQ are estimated values and must be qualified as such. This approach is also consistent with the protocol used by the MassDEP Drinking Water Program.
- **QA/QC PARAMETERS ADDED** – In 2019, the only QA/QC measure included in the analytical report was percent recovery, a measure of accuracy. In 2020, additional QA/QC measures, including a laboratory reagent blank, a laboratory fortified blank, a laboratory matrix spike and duplicate, and percent surrogate recovery, were required and included.

Temporary Changes from 2020 Sampling Guidance to Sampling Protocol Used to Collect 2020 Water Samples

Several minor modifications to the updated sampling protocol described in the 2020 sampling guidance document were made shortly before sampling commenced in 2020 as a result of several last-minute laboratory issues that arose.

Because many regional offices already had a supply of stockpiled 1-L bottles, WES proposed to prepare and deliver to the regional offices small vials containing the three preservatives (as described above) that could then be added to sample bottles by regional sampling staff. However, due to supply issues, the lab was unable to obtain vials that could hold all three preservatives. In addition, MPAL had not had a chance to fully validate the updated analytical methodology pertaining to use of the preservatives recommended by WES before the aerial spraying event. For these reasons, a decision was made to only use one of the preservatives, the dechlorinator, which would only be added to finished chlorinated water samples from PWS, and which could be delivered to regional offices in smaller vials that WES had in stock. Thus, an addendum to the 2020 Sampling Guidance was distributed to regional office sampling staff, with one-time changes in the sampling protocol to address the above issues. These changes included:

- **ADDITION OF PRESERVATIVES TO SAMPLE BOTTLES** – The dechlorinator was the only preservative added to bottles used by PWS to collect a finished preserved sample.
- **COMPARISON OF PRESERVED AND NON-PRESERVED FINISHED WATER SAMPLE**S - PWS were instructed to take one finished water sample using bottles to which the dechlorinator had not been added and a second finished water sample using bottles to which the dechlorinator had been added, so that a comparison could be done between preserved and

unpreserved sample results. (Each PWS was also instructed to take one raw water sample, as per the usual protocol.)

- **DUPLICATE WATER SAMPLES** - One of the PWS per sampling day was also instructed to take both a duplicate finished water sample to which the dechlorinator had not been added and a duplicate finished water sample to which the dechlorinator had been added.
- **NO PRESERVATIVES USED FOR NON-PWS SAMPLES** - No preservatives (for reasons discussed above) were to be added to the empty sample bottles prior to sampling non-PWS waterbodies.

Appendix 2:
Samples Collected and Analytical Results

Summary Tables of the Water Samples Analyzed

Twenty-six samples were collected by MassDEP and analyzed for the synergist piperonyl butoxide (PBO) and Sumithrin by University of Massachusetts Pesticide Analysis Lab (MPAL) in Amherst. Details about these samples and their results are presented in Tables 2-1 through 2-5. Table 2-3 presents results of all samples collected

Table 2-1. Number of Water Samples of Each Type Analyzed

SAMPLE TYPE	# ANALYZED
RAW[1] Water from PWS	4
FINISHED[1] Water from PWS	4
FINISHED DUPLICATE[2] Water from PWS	1
FINISHED PRESERVED[3] Water from PWS	4
FINISHED PRESERVED[3] DUPLICATE[2] Water from PWS	1
non-PWS	7
non-PWS DUPLICATE[2]	2
Control Site[4]	1
FIELD BLANK[5]	2
TOTAL SAMPLES	26

[1]RAW Water – water that has not been processed on a water treatment;
FINISHED Water – water that has been processed in a water treatment plant and is ready to be delivered to consumers.
[2]DUPLICATE – a second water sample collected concurrently with a first sample;
[3]PRESERVED – a sample to which a preservative has been added.
[4]Control Site – a waterbody outside of the spray area used as a reference to compare to data from within the spray area;
[5]FIELD BLANK – a clean, unopened sample bottle that accompanies the sample bottles to the "field" and back to the analytical laboratory.

Table 2-2. Number of Detections of PBO and Sumithrin of Each Sample Type

SAMPLE TYPE DETECTIONS	PBO	Sumithrin
TOTAL detections	6	---
RAW[1] WATER detections	1	---
FINISHED[1] WATER detections	---	---
FINISHED WATER DUPLICATE[2] detections	---	---
FINISHED PRESERVED[3] detections	---	---
FINISHED PRESERVED[3] DUPLICATE[2] detections	---	---
Non-PWS detections	4	---
Non-PWS DUPLICATE[2] detections	1	---
Control Site[4] detections	---	---
FIELD BLANK[5] detections	---	---

[1]RAW Water – water that has not been processed on a water treatment;
FINISHED Water – water that has been processed in a water treatment plant and is ready to be delivered to consumers.
[2]DUPLICATE – a second water sample collected concurrently with a first sample;
[3]PRESERVED – a sample to which a preservative has been added.
[4]Control Site – a waterbody outside of the spray area used as a reference to compare to data from within the spray area;
[5]FIELD BLANK – a clean, unopened sample bottle that accompanies the sample bottles to the "field" and back to the analytical lab.

Table 2-3. 2020 Water Sampling Data for August 10, 2020 Anvil 10+10 Spraying Event

EventID	Chain Of Custody ID[1]	PBO > LOQ[2] (ug/mL)[3]	Sumithrin > LOQ[2] (ug/mL)[3]	Surrogate Recovery[4] (%)	Sample Type	Geographic Town	SOURCE_ID	Water Body Name
BP1-2020	EPD1F	---	---	67.0	FINISH	LAKEVILLE	4293000-02S	Elders Pond
BP1-2020	EPD1F+	---	---	68.7	FINISH PRESERVED	LAKEVILLE	4293000-02S	Elders Pond
BP1-2020	EPD1R	---	---	64.1	RAW	LAKEVILLE	4293000-02S	Elders Pond
BP1-2020	EPD1FB	---	---	63.5	FIELD BLANK			
BP1-2020	GSBD1F	---	---	78.8	FINISH	PEMBROKE	4001000-01S	Great Sandy Bottom Pond
BP1-2020	GSBD1F+	---	---	76.1	FINISH PRESERVED	PEMBROKE	4001000-01S	Great Sandy Bottom Pond
BP1-2020	GSBD1R	0.079	---	74.8	RAW	PEMBROKE	4001000-01S	Great Sandy Bottom Pond
BP1-2020	LQD1F	---	---	62.6	FINISH	ROCHESTER	4201000-02S	Little Quittacas Pond
BP1-2020	LQD1F+	---	---	66.0	FINISH PRESERVED	ROCHESTER	4201000-02S	Little Quittacas Pond
BP1-2020	LQD1R	---	---	63.8	RAW	ROCHESTER	4201000-02S	Little Quittacas Pond
BP1-2020	LQD1FD	---	---	64.2	FINISH DUP	ROCHESTER	4201000-02S	Little Quittacas Pond
BP1-2020	LQD1FD+	---	---	67.4	FINISH PRESERVED DUP	ROCHESTER	4201000-02S	Little Quittacas Pond
BP1-2020	SLD1F	---	---	66.0	FINISH	HALIFAX	4044000-01S	Silver Lake
BP1-2020	SLD1F+	---	---	66.4	FINISH PRESERVED	HALIFAX	4044000-01S	Silver Lake
BP1-2020	SLD1R	---	---	56.4	RAW	HALIFAX	4044000-01S	Silver Lake
BP1-2020	HP01	---	---	74.3	Non-PWS	PEMBROKE	No SOURCE_ID	Hobomock Pond
BP1-2020	LN01	0.132	---	61.2	Non-PWS	BRIDGEWATER	No SOURCE_ID	Lake Nippenicket
BP1-2020	MP01	---	---	67.4	Non-PWS	ROCHESTER	No SOURCE_ID	Mary's Pond
BP1-2020	MP02D	0.041	---	62.2	Non-PWS DUP	ROCHESTER	No SOURCE_ID	Mary's Pond
BP1-2020	NR01CS	---	---	63.7	ControlSite	NORTON	No SOURCE_ID	Norton Reservoir
BP1-2020	SN01	0.125	---	64.3	Non-PWS	ROCHESTER	No SOURCE_ID	Snipatuit Pond
BP1-2020	SP01	0.06	---	58.0	Non-PWS	CARVER	No SOURCE_ID	Sampsons Pond
BP1-2020	SP02B	---	---	68.2	FIELD BLANK			
BP1-2020	ST01	---	---	61.5	Non-PWS	PEMBROKE	No SOURCE_ID	Stetson Pond
BP1-2020	ST02-D	---	---	66.4	Non-PWS DUP	PEMBROKE	No SOURCE_ID	Stetson Pond
BP1-2020	TQ01	0.078	---	65.9	Non-PWS	MIDDLEBOROUGH	No SOURCE_ID	Tispaquin Pond

[1]Chain of Custody ID = Unique sample identifier from Field Sample Collection Datasheet for tracking purposes

[2]LOQ = Limit of Quantitation; The LOQ for both Sumithrin and PBO is 0.04 ug/L (ppb).

[3]ug/L means micrograms per liter (also equal to parts per billion (ppb)).

[4]Surrogate Recovery measures the % recovery of surrogate standards added to each sample. These are compounds similar in physical and chemical properties to the method compounds that are not expected to be present in the environment, which are added to each environmental and QA/AC sample in known amount(s) and used to monitor matrix effects and overall method performance. Acceptance criteria are 60-140% recovery

Table 2-4. Laboratory Quality Control Data for 8/11/20 Anvil 10+10 Water Analyses

Limit of Detection (LOD)	The LOD for both Sumithrin and PBO is 0.02 ug/L	
Limit of Quantitation (LOQ)	The LOQ for both Sumithrin and PBO is 0.04 ug/L	
Laboratory Quality Control Parameter	**Result**	
	Sumithrin	**PBO**
Laboratory Reagent Blank (LRB)	**Acceptance Criteria: Either ND (i.e., < LOD) or ≤ one-third of the LOQ**	
	(ug/L)[1]	**(ug/L)[1]**
	ND	ND
Laboratory Fortified Blanks (LFB)	**Acceptance Criteria: 50-150% Recovery at ≤ LOQ or 70-130% Recovery at Mid-Calibration Range**	
	(%)	**(%)**
LFB 1 (spiked at 0.4 ug/L[1])	55.8	90.5
LFB 2 (spiked at 0.02 ug/L[1])	99.0	81.2
Laboratory Matrix Spikes (MS) (spiked at 0.04 ug/L)[1]	**Acceptance Criteria: 50-150% Recovery at LOQ**	
	(%)	**(%)**
LQD1FD A	76.3	92.9
LQD1FD B	81.5	98.0
LQD1FD C	58.7	74.9
LQD1FD+ A	80.2	91.6
LQD1FD+ B	81.1	94.3
ST02 A	74.3	158.7
ST02 B	77.7	156.5
MP02D A	69.5	199.5
MP02D B	63.1	203.1
Laboratory Matrix Spike Duplicates (MSD) (spiked at 0.04 ug/L)[1]	**Acceptance Criteria: RPD[2] ≤ 50% at LOQ**	
	(%)	**(%)**
LQD1FD (A &B)	6.65	5.23
LQD1FD (B & C)	32.4	26.6
LQD1FD (A & C)	25.9	21.4
LQD1Fd+	0.93	2.96
SP02	4.61	1.43
MP02D	9.81	1.74
Surrogate Standard Recovery (all samples spiked at 0.2 ug/L)[1]	**Acceptance Criteria: 60-140% Recovery**	
	(%)	
LRB 1	70.9	
LFB 1	59.3	
LFB 2	59.3	
LQD1FD A	63.8	
LQD1FD B	65.5	
LQD1FD C	63.2	
LQD1FD+ A	69.2	
LQD1FD+ B	65.5	
ST02 A	61.1	
ST02 B	71.7	
MP02D A	63.4	
MP02D B	61.0	

[1]ug/L means micrograms per liter (also equal to parts per billion (ppb)).

[2] Relative Percent Difference – a measure of precision calculated from duplicate measurements as RPD=((C1-C2)x100)/((C1+C2)/2) where C1=larger of two observed values and C2=smaller of two observed values.

[3] NOTE: The left column references select lab and field samples used in quality control assessment.

Table 2-5. Field Quality Control Data for 8/11/20 Anvil 10+10 Water Analyses

	Sumithrin	**PBO**
Field Reagent Blanks (FRB)	**Acceptance Criteria: Either ND (i.e., < LOD[1]) or ≤ one-third of the LOQ[2]**	
	(ug/L)[3]	**(ug/L)[3]**
EPD1FB	ND	ND
SP02B	ND	ND
Field Duplicates (FD)	**Acceptance Criteria: RPD[4] ≤ 30%**	
	(%)	**(%)**
LQD1F/LQD1FD	0	0
LQD1F+/LQD1FD+	0	0
ST01/ST02	0	8.3
MP01/MP02D	0	5
Control Site Sample (CS)	**Comparative Sample from an Area Outside of the Spray Area**	
	(ug/L)[3]	**(ug/L)[3]**
NR01CS	ND	ND

[1]LOD = Limit of Detection; The LOD for both Sumithrin and PBO is 0.02 ug/L (ppb).

[2]LOQ = Limit of Quantitation; The LOQ for both Sumithrin and PBO is 0.04 ug/L (ppb).

[3]ug/L means micrograms per liter (also equal to parts per billion (ppb)).

[4]Relative Percent Difference – a measure of precision calculated from duplicate measurements as RPD=((C1-C2)x100)/((C1+C2)/2) where C1=larger of two observed values and C2=smaller of two observed values.