Ambient Monitoring for Pesticides in Washington State Surface Water

May 2020

2017 Technical Report

Washington State Department of Agriculture
Natural Resources Assessment Section

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Executive Summary

The Washington State Department of Agriculture (WSDA) has been generating surface water monitoring data for pesticides since 2003 in an ongoing effort to assess the frequency and degree to which pesticides are found in surface water across a diverse cross section of land use patterns in Washington State. State and federal agencies use this data to evaluate water quality and make exposure assessments for pesticides registered for use in Washington State.

In 2017, WSDA's Natural Resources Assessment Section (NRAS) collected surface water samples weekly or biweekly from March through November at 16 monitoring sites. Sites were selected where pesticide contamination and poor water quality conditions were expected based on land use with high pesticide application rates or historic pesticide detections. These sites were located in Benton, Chelan, Clark, Grant, Kittitas, Skagit, Thurston, Whatcom, and Yakima counties with watershed areas ranging from 2,000 acres to over 200,000 acres. Land use within each watershed varied from commercial, residential, and urban to agricultural uses like tree fruit, berry, wheat, corn, grass hay, and potato production. Sample analysis for pesticides was conducted at the Manchester Environmental Laboratory (MEL) in Port Orchard, Washington.

The United States Endangered Species Act lists several species of endangered salmonids found in Washington State's waterways including some in the waterways WSDA monitors (ESA, 1973). Salmonids are valuable in the Pacific Northwest due to their contribution to the economy, cultural significance, and function in the ecosystem. All of the watersheds sampled in 2017 have historically supported salmonid populations or contain habitat conducive to salmonid use. To assess potential biological effects and to be adequately protective of endangered and non-endangered species, WSDA compares detected pesticide concentrations from surface water samples to WSDA assessment criteria. WSDA assessment criteria are derived from toxicity study criteria and state and national water quality standards. Exceedances of assessment criteria indicate pesticide concentrations approaching levels with possible adverse effects to aquatic life such as fish, invertebrates, and aquatic plants. WSDA classifies a current-use pesticide as a WSDA Pesticide of Concern (POC) if the pesticide has exceeded WSDA assessment criteria within recent years somewhere in the state. To represent the most up-to-date toxicological research available during the creation of this publication, analysis of 2017 monitoring data used 2018 WSDA assessment criteria and POCs. WSDA's POC list of 21 chemicals in 2018 included pesticides such as bifenthrin, chlorpyrifos, clothianidin, diazinon, imidacloprid, malathion, pyridaben, and thiamethoxam.

At many monitoring sites, pesticide concentrations detected were above both WSDA assessment criteria and toxicity study criteria, state standards, or national standards. Of the 120 exceeding detections of WSDA assessment criteria, 84% (101 detections) also exceeded state, federal, or toxicity study criteria. Malathion and/or chlorpyrifos were detected above state or national water quality standards at 7 monitoring sites in Eastern

Washington and 1 site in Western Washington. Imidacloprid, found at 75% of the monitoring sites, exceeded the invertebrate toxicity study criterion every detection (42 detections). Other pesticides detected less often, that still exceeded toxicity study criteria include clothianidin, diuron, fipronil, pyridaben, thiamethoxam, and tefluthrin.

This report summarizes activities and data from the 16 separate sites selected for the 2017 ambient surface water monitoring season. Below is a brief overview of the findings.

- There were 292 surface water sampling events between March 21 and November 7.
- Out of 144 pesticide active ingredients and breakdown products tested, there were 85 unique pesticides detected.
- There were 1,639 positively identified pesticide detections.
- At 247 of the 292 sampling events, mixtures of 2 or more pesticides were detected.
- A breakdown product of the herbicide dichlobenil (2,6-dichlorobenzamide) was the most frequently detected chemical (174 times). Detections of this analyte occurred in almost 60% of the sampling events.
- The most frequently detected herbicide was 2,4-D (110 times), thiamethoxam and imidacloprid were the most frequently detected insecticides (71 and 42 times, respectively), and boscalid was the most frequently detected fungicide (76 times).
- There were 120 unique pesticide detections above WSDA assessment criteria (7.3% of total detections), which means they were near levels that could adversely affect aquatic life.
    - The legacy insecticide DDT and its breakdown products accounted for 30 of these detections (25% of exceedances).
    - Current-use pesticides found at concentrations above assessment criteria were carbendazim (2 exceedances), chlorpyrifos (21 exceedances), clothianidin (5 exceedances), diazinon (1 exceedance), diuron (1 exceedance), fipronil (1 exceedance), imidacloprid (42 exceedances), malathion (9 exceedances), pyridaben (3 exceedances), pyriproxyfen (1 exceedance), tefluthrin (1 exceedance), and thiamethoxam (3 exceedances).
    - Naneum Creek was the only monitoring site where no detected pesticide concentrations were above WSDA assessment criteria.

WSDA sampled for total suspended solids as well as field measurements for dissolved oxygen, pH, conductivity, and streamflow at sampling events. WSDA also collected continuous temperature measurements during the entire monitoring season in situ. Dissolved oxygen, pH, and temperature measurements were compared to Water Quality Standards for Surface Waters of the State of Washington (WAC, 2019). At least 1 conventional water quality parameter exceeded state water quality standards at each monitoring site. When these exceedances coincide with exceedances of WSDA pesticide assessment criteria, it could compound stress on aquatic life.

Maintaining the highest level of data quality is an essential component of the monitoring program. WSDA staff closely adhere to consistent field procedures while MEL staff reliably produce high quality testing results to achieve the highest quality assurance standards recommended by the Environmental Protection Agency (EPA) (EPA, 2017). Appendix B:

2017 Quality Assurance Summary provides a summary of quality assurance and quality control sample results with a detailed analysis of how the field and laboratory methods performed over the season.

The NRAS ambient monitoring program is a tool for identifying state-specific pesticide issues that can be addressed according to WSDA's EPA-approved Pesticide Management Strategy (Cook and Cowles, 2009). Maintaining an adaptive monitoring approach helps identify pesticide use patterns that can lead to water contamination. The statewide ambient surface water monitoring program also forms the groundwork for additional studies focusing on particular scientific questions of interest regarding pesticide fate and transport. WSDA shares the data generated by this program with the agricultural community, regulatory community, and the public through WSDA's website, reports, watershed-specific fact sheets, and numerous public presentations.

Introduction

The Washington State Department of Agriculture (WSDA) has authority as a state lead agency to regulate the sale and use of pesticides in Washington State under federal regulation according to the amended Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA, 1947), and state regulation according to Washington Pesticide Control Act (WPCA, 1971) and Washington Pesticide Application Act (WPAA, 1971).

Since 2003, WSDA has received funding from the Washington State Legislature and the US Environmental Protection Agency (EPA) to administer a comprehensive program to assess the frequency and biological significance of pesticides detected in Washington State surface waters. To make that evaluation, WSDA's Natural Resources Assessment Section (NRAS) collects 3 kinds of information;

- pesticide usage data: quantities and types of pesticides used on different crops,
- agricultural land use data: crop types grown and their locations in the state, and
- ambient monitoring data: pesticide concentrations in surface water.

NRAS's ambient surface water monitoring program provides information about the fate, transport, and potential effects of pesticides in the environment, allowing regulators to refine exposure assessments for pesticides registered for use in Washington State and providing feedback to pesticide users. It is of critical importance to minimize the potential effects of pesticides on aquatic systems while also minimizing the economic impacts to agricultural systems that are responsible for providing a sustainable food supply.

The technical report is intended to:

- summarize results, data quality, and monitoring activities conducted in 2017,
- provide data for the pesticides that are listed for agency Endangered Species Act consultations,
- determine if any pesticides in surface waters may be present at concentrations that could adversely affect aquatic life,
- provide a basis for potential modifications to the program in upcoming years, and
- provide data to support implementation decisions under the agency's Pesticide Management Strategy (Cook and Cowles, 2009).

WSDA conducted ambient surface water monitoring for pesticides in 2017 from March through November throughout the state. During the first year of monitoring (2003) WSDA sampled at 9 monitoring sites in agricultural and urban areas. The program has since expanded to 16 monitoring sites in 2017, which included 2 of the 9 original monitoring sites. WSDA has monitored surface water in 19 unique watersheds since the start of the program. Site changes from 2016 to 2017 include the addition of 4 new sites (2 in Western Washington, 2 in Eastern Washington) and the removal of 1 site in Western Washington.

Water samples were sent to the Manchester Environmental Lab (MEL) for analysis of pesticide and pesticide-related chemicals (insecticides, herbicides, fungicides, degradates, an antimicrobial, a wood preservative, an insect repellent, and synergists). In 2017, there were 144 analytes tested, with 85 confirmed analytes detected in surface water samples. Between the 2016 and 2017 monitoring seasons, there were 11 analytes removed and 1 analyte added to the WSDA testing list. The analytes tested every year change because of new use restrictions, changes in pesticide registration, or lack of detections in surface water.

WSDA compares the surface water data to internal assessment criteria that are derived by applying a safety factor to state and national water quality standards and toxicity study criteria in order to be adequately protective of aquatic life. WSDA identifies a current-use pesticide as a Pesticide of Concern (POC) when it has been found somewhere in the state above WSDA assessment criteria in recent years. When persistent contamination of waters with POCs and other chemicals is documented, WSDA can implement its EPA-approved Pesticide Management Strategy (Cook and Cowles, 2009). WSDA's Pesticide Management Strategy specifies adaptive management techniques including voluntary best management practices, voluntary use prohibition, technical assistance, stakeholder outreach, and monitoring to investigate and eliminate surface water or groundwater contamination with pesticides.

NRAS's ambient surface water monitoring program provides a non-regulatory framework for addressing off-target pesticide movement into streams and rivers. The ambient monitoring program data can be used to identify targets for technical assistance and outreach efforts from other private and public organizations to address local and regional water quality issues. WSDA keeps the agricultural community, regulatory community, and the public informed about pesticide detection trends that occurred in surface water with numerous public presentations and annual reports. In addition to this report, site-specific fact sheets are published yearly to share data and improve awareness of simple practices that can protect surface water.

Study Area

Since the ambient surface water monitoring program began in 2003, sampling sites and subbasins have been both added and removed based on pesticide detection history, changing pesticide use practices, site conditions, land use patterns, and the presence of federally-listed threatened or endangered species. Water Resource Inventory Areas (WRIA) are typically used to study and manage water resources within the State of Washington. These subbasin boundaries are also used by Washington State for their water quality standards for surface waters (WAC, 2019). Figure 1 shows the boundaries of the 9 WRIA subbasins that WSDA monitored in, identified by their WRIA codes and corresponding subbasin names.

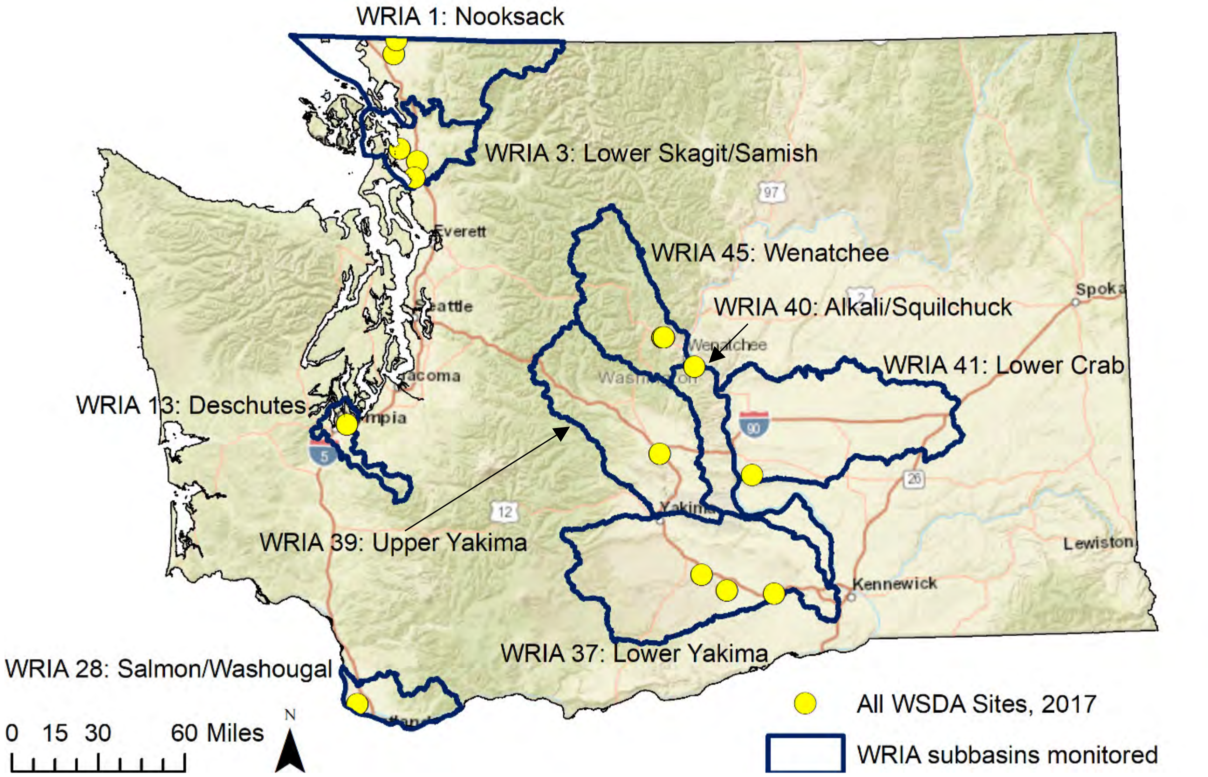

Figure 1 – Subbasins monitored in Washington State in 2017

All 9 subbasins exist within the greater Pacific Northwest Region. Of these, 2 subbasins represent mixed urban and residential landscapes and were selected due to land-use characteristics, history of pesticide detections, and the habitat provided for endangered species including pacific salmonids. The other 7 subbasins represent a variety of agricultural landscapes. These subbasins were chosen because they produce different varieties of agricultural commodities in close proximity to waterbodies, they have a wide range in terms of the percentage of the total areas in agricultural production, and they also provide habitat for endangered Pacific salmonids.

Study Methodology

Study Design

The objective of this sampling program was to assess pesticide presence and concentration in salmonid-bearing streams during a typical pesticide-use period of March through November. Surface water samples were collected and tested for 144 pesticide active ingredients and pesticide breakdown products at 16 monitoring sites across the state. The sampling schedule was determined individually for each site by focusing sampling efforts during the duration of peak pesticide application as well as around the weeks with pesticide detections in previous years.

Conventional water quality parameters such as total suspended solids, pH, conductivity, continuous temperature data (collected at 30-minute intervals), dissolved oxygen, and streamflow were monitored at all sampling events to assess overall stream health in relation to Washington State water quality standards.

Detailed information on study design and methods are described in the Quality Assurance Project Plan (Johnson and Cowles, 2003), and subsequent addendums (Burke and Anderson, 2006; Dugger et al., 2007; Anderson and Sargeant, 2009; Anderson, 2011; Anderson, 2012; Sargeant, 2013).

Field Procedures

Surface water samples were collected using a 1-liter glass jar by hand grab or pole grab as described in the Washington State Department of Ecology's (Ecology) *Standard Operating Procedure for Sampling of Pesticides in Surface Waters* (Anderson and Sargeant, 2012). After collection, all samples were labeled and preserved according to the Quality Assurance Project Plan (Johnson and Cowles, 2003) before being delivered to MEL.

At each sampling event, water temperature, pH, dissolved oxygen, and specific conductivity parameters were recorded using Hach Hydrolab MS5 or YSI ProDSS field meters. Field meters were calibrated and post-checked at the beginning and end of every sampling week based on the manufacturers' specifications, using Ecology's *Standard Operating Procedure for Hydrolab® DataSonde® and MiniSonde® Multiprobes* (Swanson, 2010) or *YSI ProDSS User Manual* (YSI, 2014). Dissolved oxygen field measurements were compared to grab samples analyzed by Winkler Titration following Ecology standard operating procedure (SOP) EAP023 (Ward, 2017). Continuous, 30-minute interval temperature data was collected at every monitoring site except Mission Creek and Lower Bertrand Creek using Ecology's *Standard Operating Procedure for Continuous Temperature Monitoring of Fresh Water Rivers and Streams* (Ward, 2015). Mission Creek and Lower Bertrand Creek temperature data was obtained from an Ecology gauging station present at those monitoring sites. The 2017 field data quality results are summarized in Appendix B of this report.

Streamflow data in cubic feet per second was measured at 12 of the monitoring sites using an OTT MF pro flow meter and top-setting wading rod, as described in Ecology SOP

EAP056 (Shedd, 2014). Streamflow data for the remaining 4 sites was obtained from gauging stations managed by other agencies. Details of those gauging stations are listed below.

- Lower Bertrand Creek - Ecology gauging station located at Rathbone Road (Station ID: 01N060)
- Lower Crab Creek – USGS gauging station located near Beverly, Washington (Station ID: 12472600)
- Mission Creek – Ecology gauging station located near north Cashmere (Station ID: 45E070)
- Sulphur Creek Wasteway - US Bureau of Reclamation gauging station at Holaday Road near Sunnyside (Station ID: SUCW).

The gauging stations provided 15-minute streamflow measurements throughout the sampling season. The recorded streamflow closest to the actual sampling start time was used.

Laboratory Analyses

The surface water grab samples were analyzed by MEL for pesticides, TSS, and conductivity. Table 1 provides a summary of the extraction and analytical methods used by MEL.

Table 1 – Summary of laboratory methods

Analytical method	Extraction method reference[1]	Analytical method reference[1]	Instrument
GCMS-Pesticides	3535A	8270D	GC/MS/MS
GCMS-Herbicides (Derivitizable acid herbicides)	3535A	8270D	GC/MS/MS
LCMS-Pesticides	n/a	8321B	LC/MS/MS
TSS	n/a	SM 2540D	Gravimetric
Conductivity	n/a	SM 2510B	Electrode

[1] analytical methods refer to EPA SW 846, unless otherwise noted.
LC/MS/MS: high performance liquid chromatography/triple quadrupole mass spectrometry
GC/MS/MS: gas chromatography/mass spectrometry

Data Quality, Quality Assurance, and Quality Control Measures

The quality assurance (QA) and quality control (QC) protocol for this program employs blanks, replicates, and surrogate recoveries. Laboratory surrogate recoveries, laboratory blanks, laboratory control samples, and laboratory control sample duplicates are analyzed as the laboratory component of QA/QC. Field blanks, field replicates, matrix spikes, and matrix spike duplicates integrate field and laboratory components. In 2017, 11% of the samples collected in the field were QC samples. The full QA/QC analysis is contained in Appendix B: 2017 Quality Assurance Summary.

Laboratory data were qualified as needed. Positive pesticide detections included values not needing qualification and qualified as an approximate concentration (“J”) or estimated concentration outside of a calibration range (“E”). Data that was tentatively identified (“NJ” or “N”), rejected (“REJ”), or not detected (”U” or “UJ”) were not used for comparison to pesticide assessment criteria or water quality standards. All qualifiers are described in Appendix B.

Field Replicates

Field replicate samples were used to determine precision in sample collection and analysis, which was calculated using relative percent difference (RPD). The RPD is calculated by dividing the absolute value of the difference between the replicates by their mean and then multiplying by 100 for a percent value. Replicates can be either consistently or inconsistently identified pairs. Consistently identified field replicate pairs are those where the pesticide or TSS was detected in both the field sample and replicate. Only 3 of the 74 consistently identified field replicate pairs for TSS and pesticide analysis exceeded an RPD criterion. The results were not qualified for these 3 pairs because RPD has limited usefulness at low levels (Mathieu, 2006). Conversely, inconsistently identified replicate pairs are those where the pesticide or TSS is detected in only 1 of the 2 samples collected. Out of 19 inconsistently identified field replicate pairs for pesticides, 11 exceeded the 40% RPD criterion. The single inconsistently identified field replicate pair for TSS did not exceed the 20% RPD criterion. In most cases, the detections were at or below the reporting limit but above the detection limit.

All pesticide and TSS data for replicates are of acceptable data quality. There were no sample detections qualified due to consistently or inconsistently identified field replicate results. Sample results were averaged with their replicates for comparison to WSDA assessment criteria.

Blanks

Field and laboratory blanks indicate the potential for sample contamination or the potential for false detections due to analytical error. In 2017, there were no detections in field blank samples for TSS and pesticide analysis. It is unlikely that samples are becoming contaminated during field operations. There were 33 analyte detections that occurred in laboratory blanks. If lab blank detections occur outside MEL QC criteria, regular sample detections from the same batch will be qualified if the regular sample result is less than 5 times the lab blank result.

Surrogates, Matrix Spikes, and Laboratory Control Samples

Surrogates are spiked into all samples to evaluate recoveries for structurally similar groups of organic compounds. A surrogate is not normally found in environmental samples but is similar to the target analytes it is being tested for. The majority (99%) of surrogate recoveries fell within the control limits established by MEL in 2017. Sample results were qualified as estimates when surrogate recoveries did not meet MEL QC criteria.

Matrix spikes (MS) and matrix spike duplicates (MSD) provide an indication of bias due to interferences from components of the sample matrix. The duplicate spike can be used to estimate analytical precision at the concentration of the spiked samples and ensure the analytical method is efficient. For most compounds, percent recovery and RPD of MS/MSD pairs showed acceptable performance and were within defined limits for the project. Analyte recoveries from MS and MSD samples fell between both the upper and lower control limits 95% of the time and the RPDs of the paired recoveries fell below the 40% RPD control limit 99% of the time. If a MS/MSD sample exceeded MEL QC criteria, sample results were not qualified unless other QC criteria for that analyte was exceeded in the laboratory batch.

Laboratory control samples (LCS) are deionized water spiked with analytes at known concentrations and subjected to analysis. They are used to evaluate precision and bias of pesticide residue recovery for a specific analyte. For most compounds, percent recovery and RPDs of LCS and LCS duplicates (LCSD) showed acceptable performance and were within limits for the project. Analyte recoveries from LCS and LCSD samples fell between both the upper and lower control limits 93% of the time and the RPDs of the paired recoveries fell below the 40% RPD upper control limit 99% of the time. Sample results were qualified as estimates if the LCS/LCSD recoveries did not meet MEL QC criteria.

Assessment Criteria

The potential effects of pesticide exposure to aquatic life and endangered species were evaluated by comparing pesticide concentrations detected in surface water to reference values with known effects. The reference values WSDA uses as assessment criteria come from several sources: data from studies used to fulfill the requirements for pesticide registration under federal law (CFR, 2007), EPA’s National Recommended Water Quality Criteria (EPA, 2019), and Washington State regulations (WAC, 2019). WSDA applies a 0.5x safety factor to all of these reference values before comparison to detected pesticide concentrations to ensure that the criteria are adequately protective of aquatic life and that potential water quality issues are detected early on.

WSDA’s ability to make these comparisons is limited by several factors. Assessment criteria and water quality standards are developed by evaluating the effects of a single chemical on a specific species and do not take into account the effects of multiple chemicals or pesticide mixtures on an organism. Mixtures are frequently detected and the effects of several pesticides in combination may be either more or less toxic than the effects of those pesticides individually. In addition, toxicity values such as those used for pesticide registration are determined from continuous exposure over time. WSDA sampling consists of a one-time grab sample, and it is not possible to determine if the time threshold has been exceeded based solely on an individual sample because the sampling frequency is often once a week or less. However, this comparison is consistent with Ecology practices, when for Clean Water Act section 303(d) listing purposes, measurements of instantaneous concentrations are assumed to represent the averaging periods specified in the water quality standards and assessment criteria for acute and chronic criteria (ECY, 2018). WSDA assessment criteria for fish, invertebrates, and aquatic plants are shown in Appendix A: Assessment Criteria for Pesticides.

Pesticide Registration Toxicity Data

Toxicity data from studies generated following EPA-provided test guidelines are commonly used to conduct screening-level risk assessments of pesticides and pesticide degradates. EPA uses these values to develop aquatic life criteria (published as the Office of Pesticide Programs' Aquatic Life Benchmarks) for pesticide active ingredients by applying their own safety factors (EPA, 2018).

Acute toxicity is calculated by a standardized testing method. A sensitive (representative) species at a susceptible life stage is exposed to a pesticide under a range of concentrations. The LC_{50} (concentration causing death to 50% of the organisms, in the case of fish) or EC_{50} (concentration causing immobility or growth reduction to 50% of the organisms, in the case of invertebrates or plants) is calculated. The test duration is 96 hours for fish and aquatic plants and 48 hours for invertebrates.

Chronic toxicity tests normally use either reproductive effects or effects to offspring as the measured effect. A pesticide's No Observable Adverse Effects Concentration (NOAEC) is often used to derive chronic toxicity study values. This concentration signifies the highest concentration in the toxicity test not showing a statistically significant difference from the control. The chronic toxicity test is longer than the 96-hour acute test (28 days for fish, 21 days for invertebrates) to simulate the type of exposure that would result from a persistent chemical or the effect of repeated applications.

To provide an additional level of protection for endangered species an increased safety factor is used. Rainbow trout is commonly used as a surrogate species to assess the potential risk of a pesticide to salmonids. As a result, the criterion for endangered species (in this case, typically salmonids) is 1/20th of the LC_{50} for fish.

National Recommended Water Quality Criteria

EPA's National Recommended Water Quality Criteria (NRWQC) (EPA, 2019) includes a list of approximately 150 pollutants that was created to protect aquatic life and human health. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA, 1972) by the Office of Water and provide guidance for states and tribes to use in adopting water quality standards. The pesticide criteria established under the Clean Water Act are derived from acute and chronic toxicity criteria from the pesticide registration toxicity studies. The 2019 updated NRWQC list was used in the development of WSDA assessment criteria, which is presented in Appendix A: Assessment Criteria for Pesticides.

Washington State Water Quality Standards for Pesticides

Washington State maintains its own list of priority pollutants under the authority of Washington Administrative Code (WAC) 173-201A: Water Quality Standards for Surface Waters of The State of Washington (WAC, 2019). Washington State water quality standards include numeric criteria for current-use and legacy pesticides. For the purposes of this report, these values will be referred to as “state water quality standards”.

Some WAC criteria were adopted from the EPA’s NRWQC criteria. The criteria are primarily intended to avoid direct lethality to fish and other aquatic life within the specified exposure periods. The exposure periods assigned to the acute criteria are: (1) an instantaneous concentration not to be exceeded at any time, or (2) a 1-hour average concentration not to be exceeded more than once every 3 years on average. The exposure periods for the chronic criteria are either: (1) a 24-hour average not to be exceeded at any time, or (2) a 4-day average concentration not to be exceeded more than once every 3 years on average. The chronic criteria for some of the chlorinated pesticides like DDT are to protect fish-eating wildlife from adverse effects due to bioaccumulation.

Acute and chronic numeric criteria for fish, invertebrates, and aquatic plants from the WAC with the WSDA 0.5x safety factor are presented in Appendix A.

Relationship between WSDA Assessment Criteria and Sources

A combination of pesticide registration toxicity study data and national and state standards are used to derive WSDA assessment criteria. Table 2 provides a summary of how these different sources are used in the WSDA assessment criteria referred to in this report.

Table 2 – Summary of WSDA assessment criteria derived safety factors from toxicity studies, NRWQC, and WAC

Risk presumptions	Toxicity test	EPA safety factor	WSDA safety factor	Final multiplier for WSDA assessment criteria	Relationship to acute/chronic criteria & water quality standards
Fish or Invertebrate Acute	LC_{50} or EC_{50}	0.5	0.5	0.25	≥ 25% of the most protective LC_{50} for fish or invertebrates
Endangered Species Acute	LC_{50}	0.05	0.5	0.025	≥ 2.5% of the most protective LC_{50} for fish
Fish or Invertebrate Chronic	NOAEC	1	0.5	0.5	≥ 50% of the most protective NOAEC for fish or invertebrates
Aquatic Plant Acute	EC_{50}	1	0.5	0.5	≥ 50% of the most protective EC_{50} for aquatic plants
NRWQC	N/A	N/A	0.5	0.5	≥ 50% of the NRWQC
WAC	N/A	N/A	0.5	0.5	≥ 50% of the WAC acute or chronic criteria

Numeric Water Quality Standards for Temperature, pH, and Dissolved Oxygen

According to the Water Quality Standards for Surface Waters of the State of Washington (WAC, 2019), waterbodies are required to meet numeric water quality standards based on the beneficial uses of the waterbody. Table 3 shows the beneficial aquatic life uses for each of the segments of stream that include the monitoring sites. Every site WSDA monitored in 2017 is considered fresh water and thus is only compared to WAC fresh water criteria.

Table 3 – WAC aquatic life use designations for fresh waters by WRIA

Watershed	Monitoring site	WAC aquatic life uses
WRIA 1 - Nooksack	Upper & Lower Bertrand	Core Summer Habitat
WRIA 3 - Lower Skagit-Samish	Indian Slough	Spawning, Rearing, and Migration
	Upper & Lower Big Ditch	Spawning, Rearing, and Migration
WRIA 13 - Deschutes	Woodland Creek	Spawning, Rearing, and Migration
WRIA 28 - Salmon-Washougal	Burnt Bridge Creek	Spawning, Rearing, and Migration
WRIA 37 - Lower Yakima	Marion Drain	Spawning, Rearing, and Migration
	Sulphur Creek Wasteway	Rearing and Migration Only
	Snipes Creek	Spawning, Rearing, and Migration
WRIA 39 - Upper Yakima	Naneum Creek	Spawning, Rearing, and Migration
WRIA 40 - Alkali-Squilchuck	Stemilt Creek	Spawning, Rearing, and Migration
WRIA 41 - Lower Crab	Lower Crab Creek	Rearing and Migration Only
WRIA 45 - Wenatchee	Brender Creek	Spawning, Rearing, and Migration

Conventional parameters including temperature, dissolved oxygen (DO), and pH were measured and compared to the numeric criteria of the Washington State water quality standards according to the aquatic life uses. Below in Table 4, the Water Quality Standards for Washington State are listed by aquatic life use designation.

Table 4 – Water Quality Standards for Washington State by aquatic life use

WAC aquatic life uses	7-DADMax (ºC), highest allowable	DO (mg/L), lowest 1-day minimum	pH
Core Summer Salmonid Habitat	16.0	9.5	6.5-8.5
Salmonid Spawning, Rearing, & Migration	17.5	8.0	6.5-8.5
Salmonid Rearing and Migration Only	17.5	6.5	6.5-8.5

Surface water temperature criteria are listed in the WAC as the highest allowable 7-day average of the daily maximum temperatures (7-DADMax). Additional temperature water quality standards are listed in "Waters Requiring Supplemental Spawning and Incubation Protection for Salmonid Species" to be used on conjunction with WAC standards (Payne, 2011). Only 1 WSDA monitoring site in 2017 has an additional temperature standard. The stream reach that encompasses the Upper Bertrand monitoring site is considered a waterway requiring supplemental spawning and incubation protection for salmon and trout species. Between February 15 and June 15, the minimum temperature criterion is a 7-DADMax of 13°C.

Although the Water Quality Standards for Washington State lists dissolved oxygen criteria as the lowest 1-day minimum, dissolved oxygen measurements are considered point estimates (not continuous) taken at the time of sampling. The point measurements may or may not be the lowest dissolved oxygen concentration of the sampling day at an individual monitoring site.

Monitoring Site Results

In 2017, WSDA monitored 16 sites located at private and public access points. The urban subbasins were chosen due to land-use characteristics, history of pesticide detections, and habitat use by salmonids. The agricultural subbasins were chosen because they support several salmonid populations, produce a variety of agricultural commodities, and have a high percentage of cultivated areas with historical pesticide usage. The number of pesticides detected at a given site can vary greatly from year to year due to several factors including the local and regional meteorology, pest pressure, sampling schedule, and other influences.

Details including pesticide calendars, maps, agricultural land-use statistics, and water quality information are described in each monitoring site summary below. Pesticide calendars provide a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria. For specific values and information on the assessment criteria development please refer to Appendix A: Assessment Criteria for Pesticides. In the calendars, the number below the months indicates the day of the month the sampling event occurred and each column below the sampling event date indicates the data associated with that event. The blank cells in the calendars often indicate no chemical was detected, but can also mean a chemical was detected below reportable sample quantitation limits or there was no chemical analysis in special cases.

Detection of a pesticide concentration above the WSDA assessment criteria does not necessarily indicate an exceedance has occurred because the temporal component of the criteria must also be exceeded. For WSDA assessment criteria, measurements of instantaneous concentrations are assumed to represent the averaging periods specified in the water quality standards and acute and chronic assessment criteria.

It is possible for a single pesticide detection to exceed multiple WSDA assessment criteria; however, this scenario cannot be shown in the pesticide calendars. If multiple criteria exceedances of 1 pesticide occur, it is described in the summary text above or below the calendar.

Monitoring site summaries are sorted below in this section of the report by Western and Eastern regions and then sub-sorted alphabetically.

Bertrand Creek

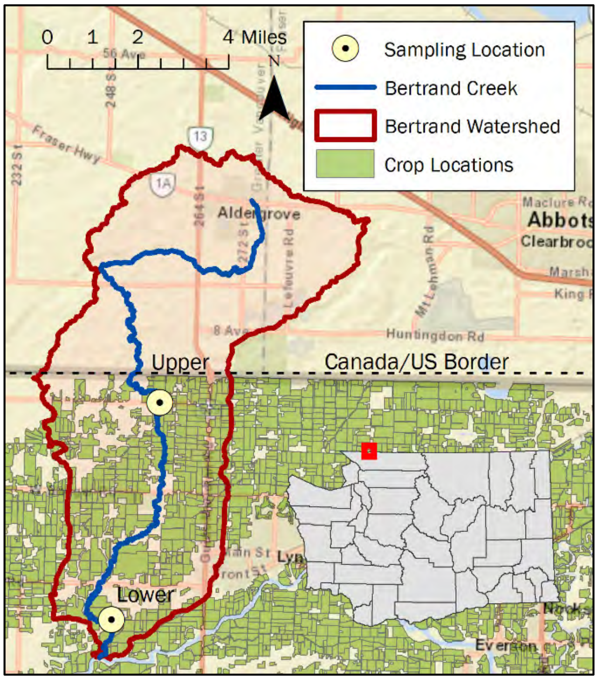

Figure 3 – Map of Bertrand Creek and its drainage area

Table 5 – Bertrand watershed crop groups and associated acreage in US

Bertrand Crop Groups	Acres
Hay/Silage	3,100
Berry	2,230
Cereal Grain	1,571
Other	502
Vegetable	448
Nursery	85
Orchard	5
Total US Ag	7,941
Total US Non-Ag	4,889
Watershed Total	26,893

The Bertrand watershed in Whatcom County has been sampled by WSDA since 2013. Two locations along this stream are monitored in order to provide an opportunity to compare potential pesticide inputs from Canada to pesticide detections downstream in the United States. The headwaters of Bertrand Creek are located in Canada and it flows approximately 11 miles before crossing the border. Currently, the Upper Bertrand Creek site is located approximately 0.25 miles south of the Canadian border at the upstream side of H Street Road (latitude: 48.9935°, longitude: -122.5094°). The Lower Bertrand Creek site is located about 7.8 miles downstream from the upper monitoring site and just upstream of the bridge crossing on Rathbone Road (latitude: 48.9241°, longitude: -122.5300°) (Figure 2, Figure 4). From the Lower Bertrand Creek site, the creek flows approximately 1 more mile south to where it enters the Nooksack River.

Figure 2 – Upper Bertrand Creek site upstream view

Bertrand Creek water drains into the Nooksack River subbasin, which is known for its endangered salmon runs. Streamflow in Bertrand Creek is influenced mostly by precipitation events and irrigation. The Washington Department of Fish and Wildlife (WDFW) has documented steelhead and Chinook, coho, chum, and sockeye salmon within the reaches of the creek that encompass both Bertrand sites (WDFW, 2019). NRAS staff have frequently observed juvenile fish of unknown species and freshwater lamprey at the Upper Bertrand Creek monitoring site (Figure 3).

Figure 4 – Lower Bertrand Creek site upstream view

The watershed that contains the Bertrand Creek monitoring sites is characterized by flat, low-lying terrain. Within the area of the watershed that is within Washington, the agricultural land use is predominantly grass hay, caneberries, field corn, blueberries, pasture, and potatoes (Table 5). Roughly 30% of the agricultural acreage within the Bertrand watershed south of the border produces berries such as blueberries, raspberries, and strawberries. The 'Other' crop group category in Table 5 includes pasture and fallow fields. About 14,000 acres of the watershed is in Canada where the main crops and management practices are outside the scope of WSDA's agricultural land use mapping program. The headwaters of Bertrand Creek are located in Aldergrove, British Columbia and the creek flows through areas with agricultural land uses similar to those in the U.S.

Below is a brief overview of the pesticide findings in Bertrand Creek in 2017.

- WSDA tested for 144 unique pesticides in Upper and Lower Bertrand Creek.
- Pesticides were detected at all 26 sampling events at each monitoring site.
- Up to 17 pesticides were detected at the same time in Upper Bertrand Creek and up to 20 in Lower Bertrand Creek.
- There were 27 unique pesticides found at both Upper and Lower Bertrand Creek. At Upper Bertrand Creek, 4 unique pesticides were detected that were not found at Lower Bertrand Creek; 10 were found at Lower Bertrand Creek but not at Upper Bertrand Creek.

- There were 208 total pesticide detections in Upper Bertrand Creek from 5 different use categories: 5 types of insecticides, 12 herbicides, 8 fungicides, 5 degradates, and 1 other pesticide-related chemical.
- Of the total detections at Upper Bertrand Creek, 11 were above WSDA's assessment criteria (Table 6).

- There were 284 total pesticide detections in Lower Bertrand Creek from 5 different use categories: 7 types of insecticides, 14 herbicides, 9 fungicides, 5 degradates, and 2 other pesticide-related chemicals.
- Of the total detections at Lower Bertrand Creek, 8 were above WSDA's assessment criteria (Table 7).

WSDA POCs detected at both Upper and Lower Bertrand Creek in 2017 included diazinon, imidacloprid, malathion, metolachlor, sulfometuron-methyl, and thiamethoxam. Upper Bertrand Creek had an additional POC, pyraclostrobin, and additional POCs at Lower Bertrand Creek included clothianidin, diuron, and pentachlorophenol. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- All 10 imidacloprid detections at Upper Bertrand Creek and 7 detections at Lower Bertrand Creek exceeded the NOAEC for invertebrates (0.01 µg/L). Of those, 1 was also found at Lower Bertrand Creek, March 28, to be approaching the invertebrate EC_{50} (0.77 µg/L).
- The single detection of malathion at Upper Bertrand Creek on March 28 was above the invertebrate NOAEC (0.06 µg/L). The single detection at Lower Bertrand Creek on July 5 did not exceed any assessment criteria.
- Out of 30 thiamethoxam detections, 1 detection at Lower Bertrand Creek on July 5 exceeded the invertebrate NOAEC (0.74 µg/L).
- The detections of clothianidin, diazinon, diuron, metolachlor, pentachlorophenol, pyraclostrobin, and sulfometuron-methyl did not exceed any assessment criteria.

The Bertrand Creek monitoring site pesticide calendars provide a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 6, Table 7). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 6 – Upper Bertrand pesticide calendar (µg/L)

Month		Mar	Apr				May					Jun				Jul					Aug				Sep		
Day of the Month	Use*	28	3	11	17	24	2	8	16	22	31	5	13	19	26	5	10	17	24	31	7	14	21	28	5	18	26
2,4-D	H	0.042				0.200	0.060	0.049	0.216	0.046			0.569	0.119													
2,6-Dichlorobenzamide	D	0.043	0.035	0.045	0.044	0.099	0.132	0.093	0.055	0.079	0.351	0.197	0.240	0.155	0.149	0.190	0.212	0.138	0.140	0.075	0.047	0.042	0.033	0.032	0.022		0.082
4-Nitrophenol	D	0.309																									
Azoxystrobin	F					0.064																					
Boscalid	F					0.156	0.111	0.102	0.185	0.086	0.186	0.113	0.107	0.116	0.084	0.077	0.100	0.078	0.079	0.057	0.049	0.058	0.045	0.032			0.068
Carbendazim	F					0.005			0.007	0.007	0.012	0.003	0.045				0.010	0.012	0.008	0.004	0.004	0.007	0.006		0.005	0.005	
Chlorothalonil	F			0.194																							
Cycloate	H	0.048																									
Diazinon	I											0.017															
Dicamba acid	H					0.053	0.026		0.054		0.022		0.026	0.073													
Dichlobenil	H	0.151	0.044	0.231	0.044	0.154	0.034	0.020	0.058	0.025	0.380	0.103	0.108	0.056	0.036	0.025	0.019	0.009	0.008								0.010
Imidacloprid	I	0.029	0.026	0.018	0.031		0.051			0.032			0.035			0.027			0.016		0.013						
Isoxaben	H											0.036	0.008									0.005					0.026
MCPA	H					0.150			0.111			0.076	0.538	0.068	0.033												
Malathion	I	0.064																									
Mecoprop (MCPP)	H			0.038		0.157	0.052	0.034	0.181	0.038	0.049		0.056	0.081													
Metalaxyl	F							0.036								0.016											
Metolachlor	H		0.022	0.089	0.033	0.340	0.025	0.026	0.038	0.017		0.009	0.010	0.017	0.010												
Myclobutanil	F																	0.011				0.007					0.045
N,N-Diethyl-m-toluamide (DEET)	IR												0.011														
Oxadiazon	H	0.024				0.033	0.063			0.065	0.297	0.048	0.042	0.044	0.030	0.025	0.028										0.028
Oxamyl	I		0.004	0.003		0.002	0.006	0.005		0.007	0.008	0.008	0.007	0.008	0.005												
Oxamyl oxime	D									0.013		0.020		0.025	0.031		0.028		0.010								
Propiconazole	F		0.040	0.122		0.129		0.007													0.014						
Pyraclostrobin	F																		0.007								
Simazine	H			0.129	0.066	0.226		0.108	0.228	0.026	0.127	0.212	0.368	0.098	0.119	0.061	0.123										0.179
Sulfometuron-methyl	H																									0.016	
Terbacil	H					0.048	0.049				0.049	0.050		0.037	0.033	0.029											
Tetrahydrophthalimide (THPI)	D							0.085	0.607		0.017			0.039													
Thiamethoxam	I						0.012		0.006	0.010	0.048	0.021	0.016				0.012			0.018	0.005						
Triazine DIA degradate	D											0.045	0.067														
Total Suspended Solids (mg/L)		21.5	4.0	18.0	5.0	18.0	3.0	3.0	99.0	3.0	2.0	1.0	2.0	1.0	1.0	2.0	1.0	3.0	1.0	7.0	19.0	2.0	--	--	1.0	--	--
Streamflow (cubic ft/sec)		--	--	--	65.25	--	29.72	27.09	--	19.94	14.94	7.25	5.90	11.39	4.33	3.02	2.09	1.44	1.72	1.01	0.85	0.95	0.95	0.68	0.75	1.09	0.98
Precipitation (total in/week)†		1.14	2.47	1.21	1.87	0.53	0.41	0.86	1.24	0.82	0.22	0.33	0.36	0.41	0	0	0	0	0.08	0	0	0.03	0	0	0	0.04	0.32

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent)

[†] Washington State University AgWeatherNet station: Lynden, (latitude: 48.94°, longitude: -122.51°)

Table 7 – Lower Bertrand pesticide calendar (µg/L)

Month		**Mar**	**Apr**				**May**					**Jun**				**Jul**					**Aug**				**Sep**		
Day of the Month	Use*	28	3	11	17	24	2	8	16	22	31	5	13	19	26	5	10	17	24	31	7	14	21	28	5	18	26
2,4-D	H					0.065	0.059	0.044	0.223	0.045			0.653	0.059													
2,6-Dichlorobenzamide	D	0.039	0.050	0.046	0.047	0.096	0.106	0.080	0.053	0.072	0.173	0.124	0.137	0.191	0.107	0.134	0.140	0.151	0.144	0.091	0.088	0.084	0.099	0.086	0.089	0.094	0.123
4-Nitrophenol	D	0.120		0.144																							
Atrazine	H							0.032																			
Azoxystrobin	F					0.017																					
Boscalid	F					0.113	0.066	0.076	0.095	0.053	0.069	0.054	0.045	0.111	0.042	0.029		0.062	0.057	0.055	0.055	0.062	0.056		0.035	0.048	0.049
Bromacil	H										0.016	0.019	0.018		0.019	0.026		0.039	0.030				0.023	0.031	0.035		
Carbendazim	F												0.016				0.004	0.003	0.003			0.004					
Chlorothalonil	F			0.083																							
Clothianidin	I															0.024				0.011							
Cyprodinil	F																				0.014						
Diazinon	I									0.026	0.015	0.014															
Dicamba acid	H					0.026			0.054					0.035													
Dichlobenil	H	0.043	0.037	0.254	0.032	0.082	0.012	0.012	0.040	0.009	0.095	0.035	0.024	0.040	0.008	0.005	0.005	0.022	0.009	0.012							
Diuron	H			0.018	0.018				0.030	0.013								0.084	0.014	0.044	0.019	0.017	0.012	0.013			
Ethoprop	I								0.083																		
Fludioxonil	F																		0.019			0.015					
Imidacloprid	I	0.269		0.017	0.029	0.026	0.186	0.040	0.051																		
Isoxaben	H																										0.011
MCPA	H					0.051			0.092		0.050	0.045	0.591	0.037	0.031				0.154	0.032							
Malaoxon	D																					0.005					
Malathion	I															0.021											
Mecoprop (MCPP)	H			0.030		0.045	0.034		0.184	0.028			0.040	0.059													
Metalaxyl	F		0.050		0.070	0.071	0.054	0.059		0.046	0.038	0.046		0.066		0.035	0.049	0.054		0.037		0.047	0.047	0.044	0.042		
Metolachlor	H		0.030	0.060	0.038	0.043	0.033	0.023	0.026	0.014	0.009	0.009	0.009	0.021	0.008		0.010										
Myclobutanil	F																			0.009							0.017
N,N-Diethyl-m-toluamide (DEET)	IR												0.009	0.019	0.008												
Oxadiazon	H					0.047			0.028	0.016	0.083	0.019	0.016	0.037													
Oxamyl	I	0.040	0.068	0.040	0.072	0.057	0.103	0.095	0.038	0.079	0.057	0.086	0.084	0.071	0.062	0.081	0.094	0.109	0.084	0.108	0.101	0.120	0.125	0.110	0.096	0.093	0.077
Oxamyl oxime	D	0.041	0.073	0.037	0.044	0.030	0.072	0.076	0.020	0.078	0.091	0.175	0.128	0.120	0.117	0.112	0.153	0.196	0.170	0.260	0.216	0.187	0.179	0.169	0.149	0.161	0.118
Pentachlorophenol	WP					0.028			0.027																		
Propiconazole	F		0.029	0.122		0.044			0.014																		
Simazine	H		0.080		0.255	0.293	0.082	0.083	0.114	0.031		0.080			0.041												0.087
Sulfentrazone	H																		0.027					0.067			0.087
Sulfometuron-methyl	H								0.008																		
Tetrahydrophthalimide (THPI)	D								0.362		0.050	0.027		0.063				0.062	0.073		0.095						
Thiamethoxam	I		0.013		0.019	0.017	0.021	0.019	0.009	0.030	0.033	0.038	0.033			0.771	0.185		0.079	0.050	0.041	0.041	0.035	0.029	0.027	0.054	0.027
Total Suspended Solids (mg/L)		41.0	10.0	27.0	12.0	26.0	3.0	4.0	106.0	5.0	4.0	2.0	3.0	2.0	2.0	1.0	--	2.0	1.0	1.0	2.0	--	1.0	1.0	--	--	--
Streamflow (cubic ft/sec)		329.0	175.0	320.0	160.0	247.0	71.9	71.5	373.0	68.6	71.1	30.5	26.8	33.3	19.5	13.2	10.7	8.8	10.1	7.2	9.0	7.4	6.6	6.4	6.1	10.1	8.1
Precipitation (total in/week)†		1.14	2.47	1.21	1.87	0.53	0.41	0.86	1.24	0.82	0.22	0.33	0.36	0.41	0	0	0	0	0.08	0	0	0.03	0	0	0	0.04	0.32

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent, WP: Wood preservative)

[†] Washington State University AgWeatherNet station: Lynden, (latitude: 48.94°, longitude: -122.51°)

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard many times at Upper and Lower Bertrand Creek. Water quality at Upper Bertrand Creek in Figure 5 and Lower Bertrand Creek in Figure 6 is shown below.

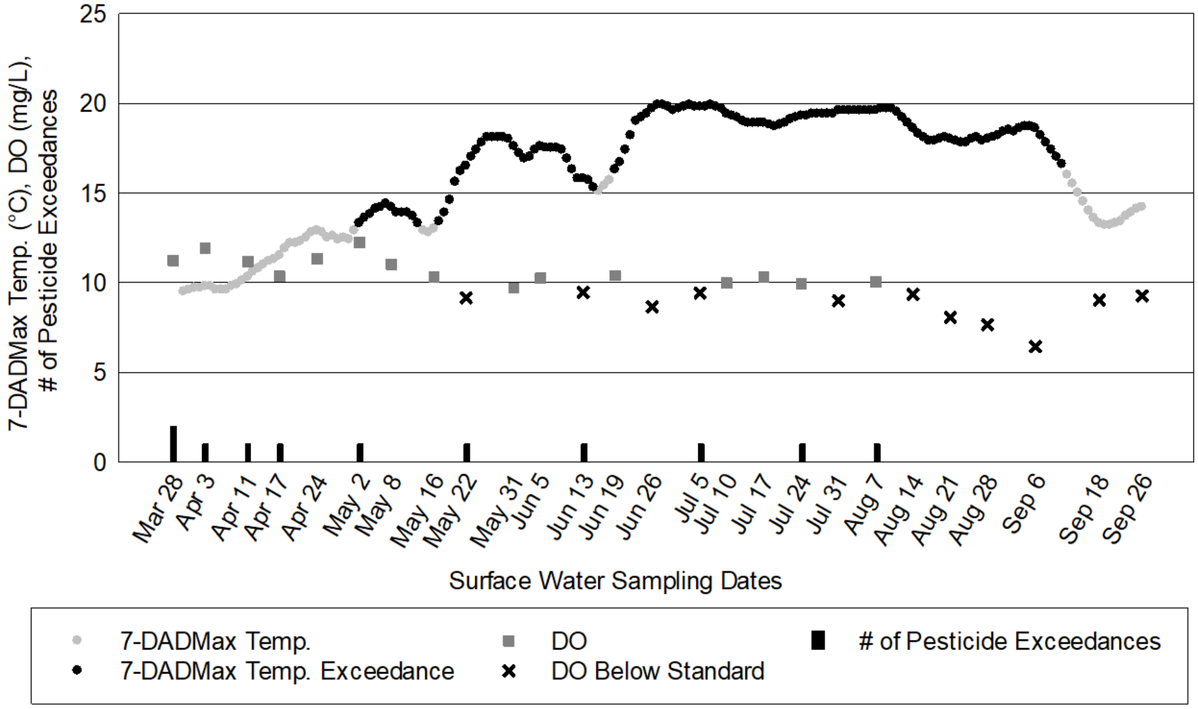

Figure 5 – Upper Bertrand Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

Pesticide exceedances at Upper Bertrand Creek coincided with failures to meet state water quality standards at least 6 times. No pH measurements taken during the 2017 sampling season at Upper Bertrand Creek exceeded state water quality standards. The pH at the 26 site visits ranged from 6.70 to 7.82 with an average of 7.43. The DO ranged from 6.44 mg/L to 12.23 mg/L with an average of 9.84 mg/L. Less than half (42%) of the measurements failed to meet the DO standard in that 11 measurements were less than 9.5 mg/L.

In the Bertrand Creek watershed, two different 7-DADMax temperature standards are applied during different times of the sampling season. From February 15 to June 15, the 7-DADMax temperature should remain below 13 °C, while from June 16 to the end of the sampling season should remain below 16 °C. Between February 15 and June 15, the 7-DADMax standard in Upper Bertrand Creek was exceeded for 42 days of the sampling season, from May 2 to May 13 and May 17 to June 15. Between June 16 and September 26, the 7-DADMax standard was exceeded 85 days of the sampling season, from June 19 to September 11. Of the DO measurements that failed to meet the standard, all 11 also coincided with 7-DADMax temperature exceedances.

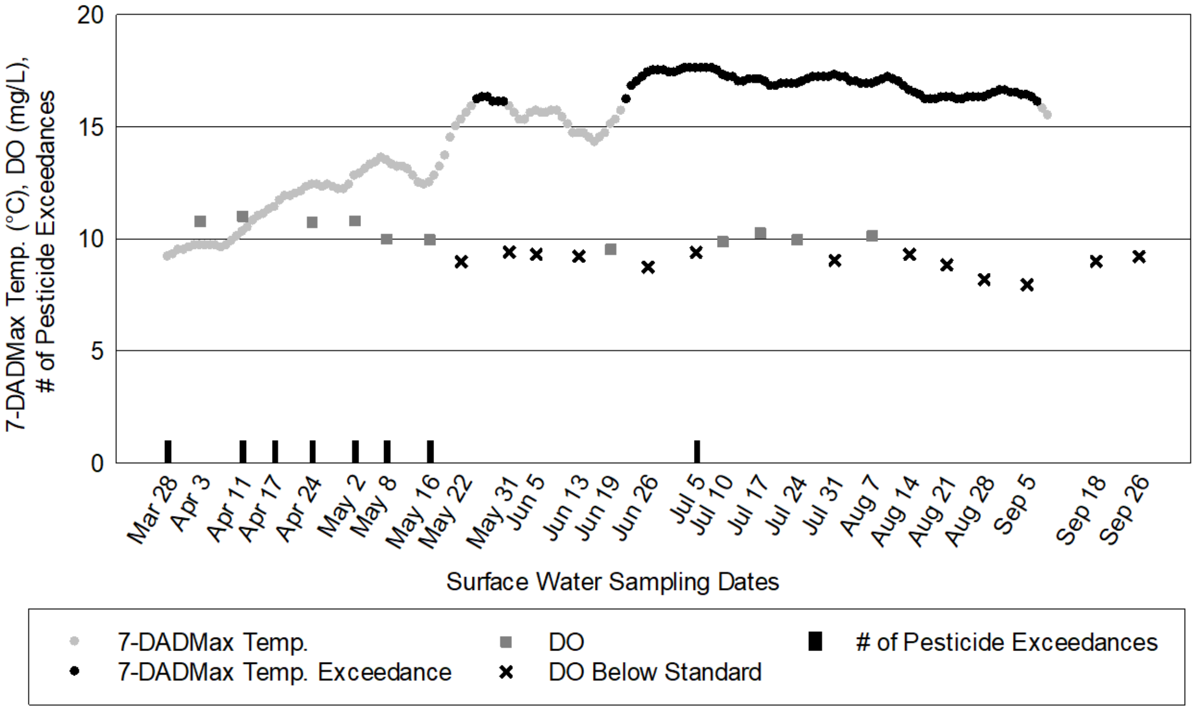

Figure 6 – Lower Bertrand Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

Due to equipment malfunctions March 28 and April 17, pH and DO were not measured at Lower Bertrand Creek. However, data from the other 24 site visits were of acceptable data quality. Water temperature data was unavailable beyond September 12 so potential exceedances of 7-DADMax standards are unknown after September 9.

Pesticide exceedances in Lower Bertrand Creek coincided with failures to meet state water quality standards at least 3 times (May 8, May 16, and July 5). Similar to Upper Bertrand Creek, there were no pH measurements at Lower Bertrand Creek that exceeded state water quality standards. The pH measurements from 24 site visits ranged from 6.78 to 7.56 with an average of 7.27. More than half (54%) of the measurements failed to meet the DO standard in that 13 measurements were less than 9.5 mg/L. DO ranged from 7.96 mg/L to 11.01 mg/L with an average of 9.57 mg/L. The 7-DADMax temperature standard was exceeded for 84 days of the sampling season, from May 25 to May 30 and from June 22 to September 7.

Bertrand Creek has been designated as a freshwater body that provides core summer habitat for salmonids by the WAC (WAC, 2019). For several seasons, there has been a steelhead spawning nest at the Upper Bertrand Creek monitoring site. This drainage will continue to be monitored because of its representative regional land use, historical sampling, and consistent, yearly detections of POCs.

Lower Big Ditch

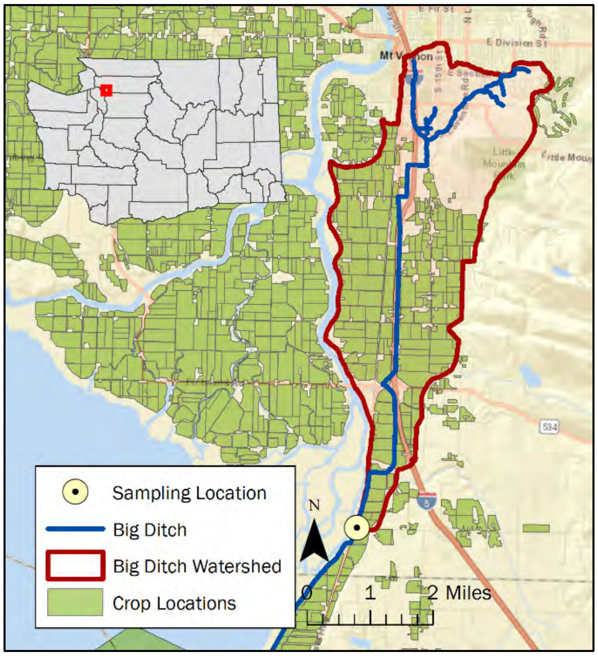

Figure 7 – Map of Lower Big Ditch and its drainage area

Table 8 – Lower Big Ditch watershed crop groups and associated acreage

Lower Big Ditch Crop Groups	Acres
Cereal Grain	1,465
Vegetable	1,153
Seed	606
Hay/Silage	558
Other	203
Nursery	78
Berry	21
Turfgrass	6
Orchard	1
Total Ag	4,088
Total Non-Ag	3,924
Watershed Total	8,012

The Lower Big Ditch monitoring site in Skagit County has been sampled by WSDA since 2006. The entire Big Ditch watershed drains a mixture of non-agricultural and agricultural land. Currently, the lower monitoring site is located just upstream from the bridge crossing at Milltown Road near Mt. Vernon (latitude: 48.3085°, longitude: -122.3474°) (Figure 7).

WSDA only samples this site when the tide gate located downstream of the monitoring site is open and the water is flowing from Big Ditch into Puget Sound to avoid sample contamination with saltwater or pooling backwater. The WDFW has documented winter steelhead, fall Chinook salmon, coho salmon, and chum salmon within the reach of ditch that encompasses the monitoring site (Figure 8) (WDFW, 2019).

Figure 8 – Lower Big Ditch upstream view

Streamflow in the ditch is generally influenced by precipitation events and agricultural irrigation. Big Ditch stretches north/northeast approximately 8 miles from the monitoring site to its headwaters. Within the Lower Big Ditch drainage area, the agricultural land use is predominantly potatoes, field corn, barley, grass hay, and ryegrass seed (Table 8). The ‘Other’ crop group category in Table 8 includes pasture and fallow fields.

Below is a brief overview of the pesticide findings in Lower Big Ditch.

- In 2017, WSDA tested for 144 unique pesticides in Lower Big Ditch.
- There were 152 total pesticide detections in Lower Big Ditch from 6 different use categories: 4 types of insecticides, 13 herbicides, 7 fungicides, 1 degradate, and 2 other pesticide-related chemicals.
- Pesticides were detected at 24 (96%) of the 25 sampling events.
- Up to 12 pesticides were detected at the same time.
- Of the total pesticide detections, 5 were above WSDA's assessment criteria (Table 9).

WSDA POCs detected in Lower Big Ditch in 2017 included clothianidin, diuron, imidacloprid, metolachlor, pentachlorophenol, pyraclostrobin, sulfometuron-methyl, and thiamethoxam. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- The single detection of clothianidin was detected at a concentration approaching the invertebrate NOAEC (0.05 µg/L).
- All 3 detections of imidacloprid met or exceeded the invertebrate NOAEC (0.01 µg/L).
- The detections of diuron, metolachlor, pentachlorophenol, pyraclostrobin, sulfometuron-methyl, and thiamethoxam did not exceed any assessment criteria.

The Lower Big Ditch monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 9). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 9 – Lower Big Ditch pesticide calendar (µg/L)

Month		**Apr**				**May**					**Jun**				**Jul**				**Aug**					**Sep**		
Day of the Month	Use*	3	11	17	25	1	9	15	23	30	6	12	20	26	5	10	18	24	1	7	15	22	29	6	13	18
2,4-D	H		0.044	0.062	0.044		0.081	0.068					0.064												0.035	0.075
2,6-Dichlorobenzamide	D	0.054	0.066	0.055	0.083	0.085	0.112	0.065	0.060	0.077		0.037	0.033	0.018	0.011											0.052
Atrazine	H												0.028													
Azoxystrobin	F	0.152	0.175		0.035	0.049	0.017	0.021	0.026	0.077	0.005	0.017	0.018	0.012	0.007	0.009	0.006							0.007		0.012
Boscalid	F					0.109		0.045	0.061	0.120			0.047													0.070
Carbendazim	F						0.004		0.009	0.008																0.061
Clothianidin	I											🟨 0.025														
Dicamba acid	H						0.016						0.021													
Dichlobenil	H		0.013	0.009																						
Difenoconazole	F		0.197		0.033	0.016	0.011	0.012							0.009	0.019					0.011	0.009	0.010			
Dinotefuran	I	0.077	0.081	0.100	0.101	0.116	0.102	0.178	0.150	0.269		0.057	0.062	0.038												1.980
Diuron	H	0.013	0.011	0.008	0.005																					
Eptam	H						0.033	0.146																		
Fludioxonil	F	0.266	0.261	0.205	0.103	0.117	0.091	0.065	0.086	0.227	0.033	0.072	0.059	0.052	0.040	0.035	0.033	0.025	0.022				0.021			
Imazapyr	H		0.006						0.008															0.025		0.174
Imidacloprid	I		🟨 0.012		🟨 0.010	🟨 0.030																				🟨 0.010
MCPA	H				0.106																					
Metalaxyl	F									0.052																0.106
Metolachlor	H	0.060	0.078	0.037	0.022	0.033		0.158	0.066	0.025	0.017	0.050	0.013	0.009												
N,N-Diethyl-m-toluamide (DEET)	IR												0.013	0.013												
Pentachlorophenol	WP	0.023																								
Pyraclostrobin	F																	0.011								
Sodium bentazon	H		0.052		0.066				0.045																	
Sulfometuron-methyl	H								0.011															0.006		0.126
Tebuthiuron	H							0.024	0.022	0.025																0.043
Thiamethoxam	I			0.049	0.022	0.201	0.024	0.028	0.035	0.105	0.019	0.033														
Triclopyr acid	H			0.051			0.046																			0.054
Total Suspended Solids (mg/L)		36.0	23.0	39.0	20.0	26.0	38.0	25.0	10.0	11.0	33.5	20.0	8.0	7.0	12.0	8.0	14.0	6.0	13.0	10.0	13.0	6.0	25.0	6.0	42.0	3.0
Streamflow (cubic ft/sec)		43.6	--	--	33.9	27.5	30.1	27.7	27.3	25.5	38.5	40.4	14.3	9.57	8.05	7.55	9.29	5.67	4.32	6.39	12.1	5.22	2.27	0.23	1.95	0.57
Precipitation (total in/week)†		0.68	0.81	0.53	0.27	0.15	0.87	0.32	0.33	0	0.08	0.41	0.19	0	0	0	0	0	0	0	0.03	0	0	0	0.19	0.17

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent, WP: Wood preservative)

[†] Washington State University AgWeatherNet station: Fir Island, (latitude: 48.36°, longitude: -122.42°)

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard for DO on April 25 and June 12, as well as 7-DADMax exceedances on June 12 and September 18 (Figure 9).

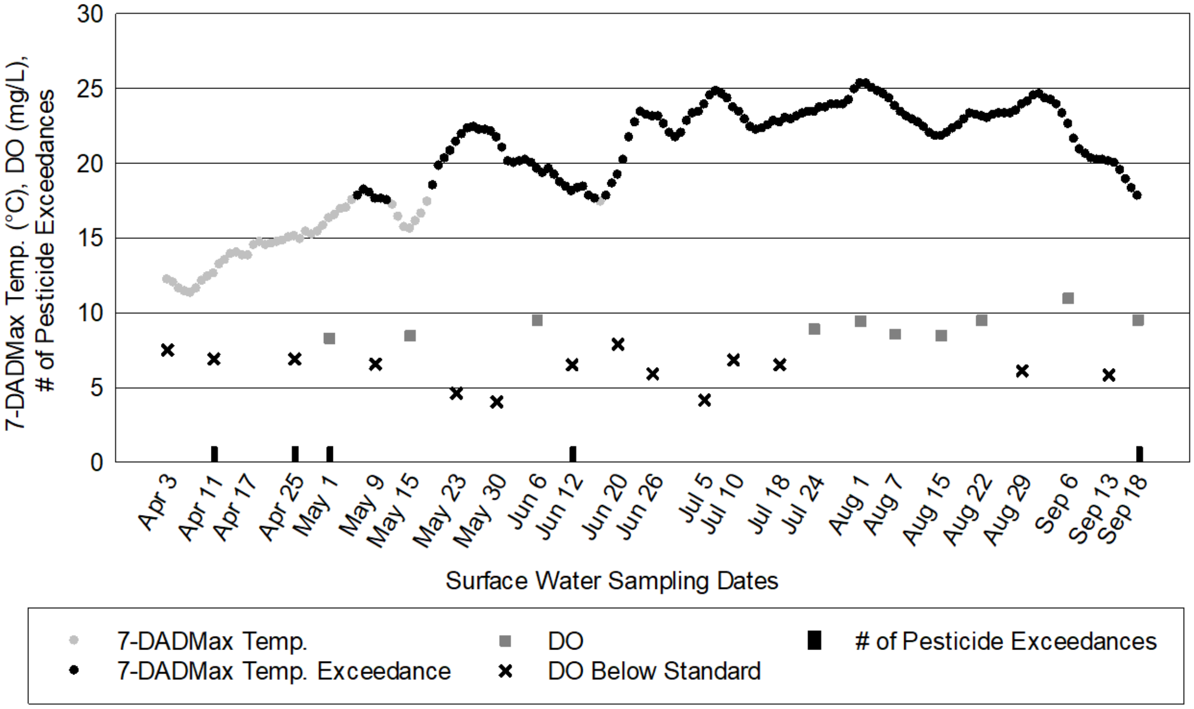

Figure 9 – Lower Big Ditch occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

Due to equipment malfunctions April 17, pH and DO could not be measured. However, data from the other 24 site visits were of acceptable data quality. The pH measurements ranged from 6.62 to 9.05 and averaged 7.29. Of these measurements, one was greater than the pH standard of 8.5 on September 6. The pH measurement that exceeded the standard did not coincide with the DO measurements that failed to meet the DO standard but did coincide with an exceedance of the 7-DADMax. Dissolved oxygen measurements ranged from 4.04 mg/L to 10.96 mg/L with an average of 7.41 mg/L. More than half (58%) of the measurements failed to meet the DO standard in that 14 measurements were less than 8 mg/L. Of the 14 DO measurements below the standard, 11 coincided with 7-DADMax temperature exceedances as well. The 7-DADMax temperatures were greater than the 17.5 °C temperature standard for 128 days of the sampling season, from May 6 to May 11, May 19 to June 16, and June 18 to September 18.

Lower Big Ditch is not only considered habitat for salmonid spawning, rearing and migration, but is also used as a corridor by migrating waterfowl (WAC, 2019). This drainage will continue to be monitored because of its representative regional land use and consistent, yearly detections of POCs such as imidacloprid.

Upper Big Ditch

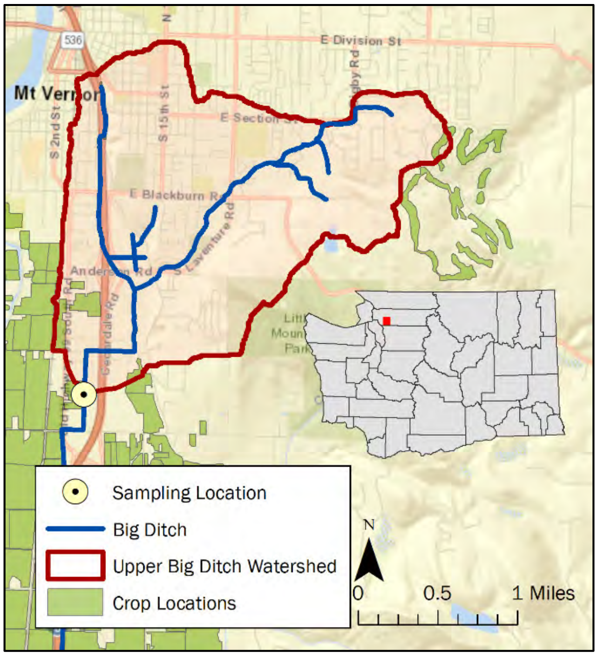

Figure 11 – Map of Upper Big Ditch and its drainage area

Table 10 – Upper Big Ditch watershed crop groups and associated acreage

Upper Big Ditch Crop Groups	Acres
Other	3,093
Nursery	20
Seed	3
Total Ag	47
Total Non-Ag	1,704
Watershed Total	1,751

The Upper Big Ditch monitoring site in Skagit County has been sampled by WSDA since 2007. The entire Big Ditch watershed, drains a mixture of non-agricultural and agricultural land. The Upper Big Ditch site has consistently had the most pesticide detections each year compared to any other site WSDA has sampled. Currently, the upper monitoring site is located just upstream from the bridge crossing at Eleanor Lane in Mt. Vernon (latitude: 48.3882°, longitude: -122.3330°) (Figure 10).

Figure 10 – Upper Big Ditch upstream view

Water from Big Ditch drains into Puget Sound. The WDFW has documented winter steelhead, fall Chinook salmon, and coho salmon within the reach of ditch that encompasses the monitoring site (WDFW, 2019). A culvert upstream of the Upper Big Ditch monitoring site is scheduled to be replaced by 2022 to extend fish passage by over 2 miles upstream (WSDOT, 2019). Coho salmon currently spawn just below the culvert. Juvenile fish of unknown species were frequently observed by staff at the site (Figure 11).

Streamflow in the ditch is generally influenced by precipitation events and commercial and residential irrigation. Big Ditch stretches north approximately 3 miles from the monitoring site to its headwaters. Within the Upper Big Ditch drainage area, the agricultural land use is predominantly commercial nursery and greenhouse (Table 10). No other watersheds WSDA samples have primarily nursery or greenhouse crop groups as their main agricultural commodity. The ‘Other’ crop group category in Table 10 includes pasture and fallow fields.

Below is a brief overview of the pesticide findings in Upper Big Ditch in 2017.

- WSDA tested for 144 unique pesticides in Upper Big Ditch.
- There were 305 total pesticide detections in Upper Big Ditch from 5 different use categories: 7 types of insecticides, 13 herbicides, 12 fungicides, 2 degradates, and 3 other pesticide-related chemicals.
- Pesticides were detected at all 25 sampling events.
- Up to 18 pesticides were detected at the same time.
- Of the total pesticide detections, 14 were above WSDA's assessment criteria (Table 11).
    - A single detection of carbendazim, often a degradate, was found at a concentration exceeding WSDA endangered species criterion (>2.5% of the fish LC_{50} (5 µg/L)).

WSDA POCs detected in Upper Big Ditch in 2017 included chlorpyrifos, clothianidin, diuron, imidacloprid, pentachlorophenol, pyraclostrobin, pyridaben, sulfometuron-methyl, and thiamethoxam. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- All 10 detections of imidacloprid exceeded the NOAEC for invertebrates (0.01 µg/L). Of those, 1 was also found to be approaching the invertebrate EC_{50} (0.77 µg/L).
- Pyridaben was detected once above the NOAEC value for invertebrates (0.044 µg/L) and above the endangered species WSDA assessment criterion (>2.5% of the fish LC_{50} (0.72 µg/L)).
- Out of 20 thiamethoxam detections, 2 were detected at concentrations approaching the invertebrate NOAEC (0.74 µg/L).
- The detections of chlorpyrifos, clothianidin, diuron, pentachlorophenol, pyraclostrobin, and sulfometuron-methyl did not exceed any assessment criteria.

The Upper Big Ditch monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 11). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 11 – Upper Big Ditch pesticide calendar (µg/L)

Month		Apr				May					Jun				Jul				Aug					Sep		
Day of the Month	Use*	3	11	17	25	1	9	15	23	31	6	12	20	26	5	10	18	24	1	7	15	22	29	5	13	18
2,4-D	H		0.061	0.049		0.047	0.041	0.074				0.079	0.169										0.044	--	0.089	0.425
2,6-Dichlorobenzamide	D	0.130	0.132	0.118	0.199	0.192	0.197	0.112	0.131	0.159	0.139	0.182	0.120	0.141	0.125	0.146	0.140	0.137	0.092	0.095	0.102	0.077	0.108	0.098	0.104	0.102
4-Nitrophenol	D					0.148											0.093							--	0.503	
Azoxystrobin	F					0.042		0.018	0.073	0.026	0.061	0.075	0.025	0.072	0.069	0.106	0.040	0.024	0.047	0.037	0.059	0.027	0.069	0.029	0.008	0.038
Boscalid	F					0.421	0.107	0.091	0.353	0.121	0.152	0.276	0.100	0.233	0.206	0.284	0.185	0.129	0.168	0.508	0.283	0.118	0.241		0.156	0.181
Carbendazim	F					0.017	0.015		0.014		0.007	0.030			0.104	0.052	0.231	0.090	0.086	0.104	0.263	0.035	0.046	0.179		0.150
Chlorpyrifos	I															0.014										
Clothianidin	I															0.021			0.010							
Cyprodinil	F					0.053														0.028	0.016					
Dichlobenil	H	0.010	0.012	0.018		0.010	0.027			0.007			0.005													
Difenoconazole	F																								0.014	
Dinotefuran	I	0.357	0.367	0.661	0.440	1.120	0.685	0.574	1.510	0.754	0.685	1.720	0.663	0.639		0.647	0.205	0.145	0.128	0.115	0.585	0.315	0.532	0.527		0.954
Diuron	H																				0.010		0.011	0.009		
Etridiazole	F					0.014									0.031	0.007	0.115	0.020								0.103
Fludioxonil	F	0.043	0.031	0.119	0.041	1.180	0.113	0.082	0.539	0.292	0.677	0.846	0.449	0.997	0.645	0.936	0.484	0.548	0.385	0.283	0.225	0.214	0.653	0.393	0.429	0.525
Imazapyr	H								0.011	0.009		0.013	0.012	0.018	0.021	0.018	0.012				0.012	0.095		0.048	0.018	0.258
Imidacloprid	I			0.010		0.040			0.025			0.050		0.232	0.070	0.100			0.020				0.097	0.024		
Isoxaben	H															0.016				0.002	0.009		0.009	0.006		0.005
MCPA	H												0.041											--		
Metalaxyl	F					0.050			0.034			0.046			0.037	0.042			0.240	0.060		0.111	0.981	0.152		0.327
Methiocarb	I									0.053	0.067	0.023														
Myclobutanil	F															0.015			0.011		0.011			0.010		
N,N-Diethyl-m-toluamide (DEET)	IR	0.017		0.015				0.010			0.015	0.015	0.011	0.010												0.033
Napropamide	H																			0.026						
Pentachlorophenol	WP	0.024			0.041																			--		0.019
Piperonyl butoxide (PBO)	Sy																		0.040		0.066					
Prodiamine	H																0.030									
Prometon	H							0.013																		
Propiconazole	F	0.007																								
Pyraclostrobin	F					0.011			0.056					0.017		0.024	0.012	0.014	0.008		0.030	0.014	0.016	0.012		0.017
Pyridaben	I																						0.062			
Simetryn	H																						0.09			
Sulfometuron-methyl	H				0.006				0.015	0.008			0.007									0.042		0.013		0.023
Tebuthiuron	H	0.044		0.046	0.059		0.046	0.043	0.045	0.056	0.069	0.085	0.094	0.120	0.126	0.177	0.171	0.184		0.116	0.134	0.090	0.124	0.086	0.098	
Thiamethoxam	I	0.019	0.012	0.133	0.039	0.469	0.055	0.068	0.210	0.081	0.131	0.432				0.153		0.039	0.067	0.111	0.175	0.069	0.243	0.037		0.025
Triclopyr acid	H			0.060	0.048		0.028		0.027			0.059	0.053											--	0.060	0.316
Trifloxystrobin	F											0.039				0.014					0.014	0.007				0.012
Total Suspended Solids (mg/L)		4.0	8.0	10.0	8.0	5.0	8.0	4.0	3.0	6.0	6.0	9.0	7.0	7.0	5.0	3.0	3.0	3.0	3.0	9.0	2.0	3.0	41.0	4.0	--	6.0
Streamflow (cubic ft/sec)		5.59	6.03	4.05	2.5	2.4	2.65	1.98	1.6	1.14	0.98	0.87	0.89	0.72	0.22	0.07	~0.0	~0.0	~0.0	0.05	0.35	~0.0	0.01	~0.0	0.04	~0.0
Precipitation (total in/week)†		1.00	1.59	0.62	0.40	0.23	0.93	0.49	0.29	0	0.12	0.55	0.36	0	0	0	0	0	0	0	0.04	0	0	0	0.28	0.22

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent, Sy: Synergist, WP: Wood preservative)

[†] Washington State University AgWeatherNet station: WSU Mt. Vernon, (latitude: 48.44°, longitude: -122.39°)

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard for temperature on June 26, August 15, August 29, and September 5 (Figure 12).

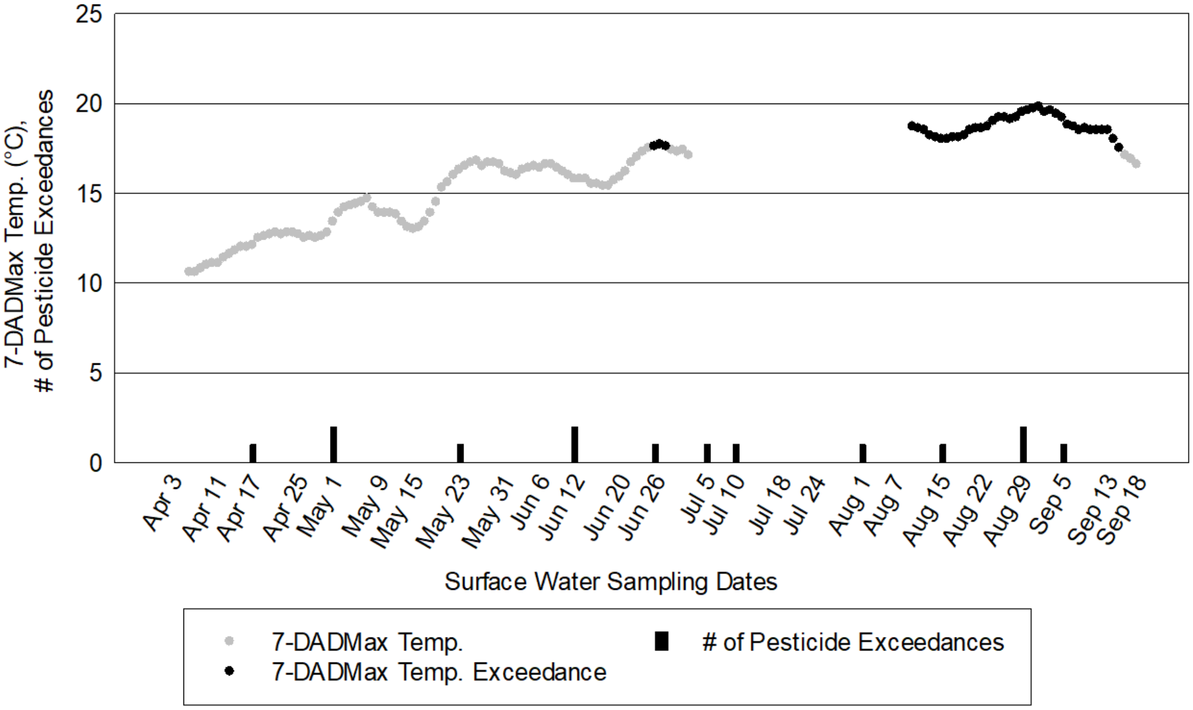

Figure 12 – Upper Big Ditch occurrences of failures to meet state water quality 7-DADMax standards and exceedances of WSDA assessment criteria

Water temperature data between July 3 and August 7 were unavailable. It is unknown if there was any 7-DADMax exceedance during this time. The 7-DADMax temperatures for the remaining sampling season were greater than the 17.5 °C temperature standard for 40 days, from June 26 to June 28 and August 10 to September 15. Of the 25 pH measurements at site visits, only 2 pH measurements failed to meet the pH standard of 6.5, on April 17 at 6.35 and May 1 at 6.30. The May 1 pH measurement that failed to meet the standard also coincided with a pesticide exceedance. The pH measurements ranged from 6.30 to 7.25 with an average of 6.79.

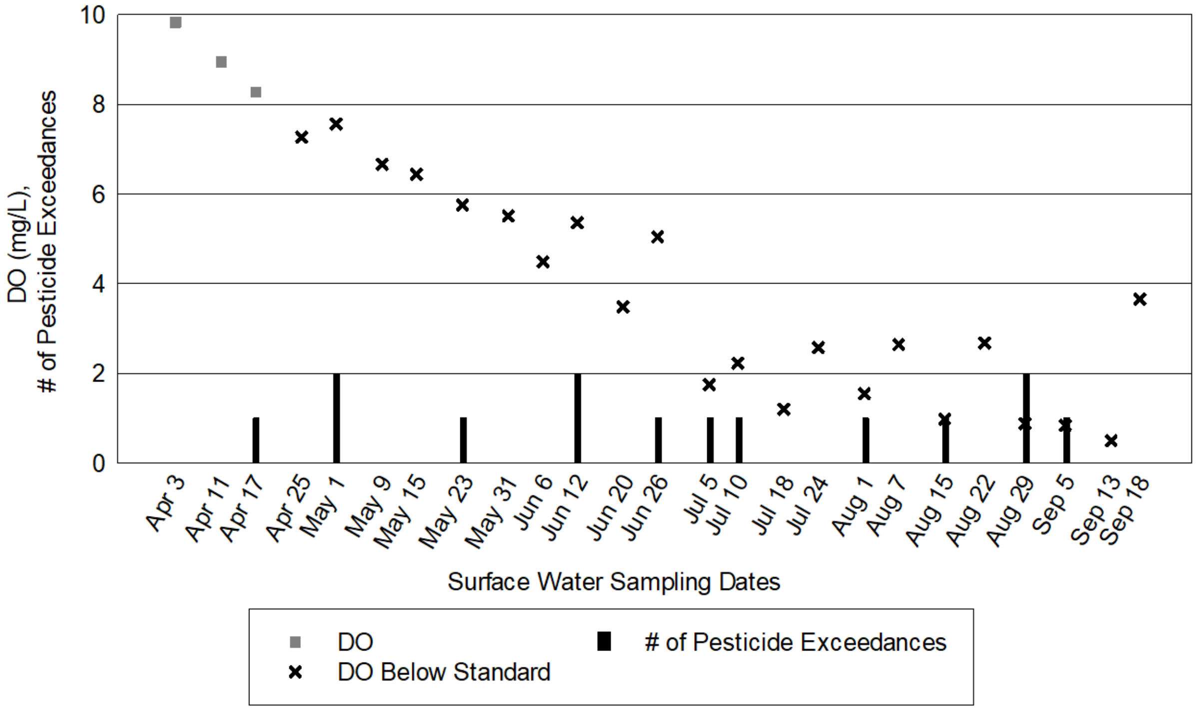

Figure 13 – Upper Big Ditch occurrences of failures to meet state water quality DO standards and exceedances of WSDA assessment criteria

Dissolved oxygen measurements ranged from 0.50 mg/L to 9.83 mg/L with an average of 4.25 mg/L (Figure 13). Almost every measurement (88%) failed to meet the DO standard in that 22 measurements were less than 8 mg/L. Of the DO measurements that failed to meet the standard, 6 coincided with 7-DADMax temperature exceedances as well. On May 1, 2 pesticide exceedances coincided with pH and DO measurements that failed to meet the state water quality standards. Upper Big Ditch had the lowest DO measurement of any monitoring site in 2017.

Upper Big Ditch has been designated as a freshwater body that provides habitat for salmonid spawning, rearing and migration by the WAC (WAC, 2019). It had the poorest water quality of all WSDA monitoring sites in 2017 with the lowest DO and most pesticide detections. It is constricted with aquatic vegetation that slows the flow of water almost completely towards the end of summer. This drainage will continue to be monitored because of its representative regional land use and consistent, yearly detections of POCs.

Burnt Bridge Creek

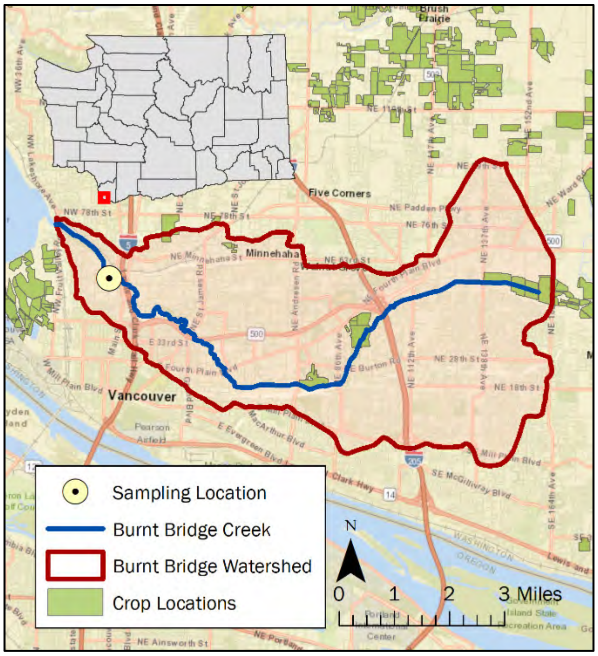

Figure 15 – Map of Burnt Bridge Creek and its drainage area

Table 12 – Burnt Bridge watershed crop groups and associated acreage

Burnt Bridge Crop Groups	Acres
Other	137
Turfgrass	128
Hay/Silage	95
Orchard	17
Vegetable	2
Total Ag	379
Total Non-Ag	16,458
Watershed Total	16,837

In 2017, WSDA started sampling the Burnt Bridge watershed in Clark County. The monitoring site selected on Burnt Bridge Creek is located approximately 10 meters downstream from the bridge crossing at Alki Road (latitude: 47.6614º, longitude: -122.6720º) (Figure 14). Roughly 10 miles of Burnt Bridge Creek flows through the center of Vancouver, Wash. making it the most urban site WSDA tests.

Figure 14 – Burnt Bridge Creek upstream view

Burnt Bridge Creek flows into Vancouver Lake which feeds the Columbia River. Streamflow in this creek is generally influenced by precipitation events. In summer, inflow from groundwater, residential irrigation, and industrial discharge from a manufacturing facility near the headwaters maintain the creek's baseflow. The WDFW has documented winter steelhead and coho salmon within the Burnt Bridge watershed (WDFW, 2019). NRAS staff frequently observe fish of unknown species at the site (Figure 15).

The watershed that contains Burnt Bridge Creek is highly impacted by residential, commercial, industrial and agricultural development. The 'Other' crop group category in Table 12 includes pasture and fallow fields.

The Burnt Bridge Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 13). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 13 – Burnt Bridge Creek pesticide calendar (µg/L)

Month		**Apr**		**May**			**Jun**		**Jul**		**Aug**		**Sep**		**Oct**
Day of the Month	Use*	5	18	3	17	30	14	27	10	25	8	23	6	19	2
2,4-D	H		0.282	0.082	0.102		0.043							0.314	0.057
2,6-Dichlorobenzamide	D	0.135	0.117	0.258	0.134	0.241	0.236	0.217	0.330	0.285	0.216	0.173	0.196	0.170	0.248
Carbaryl	I											0.011			
Carbendazim	F									0.002				0.009	
Dicamba acid	H				0.034									0.041	
Dichlobenil	H	0.010	0.019		0.020										
Difenoconazole	F								0.008						
Dithiopyr	H		0.033												
Diuron	H		0.009		4.390									0.037	
Fenarimol	F								0.049						
Fipronil	I										0.023				
Imazapyr	H		0.006		0.008		0.008								
Imidacloprid	I				0.116										
Isoxaben	H													0.006	
Mecoprop (MCPP)	H		0.035											0.032	
Metolachlor	H													0.037	
Metsulfuron-methyl	H				0.021										
N,N-Diethyl-m-toluamide (DEET)	IR				0.013									0.063	
Pentachlorophenol	WP	0.041	0.034		0.030									0.024	
Propiconazole	F				0.035									0.015	
Pyraclostrobin	F									0.009					
Pyriproxyfen	I									0.010					
Simazine	H													0.052	
Sulfometuron-methyl	H				0.028										
Triclopyr acid	H	0.490	0.150	0.048	0.249	0.032	0.087			0.046	0.068	0.032		0.935	0.558
Triclosan	A												0.023		
Total Suspended Solids (mg/L)		13.0	19.0	11.0	19.0	9.0	7.0	8.0	8.0	6.0	5.0	4.0	9.0	7.0	3.0
Streamflow (cubic ft/sec)		29.82	34.38	28.41	40.71	16.24	16.63	12.63	9.40	7.87	6.95	7.20	6.43	10.70	8.35
Precipitation (total in/week)†		0.48	0.41	0.05	1.32	0	0.87	0.01	0	0	0	0	0	0.57	0.39

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Burnt Bridge Creek.
- There were 68 total pesticide detections in Burnt Bridge Creek from 7 different use categories: 4 types of insecticides, 13 herbicides, 5 fungicides, 1 degradate, and 3 other pesticide-related chemicals.
- Pesticides were detected at 14 (100%) of the 14 sampling events.
- Up to 13 pesticides were detected at the same time.
- Of the total pesticide detections, 4 were above WSDA's assessment criteria (Table 13).

WSDA POCs detected in Burnt Bridge Creek in 2017 included diuron, fipronil, imidacloprid, metolachlor, pentachlorophenol, pyraclostrobin, pyriproxyfen, and sulfometuron-methyl. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, WP: Wood preservative, A: Antimicrobial, IR: Insect repellent)

[†] Washington State University AgWeatherNet station: WSU Vancouver RE, (latitude: 45.68°, longitude: -122.65°)

- Of the 3 diuron detections, only 1 had a concentration approaching the aquatic plant EC_{50} (2.4 µg/L).
- The single detection of fipronil exceeded the NOAEC for invertebrates (0.011 µg/L).
- Pyriproxyfen was detected once approaching the NOAEC for invertebrates (0.015 µg/L).
- The single detection of imidacloprid exceeded the NOAEC for invertebrates (0.01 µg/L).
- The detections of metolachlor, pentachlorophenol, pyraclostrobin, and sulfometuron-methyl did not exceed any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard for temperature on July 25 and August 8 (Figure 16).

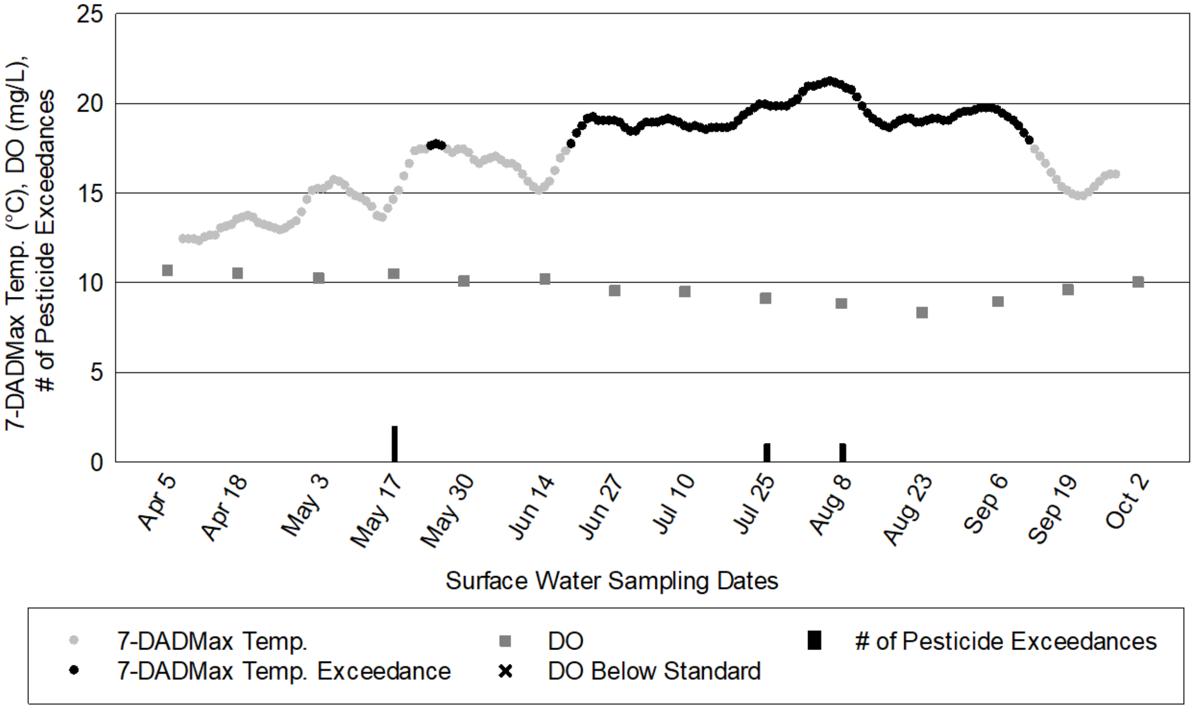

Figure 16 – Burnt Bridge Creek occurrences of occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

All pH measurements from 14 site visits met the state water quality standard, ranging from 7.38 to 8.31 and averaging 7.93. Additionally, all DO measurements met the standard, ranging from 8.33 mg/L to 10.67 mg/L and averaging 9.73 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C water quality standard for 89 days of the sampling season, primarily from June 19 through September 12.

Burnt Bridge Creek has been designated as a freshwater habitat for salmonid spawning, rearing, and migration (WAC, 2019). Historically, this urban creek has been one of the least healthy streams in Clark County, often exceeding total maximum daily loads for dissolved oxygen and temperature in certain reaches of the creek (Kardouni and Brock, 2008). In addition, the presence of invasive New Zealand mud snails has been confirmed in Burnt Bridge Creek.

Non-profits, volunteers, and government agencies such as the City of Vancouver have been actively implementing stream habitat and water quality improvement projects. This drainage will continue to be monitored because of its representative regional urban land use and consistent, yearly detections of POCs.

Indian Slough

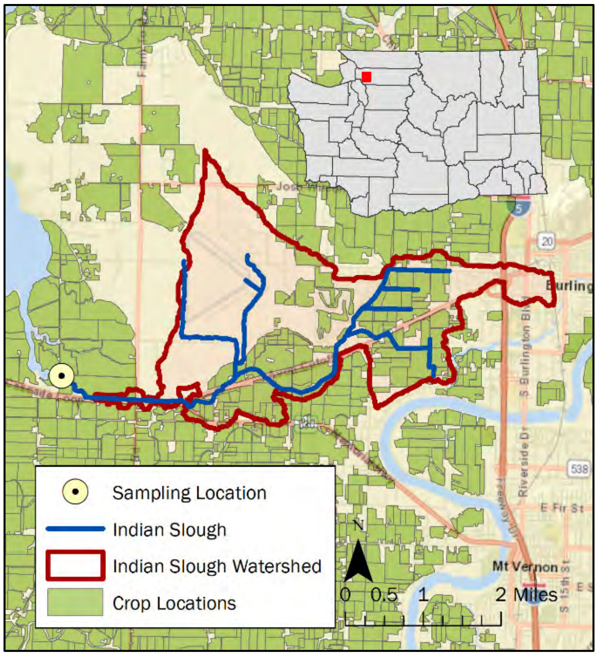

Figure 17 – Map of Indian Slough and its drainage area

Table 14 – Indian Slough watershed crop groups and associated acreage

Indian Slough Crop Groups	Acres
Vegetable	584
Other	322
Cereal Grain	250
Berry	199
Hay/Silage	176
Turfgrass	146
Nursery	96
Seed	50
Flower Bulb	26
Vineyard	1
Total Ag	1,850
Total Non-Ag	3,175
Watershed Total	5,025

The Indian Slough watershed in Skagit County has been sampled by WSDA since 2006. Currently, the monitoring site is located just upstream from the tide gate at Bayview-Edison Road near Mt. Vernon (latitude: 48.4506º, longitude: -122.4650º) (Figure 17).

Indian Slough water drains directly into Puget Sound. Streamflow in the slough is generally influenced by agricultural irrigation and precipitation events. The WDFW has documented winter steelhead and Chinook and coho salmon within the reach of slough that encompasses the Indian Slough site (WDFW, 2019). Juvenile fish of unknown species were frequently observed by NRAS staff at the site (Figure 18).

Figure 18 – Indian Slough upstream view

The Indian Slough watershed is a web of drainage ditches that pass through agricultural, industrial, and residential areas. Indian Slough stretches approximately 6 miles from its sources to the monitoring site. Within the watershed, the agricultural land use is predominantly potatoes, cucumbers, field corn, grass hay and blueberries (Table 14). The 'Other' crop group category in Table 14 includes pasture and fallow fields. Indian slough is another site where the New Zealand mud snails have been confirmed.

WSDA only samples this site when the tide gate is open and the water is flowing from Indian Slough into Puget Sound to avoid contamination with saltwater or pooling backwater. In addition, in 2017 WSDA primarily collected samples during the spring and fall due to historically infrequent pesticide detections during the summer.

The Indian Slough monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 15). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 15 – Indian Slough pesticide calendar (µg/L)

Month		**Mar**	**Apr**				**May**						**Aug**		**Sep**		
Day of the Month	Use*	28	3	11	17	25	1	9	15	23	30		15		5	13	18
2,4-D	H							0.068	0.125								0.061
2,6-Dichlorobenzamide	D	0.083	0.081	0.085	0.086	0.151	0.152	0.150	0.103	0.153	0.153		0.061		0.057	0.032	0.063
Azoxystrobin	F					0.013	0.007	0.050	0.024		0.008		0.009				
Chlorothalonil	F				0.013												
Chlorpropham	H				0.049												
Chlorsulfuron	H							0.172									
Dicamba acid	H			0.052				0.032									
Dichlobenil	H	0.012		0.010	0.011	0.041											
Diuron	H	0.025	0.020	0.022	0.011	0.006		0.009	0.008								
Fludioxonil	F							0.025									
Imazapyr	H			0.013				0.007									
Imidacloprid	I	0.016		0.013													
MCPA	H					0.136											
Mecoprop (MCPP)	H								0.021								0.010
Methoxyfenozide	I												0.004				
Metolachlor	H		0.021	0.040													
Pentachlorophenol	WP			0.024		0.030											
Propiconazole	F		0.045					0.042	0.050								
Simazine	H		0.147														
Sodium bentazon	H																0.024
Sulfometuron-methyl	H				0.008	0.007		0.008									
Tebuthiuron	H				0.068		0.061	0.060	0.039	0.042	0.049				0.040		0.057
Thiamethoxam	I		0.010	0.012	0.009			0.006		0.006							
Triclopyr acid	H							0.050	0.109	0.031							
Triclosan	A												0.017				
Total Suspended Solids (mg/L)		10.0	11.0	18.0	9.0	8.0	8.0	8.0	7.0	6.0	7.0		41		5.0	7.0	6.0
Streamflow (cubic ft/sec)		57.6	41.4	64.8	45.7	57.1	31.6	37.5	24.8	42.7	20.4		0.0		3.2	2.8	1.3
Precipitation (total in/week)†		0.75	1.00	1.59	0.62	0.40	0.23	0.93	0.49	0.29	0.03		0.04		0	0.28	0.22

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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* (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, WP: Wood preservative, A: Antimicrobial)

† Washington State University AgWeatherNet station: WSU Mt Vernon, (latitude: 48.44°, longitude: -122.39°)

- In 2017, WSDA tested for 144 unique pesticides in Indian Slough.
- There were 77 total pesticide detections in Indian Slough from 6 different use categories: 3 types of insecticides, 4 fungicides, 15 herbicides, 1 degradate, and 2 other pesticide-related chemicals.
- Pesticides were detected at 14 (100%) of the 14 sampling events.
- Up to 13 pesticides were detected at the same time.
- Of the total pesticide detections, 2 were above WSDA's assessment criteria (Table 15).

WSDA POCs detected in Indian Slough in 2017 included diuron, imidacloprid, metolachlor, pentachlorophenol, sulfometuron-methyl, and thiamethoxam. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Imidacloprid was detected twice at concentrations greater than the NOAEC for invertebrates (0.01 µg/L).
- The detections of diuron, metolachlor, pentachlorophenol, sulfometuron-methyl, and thiamethoxam did not exceed any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances in Indian Slough on March 28 and April 11 coincided with failures to meet state water quality standards (Figure 19).

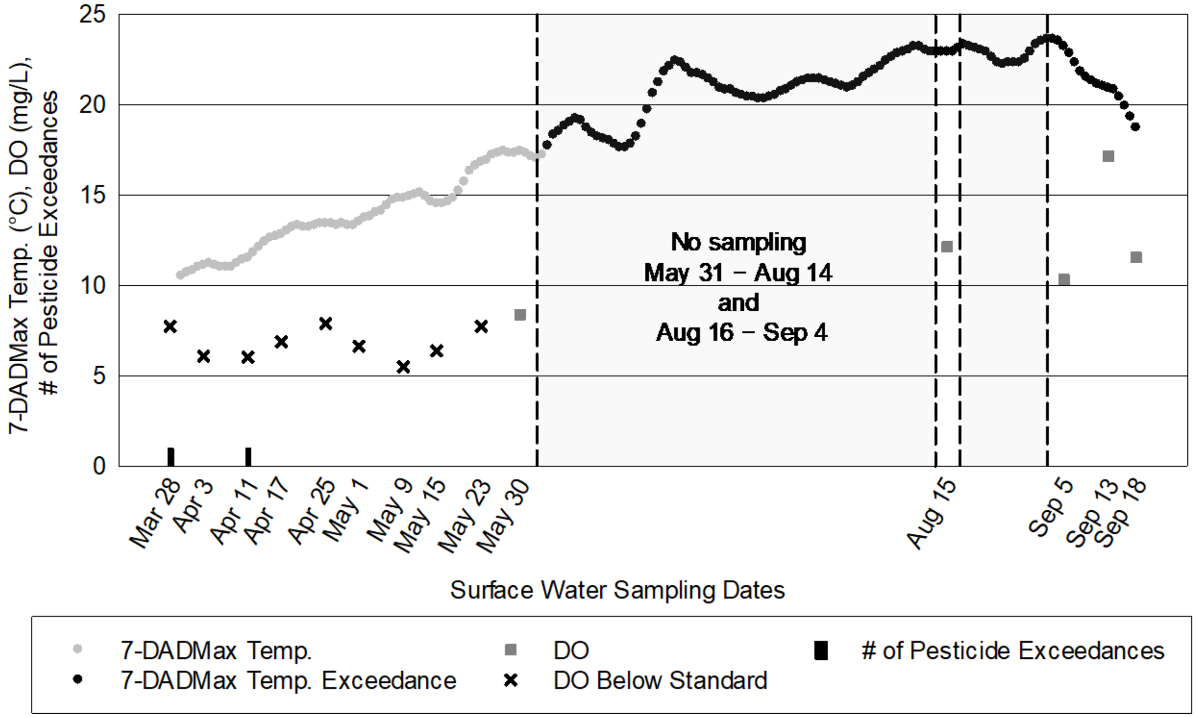

Figure 19 – Indian Slough occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

The pH measurements from 14 site visits ranged from 6.38 to 9.07 and averaged 7.22. Of these measurements, 4 were outside the acceptable pH range (6.5-8.5), with 2 above and 2 below. DO measurements ranged from 5.49 mg/L to 17.13 mg/L with an average of 8.58 mg/L. More than half of the measurements failed to meet the DO standard in that 9 measurements were less than 8 mg/L (each of the first 9 site visits). The 2 pH measurements that fell below the standard coincided with low DO measurements. The 2 pH measurements that exceeded the standard coincided with 7-DADMax temperature exceedances. The 7-DADMax temperature was greater than the 17.5 °C temperature standard for 107 days of the sampling season, from June 4 to September 18.

Indian Slough is not only considered habitat for salmonid spawning, rearing and migration, but is also used as a corridor by migrating waterfowl. This drainage will continue to be monitored because of its representative regional land use.

Woodland Creek

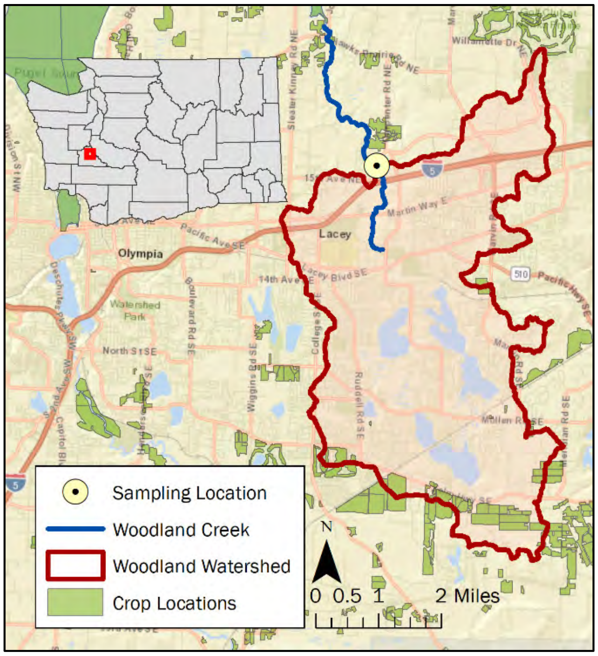

Figure 21 – Map of Woodland Creek and its drainage area

In 2017, WSDA started sampling the Woodland watershed in Thurston County. Most of Woodland Creek runs directly through Lacey. The Woodland watershed is undergoing rapid urban development from prairie and wooded lands. The Woodland Creek monitoring site is located just downstream of the open-bottom culvert under Draham Street NE (latitude: 47.0610º, longitude: -122.8044º) (Figure 20). Within the Woodland Creek drainage area, the land use is predominantly residential with a few ornamental nurseries, sod farms, golf courses, and pastures (Table 16).

Woodland Creek drains into Henderson Inlet which is known for its shellfish harvesting beds. The WDFW has documented winter steelhead, fall Chinook salmon, coho salmon, and chum salmon within the reach of creek that encompasses the monitoring site (WDFW, 2019). Adult salmon were observed by staff at the site during spawning season in 2017 (Figure 21).

Table 16 – Woodland watershed crop groups and associated acreage

Woodland Crop Groups	Acres
Nursery	184
Turfgrass	169
Other	41
Seed	34
Commercial Tree	33
Total Ag	461
Total Non-Ag	12,034
Watershed Total	12,495

Figure 20 – Woodland Creek downstream view

Woodland Creek starts approximately 3 miles south of the monitoring site along a chain of lakes: Hicks Lake, Pattison Lake, Long Lake and Lake Lois. Streamflow in the creek is generally influenced by precipitation events, runoff, and residential irrigation. A storm water retention and treatment facility was installed near Saint Martin's campus upstream of the monitoring site. The facility stores storm water during periods of heavy rain and then releases water slowly back into Woodland Creek.

The Woodland Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 17). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 17 – Woodland Creek pesticide calendar (µg/L)

Month		Mar	Apr		May		Jun		Jul		Aug			Sep	
Day of the Month	Use[*]	28	12	24	8	22	5	19	5	17	1	14	29	13	25
2,4-D	H		0.044			0.036	0.082	0.091	0.053	0.038					
2,6-Dichlorobenzamide	D	0.042	0.042	0.068	0.070	0.045	0.057	0.058	0.055	0.058	0.038	0.035		0.032	0.046
Carbendazim	F									0.023					
Difenoconazole	F										0.007				
Fenarimol	F									0.038					
Malaoxon	D					0.003									
N,N-Diethyl-m-toluamide (DEET)	IR						0.009	0.009							
Pyraflufen-ethyl	H										0.036				
Pyridaben	I								0.027						
Sulfentrazone	H														0.076
Sulfometuron-methyl	H			0.007											
Triclosan	A											0.021			
Trifloxystrobin	F											0.008			
Total Suspended Solids (mg/L)		6.0	6.0	6.0	5.0	7.0	4.0	5.0	5.5	4.0	3.0	2.0	2.0	1.0	2.0
Streamflow (cubic ft/sec)		--	55.3	47.2	41.7	38.3	32.1	29.8	20.3	16.5	11.2	11.2	9.6	9.3	9.4
Precipitation (total in/week)[†]		1.75	1.54	1.06	1.77	0.95	0.16	1.07	0	0	0	0.13	0	0.07	0.82

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Woodland Creek.
- There were 31 total pesticide detections in the creek from 6 different use categories: 1 type of insecticide, 4 fungicides, 4 herbicides, 2 degradates, and 2 other pesticide-related chemicals.
- Pesticides were detected at 13 (93%) of the 14 sampling events.
- Up to 4 pesticides were detected at the same time.
- Of the total pesticide detections, 1 was above WSDA's assessment criteria (Table 17).

WSDA POCs detected in Woodland Creek in 2017 included pyridaben and sulfometuron-methyl. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Pyridaben was detected once approaching the NOAEC for invertebrates (0.044 µg/L).
- The detection of sulfometuron-methyl did not exceed any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, A: Antimicrobial, IR: Insect repellent)

[†] Washington State University AgWeatherNet station: Olympia East, (latitude: 46.95°, longitude: -122.84°)

compounded. The single pesticide exceedance in Woodland Creek coincided with a failure to meet the state water quality standard for dissolved oxygen on July 5 (Figure 22).

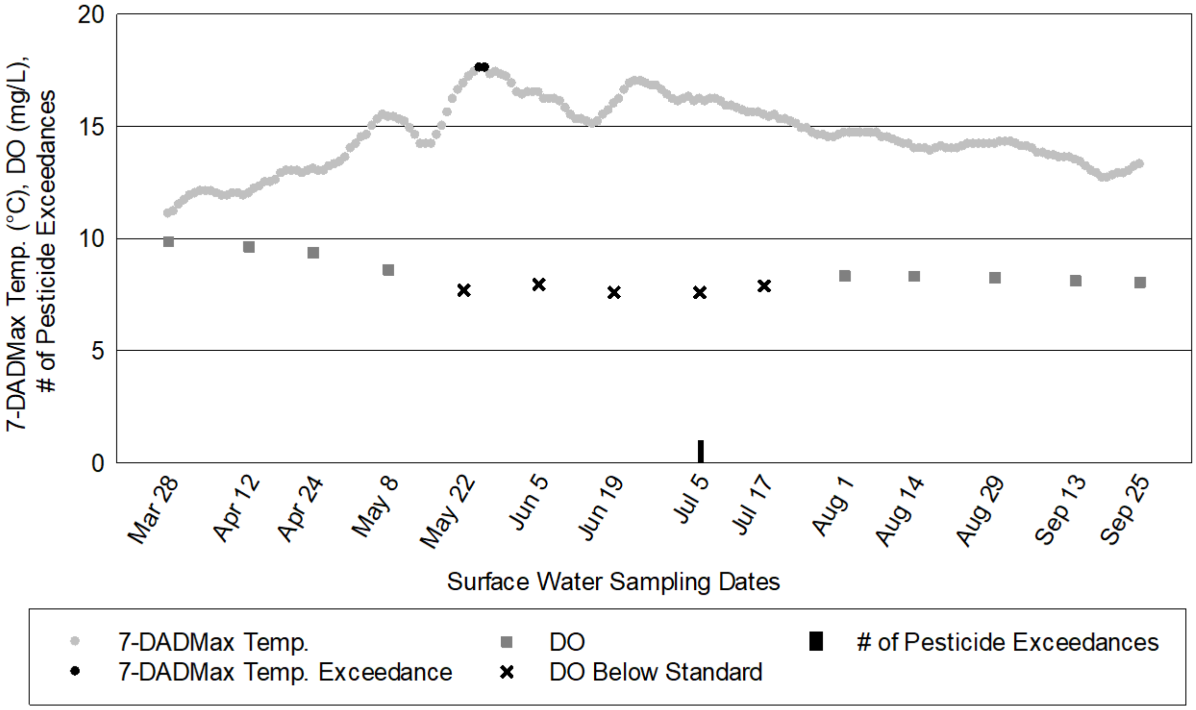

Figure 22 – Woodland Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

All pH measurements from 14 site visits met the state water quality standard, ranging from 6.51 to 7.17 and averaging 6.91. DO measurements ranged from 7.60 mg/L to 9.86 mg/L and averaged 8.38 mg/L. Of the 14 DO measurements, 5 did not meet the standard and were less than 8 mg/L. The 7-DADMax temperatures exceeded the standard of greater than 17.5 °C on May 25 and May 26.

Woodland Creek provides habitat for salmonid spawning, rearing and migration. Many local, city, county, and state partners have been actively restoring and managing the urban stream with success. If Woodland Creek continues to show relatively low pesticide contamination during subsequent sampling seasons, monitoring will be discontinued.

Brender Creek

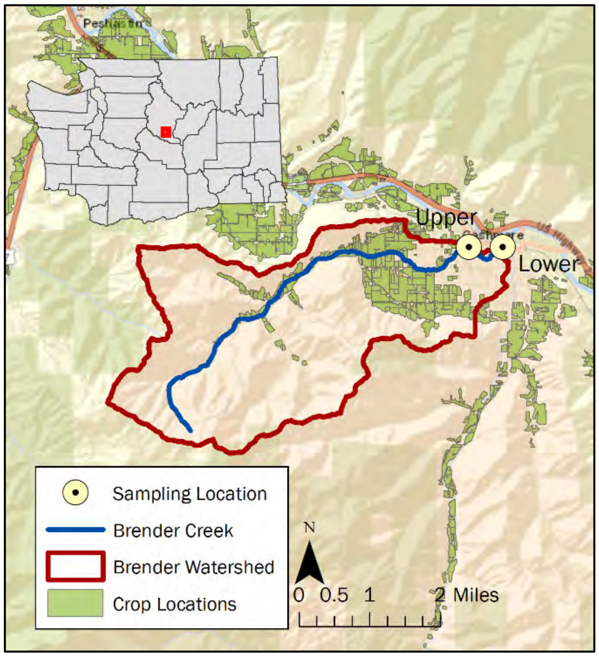

Figure 24 – Map of Brender Creek and its drainage area

Table 18 – Brender Creek watershed crop groups and associated acreage

Brender Creek Crop Groups	Acres
Orchard	765
Other	117
Turfgrass	35
Hay/Silage	5
Vineyard	2
Total Ag	924
Total Non-Ag	5,940
Watershed Total	6,864

The Brender watershed in Chelan County has been sampled by WSDA since 2007 at the Upper Brender Creek monitoring site. This watershed was originally selected to represent agricultural practices used in tree fruit cultivation in Central Washington. DDT was widely used in orchard production until it was banned in the US in 1972. It is still detected in the Brender watershed due to the chemical's strong soil binding abilities, combined with soil erosion into the adjacent creek. In response to continued detections of DDT and DDT breakdown products in Brender Creek, and in cooperation with the Cascadia Conservation District, a second sampling location was established on the creek in 2016. The newly established Lower Brender Creek location was only tested for DDT and its degradates in 2016. In 2017, both Upper and Lower Brender Creek sites were tested for the same 130 analytes. The purpose of collecting water samples at the upper and lower sites was to evaluate the effectiveness of a recently restored wetland at reducing suspended sediment and the transport of pesticides and their breakdown products in the water.

Figure 23 – Lower Brender Creek downstream view

The Upper Brender Creek monitoring site is located about 0.5 miles upstream of the Lower Brender Creek monitoring site with the wetland between them (Figure 23). The Upper Brender site is located in Cashmere, WA, on the upstream side of the culvert at Evergreen Drive (latitude: 47.5211°, longitude: -120.4863°) (Figure 25). The Lower Brender Creek site is located on the downstream side of the Sunset Highway bridge crossing of Brender Creek (latitude: 47.5213°, longitude: -120.4767°) (Figure 24). In total, Brender Creek is approximately 6.8 miles long.

Brender Creek water drains into the Wenatchee River. Flows in this stream are generally influenced by melting snowpack, precipitation events, and irrigation. The WDFW has documented spring Chinook salmon and summer steelhead within the lower reaches of the creek (WDFW, 2019).

The watershed is characterized by mountainous terrain in the upper three-quarters with a transition into low-lying, flat terrain in the bottom quarter of the watershed where tree fruit crops are plentiful. The agricultural land use is predominantly pears, apples, pasture, and cherries (Table 18). The 'Other' crop group category in Table 18 includes pasture and fallow fields.

WSDA only sampled these sites during the spring and summer in 2017 due to historically few pesticide detections during the fall. In addition, samples were only tested for 130 different pesticides; 11 herbicides, 2 herbicide degradates and a wood preservative not commonly detected here were removed.

Below is a brief overview of the pesticide findings in Brender Creek in 2017.

- WSDA tested for 130 unique pesticides in Upper and Lower Brender Creek.
- Pesticides were detected at 18 (95%) of the 19 sampling events at each monitoring site.
- Up to 7 pesticides were detected at the same time in Upper Brender Creek and up to 6 in Lower Brender Creek.
- There were 12 unique pesticides found at both Upper and Lower Brender Creek. At Upper Brender Creek there were 4 unique pesticides detected that were not found at Lower Brender Creek and 3 were found at Lower Brender Creek but not at Upper Brender Creek.
- At every paired sampling event (19), TSS, DDT and DDT's degradates were greater at Upper Brender Creek than at Lower Brender Creek.

- There were 69 total pesticide detections in Upper Brender from 5 different use categories: 7 types of insecticides, 4 herbicides, 1 fungicide, 3 degradates, and 1 other pesticide-related chemical.
- Of the total detections at Upper Brender Creek, 33 were above WSDA's assessment criteria (Table 19).
    - The 5 detections of 4,4'-DDD, 16 detections of 4,4'-DDE, and 3 detections of 4,4'-DDT exceeded NRWQC and WAC acute criteria (both 0.001 µg/L).

- There were 50 total pesticide detections in Lower Brender Creek from 5 different use categories: 5 types of insecticides, 5 herbicides, 1 fungicide, 2 degradates, and 2 other pesticide-related chemicals.
- Of the total detections at Lower Brender Creek, 12 were above WSDA's assessment criteria (Table 20).
    - The 4 detections of 4,4'-DDE, a degradate, exceeded NRWQC and WAC acute criteria (both 0.001 µg/L).

WSDA POCs detected in both Upper and Lower Brender Creek in 2017 included chlorpyrifos, diuron, imidacloprid, malathion, sulfometuron-methyl, and thiamethoxam. Upper Brender Creek had an additional POC, pyridaben. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- There were a total of 8 chlorpyrifos detections at Upper Brender Creek and a total of 5 chlorpyrifos detections at Lower Brender Creek
  - The detections of chlorpyrifos at Upper and Lower Brender Creek on April 4 and April 11 were greater than the NRWQC and state WAC acute criteria (0.083 µg/L).
  - All chlorpyrifos detections before April 25 at Upper and Lower Brender Creek (3 at each site) exceeded NRWQC and state WAC chronic criteria (0.041 µg/L).
  - Only 2 detections (April 4 and 11) at Upper Brender Creek and no detections at Lower Brender exceeded the invertebrate LC_{50} criterion (0.1 µg/L).
  - All detections of chlorpyrifos on or before May 10 at both sites approached the invertebrate NOAEC (0.04 µg/L).
  - Only 3 chlorpyrifos detections at Upper Brender Creek and 1 detection at Lower Brender Creek did not exceed any assessment criteria.
- Both imidacloprid detections at Upper Brender Creek and the single detection at Lower Brender Creek exceeded the NOAEC for invertebrates (0.01 µg/L).
- Malathion concentrations at both sites on April 4 exceeded the invertebrate LC_{50} (0.098 µg/L), invertebrate NOAEC (0.06 µg/L), and NRWQC chronic criterion (0.1 µg/L). The detections at both sites on April 11 were greater than the invertebrate NOAEC, approaching the invertebrate LC_{50}, and approaching the NRWQC chronic criterion.
- The single detection of pyridaben at Upper Brender Creek, June 21, was approaching the invertebrate NOAEC (0.044 µg/L).
- The detections of sulfometuron-methyl and thiamethoxam at both sites and both detections of diuron at Upper Brender did not exceed any assessment criteria.

The Upper and Lower Brender Creek monitoring site pesticide calendars provide a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 19, Table 20). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 19 – Upper Brender Creek pesticide calendar (µg/L)

Month		**Apr**				**May**					**Jun**				**Jul**				**Aug**	
Day of the Month	Use*	4	11	18	25	2	10	16	23	31	6	13	21	27	5	10	18	25	1	8
2,6-Dichlorobenzamide	D					0.015	0.024	0.022		0.011	0.013	0.014	0.019		0.011	0.021	0.019	0.024	0.012	
4,4'-DDD	D									0.010					0.008	0.015	0.014	0.017		
4,4'-DDE	D	0.017		0.014	0.023	0.023	0.024	0.021	0.023	0.034	0.021	0.012	0.022	0.021	0.021	0.033	0.026	0.049		
4,4'-DDT	I															0.019	0.015	0.021		
Chlorpyrifos	I	0.248	0.108	0.052		0.022	0.034				0.013			0.010	0.009					
Diuron	H													0.058	0.021					
Imazapyr	H	0.072	0.066	0.034	0.021	0.010		0.009												
Imidacloprid	I																		0.028	
Malathion	I	0.209	0.080																	
Metsulfuron-methyl	H	0.018	0.017	0.015																
Piperonyl butoxide (PBO)	Sy	0.070																		
Propiconazole	F		0.006																	
Pyridaben	I												0.038							
Spirotetramat	I								0.754										0.054	
Sulfometuron-methyl	H	0.019	0.015	0.015	0.013	0.010														
Thiamethoxam	I						0.036													
Total Suspended Solids (mg/L)		372.0	1050.0	1310.0	800.0	340.0	264.0	203.0	205.0	155.0	68.0	28.0	46.0	38.0	84.0	91.0	73.0	122.0	72.0	35.0
Streamflow (cubic ft/sec)		6.0	6.9	7.6	5.8	4.5	7.3	7.3	7.2	6.6	3.8	1.7	2.6	2.6	5.2	4.4	4.5	3.0	4.1	2.8
Precipitation (total in/week)†		0.19	0.57	0.74	0.24	0	0.26	0.37	0.03	0.17	0.19	0.16	0.01	0	0	0	0	0	0	0

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, Sy: Synergist)

[†] Washington State University AgWeatherNet station: N. Cashmere, (latitude: 47.51°, longitude: -120.43°)

Table 20 – Lower Brender Creek pesticide calendar (µg/L)

Month		**Apr**				**May**					**Jun**				**Jul**				**Aug**	
Day of the Month	Use*	4	11	18	25	2	10	16	23	31	6	13	21	27	5	10	18	25	1	8
2,6-Dichlorobenzamide	D	0.015	0.021	0.014	0.029	0.039	0.034	0.027	0.021	0.022	0.034	0.038	0.023	0.034	0.029	0.035		0.055		0.026
4,4'-DDE	D			0.010									0.008	0.007		0.013				
Bromacil	H													0.012						
Chlorpyrifos	I	0.089	0.096	0.055			0.027				0.011									
Difenoconazole	F															0.007				
Diuron	H													0.029	0.012					
Imazapyr	H	0.053	0.052	0.031		0.005														
Imidacloprid	I													0.023					0.067	
Malathion	I	0.248	0.063																	
Metsulfuron-methyl	H		0.017																	
Piperonyl butoxide (PBO)	Sy	0.058																		
Spirotetramat	I																		0.081	
Sulfometuron-methyl	H	0.018	0.017	0.015	0.013	0.010	0.008	0.007												
Thiamethoxam	I							0.008												
Triclosan	A															0.025				
Total Suspended Solids (mg/L)		34.0	178.0	211.0	78.0	26.0	26.0	14.0	13.0	9.0	7.0	5.0	5.0	4.0	8.0	9.0	9.0	5.0	5.0	4.0
Streamflow (cubic ft/sec)		6.6	6.9	8.0	6.5	5.7	6.8	7.9	6.7	7.1	4.4	3.1	4.8	3.9	5.1	4.6	4.3	2.7	4.2	4.0
Precipitation (total in/week)†		0.19	0.57	0.74	0.24	0	0.26	0.37	0.03	0.17	0.19	0.16	0.01	0	0	0	0	0	0	0

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, Sy: Synergist, A: Antimicrobial)

[†] Washington State University AgWeatherNet station: N. Cashmere, (latitude: 47.51°, longitude: -120.43°)

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard a few times at Upper and Lower Brender Creek. Conventional water quality parameters at Upper and Lower Brender Creek is shown in Figure 26 and Figure 27.

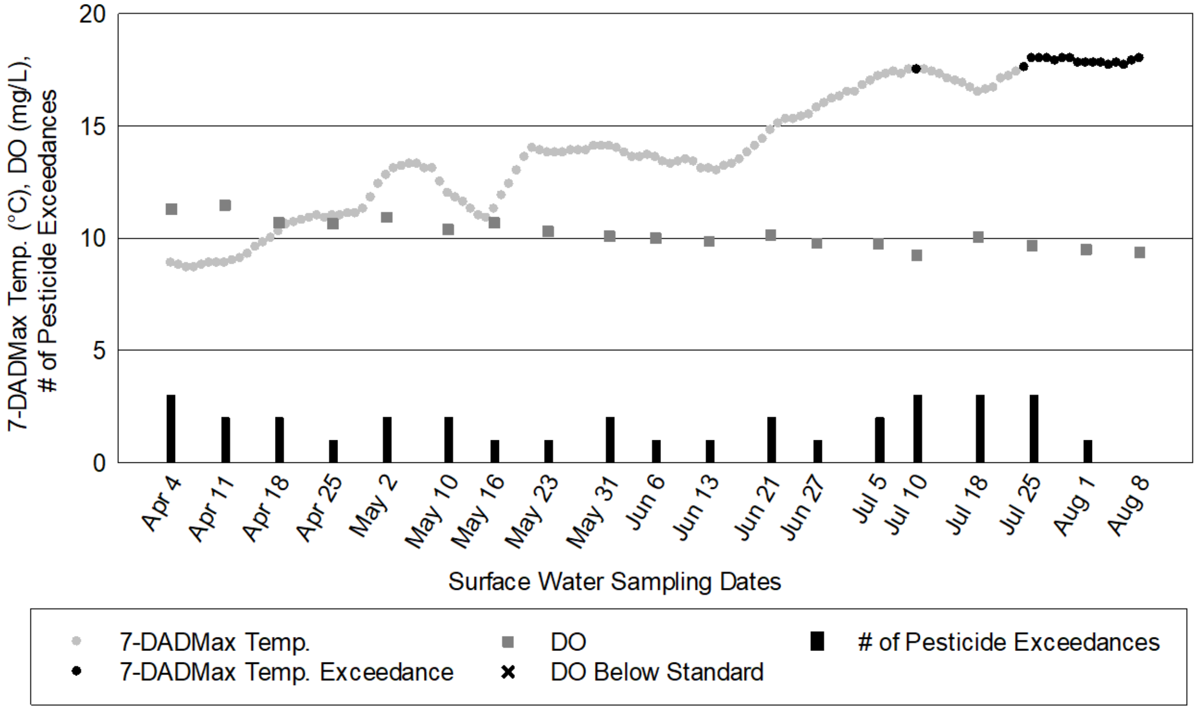

Figure 26 – Upper Brender Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

Pesticide exceedances in Upper Brender Creek coincided with failures to meet state water quality temperature standards at least 3 times (July 10, July 25, and August 1). There were no pH or DO measurements that exceeded state water quality standards. The pH measurements from 19 site visits ranged from 7.94 to 8.36 with an average of 8.10. The DO measurements ranged from 9.24 mg/L to 11.47 mg/L with an average of 10.20 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C temperature standard for 17 days of the sampling season, July 10 and from July 24 to August 14.

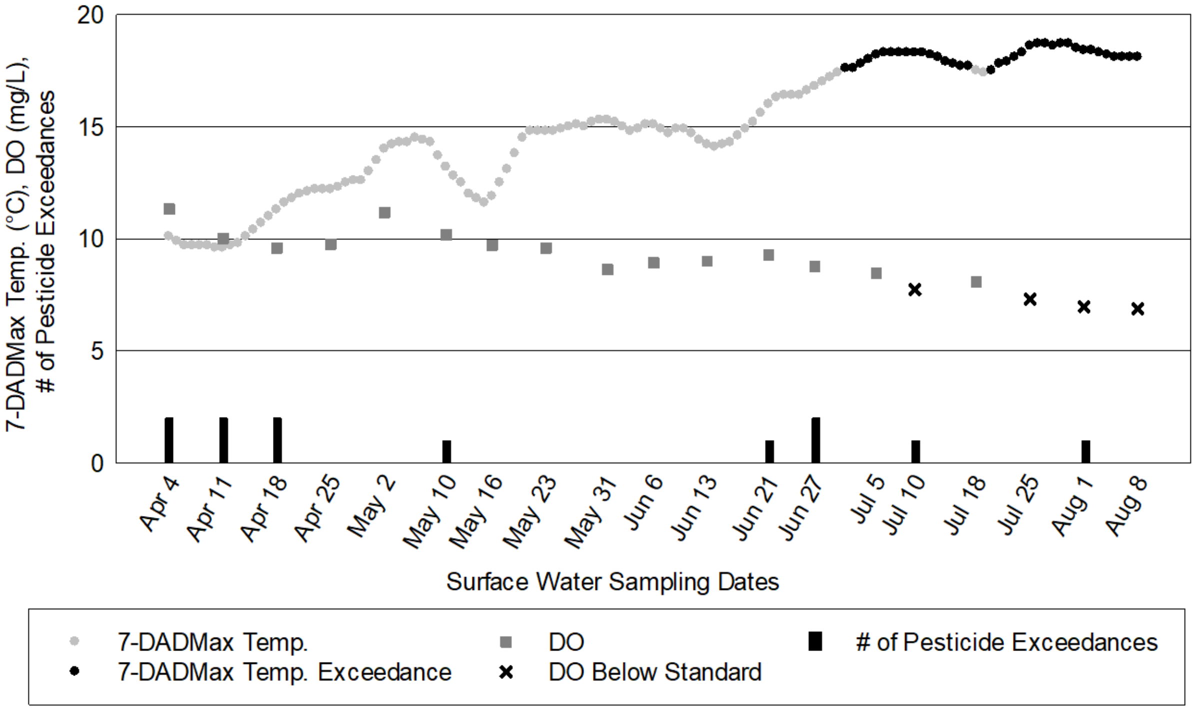

Figure 27 – Lower Brender Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

Pesticide exceedances in Lower Brender Creek coincided with failures to meet state water quality 7-DADMax and DO standards at least twice (July 10 and August 1). Similar to Upper Brender Creek, there were no pH measurements taken that exceeded state water quality standards. The pH measurements from 19 site visits ranged from 7.44 to 8.03 with an average of 7.66. The DO measurements ranged from 6.89 mg/L to 11.33 mg/L with an average of 9.03 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C temperature standard for 47 days of the sampling season, July 1 to July 17 and from July 20 to August 18.

The lower portion of Brender Creek has been designated as a freshwater body that provides habitat for salmonids spawning, rearing, and migration by the WAC (WAC, 2019). Juvenile fish of unknown species were observed by staff at both monitoring sites. This drainage will continue to be monitored because of its representative regional land use, historical sampling, and consistent, yearly detections of POCs.

Lower Crab Creek

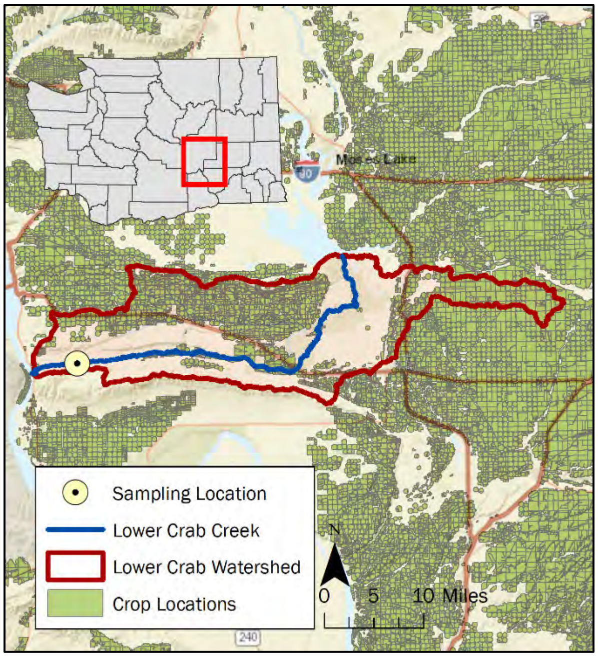

Figure 29 – Map of Lower Crab Creek and its drainage area

Table 21 – Lower Crab Creek watershed crop groups and associated acreage

Lower Crab Creek Crop Groups	Acres
Cereal Grain	34,728
Hay/Silage	22,560
Orchard	18,088
Vegetable	14,765
Other	14,702
Herb	2,582
Vineyard	1,519
Seed	283
Melon	233
Oilseed	145
Turfgrass	133
Berry	123
Green Manure	33
Nursery	15
Total Ag	109,909
Total Non-Ag	146,766
Watershed Total	256,675

In 2017, WSDA started sampling the Lower Crab watershed in Grant County. The watershed was selected for its diverse agricultural land uses and large watershed drainage area. The Lower Crab Creek monitoring site also expands the monitoring further east where WSDA sampling has not taken place before. It is located just upstream of the bridge crossing at Lower Crab Creek Road SW (latitude: 46.8298°, longitude: -119.8309°) (Figure 28).

The Columbia Basin Irrigation Project created a series of reservoirs and irrigation canals that provide Lower Crab Creek with perennial sources of water. Lower Crab Creek streamflow is predominantly groundwater fed just below Potholes Reservoir and down through the Columbia National Wildlife Refuge. Below the refuge, irrigation inflows, runoff, and seeps resupply water to the creek before it drains into the Columbia River. The WDFW has documented summer steelhead and fall Chinook salmon within the reach of the creek that encompasses the monitoring site (WDFW, 2019) (Figure 29). Data suggests the fall Chinook salmon in the creek are genetically diverse from hatchery salmon in the area (Small et al., 2011).

Figure 28 – Lower Crab Creek downstream view

The watershed that contains the approximately 48- mile-long Lower Crab Creek is characterized by desert-like habitat with a deeply incised stream channel from historically large flows. The irrigation projects in the region have allowed the conversion of the sagebrush steppe environment to productive agricultural land. Within the Lower Crab Creek drainage area, the land use is predominantly wheat, alfalfa hay, apples, field corn, and ranch grazing (Table 21). The 'Other' crop group category in Table 21 includes pasture and fallow fields.

The Lower Crab Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 22). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 22 – Lower Crab Creek pesticide calendar (µg/L)

Month		**Mar**	**Apr**		**May**		**Jun**		**Jul**			**Aug**		**Sep**		**Oct**
Day of the Month	Use[*]	28	11	25	10	23	6	21	5	17	31	14	28	12	25	9
2,4-D	H			0.037	0.034	0.069	0.115	0.158	0.111	0.105	0.239	0.150		0.560	0.105	0.057
2,6-Dichlorobenzamide	D														0.022	
Azoxystrobin	F											0.006		0.037		
Bromacil	H			0.027												
Carbendazim	F											0.007		🟨 0.698		
Clothianidin	I									0.010	0.012					
Dacthal (DCPA)	H	0.119	0.280	0.039	0.094	0.081	0.211	0.308	0.082	0.107	0.184	0.207		0.199	0.079	0.067
Dicamba acid	H					0.089	0.073	0.050	0.050	0.083	0.103	0.130		0.017		
Diuron	H	0.051	0.138	0.088	0.050		0.024	0.013	0.016			0.011				
Eptam	H					0.020										
Imazapyr	H		0.010	0.009				0.057		0.008				0.060	0.011	
Imidacloprid	I													🟨 0.079		
Malathion	I						🟨 0.102									
Methomyl	I									0.007						
Methoxyfenozide	I					0.004						0.005				
Metolachlor	H					0.014		0.011	0.008							
Metsulfuron-methyl	H														0.095	
Myclobutanil	F													0.010		
N,N-Diethyl-m-toluamide (DEET)	IR						0.009	0.012								
Pyraclostrobin	F													0.012		
Sodium bentazon	H	0.037		0.032					0.028		0.044	0.061		0.024		
Sulfometuron-methyl	H													0.067		
Thiamethoxam	I													0.022		
Triazine DEA degradate	D	0.013	0.010									0.008				
Trifloxystrobin	F													0.010		
Total Suspended Solids (mg/L)		17.0	25.0	31.0	44.0	39.0	37.0	23.0	36.0	6.0	14.0	42.0	10.5	9.0	5.0	7.0
Streamflow (cubic ft/sec)		299	285	252	206	182	175	181	166	119	129	198	212	269	284	206
Precipitation (total in/week)[†]		0.44	0.46	0.19	0.15	0.13	0.04	0.15	0	0	0	0.01	0	0	0.17	0.02

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Lower Crab Creek.
- There were 82 total pesticide detections in Lower Crab Creek from 5 different use categories: 6 types of insecticides, 11 herbicides, 5 fungicides, 2 degradates, and 1 other pesticide-related chemical.

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent)

[†] Washington State University AgWeatherNet station: Royal City W, (latitude: 46.97°, longitude: -119.83°)

- Pesticides were detected at 14 (93%) of the 15 sampling events.
- Up to 13 pesticides were detected at the same time.
- Of the total pesticide detections, 3 were above WSDA's assessment criteria (Table 22).
    - Only 1 of the 2 detections of carbendazim, often a degradate, was found at a concentration exceeding WSDA endangered species criterion (>2.5% of the fish LC_{50} (5 µg/L)). Carbendazim is not considered a pesticide of concern by WSDA.

WSDA POCs detected in Lower Crab Creek in 2017 included clothianidin, diuron, imidacloprid, malathion, metolachlor, pyraclostrobin, sulfometuron-methyl, and thiamethoxam. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Malathion was detected once at a concentration greater than the invertebrate LC_{50} (0.098 µg/L), invertebrate NOAEC (0.06 µg/L), and the NRWQC chronic criterion (0.1 µg/L).
- The single detection of imidacloprid exceeded the NOAEC for invertebrates (0.01 µg/L).
- The detections of clothianidin, diuron, metolachlor, pyraclostrobin, sulfometuron-methyl, and thiamethoxam did not exceed any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet state water quality standards on June 6 and September 12 (Figure 30).

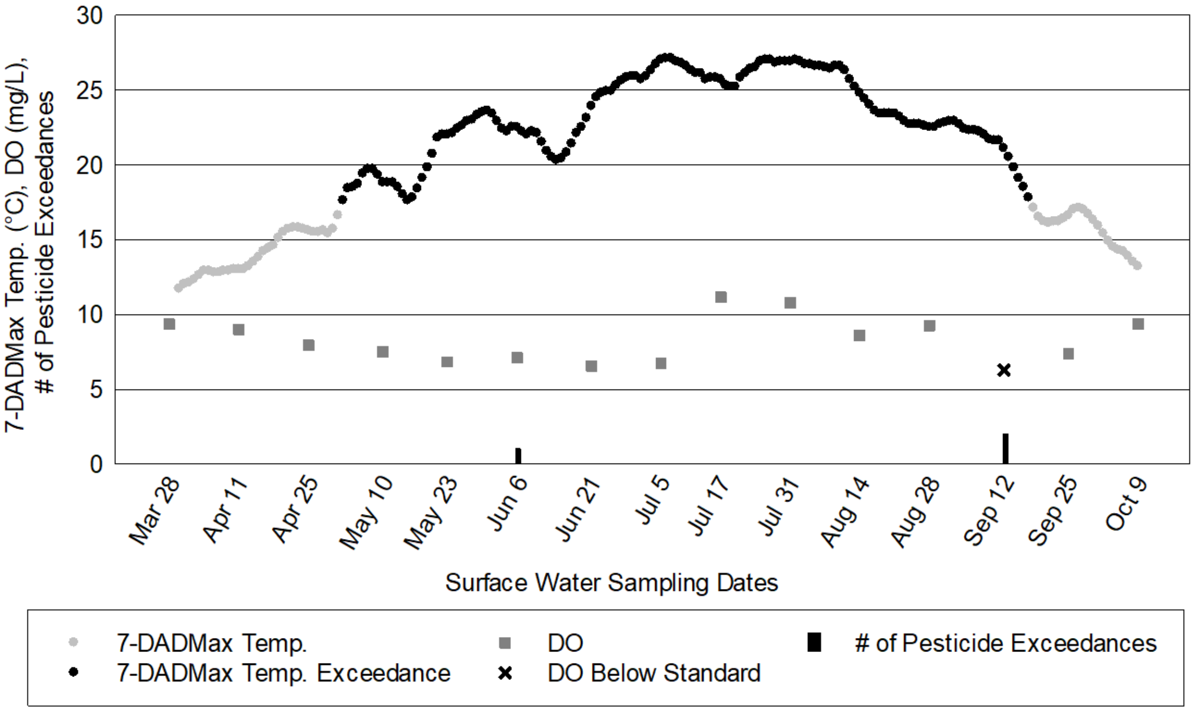

Figure 30 – Lower Crab Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

There was only 1 DO measurement lower than this site's state water quality standard of 6.5 mg/L. This exceedance also coincided with a 7-DADMax exceedance and 2 pesticide exceedances on September 12. DO measurements from 15 site visits ranged from 6.29 mg/L to 11.15 mg/L with an average of 8.26 mg/L. Measurements of pH on July 17 (8.67) and July 31 (8.65) slightly exceeded the standard at this site of 8.5 and coincided with 7-DADMax standard exceedances. The pH measurements ranged from 7.82 to 8.67 with an average of 8.16. The 7-DADMax temperatures were greater than the 17.5 °C standard for 139 days of the sampling season, from May 2 to September 17.

Lower Crab Creek has been designated as a freshwater body that provides habitat for salmonid rearing and migration by the WAC (WAC, 2019). NRAS staff at the site frequently observed juvenile fish of unknown species. This drainage will continue to be monitored because of its representative regional land use and detections of POCs.

Marion Drain

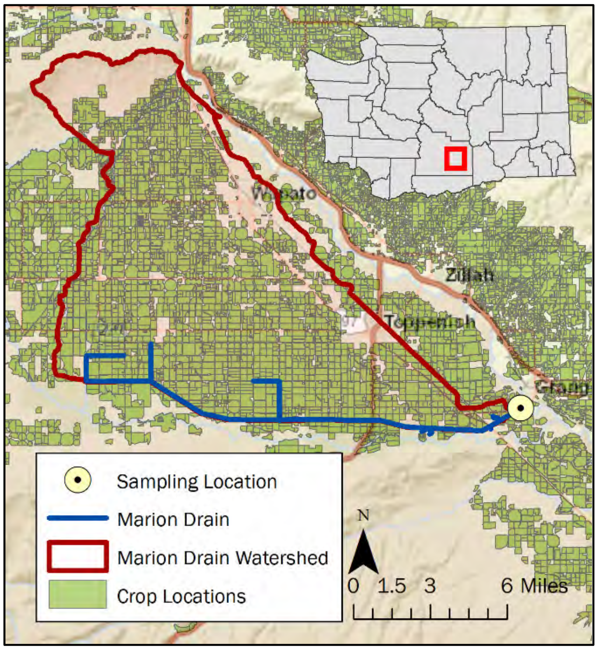

Figure 32 – Map of Marion Drain and its drainage area

Table 23 – Marion Drain watershed crop groups and associated acreage

Marion Drain Crop Groups	Acres
Herb	15,877
Cereal Grain	14,849
Orchard	10,305
Hay/Silage	5,049
Other	4,514
Vegetable	3,923
Vineyard	1,857
Seed	152
Nursery	127
Turfgrass	85
Melon	71
Berry	23
Commercial Tree	6
Total Ag	56,838
Total Non-Ag	25,577
Watershed Total	82,415

The Marion Drain watershed in Yakima County has been sampled by WSDA since 2003.The site is located near Granger, approximately 140 meters upstream from the bridge crossing at Indian Church Road (latitude: 46.3306º, longitude: -120.2000º) (Figure 31). This site was chosen to represent irrigated agricultural practices in Eastern Washington.

Marion Drain discharges directly into the Yakima River. Flows in this stream are generally influenced by melting snowpack, precipitation events, groundwater, and irrigation. Unseasonably high flows were observed during the spring at this site due to the deep snow pack (Figure 32). The WDFW and the Yakama Nation have documented fall Chinook salmon, coho salmon, and summer steelhead within the Marion Drain watershed (WDFW, 2019).

Figure 31 – Marion Drain upstream view

The watershed that contains Marion Drain is characterized by flat, low-lying terrain. Marion Drain is a highly modified waterway and travels straight about 18 miles through many irrigated agricultural fields. The agricultural land use in the area is dominated by hops (in the herb crop group), field corn, apples, alfalfa hay and wheat (Table 23). The 'Other' crop group category in Table 23 includes pasture and fallow fields.

Samples were collected at this site in the spring and early summer and again in the fall because of historically low pesticide detections during this late summer. Samples were collected into November in order to capture pesticide detections during the peak fall Chinook salmon migration and spawning in Marion Drain.

Below is a brief overview of the pesticide findings in Marion Drain.

- In 2017, WSDA tested for 144 unique pesticides in Marion Drain.
- There were 103 total pesticide detections in Marion Drain from 5 different use categories: 5 types of insecticides, 11 herbicides, 5 fungicides, 1 degradate, and 1 insect repellent.
- Pesticides were detected at 18 (86%) of the 21 sampling events.
- Up to 11 pesticides were detected at the same time.
- Of the total pesticide detections, 6 were above WSDA's assessment criteria (Table 24).

WSDA POCs detected in Marion Drain in 2017 included clothianidin, diuron, imidacloprid, tefluthrin, and thiamethoxam. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Of the 7 detections of clothianidin, 3 were approaching the invertebrate NOAEC (0.05 µg/L) and 1 was equal to the invertebrate NOAEC criterion.
- Tefluthrin was detected at a concentration greater than the fish NOAEC (0.004 µg/L), invertebrate NOAEC (0.008 µg/L), and approaching the fish LC_{50} (0.06 µg/L).
- The single detection of imidacloprid exceeded the NOAEC for invertebrates (0.01 µg/L).
- The detections of diuron and thiamethoxam did not exceed any assessment criteria.

The Marion Drain monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 24). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 24 – Marion Drain pesticide calendar (µg/L)

Month		**Mar**	**Apr**				**May**					**Jun**				**Jul**					**Oct**		**Nov**
Day of the Month	Use*	27	3	10	17	24	1	9	15	22	30	5	12	19	26	3	11	17	24		23	30	7
2,4-D	H					0.042	0.042	0.033	0.041	0.039	0.044		0.037	0.045	0.044	0.073	0.094	0.059	0.058				
Azoxystrobin	F								0.014	0.008		0.029	0.020	0.015	0.008		0.022	0.012					
Boscalid	F																0.037	0.035					
Bromoxynil	H						0.028		0.027		0.056												
Chlorantraniliprole	I																					0.006	
Clothianidin	I											0.018				0.032 🟨	0.023	0.019			0.040 🟨	0.036 🟨	0.050 🟨
Dicamba acid	H																0.027						
Difenoconazole	F																0.007						
Diuron	H					0.004			0.010			0.013	0.006										
Eptam	H								0.056	0.049													
Fludioxonil	F					0.019	0.027		0.014	0.010	0.011	0.011	0.011	0.026	0.014	0.018	0.022	0.022	0.025				
Imidacloprid	I											0.013 🟨											
MCPA	H							0.044	0.055	0.047	0.034							0.031	0.029				
Malaoxon	D																0.006						
Myclobutanil	F											0.008						0.015					
N,N-Diethyl-m-toluamide (DEET	IR										0.014			0.010	0.010								
Pendimethalin	H								0.067	0.040	0.044	0.036	0.029		0.019		0.024						
Sodium bentazon	H								0.054		0.048	0.042	0.042	0.042	0.054			0.042	0.055			0.063	
Tefluthrin	I															0.015 🟨							
Terbacil	H							0.139	0.213	0.072	0.139	0.098	0.058	0.057		0.036	0.125	0.155	0.080				
Thiamethoxam	I																				0.018	0.018	0.028
Triclopyr acid	H	0.049																					
Trifluralin	H								0.016			0.009	0.009										
Total Suspended Solids (mg/L)		19.0	13.0	43.0	32.0	29.0	27.0	28.0	26.0	12.0	4.0	9.0	4.0	5.5	5.0	16.0	30.0	3.0	4.0		7.0	5.0	5.0
Streamflow (cubic ft/sec)		--	--	--	--	--	--	--	--	66.9	38.7	77.3	43.4	49.4	35.1	62.5	97.8	34.3	40.5		240.7	176.6	167.6
Precipitation (total in/week)†		0.53	0.18	0.17	0.47	0.31	0.02	0.06	0.05	0.08	0.04	0.13	0.17	0.16	0	0	0	0	0		0.41	0	0.11

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

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* (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent)

† Washington State University AgWeatherNet station: Toppenish, (latitude: 46.37°, longitude: -120.39°)

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard for temperature on June 5 and July 3 (Figure 33).

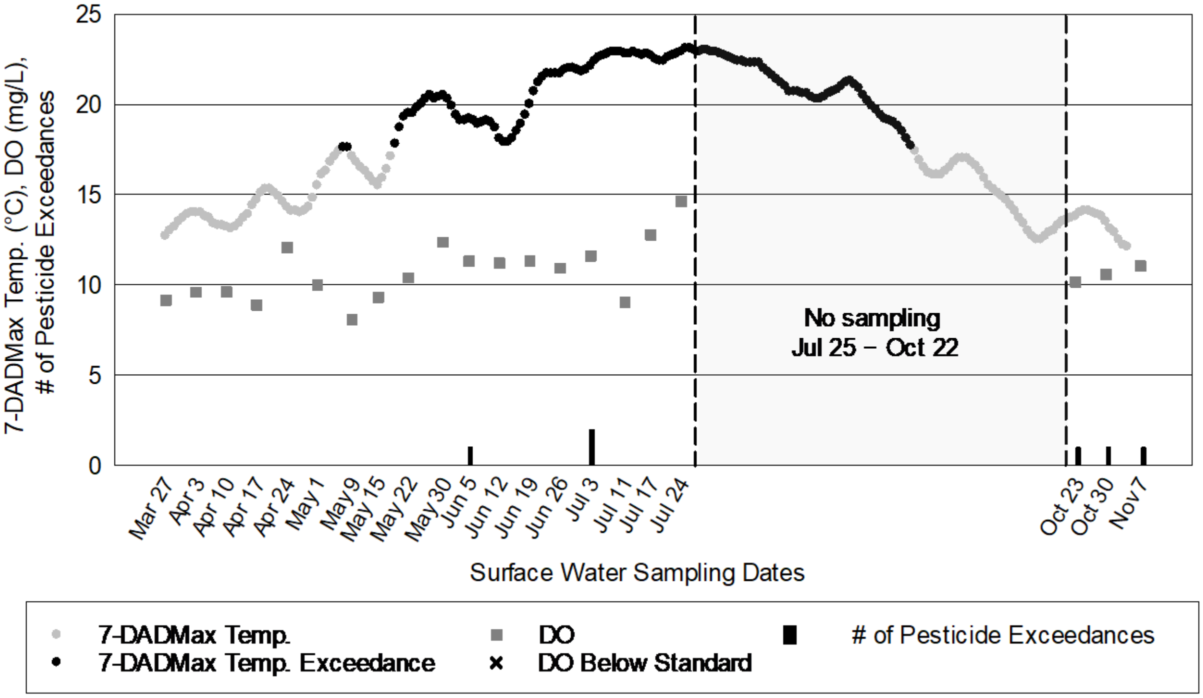
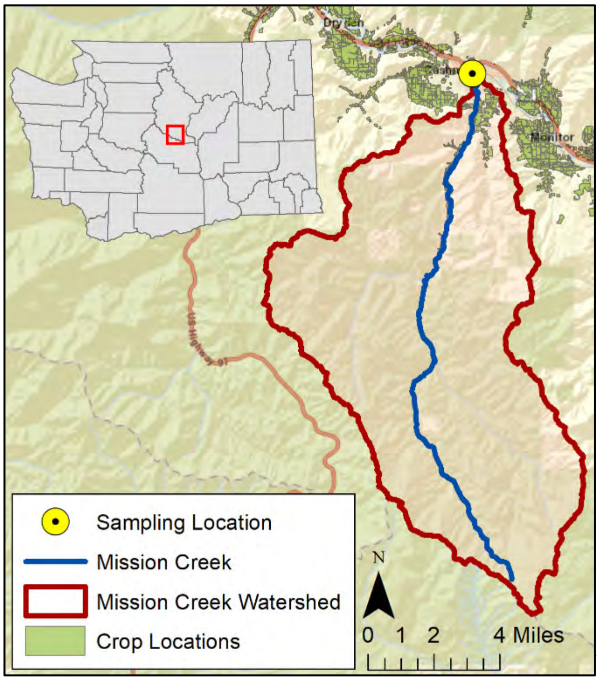


Figure 33 – Marion Drain occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

The pH measurements from 21 site visits ranged from 7.26 to 8.75 with an average of 7.69. The single pH measurement exceeding the pH standard of 8.5 on July 24 coincided with a 7-DADMax standard exceedance. There were no DO measurements below the state water quality standard (8 mg/L). DO ranged from 8.05 mg/L to 14.64 mg/L with an average of 10.67 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C standard for 122 days of the sampling season, from May 7 to May 8 and from May 19 to September 15.

Marion Drain has been designated as a freshwater body that provides habitat for salmonid spawning, rearing and migration by the WAC (WAC, 2019). NRAS staff at the site frequently observed juvenile fish of an unknown species. This drainage will continue to be monitored because of its representative regional land use, historical sampling, and consistent, yearly detections of POCs.

Mission Creek



drainage area

Table 25 – Mission Creek watershed crop groups and associated acreage

Mission Crop Groups	Acres
Orchard	577
Other	82
Hay/Silage	8
Commercial Tree	4
Total Ag	671
Total Non-Ag	51,716
Watershed Total	52,387

The Mission watershed in Chelan County has been sampled by WSDA since 2007. In 2016 the monitoring location on Mission Creek was moved downstream in order to incorporate a larger watershed capture area. Currently, the site is located in Cashmere, approximately 10 meters downstream from the bridge crossing of Sunset Highway where Ecology manages a stream gauging station (latitude: 47.5212º, longitude: -120.4760º) (Figure 34).

Mission Creek joins Brender Creek approximately 130 meters upstream of its confluence with the Wenatchee River. Flows in this stream are generally influenced by melting snowpack, precipitation events, and irrigation. The WDFW has documented summer spawning of steelhead at the headwaters of Mission Creek (WDFW, 2019). Juvenile fish of unknown species were frequently observed by staff at the site (Figure 35).

Figure 34 – Mission Creek downstream view

The watershed that contains the 18.5-mile-long Mission Creek is characterized by mountainous terrain. The agricultural land use is dominated by tree fruit production of pears, cherries, and apples (Table 25). The 'Other' crop group category in Table 25 includes pasture and fallow fields.

Samples were collected at Mission Creek during the early spring and again from midsummer through the fall due to historically few pesticide detections during the late spring and early summer. In addition, samples were only tested for 130 different pesticides; 11 herbicides, 2 herbicide degradates and a wood preservative not commonly detected here were removed.

The Mission Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 26). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 26 – Mission Creek pesticide calendar (µg/L)

Month		**Apr**				**May**		**Jun**	**Jul**				**Aug**	
Day of the Month	Use*	4	11	18	25	2		27	5	10	18	25	1	8
4,4'-DDE	D									0.013		0.009		
Chlorpyrifos	I	0.383	0.327											
Difenoconazole	F									0.007				
Fipronil sulfide	D									0.013				
Imidacloprid	I												0.018	
Malathion	I	0.223	0.273											
Piperonyl butoxide (PBO)	Sy	0.113	0.176											
Spirotetramat	I												0.041	
Total Suspended Solids (mg/L)		63.0	188.0	64.5	46.0	22.0		7.0	6.0	7.0	11.0	4.0	3.0	3.0
Streamflow (cubic ft/sec)		--	135.0	148.0	132.0	103.0		20.6	15.1	14.3	11.7	9.9	7.4	6.7
Precipitation (total in/week)†		0.19	0.57	0.74	0.24	0		0	0	0	0	0	0	0

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 130 unique pesticides in Mission Creek.
- There were 12 total pesticide detections in Mission Creek from 4 different use categories: 4 types of insecticides, 1 fungicide, 2 degradates, and 1 synergist.
- Pesticides were detected at 5 (42%) of the 12 sampling events.
- Up to 3 pesticides were detected at the same time.
- Of the total pesticide detections, 7 were above WSDA's assessment criteria (Table 26).
    - The 2 detections of 4,4'-DDE, a degradate of DDT, exceeded NRWQC and WAC acute criteria (both 0.001 µg/L).

WSDA POCs detected in Mission Creek in 2017 included chlorpyrifos, imidacloprid, and malathion. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Both detections of chlorpyrifos were greater than the NRWQC and state WAC acute and chronic criteria (0.083 and 0.041 µg/L, respectively), the invertebrate LC_{50} (0.1 µg/L), invertebrate NOAEC (0.04 µg/L), and approaching the fish NOAEC (0.57 µg/L).
- Malathion was detected twice at concentrations greater than the invertebrate LC_{50} (0.098 µg/L), invertebrate NOAEC (0.06 µg/L), and the NRWQC chronic criterion (0.1 µg/L).
- The single detection of imidacloprid exceeded the NOAEC for invertebrates (0.01 µg/L).

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[*] (I: Insecticide, F: Fungicide, D: Degradate, Sy: Synergist)

[†] Washington State University AgWeatherNet station: N. Cashmere, (latitude: 47.51°, longitude: -120.43°)

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances in Mission Creek coincided with failures to meet the state water quality standard for temperature on July 25 and August 1 (Figure 36).

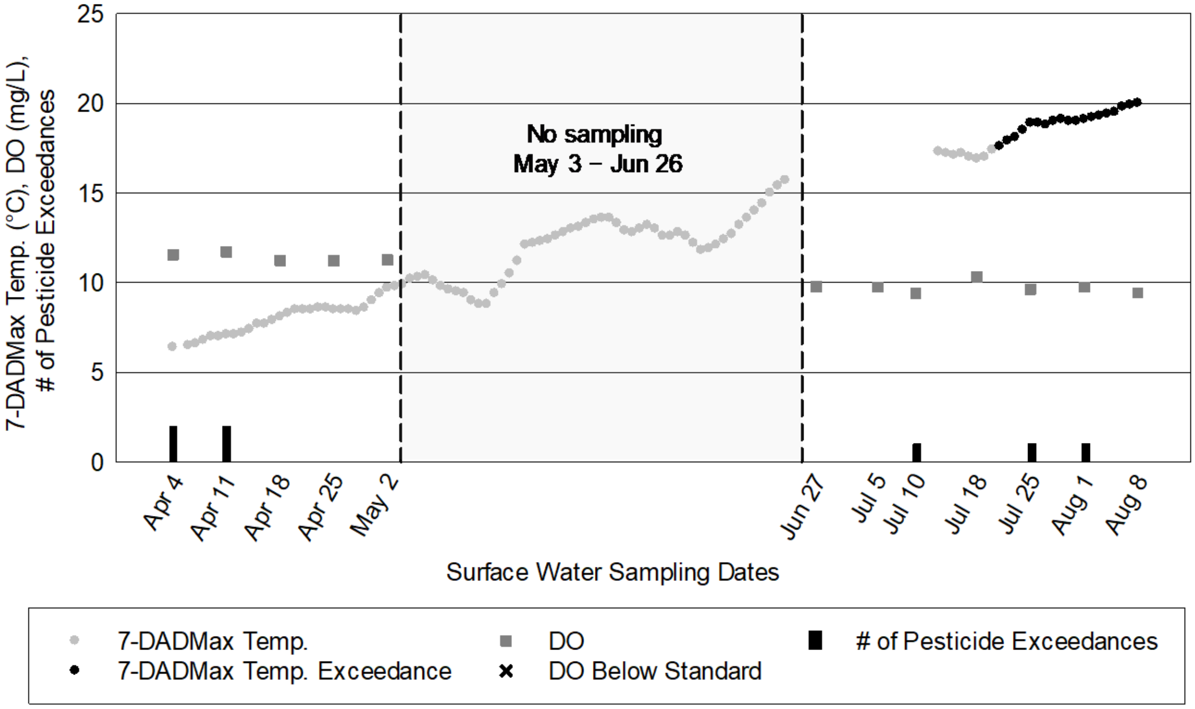

Figure 36 – Mission Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

The pH measurements from 12 site visits ranged from 8.08 to 8.52 and averaged 8.31. Of these measurements, 1 exceeded the state water quality standard (>8.5) on July 10. All DO measurements met the standard, ranging from 9.41 mg/L to 11.72 mg/L and averaging 10.42 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C water quality standard for 19 days of the sampling season from July 21 to August 8. For data collected between June 24 and July 12 the 7-DADMax could not be calculated because the temperature logger was exposured to ambient air. It is unknown if there was a 7-DADMax exceedance during this time.

Mission Creek provides habitat for salmonid spawning, rearing and migration. Dense riparian vegetation for most of the creek's length helps prevent pesticide contamination from runoff and application drift. This drainage will continue to be monitored because of its representative regional land use and consistent, yearly detections of POCs such as chlorpyrifos, malathion, and imidacloprid.

Naneum Creek

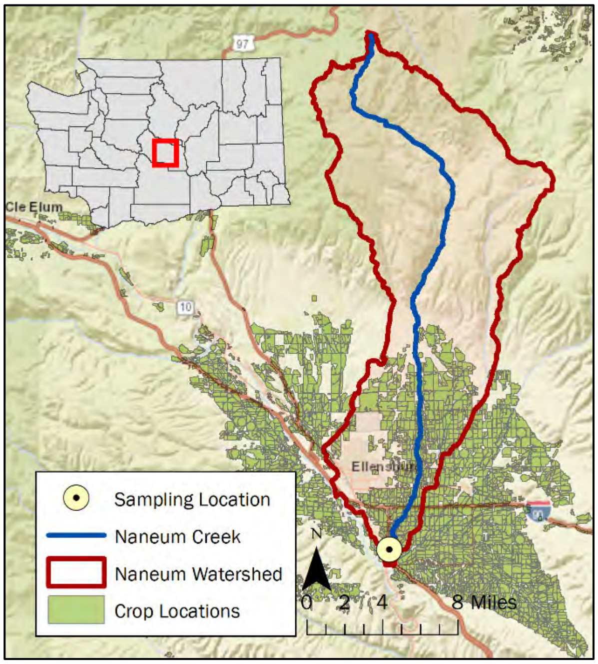

Figure 37 – Map of Naneum Creek and its drainage area

In 2017, WSDA started sampling the Naneum watershed in Kittitas County. The watershed was added to represent hay production and the mixed agricultural land uses located in the heavily irrigated Kittitas Valley. The Naneum Creek monitoring site also expands the monitoring program into an area where WSDA sampling has not taken place before as well as sampling in a watershed that is dominated by hay production which is uniquely specific to the Kittitas Valley. The site is located at the Fiorito Ponds public access road, approximately 700 feet south of the bathroom (latitude: 46.9380°, longitude: -120.5062°) (Figure 37).

Table 27 – Naneum Creek watershed crop groups and associated acreage

Naneum Crop Groups	Acres
Other	10,377
Hay/Silage	9,247
Cereal Grain	637
Vegetable	11
Herb	3
Total Ag	20,275
Total Non-Ag	93,584
Watershed Total	113,859

The 35.4-mile-long Naneum Creek drains indirectly into the Yakima River through Wilson Creek. Flows in this stream are generally influenced by melting snowpack, precipitation events, and irrigation (Figure 38). The WDFW has documented spring Chinook salmon, coho salmon, and summer steelhead in the reach of the creek that encompasses the monitoring site (WDFW, 2019).

Figure 38 – Naneum Creek downstream view

The watershed is characterized by mountainous terrain in the upper half with a transition into low-lying, flat terrain in the bottom half of the watershed where crops are plentiful. The agricultural land use is predominantly pasture, timothy hay, alfalfa hay, grass hay, and oats (Table 27). The ‘Other’ crop group category in Table 27 includes pasture and fallow fields.

The Naneum Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 28). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits.

Table 28 – Naneum Creek pesticide calendar (µg/L)

Month		**Apr**		**May**			**Jun**		**Jul**		**Aug**		**Sep**		**Oct**		
Day of the Month	Use*	4	18	2	16	31	13	27	10	24	7	21	5	19	2	17	30
2,4-D	H				0.080	0.335	0.086	0.077	0.170	0.416	0.114	0.252	0.066	0.267	0.173	0.054	
Chlorantraniliprole	I					0.004											
Clopyralid	H									0.149				0.424		0.098	
Dicamba acid	H				0.153	0.318	0.048	0.028	0.097	0.337	0.103	0.065	0.057	0.159	0.034	0.047	
Diuron	H				0.014	0.018	0.014										
Imazapyr	H					0.010											
MCPA	H				0.099	0.127	0.028	0.039	0.054	0.054					0.047		
Metolachlor	H															0.196	
Pentachlorophenol	WP					0.023			0.023		0.025						
Pyraclostrobin	F										0.002						
Sodium bentazon	H																0.064
Triazine DEA degradate	D					0.185					0.023						
Triclopyr acid	H				0.048		0.036		0.072	0.372	0.149	0.029		0.076	0.086	0.041	0.038
Total Suspended Solids (mg/L)		18.0	24.0	16.0	22.0	30.0	19.0	26.0	7.0	9.0	7.0	19.0	12.0	4.0	5.0	3.0	--
Streamflow (cubic ft/sec)		130.4	166.7	162.2	--	--	129.4	112.4	61.7	44.2	57.3	97.0	115.8	84.2	85.1	69.4	28.3
Precipitation (total in/week)†		0.12	0.83	0	0.13	0.07	0.15	0	0	0	0	0	0	0.01	0	0.02	0

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Naneum Creek.
- There were 57 total pesticide detections in Naneum Creek from 5 different use categories: 9 types of herbicides, 1 insecticide, 1 fungicide, 1 degradate, and 1 other pesticide-related chemical.
- Pesticides were detected at 13 (81%) of the 16 sampling events.
- Up to 8 pesticides were detected at the same time (Table 28).

WSDA POCs detected in Naneum Creek in 2017 included diuron, metolachlor, pentachlorophenol, and pyraclostrobin. None of the detections of these chemicals exceeded any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. There were no exceeding pesticide detections at Naneum Creek, however failures to meet the state water quality DO and temperature standards coincided on July 10 (Figure 39).

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[*] (I: Insecticide, H: Herbicide, F: Fungicide D: Degradate, WP: Wood preservative)

[†] Washington State University AgWeatherNet station: Broadview, (latitude: 46.97°, longitude: -120.5°)

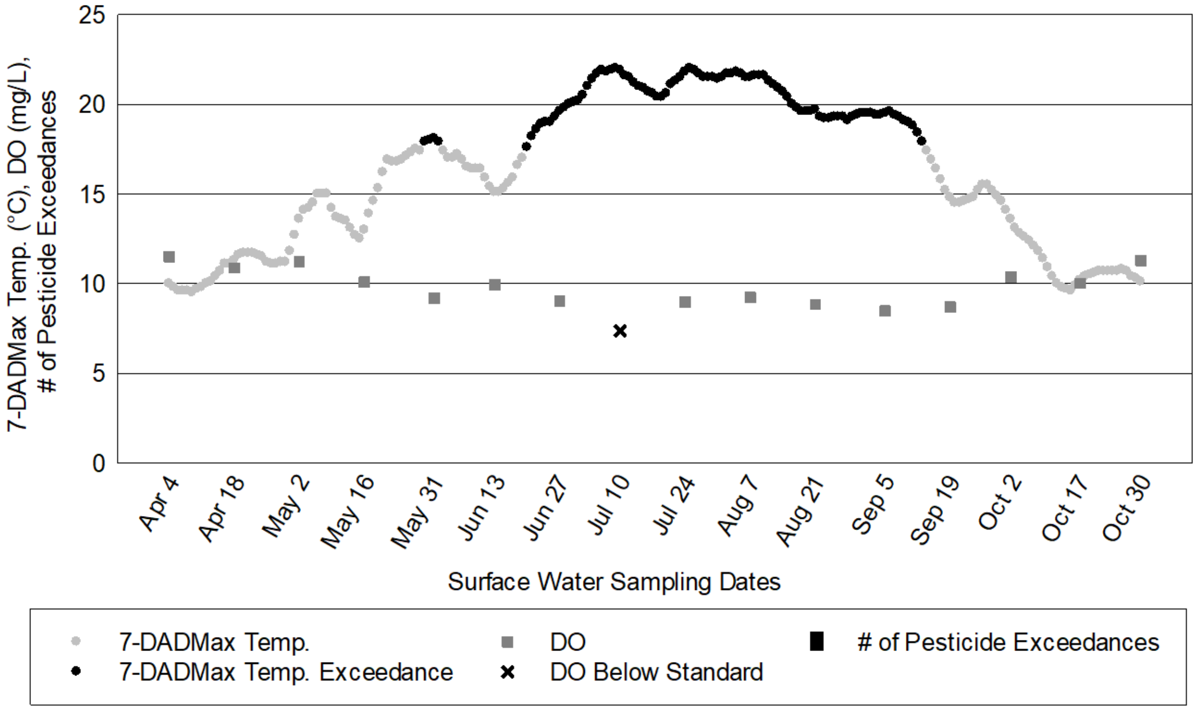

Figure 39 – Naneum Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

There were no pH measurements taken during the 2017 sampling season at this site that failed to meet state water quality standards. The pH measurements from 16 site visits ranged from 7.33 to 7.91 with an average of 7.66. Only 1 of the dissolved oxygen measurements was below this site's DO standard of 8 mg/L. The 16 DO measurements had concentrations ranging from 7.38 mg/L to 11.51 mg/L with an average of 9.70 mg/L. Water temperatures were greater than the 7-DADMax standard (17.5 °C) for 90 days of the sampling season, from May 29 to June 1 and from June 20 to September 13.

Naneum Creek has been designated as a freshwater body that provides habitat for salmonid spawning, rearing and migration by the WAC (WAC, 2019). Fish of unknown species have been observed upstream of the sampling site by NRAS staff. Monitoring will continue at this location through 2019 at which point it will be evaluated for continued monitoring efforts or dropped from the program.

Snipes Creek

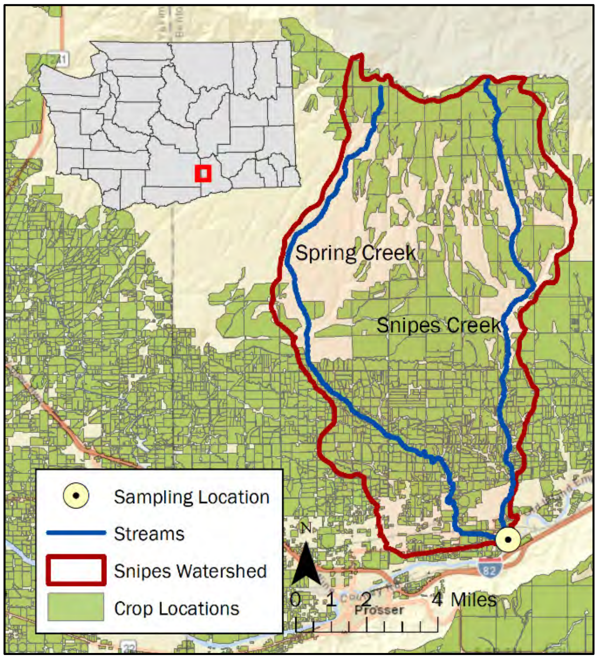

Figure 41 – Map of Snipes Creek and its drainage area

Table 29 – Snipes Creek watershed crop groups and associated acreage

Snipes Crop Groups	Acres
Other	14,054
Cereal Grain	7,058
Vineyard	4,875
Orchard	2,573
Herb	1,947
Hay/Silage	410
Berry	198
Nursery	6
Vegetable	4
Total Ag	31,125
Total Non-Ag	19,141
Watershed Total	50,266

The Snipes watershed in Benton County has been sampled by WSDA since 2016. A monitoring site in the Snipes Creek watershed on Spring Creek was sampled annually from 2003 to 2015. The monitoring site was moved downstream in order to incorporate a larger watershed capture area. Currently, the site is located near Prosser, approximately 20 meters downstream from the confluence of Spring Creek and Snipes Creek (latitude: 46.2332°, longitude: -119.6774°) (Figure 40).

The Snipes watershed contains the 14.9-mile-long Snipes Creek and 18.9 mile-long-Spring Creek which drain directly into the Yakima River. In 2017, unseasonably high streamflow was observed during the spring in Snipes Creek (Figure 41). Flows in this creek are generally influenced by melting snowpack, precipitation events, and irrigation. At times during the irrigation season, water is released from the Roza Canal into Snipes Creek. The WDFW has documented Chinook salmon, coho salmon, and steelhead within the reach of creek that encompasses the monitoring site (WDFW, 2019).

Figure 40 – Snipes Creek upstream view with average streamflow

The watershed is characterized by hilly terrain in the upper half that is protected through conservation programs or used for growing cereal with a transition into low-lying, flat terrain in the bottom half of the watershed where crop diversity increases substantially. The agricultural land use in Snipes Creek watershed is predominantly wheat, wine and juice grapes, hops, and apples (Table 29). The ‘Other’ crop group category in Table 29 includes pasture and fallow fields.

The Snipes Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 30). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits. Samples were collected at Snipes Creek during the spring and early summer and again during august due to historically few detections during July and the fall.

Table 30 – Snipes Creek pesticide calendar (µg/L)

Month		Mar		Apr				May				Jun				Jul		Aug			
Day of the Month	Use*	21	27	3	10	17	24	1	9	22	30	5	12	19	26	3		7	14	21	28
2,4-D	H	0.059				0.065	0.059	0.054	0.056	0.070	0.052	0.163	0.087	0.066	0.050	0.063		0.048	0.193	0.127	0.044
2,6-Dichlorobenzamide	D	0.017											0.008								
Boscalid	F												0.027	0.018							
Carbaryl	I								0.026												
Chlorantraniliprole	I													0.010							
Chlorpyrifos	I		0.034	0.118	0.080	0.049															
Dacthal (DCPA)	H	0.012							0.013												
Dicamba acid	H								0.042		0.020		0.020					0.030			
Diuron	H	0.192	0.078		0.034	0.038	0.016	0.017	0.039			0.011	0.007								
Fludioxonil	F												0.009	0.010		0.013					
MCPA	H							0.031	0.033	0.055											
Methoxyfenozide	I																	0.007			
Myclobutanil	F																			0.009	
N,N-Diethyl-m-toluamide (DEET	IR											0.009	0.008								
Pendimethalin	H								0.030												
Pyraclostrobin	F																			0.008	
Pyrimethanil	F		0.011																		
Spirotetramat	I												0.008								
Thiamethoxam	I												0.006								
Total Suspended Solids (mg/L)		19.0	24.0	58.0	28.0	21.0	272.0	23.0	44.0	21.0	28.0	24.0	28.5	29.0	16.0	25.0		26.0	30.0	19.0	12.0
Streamflow (cubic ft/sec)		4.0	12.9	--	--	84.3	87.0	--	87.0	43.6	45.2	40.6	35.8	84.2	23.3	31.6		44.6	76.1	54.4	75.2
Precipitation (total in/week)†		0.35	0.35	0.17	0.11	0.46	0.50	0.13	0.28	0.32	0	0.03	0	0.09	0	0		0	0.07	0	0

The “--“ signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Snipes Creek.
- There were 56 total pesticide detections in Snipes Creek from 5 different use categories: 6 types of insecticides, 6 herbicides, 5 fungicides, 1 degradate, and 1 other pesticide-related chemical.
- Pesticides were detected at 19 (100%) of the 19 sampling events.
- Up to 9 pesticides were detected at the same time.
- Field staff found an empty pesticide bag in the water on May 22 with an ingredient list that included 2,4-D and dicamba. Dicamba was not detected on May 22 but was detected May 9 and May 30, 2,4-D was detected frequently in samples from Snipes Creek.
- Of the total pesticide detections, 4 were above WSDA’s assessment criteria (Table 30).

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate, IR: Insect repellent)

[†] Washington State University AgWeatherNet station: WSU Prosser, (latitude: 46.26°, longitude: -119.74°)

WSDA POCs detected in Snipes Creek in 2017 included chlorpyrifos, diuron, pyraclostrobin, and thiamethoxam. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Detections of chlorpyrifos April 3, April 10, and April 17 exceeded the invertebrate NOAEC criterion (0.04 µg/L). The April 3 detection also exceeded the NRWQC and WAC acute and chronic criteria (0.083 and 0.041 µg/L, respectively) and the invertebrate LC_{50} (0.1 µg/L).
- The detections of diuron, pyraclostrobin, and thiamethoxam did not exceed any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. Pesticide exceedances coincided with failures to meet the state water quality standard for pH on March 27 (Figure 42, Figure 43).

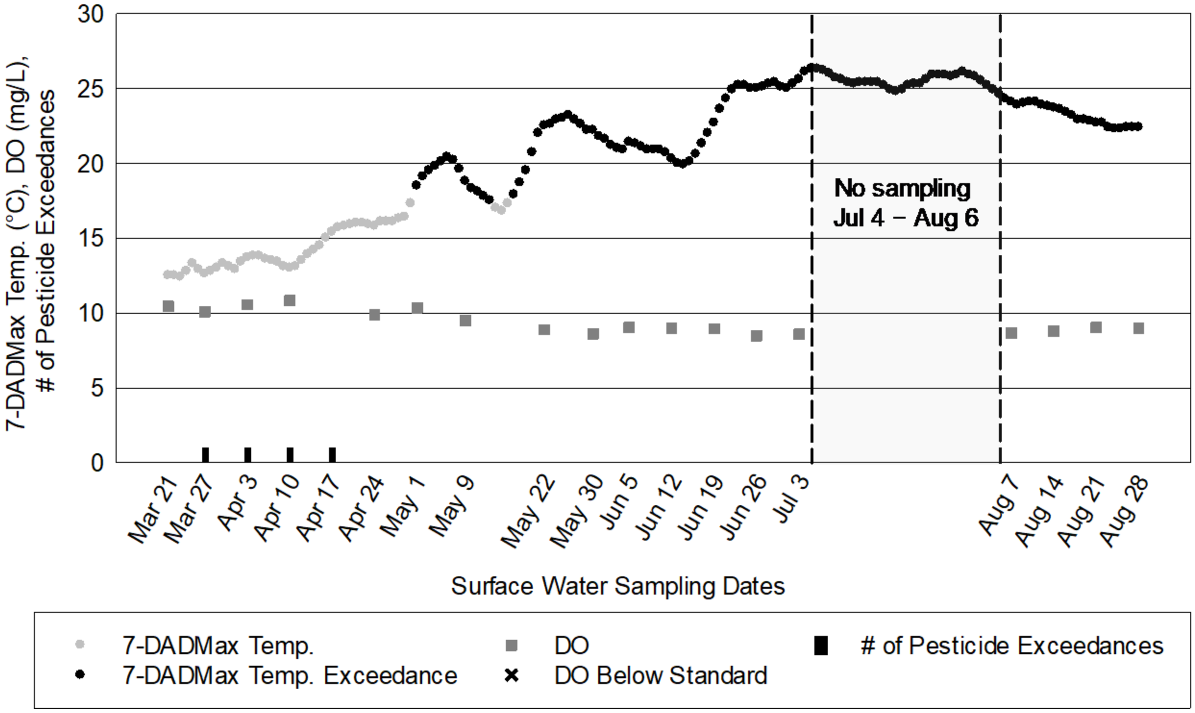

Figure 42 – Snipes Creek occurrences of failures to meet state water quality 7-DADMax standards and exceedances of WSDA assessment criteria

Due to equipment malfunctions April 17, pH and DO were not measured. However, data from the other 18 site visits were of acceptable data quality. All DO measurements taken during the 2017 sampling season met this site’s DO standard of 8 mg/L. DO ranged from 8.49 mg/L to 10.83 mg/L with an average of 9.37 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C standard for 117 days of the sampling season, from May 1 to May 13 and from May 17 to August 28.

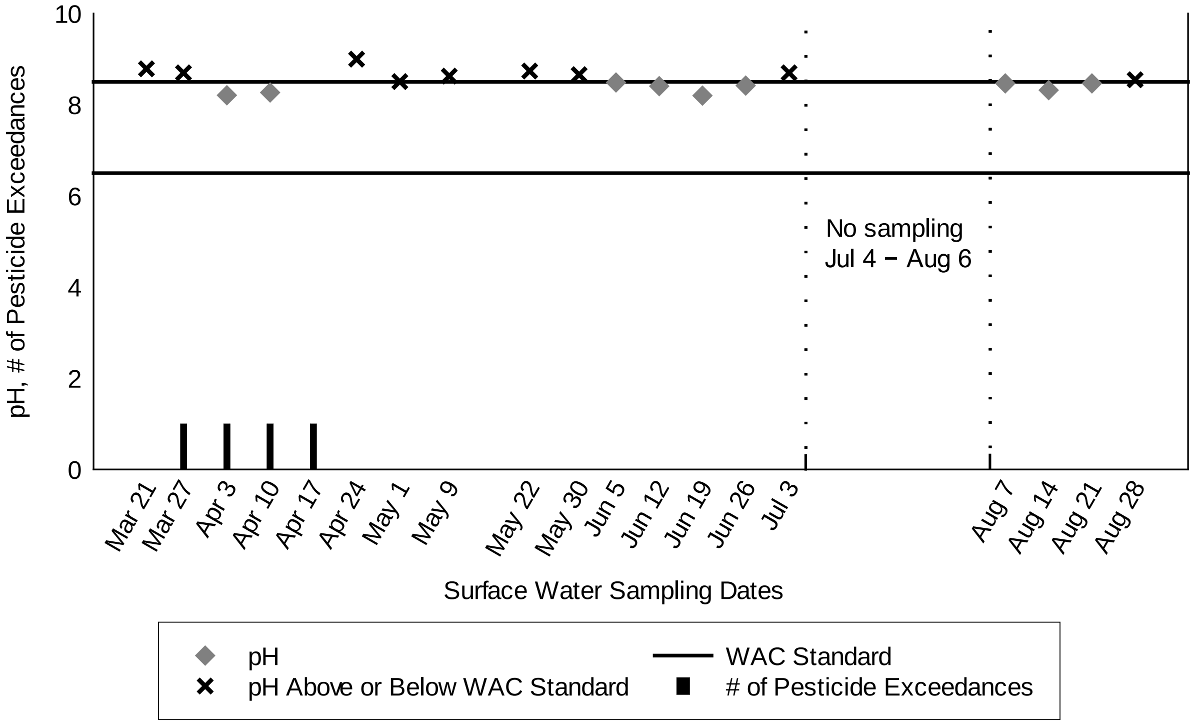

Figure 43 – Snipes Creek occurrences of failures to meet state pH standards and exceedances of WSDA assessment criteria

The pH measurements ranged from 8.20 to 9.00 with an average of 8.53. Half of the pH measurements (9) exceeded the standard of 8.5 (Figure 43). There were 6 exceeding pH measurements that coincided with 7-DADMax standard exceedances. A pesticide exceedance March 27 coincided with a pH measurement that failed to meet the state standard.

Snipes Creek has been designated as a freshwater body that provides habitat for salmonid spawning, rearing and migration by the WAC (WAC, 2019). Juvenile fish of an unknown species were observed in Snipes Creek during the sampling season. A fish passage blockage restricts salmonids from migrating beyond Spring Creek’s crossing with Hess Road. Snipes Creek is believed to be uninhibited from fish passage blockages. This drainage will continue to be monitored because of its representative regional land use and consistent, yearly detections of POCs such as chlorpyrifos.

Stemilt Creek

The Stemilt watershed in Chelan County has been sampled by WSDA since 2013. The site is located near Wenatchee, WA, approximately 30 meters upstream of the bridge over the creek on Old West Malaga Road (latitude: 47.3748°, longitude: -120.2496°) (Figure 44).

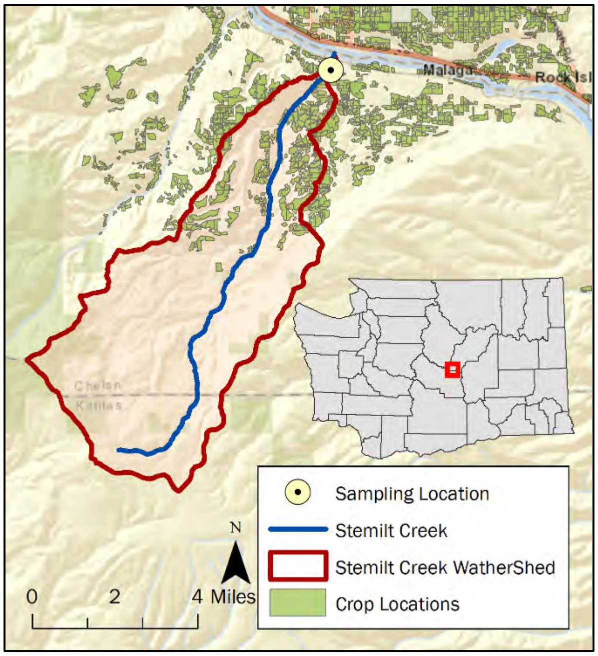

Figure 45 – Map of Stemilt Creek and its drainage area

Stemilt Creek water drains directly into the Columbia River. Flows in this creek are generally influenced by melting snowpack, precipitation events, and irrigation (Figure 45). The WDFW has documented spring Chinook salmon and summer steelhead within the reach of creek that encompasses the monitoring site (WDFW, 2019). WDFW also notes that the inlet of Stemilt Creek provides rearing habitat for salmon.

Figure 44 – Stemilt Creek downstream view

Table 31 – Stemilt Creek watershed crop groups and associated acreage

Stemilt Creek Crop Groups	Acres
Orchard	1,745
Other	84
Vineyard	17
Hay/Silage	15
Nursery	6
Total Ag	1,867
Total Non-Ag	19,326
Watershed Total	21,193

The watershed that contains the 12.4-mile-long Stemilt Creek is characterized by mountainous terrain. The Stemilt Creek site was selected to be representative of agricultural practices used in tree fruit cultivation in Central Washington. The agricultural land use is dominated by production of cherries, apples, and pears (Table 31). The 'Other' crop group category in Table 31 includes pasture and fallow fields.

The Stemilt Creek monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 32). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits. Samples were only collected at this site during the spring and early summer due to historically few pesticide detections at this site during the late summer and fall.

Table 32 – Stemilt Creek pesticide calendar (µg/L)

Month		Apr				May			Jun				Jul			
Day of the Month	Use*	4	11	18	25	2	23	31	6	13	21	27	5	10	18	25
2,6-Dichlorobenzamide	D	0.012	0.012							0.015	0.015	0.033	0.034	0.062	0.039	0.069
Boscalid	F										0.036	0.051	0.085	0.051	0.035	0.040
Bromacil	H												0.011			
Chlorpyrifos	I	0.036	0.043	0.049	0.019											
Diazinon	I		0.120													
Imidacloprid	I											0.084	0.060			
Malaoxon	D														0.002	
Malathion	I	0.047														
Methoxyfenozide	I															0.006
Picloram	H															0.037
Total Suspended Solids (mg/L)		21.0	21.0	19.0	13.5	9.0	46.0	16.0	13.0	11.0	7.0	6.0	4.0	5.0	48.0	2.0
Streamflow (cubic ft/sec)		27.9	35.5	43.8	45.1	35.0	--	--	35.4	11.3	6.7	1.2	0.7	0.5	1.8	0.1
Precipitation (total in/week)†		0.18	0.57	1.14	0.29	0	0.05	0	0.06	0.08	0.06	0	0	0	0	0

The "--" signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Stemilt Creek.
- There were 27 total pesticide detections in Stemilt Creek from 4 different use categories: 5 types of insecticides, 2 herbicides, 1 fungicide, and 2 degradates.
- Pesticides were detected at 11 (73%) of the 15 sampling events.
- Up to 4 pesticides were detected at the same time.
- Of the total pesticide detections, 7 were above WSDA's assessment criteria (Table 32).

WSDA POCs detected in Stemilt Creek in 2017 included chlorpyrifos, diazinon, imidacloprid, and malathion. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

- Only 3 of the 4 chlorpyrifos detections exceeded WSDA assessment criteria. The detections on April 11 and April 18 were greater than the NRWQC and state WAC chronic criteria (0.041 µg/L) and the invertebrate NOAEC (0.04 µg/L).
- The single detection of diazinon approached the invertebrate LC_{50} and NOAEC criteria (0.21 µg/L and 0.17 µg/L, respectively).
- Both detections of imidacloprid exceeded the NOAEC for invertebrates (0.01 µg/L).
- Malathion was detected once at a concentration approaching the invertebrate NOAEC (0.06 µg/L).

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be

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[*] (I: Insecticide, H: Herbicide, F: Fungicide, D: Degradate)

[†] Wash. State Univ. AgWeatherNet station: Wenatchee Heights, (latitude: 47.37°, longitude: -120.31°)

compounded. Pesticide exceedances coincided with failures to meet the state water quality standard at this site for temperature on June 27 and July 5 (Figure 46).

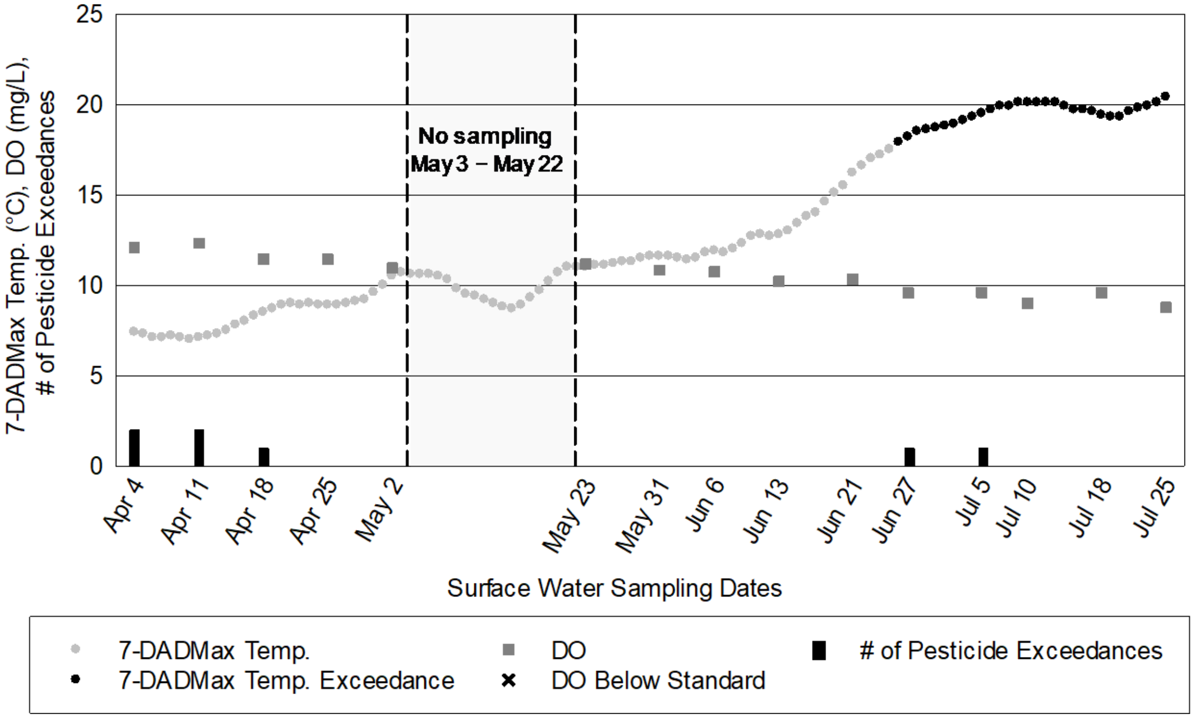

Figure 46 – Stemilt Creek occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

No DO or pH measurements taken during the 2017 sampling season at this site exceeded state water quality standards. The pH measurements from 15 site visits ranged from 7.66 to 8.39 with an average of 8.09. The DO measurements ranged from 8.76 mg/L to 12.32 mg/L with an average of 10.53 mg/L. Of the measured water quality parameters, only the 7-DADMax standard was exceeded at Stemilt Creek between June 26 and July 25.

Stemilt Creek has been designated as a freshwater body that provides habitat for salmonid spawning, rearing and migration by the WAC (WAC, 2019). Fish believed to be juvenile salmonids were frequently observed during site visits. This drainage will continue to be monitored because of its representative regional land use and consistent, yearly detections of POCs such as chlorpyrifos and malathion.

Sulphur Creek Wasteway

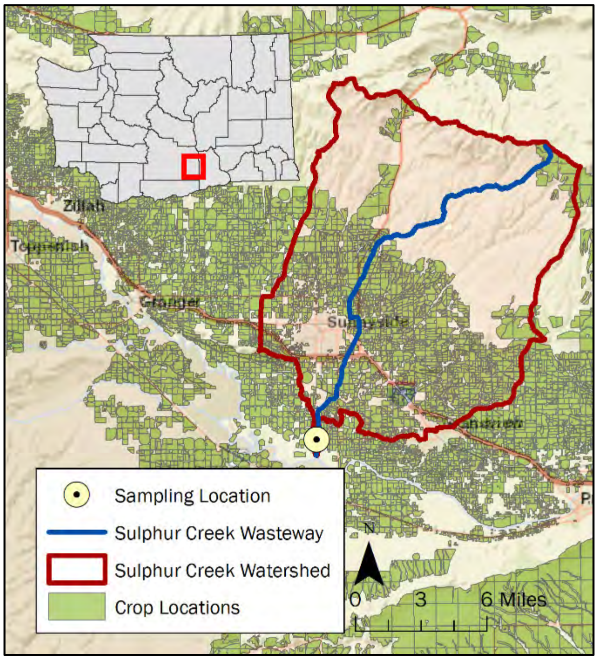

Figure 48 – Map of Sulphur Creek Wasteway and its drainage area

Table 33 – Sulphur Creek Wasteway watershed crop groups and associated acreage

Sulphur Crop Groups	Acres
Vineyard	10,338
Cereal Grain	9,814
Other	6,617
Orchard	6,196
Hay/Silage	4,406
Herb	2,638
Vegetable	910
Nursery	128
Green Manure	120
Turfgrass	114
Berry	11
Total Ag	41,292
Total Non-Ag	60,990
Watershed Total	102,282

The Sulphur Creek Wasteway watershed in Yakima County has been sampled by WSDA since the start of the monitoring program in 2003. The site is located near Sunnyside, just on the downstream side of the Holaday Road bridge crossing, adjacent to the intersection of Midvale Road (latitude: 46.2510°, longitude: -120.0200°) (Figure 47).

Sulphur Creek Wasteway water drains directly into the Yakima River approximately 0.8 miles downstream of the monitoring site. Flows in the wasteway are generally influenced by precipitation events, irrigation, and groundwater. Some of the water in the watershed comes from the Yakima River, distributed by canal systems like the Roza and Sunnyside, with the excess water returned into Sulphur Creek Wasteway. The WDFW documented Chinook salmon, coho salmon, and steelhead within the reach of wasteway downstream of the fish barrier near the Holaday Road crossing (WDFW, 2019). The fish barrier was constructed in order to restrict salmon from migrating further upstream in the irrigation return channel due to unfavorable habitat conditions (Figure 48).

Figure 47 – Sulphur Creek Wasteway downstream view

The watershed that contains the 22.8-mile-long Sulphur Creek Wasteway is characterized by flat, low-lying terrain. The agricultural land use is predominantly field corn, juice grapes, apples, wine grapes, and alfalfa hay (Table 33). The ‘Other’ crop group category in Table 33 includes pasture and fallow fields.

The Sulphur Creek Wasteway monitoring site pesticide calendar provides a chronological overview of the pesticides detected during the 2017 monitoring season and a visual comparison to WSDA assessment criteria (Table 34). The blank cells in the calendar indicate dates when no chemical was detected with confidence above reportable limits. Samples were only collected during the spring and early summer due to historically few pesticide detections during the late summer and fall at this site.

Table 34 – Sulphur Creek Wasteway pesticide calendar (µg/L)

Month		**Mar**		**Apr**				**May**					**Jun**
Day of the Month	Use*	21	27	3	10	17	24	1	9	15	22	30	5
2,4-D	H			0.037		0.100	0.130	0.057	0.066	0.131	0.726	0.069	0.065
2,6-Dichlorobenzamide	D	0.019											0.009
Chlorpyrifos	I			0.146	0.067	0.039							
Dacthal (DCPA)	H		0.009								0.013	0.013	
Dicamba acid	H								0.023	0.035	0.046	0.020	
Diuron	H	0.048	0.089	0.019	0.051	0.143	0.036	0.011	0.021	0.024		0.015	0.008
Imazapyr	H	0.017											
MCPA	H								0.035	0.046			
Metolachlor	H								0.016			0.008	
N,N-Diethyl-m-toluamide (DEET)	IR											0.025	0.012
Pendimethalin	H		0.045			0.048			0.039	0.029		0.022	
Terbacil	H	0.227											
Triazine DEA degradate	D		0.011		0.009								
Triclopyr acid	H									0.031			
Total Suspended Solids (mg/L)		70.0	88.0	81.0	88.0	64.0	56.0	30.0	65.0	56.0	80.0	46.0	23.0
Streamflow (cubic ft/sec)		485.00	201.36	324.50	430.00	291.20	260.32	197.24	296.80	220.70	270.16	218.48	225.14
Precipitation (total in/week)†		0.07	0.35	0.17	0.15	0.54	0.60	0.06	0.11	0.22	0.85	0.05	0.04

The “--“ signifies a sample or measurement that was not collected or could not be analyzed.

🟨 Current-use exceedance 🟧 DDT/degradate exceedance 🟦 Detection

- In 2017, WSDA tested for 144 unique pesticides in Sulphur Creek Wasteway.
- There were 48 total pesticide detections in Sulphur Creek Wasteway from 4 different use categories: 10 types of herbicides, 1 insecticide, 2 degradates, and 1 other pesticide-related chemical.
- Pesticides were detected at 12 (100%) of the 12 sampling events.
- Up to 7 pesticides were detected at the same time.
- Of the total pesticide detections, 3 were above WSDA’s assessment criteria (Table 34).

WSDA POCs detected in Sulphur Creek Wasteway in 2017 included chlorpyrifos, diuron, and metolachlor. Below, each POC detected is compared to any corresponding state, national, or toxicity criteria that were exceeded.

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[*] (I: Insecticide, H: Herbicide, D: Degradate, IR: Insect repellent)

[†] Washington State Univ. AgWeatherNet station: Port of Sunnyside, (latitude: 46.28°, longitude: -120.01°)

- All 3 detections of chlorpyrifos exceeded assessment criteria. The detections on April 3 and April 10 were greater than the NRWQC and state WAC acute and chronic criteria (0.083 and 0.041 µg/L, respectively) and invertebrate NOAEC (0.04 µg/L). The detection on April 3 also exceeded the invertebrate LC_{50} criterion (0.1 µg/L). On April 17, the concentration detected was approaching the invertebrate NOAEC (0.04 µg/L).
- The detections of diuron and metolachlor did not exceed any assessment criteria.

When water quality parameters fail to meet state water quality standards in concurrence with exceedances of pesticide assessment criteria, stress on aquatic life may be compounded. No pesticide exceedances coincided with failures to meet state water quality standards during the 2017 sampling season at Sulphur Creek Wasteway (Figure 49).

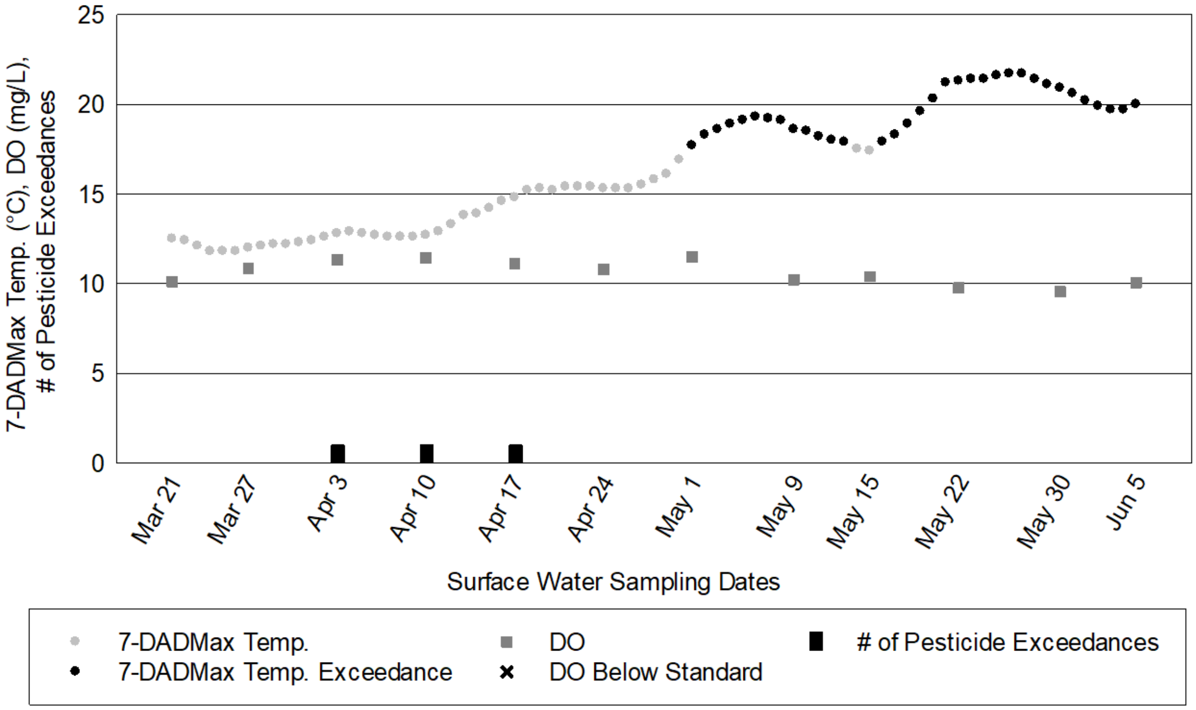

Figure 49 – Sulphur Creek Wasteway occurrences of failures to meet state water quality standards and exceedances of WSDA assessment criteria

The pH measurements from 12 site visits ranged from 8.00 to 8.57 with an average of 8.26. The single pH measurement exceeding the pH standard on May 1 coincided with a 7-DADMax standard exceedance. There were no DO measurements that fell below the state water quality standard (6.5 mg/L) for this site. DO ranged from 9.55 mg/L to 11.49 mg/L with an average of 10.60 mg/L. The 7-DADMax temperatures were greater than the 17.5 °C standard for 34 days of the sampling season, from May 1 to May 13 and from May 16 to June 5.

Sulphur Creek Wasteway provides habitat for salmonid rearing and migration. During particularly warm weather periods, Sulphur Creek Wasteway contributes cooler water to the Yakima River and acts as a thermal refuge for salmon as they travel up the Yakima River to their spawning grounds (personal communication with USGS, 2019). Exceedances of the

7-DADMax standard during this time may further negatively affect these endangered species in the region. This drainage will continue to be monitored because of its representative regional land use and consistent, yearly exceedances of chlorpyrifos.

Statewide Results

WSDA selects sites where, based on land use or historic pesticide detections, pesticide contamination and poor water quality are expected. Site comparison graphs based on total detections or exceedances are not found in this report due to variability in site characteristics and site-specific sampling practices. Each of the 16 current monitoring sites has distinct watershed and land use characteristics that dictate the pesticides detected. Different sites are sampled for different periods of time (12 to 26 sampling events) and samples from several sites are tested for a subset of pesticides compared to the majority of sites (130 to 144 analytes). In addition, WSDA monitoring sites are not representative of all Washington streams in terms of levels of pesticide contamination or other characteristics. Statewide summary information (Table 35) provides a useful overview but should be used with caution.

Table 35 – Statewide pesticide detections summarized by general use category

Pesticide general use category	# of analytes tested for	# of analytes detected	# of analytes with detections above assessment criteria	# of individual detections
Antimicrobial	1	1		4
Degradate	13	8		237
DDT and degradates	3	3	3	30
Fungicide	20	15	1	357
Herbicide	54	36	1	695
Insect repellent	1	1		27
Insecticide	49	19	10	268
Synergist	2	1		6
Wood preservative	1	1		15
Total analytes	144	85	15	1,639

There were 85 different analytes detected in 2017 (Table 35). Across 16 monitoring sites, WSDA identified 1,639 detections. To determine if the concentration of the detections could negatively affect aquatic life, WSDA compared each detection to WSDA assessment criteria.

There were 120 instances where pesticide analytes exceeded the WSDA assessment criteria listed in Appendix A: Assessment Criteria for Pesticides. The Monitoring Site Results section in this report discusses the individual exceedances in more detail while the Pesticide Detection Summary below divides the detections and associated exceedances by pesticide general use category.

Of the 120 individual exceedances, 90 (75%) were currently registered pesticides and the other 30 (25%) were detections of DDT or its degradates. More than half of the exceedances, 75 (63%), occurred at monitoring sites in Eastern Washington including all of the statewide exceedances of DDT or its degradates. Imidacloprid, a neonicotinoid insecticide, accounted for 42 (35%) of the individual exceedances and was found almost ubiquitously across monitoring sites (12 of 16). Naneum Creek, in Eastern Washington, was the only monitoring site that did not have a pesticide detection found at a concentration above any assessment criteria.

Carbendazim was the only new analyte tested for in 2017. Carbendazim is a fungicide that WSDA did not start testing for until April 17, a few weeks after the start of the sampling season. Approximately 18% of samples (45 detections) contained this analyte throughout the remainder of the sampling season.

Pesticide Detection Summary

Below, pesticide general use categories separate the summaries of statewide detections. This subsection only presents analytes detected in 2017. Appendix B: 2017 Quality Assurance Summary provides a list of all analytes tested.

Herbicide Detections

Herbicides were the most frequently detected group making up approximately 42% (695 detections) of the total pesticide detections. Of the 54 herbicides included in the laboratory analysis, 36 (67%) were detected in surface water samples. Table 36 provides a statewide summary of the detected herbicides.

Table 36 – Statewide summary of herbicides with 1 or more detections in 2017

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
2,4-D*	242	110 (45%)		12		0.033 - 0.726
Diuron	292	67 (23%)	1	12	1	0.004 - 4.390
Dichlobenil	292	54 (18%)		6		0.005 - 0.380
Metolachlor	292	47 (16%)		8		0.008 - 0.340
Dicamba acid*	242	44 (18%)		10		0.016 - 0.337
Imazapyr	292	40 (14%)		9		0.005 - 0.258
Triclopyr acid*	242	37 (15%)		7		0.027 - 0.935
MCPA*	242	36 (15%)		9		0.028 - 0.591
Tebuthiuron	292	33 (11%)		3		0.022 - 0.184
Sulfometuron methyl	292	30 (10%)		10		0.006 - 0.126
Simazine	292	26 (9%)		4		0.026 - 0.368
Mecoprop (MCPP)*	242	20 (8%)		4		0.010 - 0.184
Sodium bentazon*	242	20 (8%)		5		0.024 - 0.066
Dacthal (DCPA)*	242	19 (8%)		3		0.009 - 0.308
Oxadiazon	292	19 (7%)		2		0.016 - 0.297
Terbacil	292	19 (7%)		3		0.029 - 0.227
Bromacil	292	13 (4%)		4		0.011 - 0.039

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
Pendimethalin	292	13 (4%)		3		0.019 - 0.067
Isoxaben	292	12 (4%)		4		0.002 - 0.036
Metsulfuron-methyl	292	6 (2%)		4		0.015 - 0.095
Eptam	292	5 (2%)		3		0.020 - 0.146
Sulfentrazone	292	4 (1%)		2		0.027 - 0.087
Bromoxynil*	242	3 (1%)		1		0.027 - 0.056
Clopyralid*	242	3 (1%)		1		0.098 - 0.424
Trifluralin	292	3 (1%)		1		0.009 - 0.016
Atrazine	292	2 (1%)		2		0.028 - 0.032
Picloram*	242	1 (0%)		1		0.037 - 0.037
Chlorpropham	292	1 (0%)		1		0.049 - 0.049
Chlorsulfuron	292	1 (0%)		1		0.172 - 0.172
Cycloate	292	1 (0%)		1		0.048 - 0.048
Dithiopyr	292	1 (0%)		1		0.033 - 0.033
Napropamide	292	1 (0%)		1		0.026 - 0.026
Prodiamine	292	1 (0%)		1		0.030 - 0.030
Prometon	292	1 (0%)		1		0.013 - 0.013
Pyraflufen-ethyl	292	1 (0%)		1		0.036 - 0.036
Simetryn	292	1 (0%)		1		0.089 - 0.089

*Lower Brender Creek, Upper Brender Creek, and Mission Creek samples were not tested for these analytes.
WSDA considers bolded analytes to be POCs.

Of the herbicides detected, 2,4-D, diuron, and dichlobenil were the most frequently detected with 110, 67, and 54 detections, respectively. These were also the most commonly detected herbicides in 2015 and 2016. The herbicide, 2,4-D, was the second most detected pesticide overall. The highest detected concentration of an herbicide, diuron, was also the highest concentration of any pesticide detected at 4.390 µg/L. The second highest detected concentration of an herbicide was triclopyr acid at 0.935 µg/L.

The following herbicides were detected at over 50% of the monitoring sites:

- 2,4-D
- Diuron
- Dicamba acid
- Imazapyr
- MCPA
- Sulfometuron methyl

Only 1 herbicide, diuron, was detected above WSDA assessment criteria, accounting for less than 1% of the total exceedances in 2017. Diuron has been a WSDA POC since 2015. The 2018 WSDA POC’s metolachlor and sulfometuron methyl were detected but not at concentrations above WSDA assessment criteria.

Several of the herbicides detected break down into chemicals that may also negatively affect aquatic life. Below is a list of herbicides with a corresponding degradate that WSDA tests for.

- Dichlobenil → 2,6-dichlorobenzamide (detected at 13 monitoring sites),
- Atrazine → triazine DEA (detected at 3 monitoring sites) and triazine DIA (detected at 1 monitoring site).

Fungicide Detections

Fungicides were the second most frequently detected group of pesticides making up 357 detections, or 22%, of the total number of detections. In 2016, the fungicides were also the second most frequently detected group of pesticides making up 21% of the total number of detections. Of 20 fungicides included in the laboratory analysis, 15 (75%) were detected in surface water samples. Table 37 provides a statewide summary of the detected fungicides.

Table 37 – Statewide summary of fungicides with 1 or more detections in 2017

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
Boscalid	292	76 (26%)		7		0.018 - 0.508
Fludioxonil	292	63 (22%)		6		0.009 - 1.180
Azoxystrobin	292	55 (19%)		7		0.005 - 0.175
Carbendazim	254	45 (18%)	2	7	2	0.002 - 0.698
Metalaxyl	292	32 (11%)		4		0.016 - 0.981
Pyraclostrobin	292	18 (6%)		7		0.002 - 0.056
Difenoconazole	292	16 (5%)		7		0.007 - 0.197
Propiconazole	292	16 (5%)		6		0.006 - 0.129
Myclobutanil	292	13 (4%)		6		0.007 - 0.045
Trifloxystrobin	292	7 (2%)		3		0.007 - 0.039
Etridiazole	292	6 (2%)		1		0.007 - 0.115
Cyprodinil	292	4 (1%)		2		0.014 - 0.053
Chlorothalonil	292	3 (1%)		3		0.013 - 0.194
Fenarimol	292	2 (1%)		2		0.038 - 0.049
Pyrimethanil	292	1 (0%)		1		0.011 - 0.011

WSDA considers bolded analytes to be POCs.

Boscalid, fludioxonil, and azoxystrobin were the most commonly detected fungicides with 76, 63, and 55 detections, respectively. These were also the most commonly detected fungicides in 2015 and 2016. Detections of fungicides occur primarily at Western Washington sampling sites (approximately 86%). The wetter climate of Western Washington drives the usage of more fungicides than Eastern Washington. Fludioxonil had the highest detected concentration of a fungicide and third highest pesticide concentration overall at

1.18 µg/L followed by metalaxyl at 0.981 µg/L. At more than half of the monitoring sites, no fungicides were detected.

Carbendazim is rarely used as a fungicide and is more often found in the environment as a degradate (Montague et al., 2014). It is registered in Washington as a fungicide and is categorized as a funcigide in this program. WSDA does not test water samples for the parent compound, thiophanate-methyl, which degrades very quickly into carbendazim in surface water. Carbendazim was the only fungicide that exceeded WSDA assessment criteria, with 2 exceedances in 2017. In comparison, there were a total of 5 exceedances of fungicides in 2015 and none in 2016.

Insecticide Detections

Current-use insecticides were the third most frequently detected group of pesticides, representing approximately 16% (268 detections) of the total pesticide detections. Of the 49 current-use insecticides included in the laboratory analysis, 19 (39%) were detected in surface water samples. Table 38 provides a statewide summary of the detected insecticides.

Table 38 – Statewide summary of insecticides with 1 or more detections in 2017

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
Thiamethoxam	292	71 (24%)	3	10	2	0.005 - 0.771
Imidacloprid	292	42 (14%)	42	12	12	0.010 - 0.269
Oxamyl	292	37 (13%)		2		0.002 - 0.125
Dinotefuran	292	36 (12%)		2		0.038 - 1.980
Chlorpyrifos	292	27 (9%)	21	7	6	0.009 - 0.383
Clothianidin	292	14 (5%)	5	5	2	0.010 - 0.050
Malathion	292	10 (3%)	9	7	6	0.021 - 0.273
Diazinon	292	5 (2%)	1	3	1	0.014 - 0.120
Methoxyfenozide	292	5 (2%)		4		0.004 - 0.007
Spirotetramat	292	5 (2%)		4		0.008 - 0.754
Chlorantraniliprole	292	3 (1%)		3		0.004 - 0.010
Methiocarb	292	3 (1%)		1		0.023 - 0.067
Pyridaben	292	3 (1%)	3	3	3	0.027 - 0.062
Carbaryl	292	2 (1%)		2		0.011 - 0.026
Ethoprop	292	1 (0%)		1		0.083 - 0.083
Fipronil	292	1 (0%)	1	1	1	0.023 - 0.023
Methomyl	292	1 (0%)		1		0.007 - 0.007
Pyriproxyfen	292	1 (0%)	1	1	1	0.010 - 0.010
Tefluthrin	292	1 (0%)	1	1	1	0.015 - 0.015

WSDA considers bolded analytes to be POCs.

Thiamethoxam, imidacloprid, and oxamyl were the most commonly detected insecticides with 71, 42, and 37 detections, respectively. The insecticides thiamethoxam and imidacloprid were also the most commonly detected insecticides in 2015 and 2016. Both were the only insecticides detected at over 50% of the monitoring sites. Dinotefuran had the highest detected concentration of an insecticide at 1.980 µg/L followed by thiamethoxam at 0.771 µg/L. Dinotefuran also had the second highest overall pesticide concentration in 2017.

Detections of current-use insecticides accounted for 73% (87 detections) of all exceedances in 2017. In comparison, current-use insecticides accounted for 26% of total exceedances in 2016. The increase in insecticide exceedances is due largely to updated assessment criteria for imidacloprid, which had 42 exceedances in 2017. Of the 19 current-use insecticides detected in 2017, 53% (10 insecticides) had at least 1 cexceedance of WSDA assessment criteria. Several current-use insecticides were above WSDA assessment criteria every time they were detected: imidacloprid, pyridaben, pyriproxyfen, and tefluthrin.

Several of the insecticides detected break down into chemicals that may also negatively affect aquatic life. Below is a list of insecticides with a corresponding degradate that WSDA also tests for.

- Malathion → malaoxon (detected at 4 monitoring sites),
- Fipronil → fipronil sulfide (detected at 1 monitoring site),
- Oxamyl → oxamyl oxime (detected at 2 monitoring sites),
- Clothianidin → thiamethoxam. Although clothianidin degrades into thiamethoxam, both are registered independently in Washington.

Degradate and Other Pesticide Detections

This group includes degradates of current-use pesticides as well as several other pesticide-related chemicals. They were the least frequently detected groups of pesticides with degradates representing approximately 14% (237 detections) and pesticide-related chemicals representing 3% (52 detections) of total detections. Of the 13 current-use degradates included in the laboratory analysis, 8 (62%) were detected in surface water samples. Only 1 of the 2 synergists tested was detected. Each antimicrobial, wood preservative, and insect repellent had at least 1 detection. Table 39 provides a statewide summary of the detected degradates and other pesticide product ingredients.

Table 39 – Statewide summary of degradates and other pesticide products in 2017

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
Degradates:						
2,6-Dichlorobenzamide	292	174 (60%)		13		0.008 - 0.351
Oxamyl oxime	292	32 (11%)		2		0.010 - 0.260
Tetrahydrophthalimide	292	11 (4%)		2		0.017 - 0.607

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
Triazine DEA	292	7 (2%)		3		0.008 - 0.185
4-Nitrophenol*	242	6 (2%)		3		0.093 - 0.503
Malaoxon	292	4 (1%)		4		0.002 - 0.006
Triazine DIA	292	2 (1%)		1		0.045 - 0.067
Fipronil sulfide	292	1 (0%)		1		0.013 - 0.013
Antimicrobial:						
Triclosan	292	4 (1%)		4		0.017 - 0.025
Insect repellent:						
DEET	292	27 (9%)		10		0.008 - 0.063
Synergist:						
Piperonyl butoxide	292	6 (2%)		4		0.040 - 0.176
Wood preservative:						
Pentachlorophenol*	242	15 (6%)		6		0.019 - 0.041

*Lower Brender Creek, Upper Brender Creek, and Mission Creek samples were not tested for these analytes.
WSDA considers bolded analytes to be POCs.

The most frequently detected degradate was 2,6-dichlorobenzamide (degradate of the herbicide dichlobenil and fungicide fluopicolide) with 174 detections, followed by oxamyl oxime (degradate of carbamate insecticide oxamyl) with 32 detections. Detections of 2,6-dichlorobenzamide may be from either dichlobenil or fluopicolide; WSDA only tests samples for the presence of dichlobenil. The degradate 2,6-dichlorobenzamide was found ubiquitously throughout the season at the Western Washington sites and at all but 3 of the Eastern Washington sites. Oxamyl oxime and 2,6-dichlorobenzamide were also the most commonly detected degradates in 2016. There were no degradates from current-use pesticides that exceeded WSDA assessment criteria. Tetrahydrophthalimide had the highest detected concentration of a degradate at 0.607 µg/L followed by 4-nitrophenol at 0.503 µg/L. Tetrahydrophthalimide is the main breakdown product of captan, a fungicide, and the chemical 4-nitrophenol is a breakdown product of several natural and synthetic products.

Other associated pesticide ingredients detected include pentachlorophenol (detected 15 times). Pentachlorophenols main usage is for wood preservation. This chemical was a 2018 WSDA POC but no detections in 2017 exceeded WSDA assessment criteria. Also, the insect repellent DEET (N,N-Diethyl-m-toluamide), detected 27 times, was found at approximately 63% of monitoring sites. The only federally registered uses of DEET are for application to horses, the human body, and clothing.

Legacy Insecticide DDT and Degradate Detections

The US EPA banned products containing DDT in 1972. DDT and its associated degradates may be detected in areas where DDT-containing products were historically used because of its persistence in soils. Contaminated soil can enter surface water as a result of runoff or when sediment is disturbed.

Detected DDT and its associated degradates accounted for less than 2% (30 detections) of the total pesticide detections. All 3 legacy analytes included in the lab analysis were detected. A statewide summary of DDT and 2 of its degradates (4,4’-DDE and 4,4’-DDD) is shown below in Table 40.

Table 40 – Statewide summary of DDT and degradates with 1 or more detections in 2017

Analyte	# of samples collected	# of detections (% samples)	# of detections above WSDA assessment criteria	# of sites with detections	# of sites with exceeding detections	Concentration range (µg/L)
4,4'-DDE	292	22 (8%)	22	3	3	0.007 - 0.049
4,4'-DDD	292	5 (2%)	5	1	1	0.008 - 0.017
4,4'-DDT	292	3 (1%)	3	1	1	0.015 - 0.021

There were detections of all 3 legacy analytes. DDT’s degradate 4,4’-DDE was the most frequently detected legacy chemical with 22 detections. DDT and 2 of its associated degradates were only found at 3 monitoring sites in Eastern Washington. The highest detected concentration was 4,4’-DDE at 0.049 µg/L.

The parent compound 4,4’-DDT and its degradates (4,4'-DDE and 4,4'-DDD) accounted for 25% of the total exceedances detected in 2017. Of the 30 combined DDT exceedances, 28 (93%) were detected at the monitoring sites on Brender Creek. Although every detection of 4,4’-DDT, 4,4'-DDE, and 4,4'-DDD exceeded the state water quality criteria, these detections are not a result of current pesticide use patterns.

Conclusions

WSDA collected surface water monitoring data at 16 monitoring sites across Eastern and Western Washington in 2017. Water samples were collected during the peak pesticide application season (March – November) a total of 292 times. Samples taken from 13 of the monitoring sites were tested in a lab for 144 pesticide and pesticide-related chemicals while the remaining 3 monitoring sites were tested for a subset of 130 chemicals.

- Of 144 pesticides tested for, 85 unique pesticides were detected.
- WSDA detected pesticides in water samples a total of 1,639 times.
- Western Washington sites had more pesticide detections than Eastern Washington sites.
    - In Western Washington, the 7 monitoring sites had 1,135 (69%) total pesticide detections in 144 sampling events.
    - In Eastern Washington, the 9 monitoring sites had 504 (31%) total pesticide detections in 148 sampling events.
- 2,4-D, diuron, and dichlobenil were the most frequently detected herbicides (110, 67, and 54 times, respectively).
- Boscalid, fludioxonil, and azoxystrobin were the most frequently detected fungicides (76, 63, and 55 times, respectively).
- Thiamethoxam, imidacloprid, and oxamyl were the most frequently detected insecticides (71, 42, and 37 times, respectively).
- 2,6-dichlorobenzamide, a degradate of the herbicide dichlobenil, was the only chemical detected in over 50% (174 detections) of sampling events.

In 2017, monitoring sites commonly contained mixtures of pesticides in samples. There were 4 sites that had 2 or more pesticide detections at every sampling event during the entire field season. The maximum number of detections (20) at a single sampling event occurred May 16 at the Lower Bertrand Creek site. Although studies on the effects of pesticide mixtures are limited, there is evidence that indicates certain combinations of pesticides can have compounding adverse effects in aquatic systems (Broderius and Kahl, 1985).

In order to assess the potential effects of pesticide exposure to aquatic life and endangered species, WSDA compared detected pesticide concentrations to WSDA assessment criteria. There were 120 exceedances at 15 monitoring locations. Only 1 monitoring location, Naneum Creek in Eastern Washington, had no exceedances. Three-fourths of the total exceedances (90 exceedances) were from 12 current-use pesticides. Every detection of fipronil, imidacloprid, pyridaben, pyriproxyfen, and tefluthrin exceeded WSDA assessment criteria. However, not every detection of the other 7 pesticides did. Of the 90 current-use pesticide exceedances, 75 occurred at monitoring sites in Eastern Washington, and 45 occurred at monitoring sites in Western Washington. A summary of current-use pesticides with exceedances is below in Table 41. Detections of DDT and associated degradates accounted for the remaining one-fourth of the total exceedances across all monitoring sites (30 exceedances). Every detection of DDT exceeded WSDA assessment criteria. DDT was detected at 3 Eastern Washington sites and no Western Washington sites.

Table 41 – Summary of WSDA assessment criteria exceedances from current-use pesticides

Analyte	# of detections	# of detections above assessment criteria
Carbendazim	45	2
Chlorpyrifos	27	21
Clothianidin	14	5
Diazinon	5	1
Diuron	67	1
Fipronil	1	1
Imidacloprid	42	42
Malathion	10	9
Pyridaben	3	3
Pyriproxyfen	1	1
Tefluthrin	1	1
Thiamethoxam	71	3

Exceedances by current-use pesticide types are as follows.

- Out of 695 total herbicide detections, 1 detection exceeded criteria (<1%).
- Out of 357 total fungicide detections, 2 detections exceeded criteria (<1%).
- Out of 268 total insecticide detections, 87 detections exceeded criteria (33%).

WSDA creates a POC list annually, consisting solely of current-use pesticides, as a tool to identify pesticides in the state that have the potential to contaminate aquatic systems. The agricultural community, regulatory community, and public may also reference the POC list to keep informed about current pesticide trends in Washington State. WSDA's POC list includes mostly insecticides with very low assessment criteria. All current-use pesticides that exceeded assessment criteria in 2017, except carbendazim, were 2018 WSDA POCs (referenced in this report). The 2018 WSDA POC list did not include carbendazim because it is rarely used as a fungicide and is more often found in the environment as a degradate (Montague et al., 2014). Even though DDT and its degradates exceeded assessment criteria, they are not considered POCs because they are legacy chemicals that have not been registered for use in the US since 1972.

Washington State had approximately 870 pesticide active ingredients (including pesticides, synergists, adjuvants, and additives) registered for use in 2019 (WSPMRS, 2019). Surface water samples in 2017 were tested for roughly 17% of the total registered pesticide active ingredients. WSDA selects pesticides to test for based on lab capabilities, grower usage practices, pesticide characteristics, and toxicity to aquatic life. The analyte list is evaluated annually and pesticides are added and removed based on new registrations, label changes, changes in usage, changes in analytical equipment, and information from local and federal partners.

Generally speaking, pesticides are becoming more specific to the target organisms they are intended for. Insecticides usually have a low toxicity towards aquatic plants and vertebrates and a higher toxicity towards aquatic invertebrates. Meanwhile, herbicides and fungicides are often less toxic to fish and invertebrates but more toxic to aquatic plants. However, any pesticide at high enough concentrations in surface water can directly or indirectly effect ESA-listed salmonids. Invertebrates are the main food source of juvenile salmonids, and those invertebrates rely on aquatic plants to sustain their populations. If a pesticide is causing impairment to any organism, food webs and ecosystem functions can be potentially disrupted. Pesticide monitoring in Washington waterways is essential for understanding the fate and transport of pesticides that can cause water quality concerns. WSDA POCs should be given additional prioritization for management by WSDA and partners to ensure their concentrations are maintained or reduced below WSDA assessment criteria. WSDA will continue to implement the Pesticide Management Strategy as a way to identify and address specific pesticide issues, as well as promote public education and outreach efforts through presentations, reports, and watershed-specific fact sheets in order to support appropriate pesticide use.

Program Changes

From 2003 to 2016, each monitoring location was sampled weekly or biweekly for the duration of the Washington growing season from March through September with few exceptions. To optimize the use of WSDA resources, each individual monitoring site had a unique sampling schedule from 2017 on. Past field data, pesticide usage data, and agricultural land use data are used to customize each site's sampling schedule. Sampling schedules optimization continued in the 2018 sampling season.

A tiered site selection guideline is also being developed to determine how frequently sites should be monitored, when a monitored site can be discontinued from the program, and when and how new sites should be selected. This refined approach will allow WSDA to diversify monitoring locations across the state.

Starting in 2019, a POC decision matrix, adopted for use by EPA's Region 10 states (Alaska, Idaho, Oregon, and Washington), will be used to identify statewide and watershed-scale WSDA POCs. Exceedances of assessment criteria are still the cornerstone of the POC selection process, but the matrix also incorporates how detection frequency and the number of monitoring sites each pesticide is detected at.

All 7 monitoring sites sampled in Western Washington in 2017 continued to be sampled in 2018. Site changes in Eastern Washington included the removal of the Lower Brender site. This site was sampled in 2016 for a special project; it is less than 0.5 miles away from the Upper Brender monitoring site. A monitoring site on the Touchet River in the Walla Walla subbasin was added to represent typical Eastern Washington dryland agricultural practices and expands the monitoring further east where WSDA sampling has not taken place before.

No analytes were added or removed between 2017 and 2018. MEL installed a new Gas Chromatography/Triple Quadrupole Mass Spectrometry (GC/MS/MS) instrument before the start of the 2018 sampling season, reducing detection and reporting limits for many analytes in the GCMS-Pesticide method. This resulted in an increase in the total amount of analytes detected in 2018.

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Appendix A: Assessment Criteria for Pesticides

For this report, assessment criteria include data taken from studies determining hazards to non-target organisms and refer to acute and chronic hazard levels for fish, invertebrates, and aquatic plants. Various EPA derived risk assessments were reviewed to determine the most comparable and up-to-date toxicity guidelines for freshwater species.

WSDA applies a safety factor to state and national water quality standards and toxicity study criteria in order to be adequately protective of aquatic life. A safety factor was applied to each criteria found in Table 42a. The 2018 versions of the WAC 173-201A and the EPA's NRWQC were included in the development of the assessment criteria. Pesticide detections at all monitoring sites were evaluated using freshwater assessment criteria.

The following acronyms are used to describe testing details or organisms (spp.) used for testing.

- Fish:
    - AS-Atlantic salmon
    - BS-bluegill sunfish
    - BT-brook trout
    - BrT-brown trout
    - CC-carp
    - CF-catfish
    - FF-flagfish
    - FM-fathead minnow
    - JM-Japanese medaka
    - LT-lake trout
    - ND-not described
    - RT-rainbow trout
    - SB-striped bass

- Invertebrate:
    - ACR-acute to chronic ratio
    - AG-astacopsis gouldi (crayfish)
    - CG-chloroperia grammatical (stonefly)
    - CR-chironomus riparius
    - CT-chironomus tentans (midge)
    - DM-daphnia magna
    - DP-daphnia pulex
    - GF-gammarus fasciatus (scud)
    - HA-hyalella azteca (amphipod)
    - ND-not described
    - PC-pteronarcys californica (stonefly)

- Aquatic plant:
    - AF-anabaena flos-aquae (cyanobacteria)
    - EN-elodea nuttali (waterweed)
    - LG- lemna gibba
    - LM-Lemna minor
    - ND-not described
    - NP-navicula pelliculosa
    - OL-oscillatoria lutea (blue-green algae)
    - SC-pseudokirchneriella subcapitata
    - SP-scenedesmus pannonicus
    - SS-scendesmus subspicatus (green algae)

In cases where different organisms were used for acute and chronic toxicity tests, the organism used for the acute test is noted first and the organism used for the chronic test is second.

Table 42a shows only analytes with 2018 WSDA assessment criteria. Blank cells indicate no criteria available. A list of all chemicals tested can be found in Appendix B: 2017 Quality Assurance Summary.

Table 42a – WSDA Freshwater assessment criteria (WSDA safety factors applied, µg/L)

	Fish				**Invertebrate**			**Aquatic Plant**		**WAC**		**NRWQC**	
Pesticide	**Endangered Species Acute**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Spp.**	**Acute**	**Chronic**	**CMC**	**CCC**
2,4-D[b]	2040	20400	11800	RT/FM	6250	8025	DM	149.6	LG				
2,6-Dichlorobenzamide	3000	30000	5000	BS/RT	46000	160000	DM	50000	SP				
3,5-Dichlorobenzoic Acid													
4,4'-DDD										0.55[a]	0.0005[a]	0.55[a]	0.0005[a]
4,4'-DDE										0.55[a]	0.0005[a]	0.55[a]	0.0005[a]
4,4'-DDT										0.55[a]	0.0005[a]	0.55[a]	0.0005[a]
4-Nitrophenol	100	1000		RT	1250		DM						
Acetamiprid	2500	25000	9600	RT/FM	5.25	1.05	CR/ACR	500	LG				
Acetochlor	9.5	95	65	RT	2050	11.05	DM	0.715	SC				
Alachlor	45	450	93.5	RT	625	55	DM	0.82	SC				
Aldicarb Sulfoxide	178.5	1785		RT	10.75		DM						
Atrazine	132.5	1325	2.5	RT/JM	180	30	DM/GF	0.5	OL				
Azoxystrobin	11.75	117.5	73.5	RT/FM	65	22	DM	24.5	NP				
Bifenazate	14.5	145	150	BS	125	75	DM	445	SC				
Bifenthrin	0.00375	0.0375	0.02	RT/FM	0.4	0.00065	DM						
Boscalid	67.5	675	58		1332.5	395		670					
Bromacil	900	9000	1500	RT	30250	4100	DM	3.4	SC				
Bromoxynil	52.5	525		RT	4805		DM						
Captan	0.655	6.55	8.25	BrT/FM	2100	280	DM	160	SS				
Carbaryl	5.5	55	3.4	AS/ACR	0.425	0.25	CG/ACR	330	NP			1.05	1.05
Carbendazim	0.25	2.5	0.495		27.5	1.55							
Chlorantraniliprole	345	3450	55	RT	2.9	2.235	DM	890	SC				
Chlorothalonil	0.2625	2.625	1.5	RT/AG	0.9	0.3	DM	3.4	SC				
Chlorpropham	75.25	752.5		RT	927.5		DM						
Chlorpyrifos	0.045	0.45	0.285	RT/FM	0.025	0.02	DM	70		0.0415	0.0205	0.0415	0.0205
Chlorsulfuron	7500	75000	16000	RT	92500	10000	DM	0.175	LG				

	Fish				**Invertebrate**			**Aquatic Plant**		**WAC**		**NRWQC**	
Pesticide	**Endangered Species Acute**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Spp.**	**Acute**	**Chronic**	**CMC**	**CCC**
cis-Permethrin	0.01975	0.1975	0.02575	BS/FM	0.00975	0.0007	DM	34	SC				
Clopyralid	2587.5	25875		RT	58250		DM	3450	SC				
Clothianidin	2537.5	25375	4850	RT/FM	5.5	0.025	CR	32000					
Cycloate	112.5	1125		RT	6000		DM						
Cyprodinil	60.25	602.5	115	RT/FM	8	4		1125					
Dacthal (DCPA)	165	1650		RT	4505		DM						
Diazinon	2.25	22.5	0.275	RT/BT	0.0525	0.085	DM	1850	SC			0.085	0.085
Dicamba acid	700	7000		RT	25000		DM	30.5	AF				
Dichlobenil	123.25	1232.5	165	RT	1550	280	DM	15	LG				
Dichlorprop	2287.5	22875		RT	139500	50000	DM	38.5	NP				
Dichlorvos (DDVP)	4.575	45.75	2.6	LT/RT	0.0175	0.0029	DM	7000	ND				
Dicofol	1.325	13.25	2.2		35	9.5		2500					
Difenoconazole	20.25	202.5	0.43	RT/FM	192.5	2.8	DM	49	NP				
Dimethoate	155	1550	215	RT	10.75	0.25	PC	10000	AF				
Dinotefuran	2477.5	24775	3180	CC/RT	242075	47650	DM	48800	SC				
Dithiopyr	11.75	117.5	28	BS/RT	425	40.5	DM	10	SC				
Diuron	10	100	13.2	SB/FM	40	100	GF/DM	1.2	SC				
Eptam	350	3500		BS	1625	400	DM	700	SC				
Ethoprop	7.5	75	12	RT/FM	11	0.4	DM	4200					
Etoxazole	9.25	92.5	7.5	RT	1.825	0.065	DM	25.95	NP				
Etridiazole	30.25	302.5	60	RT	770	185	DM	36	SC				
Fenarimol	22.5	225	90	RT	1700	56.5	DM	50	SC				
Fipronil	2.075	20.75	3.3	BS	0.055	0.0055	DM/ACR	50					
Fipronil Disulfinyl	0.5	5	0.295		50	5.155		38					
Fipronil Sulfide	2.075	20.75	3.3		0.26625	0.055		50	ND				
Fipronil Sulfone	0.625	6.25	0.335	RT/ND	0.18	0.0185	DM/ND	50	ND				
Fludioxonil	11.75	117.5	9.5	RT/FM	225	9.5	DM	35					

	Fish				**Invertebrate**			**Aquatic Plant**		**WAC**		**NRWQC**	
Pesticide	**Endangered Species Acute**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Spp.**	**Acute**	**Chronic**	**CMC**	**CCC**
Flumioxazin	57.5	575	3.85	RT	1375	14	DP/DM	0.245	LG				
Hexazinone	6850	68500	8500	RT/FM	37900	10000	DM	3.5	SC				
Imazapic	2500	25000	48000	RT/FM	25000	48000	DM	3.11	LM				
Imazapyr	2500	25000	21550	RT/FM	25000	48550	DM	9	LM				
Imidacloprid	5725	57250	4500	RT	0.1925	0.005		5000	ND				
Isoxaben	25	250	200	RT	325	345	DM	5	LG				
Linuron	75	750	2.79	RT	30	0.045	DM	1.25	EN				
Malaoxon	0.1025	1.025	4.3	RT/FF	0.0245	0.03	DM	1020					0.05
Malathion	0.1025	1.025	4.3	RT/FF	0.0245	0.03	DM	1020					0.05
MCPA								85	SC				
Mecoprop (MCPP)	2325	23250		RT	22750	25400	DM	7	SC				
Metalaxyl	3250	32500	4550	RT/FM	7000	50	DM	46000	SC				
Methiocarb	4.5	45	25	BS	1.375								
Methomyl	8	80	6	CF	1.25	0.35	DM						
Methoxychlor	0.475	4.75		BT	0.35		PC						
Methoxyfenozide	105	1050	265	RT/FM	12.5	3.15	CR	1700	SC				
Metolachlor	95	950	15	RT	275	0.5	DM	4	SC				
Metribuzin	1050	10500	1500	RT	1050	645	DM	4.05					
Metsulfuron-methyl	3750	37500	2250	BS	37500		DM	0.18	LG				
Monocrotophos													
Myclobutanil	60	600	490	BS/FM	2750		DM	415	SC				
N,N-Diethyl-m-toluamide (DEET)	1875	18750		RT	18750		DM						
Napropamide	160	1600	550	RT	3575	550	DM	1700	SC				
Norflurazon	202.5	2025	385	RT	3750	500	DM	4.85	SC				
Oryzalin	72	720	110	BS/FM	375	179	DM	6.5	LG				
Oxadiazon	30	300	16.5	RT/FM	545	16.5	DM	2.6	SC				

	Fish				Invertebrate			Aquatic Plant		WAC		NRWQC	
Pesticide	**Endangered Species Acute**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Chronic**	**Spp.**	**Acute**	**Spp.**	**Acute**	**Chronic**	**CMC**	**CCC**
Oxamyl	105	1050	250	RT/FM	45	13.5	ACR	60	SC				
Oxamyl oxime	105	1050	250	RT/FM	45	13.5	ACR	60	SC				
Oxyfluorfen	5	50	0.65	BS/FM	375	6.5	DM	0.145	SC				
Pendimethalin	3.45	34.5	3.15	RT/FM	70	7.25	DM	2.6	SC				
Pentachloronitrobenzene (PCNB)	2.5	25	6.5		192.5	9							
Pentachlorophenol	0.375	3.75	5.5	RT	23	2.05	DM	25	SC			9.5	7.5
Phosmet	1.75	17.5	1.6	RT	0.5	0.4	DM						
Picloram	137.5	1375	275	RT	8600	5900	DM	17450	SC				
Piperonyl butoxide (PBO)	47.5	475	20	RT	127.5	15	DM						
Prodiamine	0.325	3.25		BS	3.25	0.75	DM						
Prometon	300	3000	9850	RT/FM	6425	1725	DM	49	SC				
Prometryn	72.75	727.5	310	RT/FM	2425	500	DM	0.52	NP				
Propargite	2.025	20.25	8	BS/FM	3.5	4.5	DM	9.7	SC				
Propazine	109.5	1095	280	BS/FM	1330	23.5	DM	12.45	NP				
Propiconazole	21.25	212.5	47.5	RT/FM	325	130	DM	10.5	ND				
Propoxur	92.5	925		RT	2.75		DM						
Propyzamide (Pronamide)	265	2650	112	RT/FM	1400	300	DM	380	SC				
Pyraclostrobin	0.155	1.55	1.175	RT	3.925	2	DM	0.75	NP				
Pyraflufen-ethyl	2.125	21.25	0.445		20.5	40.5		0.75					
Pyridaben	0.018	0.18	0.0435	RT	0.1325	0.022	DM	8.1	LG				
Pyrimethanil	252.5	2525	10	RT	750	500	DM	900	ND				
Pyriproxyfen	8.25	82.5	2.15	RT	100	0.0075	DM	0.09	LG				
Simazine	160	1600	30	FM	250	20	DM/ACR	3	SC				
Sodium bentazon	4750	47500	4915	RT/FM	15575	50600	CR/DM	2250	SC				
Spirotetramat	35.25	352.5	267	RT/FM	165	50	CT	2025	NP				
Sulfentrazone	2345	23450	1475	BS/RT	15100	100	DM	14.4	SC				

	Fish				Invertebrate			Aquatic Plant		WAC		NRWQC	
Pesticide	Endangered Species Acute	Acute	Chronic	Spp.	Acute	Chronic	Spp.	Acute	Spp.	Acute	Chronic	CMC	CCC
Sulfometuron methyl	3700	37000		RT	37500	48500	DM	0.225	LG				
Tebuthiuron	2650	26500	4650	FM	74250	10900	DM	25	SC				
Tefluthrin	0.0015	0.015	0.002	RT/FM	0.0175	0.004	DM						
Terbacil	1155	11550	600	RT	16250	25	DM	5.5	NP				
Tetrachlorvinphos	13.25	132.5	23.5	BS/FM	0.475	0.0625	DM	1600	SC				
Tetrahydrophthalimide (THPI)	3000	30000		RT	28250		DM	90500					
Thiacloprid	630	6300	459	BS/RT	9.45	0.485	HA/ACR	22500	SC				
Thiamethoxam	2850	28500	10000	BS/RT	8.75	0.37	CR	45100	LM				
Total Cypermethrin	0.00975	0.0975	0.07	RT/FM	0.105	0.0345	DM						
Total Fluvalinate	0.00875	0.0875	0.032	CC/FM	0.235	0.05	DM						
Triadimefon	102.5	1025	85	RT	400	26	DM	1000	SC				
Triazine DEA degradate								500					
Triazine DIA degradate	425	4250			31500			1250					
Triclopyr acid	2925	29250	52000	RT/FM	33225	40350	DM	2950	SC				
Triclosan	7.2	72		RT	97.5		DM	0.35	SS				
Trifloxystrobin	0.3575	3.575	2.15	RT	6.325	1.38	DM	18.55	SC				
Trifluralin	0.4625	4.625	0.95		62.75	1.2		10.95					

CMC: Criteria Maximum Concentration

CCC: Criteria Continuous Concentration

[a] Criteria is specific to total DDT but is used here for individual metabolites as well.

[b] 2,4-D criteria reflect toxicity of the 2,4-D acids and salts. Toxicity values for the individual forms of 2,4-D are available in the referenced document.

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Appendix B: 2017 Quality Assurance Summary

Quality assurance (QA) elements and quality control (QC) samples assure consistency and accuracy throughout sample collection, sample analysis, and the data reporting process. For this project, QC samples used in analysis of pesticides, total suspended solids (TSS), and specific conductivity include field replicates, field blanks, matrix spike/matrix spike duplicates (MS/MSD), laboratory control samples/laboratory control sample duplicates (LCS/LCSD), surrogate spikes, and method blanks.

In 2017, QC samples were 11% of all the samples collected in the field. There were 134 QC samples in total which included 58 field replicates, 36 field blanks, 24 MS/MSD samples and 16 conductivity check samples and replicates. The lab contributed the remaining LCS/LCSD and method blank samples.

Data Qualification

Performance measures are used to determine when data should be qualified. Performance measures for this program consist of percent recovery control limits and relative percent difference (RPD) control limits of QC data. Percent recovery is used to assess bias in an analysis; a known amount of chemical is added to a sample before analysis and compared to the amount detected during analysis. Systematically low percent recoveries show analytical bias. Control limits may be specified by the EPA method or provided by the lab. The analytical method named GCMS-Pesticide in this report has percent recovery control limits that are analyte-specific. All other percent recovery limits are default limits specified by the EPA method. RPD is used to assess analytical precision; the difference between replicate pairs (matrix spike duplicates, laboratory control sample duplicates, and field replicates) is compared. When RPDs and percent recoveries are outside control limits, analytical results may be qualified.

The Manchester Environmental Laboratory (MEL) qualifies all sample results based on the analysis of LCS/LCSDs, MS/MSDs, surrogates, and method blanks. LCS/LCSDs are generated by adding analytes at known concentrations to purified water free of all organics. An LCS/LCSD pair is extracted and analyzed with every batch. They are used to evaluate method performance for a specific analyte and to check for bias and precision of the lab's extraction and analytical processes. Detections from a batch may be qualified based on high/low recovery and/or high RPD between the paired LCS and LCSD. Similarly, samples collected in the field that have added analytes at known concentrations and analyzed are MS/MSD samples. The analysis of this type of QC sample can assess the potential for matrix interactions or interaction between analytes within field samples that can affect analytical results. At least 1 MS/MSD sample was collected and analyzed from each monitoring site during the field season. In 2017, almost all analytes tested for during the season were used to spike MS/MSDs, although the lab rotated between 2 spike mixtures for the GCMS-Pesticides analytical method to avoid coelution of analytes. Surrogates are analytes not normally found in environmental samples that are spiked into all field and QC samples to evaluate recoveries for groups of organic compounds. Results of surrogates can evaluate extraction efficiency and matrix interference within the sample.

WSDA staff qualify the remainder of the field sample data based on field replicates, field blanks, and MS/MSD results. Field replicates are used to evaluate variability in analytical results. No field sample results were requalified due solely to field replicate results in 2017. Field blank results are used to examine bias caused by contamination in the field and during transport to the lab. There were no detections of analytes in field blanks in 2017 indicating little to no contamination happened during sampling or sample transport. In 2017, WSDA staff did not change qualifiers of any field sample or QC result beyond what MEL had already qualified each result.

MEL reports the method reporting limit (MRL) which is the lowest concentration used in the initial calibration for each analyte. The MRL is adjusted for each individual sample according to sample volume and dilution (if needed). Results outside the instrument calibration range may be qualified as estimates (J). Mean MRL (calculated for each individual sample in 2017) and standard deviation are presented in Table 43b.

Table 43b – Mean performance of method reporting limits (µg/L)

Analyte	CAS number	Analytical method	Pesticide type	Mean MRL	Standard deviation
2,4-D	94-75-7	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
2,6-Dichlorobenzamide	2008-58-4	GCMS-Pesticides	Degradate	3.27E-02	4.96E-04
3,5-Dichlorobenzoic Acid	51-36-5	GCMS-Herbicides	Degradate	6.11E-02	8.94E-03
4,4'-DDD	72-54-8	GCMS-Pesticides	Degradate	3.27E-02	4.96E-04
4,4'-DDE	72-55-9	GCMS-Pesticides	Degradate	3.27E-02	4.96E-04
4,4'-DDT	50-29-3	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
4-Nitrophenol	100-02-7	GCMS-Herbicides	Degradate	6.11E-02	8.94E-03
Acetamiprid	135410-20-7	LCMS-Pesticides	Insecticide	2.00E-02	2.35E-09
Acetochlor	34256-82-1	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Alachlor	15972-60-8	GCMS-Pesticides	Herbicide	3.64E-02	1.06E-02
Aldicarb Sulfoxide	1646-87-3	LCMS-Pesticides	Degradate	1.00E-02	1.18E-09
Atrazine	1912-24-9	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Azoxystrobin	131860-33-8	LCMS-Pesticides	Fungicide	2.00E-02	2.35E-09
Baygon	114-26-1	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Benefin	1861-40-1	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Bentazon	25057-89-0	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Bifenazate	149877-41-8	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Bifenthrin	82657-04-3	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Boscalid	188425-85-6	GCMS-Pesticides	Fungicide	9.90E-02	1.26E-03
Bromacil	314-40-9	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Bromoxynil	1689-84-5	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Captan	133-06-2	GCMS-Pesticides	Fungicide	3.27E-02	4.96E-04
Carbaryl	63-25-2	LCMS-Pesticides	Insecticide	2.00E-02	2.35E-09

Analyte	CAS number	Analytical method	Pesticide type	Mean MRL	Standard deviation
Carbendazim	10605-21-7	LCMS-Pesticides	Fungicide	2.16E-02	3.58E-02
Chlorantraniliprole	500008-45-7	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Chlorethoxyfos	54593-83-8	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Chlorothalonil (Daconil)	1897-45-6	GCMS-Pesticides	Fungicide	3.27E-02	4.96E-04
Chlorpropham	101-21-3	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Chlorpyriphos	2921-88-2	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Chlorsulfuron	64902-72-3	LCMS-Pesticides	Herbicide	5.60E-02	1.63E-02
cis-Permethrin	54774-45-7	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Clopyralid	1702-17-6	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Clothianidin	210880-92-5	LCMS-Pesticides	Insecticide	1.00E-01	1.42E-08
Coumaphos	56-72-4	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Cycloate	1134-23-2	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Cyfluthrin	68359-37-5	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Cypermethrin	52315-07-8	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Cyprodinil	121552-61-2	LCMS-Pesticides	Fungicide	1.13E-02	4.97E-03
Dacthal	1861-32-1	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Deisopropyl Atrazine	1007-28-9	LCMS-Pesticides	Degradate	1.69E-02	1.33E-02
Deltamethrin	52918-63-5	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Desethylatrazine	6190-65-4	LCMS-Pesticides	Degradate	1.20E-02	6.06E-03
Diazinon	333-41-5	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Dicamba	1918-00-9	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Dichlobenil	1194-65-6	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Dichlorprop	120-36-5	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Dichlorvos (DDVP)	62-73-7	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Difenoconazole	119446-68-3	LCMS-Pesticides	Fungicide	1.00E-02	1.18E-09
Diflubenzuron	35367-38-5	LCMS-Pesticides	Insecticide	7.25E-02	8.34E-03
Dimethoate	60-51-5	GCMS-Pesticides	Insecticide	3.31E-02	2.58E-03
Dinotefuran	165252-70-0	LCMS-Pesticides	Insecticide	2.14E-02	1.46E-02
Dithiopyr	97886-45-8	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Diuron	330-54-1	LCMS-Pesticides	Herbicide	1.03E-02	4.93E-03
Eptam	759-94-4	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Ethalfluralin (Sonalan)	55283-68-6	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Ethoprop	13194-48-4	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Etoxazole	153233-91-1	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Etridiazole	2593-15-9	GCMS-Pesticides	Fungicide	4.96E-02	6.38E-04
Fenarimol	60168-88-9	GCMS-Pesticides	Fungicide	3.27E-02	4.96E-04
Fenbuconazole	114369-43-6	LCMS-Pesticides	Fungicide	2.00E-02	2.35E-09
Fenvalerate	51630-58-1	GCMS-Pesticides	Insecticide	3.31E-02	2.58E-03
Fipronil	120068-37-3	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Fipronil Desulfinyl	205650-65-3	GCMS-Pesticides	Degradate	9.90E-02	1.27E-03
Fipronil Sulfide	120067-83-6	GCMS-Pesticides	Degradate	9.90E-02	1.26E-03

Analyte	CAS number	Analytical method	Pesticide type	Mean MRL	Standard deviation
Fipronil Sulfone	120068-36-2	GCMS-Pesticides	Degradate	9.90E-02	1.26E-03
Fludioxonil	131341-86-1	GCMS-Pesticides	Fungicide	5.02E-02	1.07E-02
Flumioxazin	103361-09-7	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Fluroxypyr-meptyl	81406-37-3	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Hexazinone	51235-04-2	GCMS-Pesticides	Herbicide	4.96E-02	6.38E-04
Imazapic	104098-48-8	LCMS-Pesticides	Herbicide	1.00E-01	1.42E-08
Imazapyr	81334-34-1	LCMS-Pesticides	Herbicide	1.00E-01	1.42E-08
Imidacloprid	138261-41-3	LCMS-Pesticides	Insecticide	2.00E-02	2.35E-09
Imidan	732-11-6	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Isoxaben	82558-50-7	LCMS-Pesticides	Herbicide	1.00E-02	1.18E-09
Kelthane	115-32-2	GCMS-Pesticides	Insecticide	2.97E-01	3.83E-03
Linuron	330-55-2	LCMS-Pesticides	Herbicide	9.01E-02	6.49E-02
Malaoxon	1634-78-2	LCMS-Pesticides	Degradate	1.00E-02	1.18E-09
Malathion	121-75-5	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
MCPA	94-74-6	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
MCPP	93-65-2	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Metalaxyl	57837-19-1	GCMS-Pesticides	Fungicide	3.27E-02	4.96E-04
Methiocarb	2032-65-7	LCMS-Pesticides	Insecticide	3.38E-02	7.84E-03
Methomyl	16752-77-5	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Methomyl oxime	13749-94-5	LCMS-Pesticides	Degradate	1.00E-01	1.39E-08
Methoxyfenozide	161050-58-4	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Methyl Chlorpyrifos	5598-13-0	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Metolachlor	51218-45-2	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Metribuzin	21087-64-9	GCMS-Pesticides	Herbicide	3.34E-02	3.39E-03
Metsulfuron-methyl	74223-64-6	LCMS-Pesticides	Herbicide	5.60E-02	1.63E-02
MGK264	113-48-4	GCMS-Pesticides	Synergist	4.96E-02	6.38E-04
Myclobutanil	88671-89-0	LCMS-Pesticides	Fungicide	1.00E-02	1.18E-09
N,N-Diethyl-m-toluamide	134-62-3	GCMS-Pesticides	Insect Repellent	4.96E-02	6.38E-04
Naled	300-76-5	GCMS-Pesticides	Insecticide	3.78E-02	7.68E-03
Napropamide	15299-99-7	GCMS-Pesticides	Herbicide	4.96E-02	6.38E-04
Norflurazon	27314-13-2	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Oryzalin	19044-88-3	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Oxadiazon	19666-30-9	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Oxamyl	23135-22-0	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Oxamyl oxime	30558-43-1	LCMS-Pesticides	Degradate	1.07E-02	3.73E-03
Oxyfluorfen	42874-03-3	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Pendimethalin	40487-42-1	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Pentachloronitrobenzene	82-68-8	GCMS-Pesticides	Fungicide	4.96E-02	6.38E-04
Pentachlorophenol	87-86-5	GCMS-Herbicides	Wood Preservative	6.11E-02	8.94E-03
Phenothrin	26002-80-2	GCMS-Pesticides	Insecticide	3.27E-02	4.96E-04
Phorate	298-02-2	GCMS-Pesticides	Insecticide	2.97E-01	3.83E-03

Analyte	CAS number	Analytical method	Pesticide type	Mean MRL	Standard deviation
Picloram	1918-02-1	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Piperonyl Butoxide (PBO)	51-03-6	GCMS-Pesticides	Synergist	9.90E-02	1.26E-03
Prallethrin	23031-36-9	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Prodiamine	29091-21-2	GCMS-Pesticides	Herbicide	4.96E-02	6.38E-04
Prometon	1610-18-0	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Prometryn	7287-19-6	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Pronamide (Kerb)	23950-58-5	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Propargite	2312-35-8	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Propiconazole	60207-90-1	LCMS-Pesticides	Fungicide	2.00E-02	2.35E-09
Pyraclostrobin	175013-18-0	LCMS-Pesticides	Fungicide	2.00E-02	2.35E-09
Pyraflufen-ethyl	129630-19-9	GCMS-Pesticides	Herbicide	4.96E-02	6.38E-04
Pyrethrins	121-21-1	GCMS-Pesticides	Insecticide	4.96E-02	6.39E-04
Pyridaben	96489-71-3	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Pyrimethanil	53112-28-0	LCMS-Pesticides	Fungicide	1.00E-02	1.18E-09
Pyriproxyfen	95737-68-1	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Simazine	122-34-9	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Simetryn	1014-70-6	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Specific Conductivity	COND	SCOND	N/A	1.50E+01	0.00E+00
Spirotetramat	203313-25-1	LCMS-Pesticides	Insecticide	1.20E-02	6.06E-03
Sulfentrazone	122836-35-5	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Sulfometuron methyl	74222-97-2	LCMS-Pesticides	Herbicide	2.00E-02	2.35E-09
Tau-fluvalinate	102851-06-9	GCMS-Pesticides	Insecticide	5.83E-02	1.88E-02
Tebuthiuron	34014-18-1	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Tefluthrin	79538-32-2	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Terbacil	5902-51-2	GCMS-Pesticides	Herbicide	3.32E-02	3.12E-03
Tetrachlorvinphos (Gardona)	961-11-5	GCMS-Pesticides	Insecticide	4.96E-02	6.38E-04
Tetrahydrophthalimide	27813-21-4	GCMS-Pesticides	Degradate	9.90E-02	1.26E-03
Tetramethrin	7696-12-0	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Thiacloprid	111988-49-9	LCMS-Pesticides	Insecticide	1.00E-02	1.18E-09
Thiamethoxam	153719-23-4	LCMS-Pesticides	Insecticide	2.00E-02	2.35E-09
Total Suspended Solids	TSS	TSS	N/A	3.68E+00	6.86E+00
Tralomethrin	66841-25-6	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
trans-Permethrin	61949-77-7	GCMS-Pesticides	Insecticide	9.90E-02	1.26E-03
Treflan (Trifluralin)	1582-09-8	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Triadimefon	43121-43-3	GCMS-Pesticides	Fungicide	3.27E-02	4.96E-04
Triallate	2303-17-5	GCMS-Pesticides	Herbicide	3.27E-02	4.96E-04
Triclopyr	55335-06-3	GCMS-Herbicides	Herbicide	6.11E-02	8.94E-03
Triclopyr-butoxyl	64700-56-7	GCMS-Pesticides	Herbicide	9.90E-02	1.26E-03
Triclosan	3380-34-5	GCMS-Pesticides	Antimicrobial	9.90E-02	1.26E-03
Trifloxystrobin	141517-21-7	LCMS-Pesticides	Fungicide	1.00E-02	1.18E-09

Analyte	CAS number	Analytical method	Pesticide type	Mean MRL	Standard deviation
Zoxamide	156052-68-5	LCMS-Pesticides	Fungicide	1.00E-02	1.18E-09

Data qualifiers describe the level of confidence associated with the data points. Laboratory data was qualified according to the National Functional Guidelines for Organic Data Review (EPA, 2017), Manchester Environmental Lab's data qualification criteria and professional judgement. The Manchester Environmental Lab provides a list of data qualifiers and their definitions in Table 44b that are used for sample analysis of pesticides, TSS, and specific conductivity (MEL, 2016).

Table 44b – Data qualification definitions

Qualifier	Definition
	The analyte was positively identified and was detected at the reported concentration.
E	Reported result is an estimate because it exceeds the calibration range.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified," and the associated numerical value represents its approximate concentration.
NAF	Not analyzed for.
NC	Not calculated.
REJ	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
U	The analyte was not detected at or above the reported sample quantitation limit.
UJ	The analyte was not detected at or above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately measure the analyte in the sample.

Laboratory data points that were not assigned a qualifier are equivalent to having "No qualifier" which is the traditionally accepted method of assigning the highest level of confidence. Laboratory data assigned a qualifier of "E" or "J" are considered confirmed pesticide detections. Laboratory data qualified with "NJ", "N", "U," or "UJ" are considered non-detects. A non-detect is a typical qualifier for no chemical detected, but can also include chemicals that were potentially detected below reported sample quantitation limits that cannot be confirmed. All pesticide laboratory results that were not assigned a qualifier or assigned a qualifier of “E” or “J” were compared to the WSDA assessment criteria that were developed for this report.

Analytical Quality Assurance and Quality Control Sample Summaries

In this section of the report, quality control data is summarized from field replicate, field blank, MS/MSD, laboratory duplicate, surrogate and LCS/LCSD results. Overall, analyte recoveries and RPDs were of acceptable data quality.

Field Replicate Results

Field replicate samples are collected in order to assess the potential for variation in sample homogeneity and the entire process of sampling and analysis. During 2017, 5% of pesticide and TSS samples were field replicates, which were evaluated using RPD control limits. There were 59 consistently identified pairs for pesticide analysis and 15 consistently identified pairs for TSS analysis (Table 45b). Consistent identification refers to analytes identified in both the original sample and field replicate with unqualified or qualified J and E results.

Table 45b presents the results and relative percent difference for analytes consistently identified in both the grab sample and replicate sample.

Table 45b – Consistently detected field replicate pairs

Sample date	Analyte	Site ID	Mean (µg/L)	MRL (µg/L)	RPD (%)	Sample and replicate sample details
5/15	2,4-D	Lower Big Ditch	0.068	0.059	7	(0.065 ug/L D and 0.07 ug/L D)
5/9	2,4-D	Indian Slough	0.068	0.060	35	(0.08 ug/L D and 0.056 ug/L J)
6/27	2,4-D	Naneum	0.077	0.060	3	(0.078 ug/L J and 0.076 ug/L J)
4/24	2,4-D	Snipes Creek	0.060	0.060	22	(0.066 ug/L D and 0.053 ug/L J)
5/1	2,4-D	Sulphur Wasteway	0.057	0.060	23	(0.05 ug/L J and 0.063 ug/L D)
8/7	2,6-Dichlorobenzamide	Lower Bertrand	0.088	0.033	0	(0.088 ug/L D and 0.088 ug/L D)
5/8	2,6-Dichlorobenzamide	Upper Bertrand	0.093	0.032	11	(0.088 ug/L D and 0.098 ug/L D)
8/22	2,6-Dichlorobenzamide	Upper Big Ditch	0.077	0.033	0	(0.077 ug/L D and 0.077 ug/L D)
4/3	2,6-Dichlorobenzamide	Indian Slough	0.081	0.032	16	(0.074 ug/L D and 0.087 ug/L D)
5/17	2,6-Dichlorobenzamide	Burnt Bridge	0.134	0.033	5	(0.13 ug/L D and 0.137 ug/L D)
6/27	2,6-Dichlorobenzamide	Stemilt Creek	0.033	0.032	6	(0.034 ug/L D and 0.032 ug/L J)
8/1	2,6-Dichlorobenzamide	Woodland Creek	0.038	0.033	0	(0.038 ug/L D and 0.038 ug/L D)

Sample date	Analyte	Site ID	Mean (µg/L)	MRL (µg/L)	RPD (%)	Sample and replicate sample details
7/10	Azoxystrobin	Lower Big Ditch	0.009	0.020	12	(0.009 ug/L J and 0.008 ug/L J)
4/25	Azoxystrobin	Indian Slough	0.013	0.020	15	(0.014 ug/L J and 0.012 ug/L J)
8/7	Boscalid	Lower Bertrand	0.055	0.100	15	(0.051 ug/L J and 0.059 ug/L J)
5/8	Boscalid	Upper Bertrand	0.102	0.098	4	(0.104 ug/L D and 0.1 ug/L D)
8/22	Boscalid	Upper Big Ditch	0.119	0.099	1	(0.118 ug/L D and 0.119 ug/L D)
6/27	Boscalid	Stemilt Creek	0.052	0.098	2	(0.051 ug/L J and 0.052 ug/L J)
5/9	Carbendazim	Upper Big Ditch	0.015	0.010	7	(0.015 ug/L J and 0.014 ug/L J)
4/11	Chlorpyriphos	Lower Brender	0.096	0.032	5	(0.098 ug/L J and 0.093 ug/L J)
4/11	Dacthal	Crab Creek	0.280	0.060	63	(0.192 ug/L D and 0.367 ug/L D)
5/9	Dicamba	Indian Slough	0.032	0.060	35	(0.037 ug/L J and 0.026 ug/L J)
6/27	Dicamba	Naneum	0.028	0.060	29	(0.024 ug/L J and 0.032 ug/L J)
5/8	Dichlobenil	Upper Bertrand	0.020	0.032	30	(0.017 ug/L J and 0.023 ug/L J)
7/10	Difenoconazole	Lower Big Ditch	0.020	0.010	5	(0.02 ug/L J and 0.019 ug/L J)
5/9	Dinotefuran	Upper Big Ditch	0.686	0.020	2	(0.677 ug/L D and 0.694 ug/L D)
4/18	Diuron	Burnt Bridge	0.009	0.010	59	(0.011 ug/L D and 0.006 ug/L J)
6/21	Diuron	Crab Creek	0.014	0.010	22	(0.012 ug/L D and 0.015 ug/L D)
4/25	Diuron	Indian Slough	0.007	0.010	46	(0.008 ug/L J and 0.005 ug/L J)
5/1	Diuron	Snipes Creek	0.017	0.010	18	(0.018 ug/L D and 0.015 ug/L D)
4/10	Diuron	Sulphur Wasteway	0.051	0.010	0	(0.051 ug/L D and 0.051 ug/L D)
7/18	Fludioxonil	Lower Big Ditch	0.033	0.050	6	(0.034 ug/L J and 0.032 ug/L J)
8/22	Fludioxonil	Upper Big Ditch	0.215	0.050	1	(0.213 ug/L D and 0.216 ug/L D)
4/24	Fludioxonil	Marion Drain	0.019	0.050	0	(0.019 ug/L J and 0.019 ug/L J)
4/18	Imazapyr	Burnt Bridge	0.006	0.100	0	(0.006 ug/L J and 0.006 ug/L J)
4/4	Imazapyr	Upper Brender	0.072	0.100	17	(0.066 ug/L J and 0.078 ug/L J)
5/2	Imidacloprid	Upper Bertrand	0.052	0.020	2	(0.052 ug/L D and 0.051 ug/L D)
4/11	Malathion	Lower Brender	0.063	0.032	3	(0.062 ug/L J and 0.064 ug/L J)
5/8	Metalaxyl	Upper Bertrand	0.036	0.032	0	(0.036 ug/L D and 0.036 ug/L D)
8/22	Metalaxyl	Upper Big Ditch	0.111	0.033	2	(0.112 ug/L D and 0.11 ug/L D)
5/8	Metolachlor	Upper Bertrand	0.026	0.032	0	(0.026 ug/L J and 0.026 ug/L J)

Sample date	Analyte	Site ID	Mean (µg/L)	MRL (µg/L)	RPD (%)	Sample and replicate sample details
4/3	Metolachlor	Indian Slough	0.022	0.032	5	(0.022 ug/L J and 0.021 ug/L J)
4/4	Metsulfuron-methyl	Upper Brender	0.018	0.050	6	(0.018 ug/L J and 0.017 ug/L J)
5/17	N,N-Diethyl-m-toluamide	Burnt Bridge	0.014	0.050	7	(0.014 ug/L J and 0.013 ug/L J)
4/3	Oxamyl	Lower Bertrand	0.068	0.010	1	(0.068 ug/L D and 0.067 ug/L D)
5/2	Oxamyl	Upper Bertrand	0.006	0.010	0	(0.006 ug/L J and 0.006 ug/L J)
4/3	Oxamyl oxime	Lower Bertrand	0.074	0.010	10	(0.077 ug/L J and 0.07 ug/L J)
5/9	Pendimethalin	Snipes Creek	0.030	0.032	7	(0.031 ug/L J and 0.029 ug/L J)
4/3	Propiconazole	Lower Bertrand	0.029	0.020	39	(0.034 ug/L J and 0.023 ug/L J)
4/3	Simazine	Indian Slough	0.147	0.032	1	(0.146 ug/L D and 0.148 ug/L D)
4/4	Sulfometuron methyl	Upper Brender	0.020	0.020	5	(0.02 ug/L J and 0.019 ug/L J)
4/25	Sulfometuron methyl	Indian Slough	0.007	0.020	0	(0.007 ug/L J and 0.007 ug/L J)
8/22	Tebuthiuron	Upper Big Ditch	0.090	0.033	7	(0.087 ug/L D and 0.093 ug/L D)
8/7	Tetrahydrophthalimide	Lower Bertrand	0.095	0.100	34	(0.111 ug/L J and 0.079 ug/L J)
5/8	Tetrahydrophthalimide	Upper Bertrand	0.085	0.098	32	(0.098 ug/L J and 0.071 ug/L J)
4/3	Thiamethoxam	Lower Bertrand	0.014	0.020	7	(0.014 ug/L J and 0.013 ug/L J)
5/2	Thiamethoxam	Upper Bertrand	0.012	0.020	0	(0.012 ug/L J and 0.012 ug/L J)
5/9	Thiamethoxam	Upper Big Ditch	0.055	0.020	4	(0.054 ug/L D and 0.056 ug/L D)
8/23	Total Suspended Solids	Burnt Bridge	4.000	1 mg/L	0	(4 mg/L D and 4 mg/L D)
5/16	Total Suspended Solids	Lower Bertrand	106.0	4 mg/L	13	(113 mg/L J and 99 mg/L J)
3/28	Total Suspended Solids	Upper Bertrand	21.50	10 mg/L	14	(20 mg/L D and 23 mg/L D)
6/6	Total Suspended Solids	Lower Big Ditch	33.50	3 mg/L	3	(33 mg/L D and 34 mg/L D)
7/10	Total Suspended Solids	Upper Big Ditch	3.000	1 mg/L	0	(3 mg/L D and 3 mg/L D)
5/10	Total Suspended Solids	Upper Brender	264.0	8 mg/L	14	(246 mg/L D and 282 mg/L D)
5/2	Total Suspended Solids	Lower Brender	26.00	5 mg/L	15	(28 mg/L D and 24 mg/L D)
8/28	Total Suspended Solids	Crab Creek	10.50	2 mg/L	10	(11 mg/L D and 10 mg/L D)
6/19	Total Suspended Solids	Marion Drain	5.500	1 mg/L	18	(6 mg/L D and 5 mg/L D)
4/18	Total Suspended Solids	Mission Creek	64.50	5 mg/L	11	(61 mg/L D and 68 mg/L D)
8/7	Total Suspended Solids	Naneum	7.000	1 mg/L	0	(7 mg/L D and 7 mg/L D)
4/25	Total Suspended Solids	Stemilt Creek	13.50	4 mg/L	7	(13 mg/L D and 14 mg/L D)

Sample date	Analyte	Site ID	Mean (µg/L)	MRL (µg/L)	RPD (%)	Sample and replicate sample details
6/12	Total Suspended Solids	Snipes Creek	28.50	2 mg/L	4	(29 mg/L D and 28 mg/L D)
3/27	Total Suspended Solids	Sulphur Wasteway	88.00	7 mg/L	5	(86 mg/L D and 90 mg/L D)
7/5	Total Suspended Solids	Woodland Creek	5.500	2 mg/L	18	(5 mg/L D and 6 mg/L D)
4/5	Triclopyr	Burnt Bridge	0.491	0.060	9	(0.468 ug/L D and 0.513 ug/L D)

For pesticides, the mean RPD of the consistently identified replicate pairs was 12%. For TSS, the mean RPD of the consistently detected replicates was 9%.

Only 3 of the 59 consistently identified replicate pairs for pesticides exceeded the 40% RPD criterion (dacthal April 11 and diuron April 25 and April 18). There were no RPD exceedances for the 15 replicate pairs for TSS. The diuron and dacthal results were not requalified because the RPD has limited effectiveness in assessing variability at low levels (Mathieu, 2006). When concentrations are low the RPD may be large even though the actual difference between the pairs is low. The remaining data for pesticide and TSS field replicates are of acceptable data quality.

In 2017, there were 19 inconsistently identified replicate pairs for pesticides and 1 inconsistently identified replicate pair for TSS (Table 46b). The majority of the inconsistently identified pairs were detections between the MRL and the method detection limit (below which the laboratory is unable to distinguish between instrument response due to the presence of analytes or background noise). The RPD also exceeded the 40% criterion for 11 of the 19 replicate pairs. Most of these replicate pairs consist of a J qualified detection and a U or UJ qualified detection with the concentration replaced with the MRL.

There were no sample detections requalified due solely to inconsistent field replicate results. Consistently and inconsistently identified replicate pair values were averaged for comparisons to WSDA assessment criteria.

Table 46b – Inconsistently detected field replicate pairs

Sample date	Analyte	Site ID	Mean (µg/L)	MRL (µg/L)	RPD (%)	Sample and replicate sample details
4/25	2,4-D	Upper Big Ditch	0.048	0.06	50	(0.036 ug/L J and 0.06 ug/L U)
4/11	2,6-Dichlorobenzamide	Lower Brender	0.022	0.032	98	(0.032 ug/L UJ and 0.011 ug/L J)
8/7	Bromacil	Lower Bertrand	0.039	0.033	8	(0.037 ug/L D and 0.04 ug/L NJ)

Sample date	Analyte	Site ID	Mean (µg/L)	MRL (µg/L)	RPD (%)	Sample and replicate sample details
4/10	Chlorantraniliprole	Sulphur Wasteway	0.010	0.01	11	(0.01 ug/L U and 0.009 ug/L J)
4/10	Desethylatrazine	Sulphur Wasteway	0.010	0.01	11	(0.01 ug/L U and 0.009 ug/L J)
5/17	Dichlobenil	Burnt Bridge	0.020	0.033	130	(0.007 ug/L J and 0.033 ug/L U)
6/21	Imazapyr	Crab Creek	0.057	0.1	154	(0.013 ug/L J and 0.1 ug/L U)
4/3	Imidacloprid	Lower Bertrand	0.036	0.02	25	(0.04 ug/L D and 0.031 ug/L NJ)
6/27	MCPA	Naneum	0.039	0.06	5	(0.04 ug/L J and 0.038 ug/L NJ)
4/11	MCPP	Upper Bertrand	0.039	0.06	112	(0.06 ug/L U and 0.017 ug/L J)
4/5	Pentachlorophenol	Burnt Bridge	0.041	0.06	96	(0.06 ug/L U and 0.021 ug/L J)
4/25	Pentachlorophenol	Upper Big Ditch	0.041	0.06	93	(0.022 ug/L J and 0.06 ug/L U)
8/22	Prodiamine	Upper Big Ditch	0.045	0.05	25	(0.05 ug/L U and 0.039 ug/L J)
8/1	Pyraflufen-ethyl	Woodland Creek	0.037	0.05	74	(0.023 ug/L J and 0.05 ug/L U)
5/8	Simazine	Upper Bertrand	0.108	0.032	20	(0.097 ug/L D and 0.119 ug/L NJ)
5/8	Terbacil	Upper Bertrand	0.043	0.032	0	(0.043 ug/L NJ and 0.043 ug/L D)
9/6	Total Suspended Solids	Upper Bertrand	1.000	1 (mg/L)	0	(1 mg/L D and 1 mg/L U)
4/25	Triclopyr	Upper Big Ditch	0.048	0.06	50	(0.036 ug/L J and 0.06 ug/L U)
5/9	Triclopyr	Indian Slough	0.050	0.06	42	(0.039 ug/L J and 0.06 ug/L U)
8/14	Trifloxystrobin	Woodland Creek	0.008	0.01	50	(0.01 ug/L U and 0.006 ug/L J)

Field Blank Results

Field blank detections indicate the potential for sample contamination in the field and laboratory or the potential for false detections due to analytical error. In 2017, there were no detections in the 36 field blank samples collected for TSS and pesticide analysis. It is unlikely that samples are becoming contaminated during field operations.

Laboratory Duplicates

MEL uses split sample duplicates to evaluate the precision of TSS and conductivity analyses. In 2017, there were 96 laboratory duplicate pairs for TSS and 9 duplicate pairs for conductivity (Table 47b). Of the TSS and conductivity duplicate pairs, 1 each was U qualified, leaving 95 TSS pairs and 8 conductivity pairs with RPD calculated. No field TSS or conductivity samples were requalified due solely to RPD exceedances. Overall, laboratory duplicate results were of acceptable data quality.

Table 47b – Laboratory duplicate results

Specific conductivity	8	20	0	0%
Total suspended solids	95	20	0	0%

Matrix Spike/Matrix Spike Duplicate Results

Summary MS/MSD results for each analyte are shown in Table 48b with control limits, percent recoveries, and RPDs. The table describes the number of MS/MSD recoveries that were above or below the laboratory control limits set for each analyte and the number of detections from all grab samples throughout the season for each analyte. Only the MS/MSD recoveries that were unqualified, E, or J qualified are included in the table. Some RPDs were unable to be calculated because of a U, NAF, or NC qualified MS/MSD recovery result. The summary table excluded these RPDs. Analytes and parameters that were not spiked into MS/MSD samples but were tested for in field samples include deltamethrin, pyrethrins, trans-permethrin, TSS, and specific conductivity.

Table 48b – Summary of MS/MSD results

Analyte	MS/MSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	MS/MSD recoveries below control limits	MS/MSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)	Total number of detections in 2017
2,4-D	14	40	130	88	70 - 109	0	0	7	10	2 - 20	110
2,6-Dichlorobenzamide	14	30	140	81	62 - 102	0	0	7	4	0.5 - 11	174
3,5-Dichlorobenzoic Acid	14	40	130	97	77 - 122	0	0	7	7	0.7 - 13	0
4,4'-DDD	18	49	143	83	59 - 112	0	0	9	7	0.5 - 21	5
4,4'-DDE	18	40	130	67	44 - 84	0	0	9	8	0.5 - 25	22
4,4'-DDT	18	42	120	62	37 - 86	3	0	9	8	1 - 25	3

Analyte	MS/MSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	MS/MSD recoveries below control limits	MS/MSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)	Total number of detections in 2017
4-Nitrophenol	14	40	130	86	48 - 133	0	1	7	10	0.2 - 20	6
Acetamiprid	14	40	130	98	87 - 110	0	0	7	2	0.3 - 6	0
Acetochlor	16	30	130	99	75 - 141	0	1	8	5	0.7 - 9	0
Alachlor	16	16	181	161	72 - 197	0	6	8	4	2 - 7	0
Aldicarb Sulfoxide	14	40	130	94	80 - 111	0	0	7	2	0.06 - 4	0
Atrazine	16	13	172	82	58 - 111	0	0	8	3	0.2 - 7	2
Azoxystrobin	14	40	130	93	86 - 103	0	0	7	3	0.2 - 8	55
Baygon	14	40	130	93	83 - 103	0	0	7	2	0.3 - 6	0
Benefin	18	50	151	84	60 - 121	0	0	9	4	0.2 - 10	0
Bentazon	14	40	130	108	86 - 136	0	1	7	9	5 - 18	20
Bifenazate	14	50	150	82	63 - 104	0	0	7	9	0.2 - 15	0
Bifenthrin	16	30	130	86	37 - 120	0	0	8	8	1 - 40	0
Boscalid	14	50	150	103	90 - 115	0	0	7	4	0.01 - 13	76
Bromacil	16	55	181	90	65 - 112	0	0	8	5	0.6 - 8	13
Bromoxynil	14	40	130	98	74 - 117	0	0	7	8	0.6 - 18	3
Captan	18	10	219	82	36 - 178	0	0	9	19	2 - 37	0
Carbaryl	14	40	130	95	90 - 103	0	0	7	4	0.5 - 7	2
Carbendazim	14	40	130	49	21 - 89	7	0	7	3	0.6 - 6	45
Chlorantraniliprole	14	40	130	90	65 - 107	0	0	7	12	4 - 28	3
Chlorethoxyfos	14	30	130	83	64 - 96	0	0	7	5	0.09 - 11	0
Chlorothalonil (Daconil)	18	57	227	80	32 - 100	2	0	9	6	0.3 - 19	3
Chlorpropham	16	53	181	91	65 - 116	0	0	8	5	2 - 12	1
Chlorpyriphos	18	52	152	86	67 - 102	0	0	9	2	0.4 - 5	27
Chlorsulfuron	14	40	130	58	30 - 82	2	0	7	8	1 - 23	1
cis-Permethrin	18	17	201	78	41 - 103	0	0	9	7	2 - 25	0
Clopyralid	14	40	130	65	50 - 90	0	0	7	6	0.4 - 19	3
Clothianidin	14	40	130	95	78 - 102	0	0	7	3	0.2 - 10	14
Coumaphos	18	10	487	122	94 - 180	0	0	9	7	0.04 - 14	0
Cycloate	16	49	151	84	63 - 110	0	0	8	7	1 - 13	1
Cyfluthrin	16	50	150	104	56 - 158	0	1	8	16	6 - 28	0

Analyte	MS/MSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	MS/MSD recoveries below control limits	MS/MSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)	Total number of detections in 2017
Cypermethrin	16	30	130	98	46 - 159	0	2	8	13	5 - 30	0
Cyprodinil	14	40	130	104	92 - 126	0	0	7	4	0.8 - 9	4
Dacthal	14	40	130	124	94 - 156	0	5	7	7	1 - 16	19
Deisopropyl Atrazine	14	40	130	93	63 - 107	0	0	7	9	3 - 15	2
Desethylatrazine	14	40	130	88	68 - 101	0	0	7	2	0.2 - 9	7
Diazinon	18	59	168	98	68 - 141	0	0	9	4	0.8 - 10	5
Dicamba	14	40	130	97	76 - 115	0	0	7	8	0.2 - 18	44
Dichlobenil	18	34	153	80	52 - 106	0	0	9	6	0.3 - 18	54
Dichlorprop	14	40	130	109	85 - 135	0	1	7	8	0.6 - 19	0
Dichlorvos (DDVP)	18	27	169	98	56 - 132	0	0	9	5	0.3 - 16	0
Difenoconazole	14	40	130	103	71 - 127	0	0	7	5	0.4 - 14	16
Diflubenzuron	14	40	130	101	71 - 175	0	2	7	15	3 - 25	0
Dimethoate	16	65	217	90	67 - 110	0	0	8	7	1 - 19	0
Dinotefuran	14	40	130	117	93 - 182	0	2	7	4	0.5 - 6	36
Dithiopyr	14	30	130	84	70 - 91	0	0	7	3	1 - 6	1
Diuron	14	40	130	96	87 - 105	0	0	7	4	1 - 9	67
Eptam	16	41	159	81	55 - 117	0	0	8	6	0.4 - 13	5
Ethalfluralin (Sonalan)	18	6	243	92	74 - 131	0	0	9	5	0.5 - 14	0
Ethoprop	18	10	263	101	79 - 129	0	0	9	4	0.2 - 10	1
Etoxazole	14	50	150	86	66 - 111	0	0	7	7	0.6 - 16	0
Etridiazole	16	50	150	79	49 - 104	1	0	8	8	3 - 14	6
Fenarimol	16	30	130	101	83 - 140	0	1	8	7	0.6 - 14	2
Fenbuconazole	14	40	130	101	85 - 117	0	0	7	5	0.4 - 12	0
Fenvalerate	18	30	130	105	45 - 158	0	3	9	7	2 - 26	0
Fipronil	16	30	130	84	53 - 121	0	0	8	5	0.4 - 12	1
Fipronil Desulfinyl	16	30	130	93	63 - 121	0	0	8	4	0.1 - 15	0
Fipronil Sulfide	16	30	130	88	67 - 124	0	0	8	4	0.4 - 11	1
Fipronil Sulfone	16	30	130	84	72 - 111	0	0	8	8	2 - 15	0
Fludioxonil	16	50	150	87	64 - 127	0	0	8	4	1 - 16	63
Flumioxazin	16	50	150	83	23 - 106	2	0	8	6	0.7 - 17	0

Analyte	MS/MSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	MS/MSD recoveries below control limits	MS/MSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)	Total number of detections in 2017
Fluroxypyr-meptyl	16	50	150	78	51 - 101	0	0	8	7	0.8 - 18	0
Hexazinone	16	41	183	92	64 - 136	0	0	8	7	0.5 - 17	0
Imazapic	14	40	130	102	80 - 125	0	0	7	6	0.7 - 14	0
Imazapyr	14	40	130	61	24 - 91	2	0	7	9	2 - 22	40
Imidacloprid	14	40	130	100	84 - 123	0	0	7	8	3 - 15	42
Imidan	18	32	203	106	44 - 144	0	0	9	5	1 - 15	0
Isoxaben	14	40	130	94	84 - 102	0	0	7	2	0.2 - 4	12
Kelthane	14	10	265	75	26 - 127	0	0	7	5	0.4 - 11	0
Linuron	14	40	130	83	58 - 130	0	0	7	23	4 - 54	0
Malaoxon	14	40	130	90	82 - 97	0	0	7	3	0.3 - 6	4
Malathion	16	50	147	100	78 - 129	0	0	8	6	1 - 11	10
MCPA	14	40	130	96	73 - 120	0	0	7	8	2 - 20	36
MCPP	14	40	130	110	81 - 135	0	1	7	8	2 - 16	20
Metalaxyl	18	56	149	88	71 - 118	0	0	9	9	3 - 17	32
Methiocarb	14	40	130	93	79 - 107	0	0	7	11	4 - 26	3
Methomyl	14	40	130	93	81 - 105	0	0	7	4	0.6 - 10	1
Methomyl oxime	4	40	130	61	39 - 94	1	0	2	17	4 - 29	0
Methoxyfenozide	14	40	130	94	86 - 105	0	0	7	2	0.3 - 4	5
Methyl Chlorpyrifos	18	50	144	95	69 - 131	0	0	9	6	1 - 16	0
Metolachlor	16	55	180	89	63 - 110	0	0	8	3	0.3 - 6	47
Metribuzin	16	30	130	85	62 - 103	0	0	8	5	2 - 9	0
Metsulfuron-methyl	14	40	130	53	36 - 70	4	0	7	9	2 - 30	6
MGK264	16	49	193	82	59 - 118	0	0	8	5	3 - 13	0
Myclobutanil	14	40	130	94	81 - 102	0	0	7	4	0.8 - 6	13
N,N-Diethyl-m-toluamide	16	50	150	92	68 - 118	0	0	8	1	0.2 - 5	27
Naled	18	10	220	89	49 - 183	0	0	9	5	0.7 - 10	0
Napropamide	16	70	180	91	59 - 124	2	0	8	9	3 - 15	1
Norflurazon	16	70	168	91	62 - 120	1	0	8	6	0.1 - 16	0
Oryzalin	14	10	230	62	12 - 86	0	0	7	27	1 - 123	0
Oxadiazon	16	50	150	83	61 - 116	0	0	8	7	0.4 - 16	19

Analyte	MS/MSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	MS/MSD recoveries below control limits	MS/MSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)	Total number of detections in 2017
Oxamyl	14	40	130	98	85 - 108	0	0	7	4	0.3 - 13	37
Oxamyl oxime	14	40	130	95	71 - 105	0	0	7	6	0.3 - 13	32
Oxyfluorfen	18	51	153	92	74 - 134	0	0	9	4	0.3 - 8	0
Pendimethalin	18	39	163	90	70 - 121	0	0	9	5	0.2 - 12	13
Pentachloronitrobenzene	16	50	150	85	63 - 101	0	0	8	6	2 - 12	0
Pentachlorophenol	14	40	130	98	81 - 118	0	0	7	8	2 - 14	15
Phenothrin	18	22	130	65	26 - 114	0	0	9	14	1 - 42	0
Phorate	18	12	130	102	70 - 154	0	2	9	6	1 - 12	0
Picloram	14	40	130	42	21 - 79	8	0	7	31	5 - 85	1
Piperonyl Butoxide	16	30	130	89	75 - 122	0	0	8	4	1 - 8	6
Prallethrin	14	30	130	17	10 - 23	14	0	7	21	4 - 36	0
Prodiamine	14	30	130	88	75 - 98	0	0	7	4	0.1 - 7	1
Prometon	16	55	164	89	62 - 130	0	0	8	3	0.2 - 5	1
Prometryn	16	62	165	86	66 - 113	0	0	8	4	0.2 - 9	0
Pronamide (Kerb)	16	63	169	89	62 - 126	1	0	8	4	0.6 - 8	0
Propargite	18	30	130	70	50 - 91	0	0	9	6	2 - 9	0
Propiconazole	14	40	130	99	78 - 114	0	0	7	3	0.2 - 9	16
Pyraclostrobin	14	40	130	108	87 - 124	0	0	7	3	0.2 - 8	18
Pyraflufen-ethyl	16	50	150	91	71 - 129	0	0	8	5	0.6 - 11	1
Pyridaben	16	50	150	89	55 - 135	0	0	8	7	0.3 - 14	3
Pyrimethanil	14	40	130	101	91 - 117	0	0	7	4	1 - 9	1
Pyriproxyfen	14	40	130	125	81 - 153	0	8	7	3	0.1 - 14	1
Simazine	16	72	192	94	68 - 121	5	0	8	6	1 - 17	26
Simetryn	16	61	171	85	62 - 114	0	0	8	3	0.09 - 8	1
Spirotetramat	14	40	130	86	77 - 104	0	0	7	10	0.9 - 29	5
Sulfentrazone	16	50	150	84	24 - 126	1	0	8	22	3 - 88	4
Sulfometuron methyl	14	40	130	71	60 - 85	0	0	7	2	0.3 - 5	30
Tau-fluvalinate	16	50	150	105	70 - 165	0	2	8	8	2 - 32	0
Tebuthiuron	16	10	235	101	71 - 145	0	0	8	3	0.3 - 6	33
Tefluthrin	14	30	130	76	61 - 85	0	0	7	2	0.04 - 5	1

Analyte	MS/MSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	MS/MSD recoveries below control limits	MS/MSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)	Total number of detections in 2017
Terbacil	16	27	237	95	72 - 114	0	0	8	5	0.2 - 12	19
Tetrachlorvinphos	18	70	196	99	72 - 139	0	0	9	5	0.4 - 15	0
Tetrahydrophthalimide	14	50	150	98	64 - 135	0	0	7	6	2 - 10	11
Tetramethrin	14	30	130	83	34 - 106	0	0	7	7	2 - 19	0
Thiacloprid	14	40	130	95	82 - 104	0	0	7	4	0.002 - 17	0
Thiamethoxam	14	40	130	103	92 - 131	0	1	7	4	0.1 - 14	71
Tralomethrin	14	30	130	124	72 - 180	0	6	7	12	0.07 - 30	0
Treflan (Trifluralin)	16	58	174	81	65 - 109	0	0	8	4	0.9 - 9	3
Triadimefon	16	61	178	86	62 - 122	0	0	8	6	0.8 - 12	0
Triallate	18	52	128	90	61 - 131	0	1	9	5	1 - 12	0
Triclopyr	14	40	130	126	98 - 156	0	5	7	9	0.1 - 16	37
Triclopyr-butoxyl	16	50	150	79	64 - 96	0	0	8	9	0.9 - 23	0
Triclosan	14	30	130	89	80 - 100	0	0	7	2	0.05 - 6	4
Trifloxystrobin	14	40	130	94	45 - 104	0	0	7	11	1 - 62	7
Zoxamide	14	40	130	83	72 - 100	0	0	7	7	0.7 - 33	0

* RPD control limit for every analyte in this table is 40%.

There were a total of 2,158 spiked results (1,079 MS/MSD pairs) from MS and MSD recoveries that were unqualified or qualified J. Overall, the mean recovery was 90% with a standard deviation of 23 µg/L. RPDs for those 1,079 MS/MSD pairs were below the 40% RPD control limit 99% of the time. The mean RPD for paired MS/MSD recoveries that were below the 40% RPD control limit was 6% with a standard deviation of 6 µg/L. The mean RPD for paired MS/MSD recoveries that were equal to or above the 40% RPD control limit was 68% with a standard deviation of 27 µg/L.

The percentage of analyte recoveries from MS/MSD samples that were above, below, or fell within the laboratory control limits are as follows:

- 3% of analyte recoveries fell below the control limits for MS/MSD samples,
- 95% of analyte recoveries were within the control limits for MS/MSD samples,
- 2% of analyte recoveries were above the control limits for MS/MSD samples.

If a MS/MSD sample exceeded MEL QC criteria, sample results were not requalified unless other QC criteria for that analyte was exceeded in the laboratory batch.

Laboratory Blanks

MEL uses laboratory blanks to assess the precision of equipment and the potential for internal laboratory contamination. Lab blanks also provide a method to measure the response of an analytical process to the analyte at a theoretical concentration of zero, helping to determine at what concentration samples can be distinguished from background noise. If lab blank detections occur, the sample MRL may be increased, and detections may be qualified as estimates. Table 49b lists the analyte detections that occurred in the laboratory blanks (33 detections). Regular field sample detections corresponding to the lab blank samples in the same batch were requalified if the regular sample result was less than 5 times the lab blank result.

Table 49b – Analyte detections in laboratory blanks

Analysis date	Analytical method	Analyte	Result (µg/L)	MRL (µg/L)	MDL (µg/L)	Qualifier
4/6	LCMS-Pesticides	Difenoconazole	0.014	0.01	0.004	
4/6	LCMS-Pesticides	Isoxaben	0.007	0.01	0.002	J
4/6	LCMS-Pesticides	Pyriproxyfen	0.013	0.01	0.0008	
4/6	LCMS-Pesticides	Trifloxystrobin	0.011	0.01	0.009	
4/13	LCMS-Pesticides	Difenoconazole	0.011	0.01	0.004	
4/13	LCMS-Pesticides	Isoxaben	0.006	0.01	0.002	J
4/13	LCMS-Pesticides	Methoxyfenozide	0.005	0.01	0.004	J
4/13	LCMS-Pesticides	Pyriproxyfen	0.013	0.01	0.0008	
6/16	GCMS-Pesticides	Triclosan	0.011	0.1	0.062	J
6/17	GCMS-Pesticides	Triclosan	0.013	0.1	0.062	J
6/19	GCMS-Pesticides	Fenarimol	0.024	0.033	0.021	J
6/23	LCMS-Pesticides	Carbendazim	0.013	0.02	0.002	J
6/23	LCMS-Pesticides	Clothianidin	0.024	0.1	0.014	J
6/23	LCMS-Pesticides	Thiamethoxam	0.092	0.02	0.009	
7/13	LCMS-Pesticides	Carbendazim	0.013	0.02	0.002	J
7/13	LCMS-Pesticides	Thiamethoxam	0.095	0.02	0.009	

Analysis date	Analytical method	Analyte	Result (µg/L)	MRL (µg/L)	MDL (µg/L)	Qualifier
7/14	LCMS-Pesticides	Thiamethoxam	0.094	0.02	0.009	
7/27	LCMS-Pesticides	Pyraclostrobin	0.009	0.02	0.004	J
7/27	LCMS-Pesticides	Pyriproxyfen	0.009	0.01	0.0008	J
7/27	LCMS-Pesticides	Trifloxystrobin	0.005	0.01	0.009	J
7/31	LCMS-Pesticides	Azoxystrobin	0.005	0.02	0.005	J
7/31	LCMS-Pesticides	Difenoconazole	0.008	0.01	0.004	J
7/31	LCMS-Pesticides	Pyriproxyfen	0.008	0.01	0.0008	J
8/1	GCMS-Pesticides	DEET	0.014	0.05	0.016	J
8/1	GCMS-Pesticides	Triclosan	0.022	0.1	0.062	J
8/2	GCMS-Pesticides	DEET	0.013	0.05	0.016	J
8/2	GCMS-Pesticides	Triclosan	0.022	0.1	0.062	J
8/3	GCMS-Pesticides	DEET	0.013	0.05	0.016	J
8/3	GCMS-Pesticides	Triclosan	0.023	0.1	0.062	J
8/28	GCMS-Pesticides	Triclosan	0.017	0.1	0.062	J
8/29	GCMS-Pesticides	Triclosan	0.016	0.1	0.062	J
9/13	GCMS-Pesticides	Triclosan	0.018	0.1	0.062	J
9/17	LCMS-Pesticides	Trifloxystrobin	0.005	0.01	0.009	J

Surrogates

Surrogates are analytes used to assess recovery for a group of structurally related chemicals. Surrogates specific to the list of analytes are spiked into all samples that are analyzed for pesticides. For instance, triphenyl phosphate is a surrogate for organophosphate insecticides. Summary statistics for surrogate recoveries are presented in Table 50b.

Table 50b – Pesticide surrogates

Analytes by structurally related group	Analytical method	Results (n)	Mean recovery (%)	Results within control limits (%)	Lower Control Limit (%)	Upper Control Limit (%)
Carbamate pesticides:						
Carbaryl C13	LCMS-Pesticides	418	97	100.0	40	130
Acid-derivitizable herbicides:						
2,4,6-Tribromophenol	GCMS-Herbicides	380	80	96.3	40	130
2,4-Dichlorophenylacetic acid	GCMS-Herbicides	380	100	96.1	40	130
Nitrogen containing pesticides:						
1,3-Dimethyl-2-nitrobenzene	GCMS-Pesticides	441	92	81.9	41	135
Chlorinated pesticides:						
4,4'-DDE-13C12	GCMS-Pesticides	441	68	99.8	20	117
Decachlorobiphenyl (DCB)	GCMS-Pesticides	441	61	98.4	13	98
Organophosphate pesticides:						
Chlorpyrifos-D10	GCMS-Pesticides	441	85	100.0	30	178
Triphenyl phosphate	GCMS-Pesticides	441	88	99.8	45	137
Chlorine and nitrogen containing pesticides:						
Trifluralin-D14	GCMS-Pesticides	441	67	99.8	26	180
Atrazine-D5	GCMS-Pesticides	441	83	100.0	45	167

In 2017, the overall mean recovery for surrogates was 82% and 81% of surrogate recoveries were within control limits. Surrogate results indicate method performance is of acceptable quality. The nitrogen-containing compounds experienced some recovery results outside of control limits, indicating poor extraction efficiency or matrix interference. There was no indication that water at a specific monitoring site was the problem. No WSDA 2019 POCs are nitrogen-containing compounds so it's likely their results were not affected by these potential recovery complications.

Laboratory Control Samples

Summary LCS/LCSD results for each analyte are shown in Table 51b, with control limits, percent recoveries, and RPDs. The table describes the number of LCS/LCSD recoveries that were above or below the laboratory control limits set for each analyte and the number of detections from all grab samples throughout the season for each analyte. Only the LCS/LCSD recoveries that were unqualified, E, or J qualified are included in the table. Some RPDs were unable to be calculated because of a U, NAF, or NC qualified LCS/LCSD recovery result. The summary table excludes these RPDs. Analytes that were not spiked into LCS/LCSD samples but were tested for in field samples include deltamethrin, pyrethrins, and trans-permethrin.

Table 51b – Summary statistics for LCS/LCSD recoveries and RPD

Analyte	LCS/LCSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	LCS/LCSD recoveries below control limits	LCS/LCSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)
2,4-D	68	40	130	93	58 - 127	0	0	34	9	0.07 - 39
2,6-Dichlorobenzamide	50	30	140	72	57 - 91	0	0	25	6	0.5 - 28
3,5-Dichlorobenzoic Acid	68	40	130	96	59 - 154	0	8	34	9	0.003 - 40
4,4'-DDD	60	64	138	87	53 - 127	2	0	30	5	0.8 - 12
4,4'-DDE	60	43	140	81	50 - 115	0	0	30	7	0.08 - 15
4,4'-DDT	60	49	148	86	54 - 122	0	0	30	6	0.2 - 15
4-Nitrophenol	68	40	130	123	58 - 294	0	22	34	13	0.8 - 66
Acetamiprid	54	40	130	107	83 - 122	0	0	27	5	0.04 - 15
Acetochlor	58	30	130	93	67 - 134	0	3	29	5	0.5 - 14
Alachlor	58	13	184	141	71 - 201	0	8	29	4	0.3 - 10
Aldicarb Sulfoxide	53	40	130	101	55 - 172	0	2	26	4	0.2 - 18
Atrazine	58	14	178	82	58 - 118	0	0	29	5	0.2 - 14
Azoxystrobin	54	40	130	103	86 - 126	0	0	27	4	0.2 - 17
Baygon	54	40	130	103	87 - 147	0	1	27	5	0.2 - 36
Benefin	60	44	143	85	61 - 133	0	0	30	6	1 - 14
Bentazon	68	40	130	107	67 - 143	0	4	34	7	0.1 - 29
Bifenazate	50	50	150	76	39 - 120	7	0	25	10	0.9 - 51
Bifenthrin	58	30	130	90	56 - 125	0	0	29	7	0.6 - 21
Boscalid	50	50	150	93	59 - 111	0	0	25	5	0.5 - 11
Bromacil	58	58	170	90	68 - 116	0	0	29	5	0.09 - 14
Bromoxynil	68	40	130	92	58 - 122	0	0	34	9	0.9 - 37
Captan	60	36	168	86	27 - 166	1	0	30	13	0.2 - 68
Carbaryl	54	40	130	98	74 - 120	0	0	27	9	0.2 - 35
Carbendazim	48	40	130	47	20 - 91	13	0	24	4	0.4 - 12
Chlorantraniliprole	54	40	130	103	51 - 167	0	2	27	10	0.5 - 28

Analyte	LCS/LCSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	LCS/LCSD recoveries below control limits	LCS/LCSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)
Chlorethoxyfos	50	30	130	70	48 - 84	0	0	25	6	0.2 - 15
Chlorothalonil (Daconil)	60	86	221	82	43 - 126	37	0	30	9	0.3 - 60
Chlorpropham	58	58	150	87	64 - 118	0	0	29	5	0.2 - 19
Chlorpyriphos	60	64	146	85	62 - 105	2	0	30	5	0.2 - 14
Chlorsulfuron	54	40	130	61	15 - 120	13	0	27	24	2 - 144
cis-Permethrin	60	48	178	83	57 - 122	0	0	30	6	0.4 - 13
Clopyralid	68	40	130	75	51 - 100	0	0	34	12	1 - 36
Clothianidin	54	40	130	104	73 - 136	0	1	27	7	0.3 - 25
Coumaphos	60	65	207	106	67 - 171	0	0	30	5	0.1 - 15
Cycloate	58	50	141	77	54 - 112	0	0	29	6	0.2 - 19
Cyfluthrin	58	30	130	97	56 - 158	0	5	29	11	0.4 - 34
Cypermethrin	58	30	130	102	63 - 154	0	6	29	5	0.04 - 19
Cyprodinil	54	40	130	106	87 - 123	0	0	27	4	0.1 - 10
Dacthal	68	40	130	110	68 - 149	0	6	34	8	0.003 - 32
Deisopropyl Atrazine	54	40	130	111	60 - 278	0	7	27	10	0.2 - 52
Desethylatrazine	54	40	130	113	67 - 229	0	7	27	5	0.2 - 29
Diazinon	60	70	142	91	69 - 152	1	2	30	5	0.3 - 12
Dicamba	68	40	130	93	60 - 130	0	0	34	9	0.2 - 38
Dichlobenil	60	44	139	75	57 - 124	0	0	30	9	0.2 - 23
Dichlorprop	68	40	130	103	64 - 140	0	3	34	8	0.6 - 34
Dichlorvos (DDVP)	60	39	145	85	57 - 125	0	0	30	7	0.05 - 31
Difenoconazole	54	40	130	136	101 - 224	0	26	27	5	0.06 - 27
Diflubenzuron	54	40	130	108	29 - 212	2	12	27	20	0.8 - 91
Dimethoate	58	48	206	92	64 - 126	0	0	29	9	0.5 - 22
Dinotefuran	53	40	130	105	83 - 127	0	0	26	4	0.06 - 15
Dithiopyr	50	30	130	84	66 - 103	0	0	25	4	0.6 - 11
Diuron	54	40	130	103	90 - 141	0	1	27	5	0.2 - 23
Eptam	58	48	142	73	49 - 113	0	0	29	7	0.6 - 23
Ethalfluralin (Sonalan)	60	31	167	87	63 - 139	0	0	30	7	0.1 - 21
Ethoprop	60	55	163	90	60 - 137	0	0	30	5	0.1 - 17

Analyte	LCS/LCSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	LCS/LCSD recoveries below control limits	LCS/LCSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)
Etoxazole	50	50	150	86	60 - 111	0	0	25	7	0.3 - 27
Etridiazole	58	30	130	82	58 - 130	0	0	29	9	0.4 - 25
Fenarimol	58	30	130	89	55 - 133	0	3	29	5	0.2 - 20
Fenbuconazole	54	40	130	116	89 - 141	0	7	27	5	0.09 - 20
Fenvalerate	60	30	130	99	60 - 147	0	7	30	8	0.6 - 20
Fipronil	58	30	130	91	54 - 154	0	4	29	7	0.4 - 27
Fipronil Desulfinyl	58	30	130	92	69 - 127	0	0	29	4	0.09 - 14
Fipronil Sulfide	58	30	130	89	54 - 132	0	1	29	5	0.2 - 12
Fipronil Sulfone	58	30	130	89	62 - 119	0	0	29	6	0.08 - 19
Fludioxonil	58	30	130	85	53 - 135	0	1	29	5	0.04 - 12
Flumioxazin	58	30	130	78	18 - 139	4	3	29	9	0.3 - 36
Fluroxypyr-meptyl	58	30	130	83	52 - 121	0	0	29	7	0.004 - 20
Hexazinone	58	69	150	88	51 - 127	3	0	29	6	0.5 - 19
Imazapic	54	40	130	99	48 - 206	0	3	27	7	1 - 23
Imazapyr	53	40	130	91	45 - 139	0	4	26	9	0.3 - 33
Imidacloprid	54	40	130	100	79 - 139	0	1	27	5	0.03 - 17
Imidan	60	44	190	90	42 - 146	2	0	30	9	0.2 - 22
Isoxaben	54	40	130	103	85 - 117	0	0	27	5	0.2 - 19
Kelthane	50	31	179	87	41 - 146	0	0	25	12	0.4 - 38
Linuron	54	40	130	88	41 - 166	0	3	27	25	2 - 85
Malaoxon	54	40	130	99	85 - 110	0	0	27	4	0.3 - 13
Malathion	58	61	138	94	66 - 134	0	0	29	5	0.1 - 14
MCPA	68	40	130	93	61 - 125	0	0	34	9	0.5 - 32
MCPP	68	40	130	101	63 - 136	0	3	34	9	0.2 - 37
Metalaxyl	60	59	153	86	70 - 105	0	0	30	5	0.09 - 20
Methiocarb	54	40	130	95	64 - 125	0	0	27	10	0.2 - 29
Methomyl	54	40	130	98	82 - 114	0	0	27	4	0.02 - 16
Methomyl oxime	28	40	130	77	37 - 169	1	2	14	20	3 - 121
Methoxyfenozide	54	40	130	106	86 - 148	0	3	27	3	0.2 - 17
Methyl Chlorpyrifos	60	58	135	91	69 - 135	0	0	30	5	0.6 - 18

Analyte	LCS/LCSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	LCS/LCSD recoveries below control limits	LCS/LCSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)
Metolachlor	58	68	158	87	68 - 111	0	0	29	3	0.2 - 8
Metribuzin	58	30	130	85	61 - 115	0	0	29	5	0.03 - 13
Metsulfuron-methyl	54	40	130	55	17 - 104	19	0	27	17	0.3 - 80
MGK264	58	71	169	82	53 - 123	7	0	29	7	0.04 - 23
Myclobutanil	54	40	130	108	76 - 135	0	4	27	5	0.03 - 15
N,N-Diethyl-m-toluamide	58	30	130	86	63 - 125	0	0	29	5	0.08 - 12
Naled	60	22	159	100	65 - 207	0	3	30	11	0.3 - 41
Napropamide	58	82	176	86	52 - 122	23	0	29	6	0.6 - 17
Norflurazon	58	85	143	86	59 - 120	31	0	29	5	0.4 - 14
Oryzalin	50	10	277	81	53 - 138	0	0	25	10	0.2 - 35
Oxadiazon	58	30	130	86	54 - 121	0	0	29	7	0.05 - 22
Oxamyl	54	40	130	99	22 - 113	1	0	27	8	0.07 - 128
Oxamyl oxime	54	40	130	109	80 - 146	0	3	27	6	0.6 - 22
Oxyfluorfen	60	42	154	96	70 - 130	0	0	30	5	0.4 - 11
Pendimethalin	60	49	159	93	72 - 118	0	0	30	4	0.06 - 14
Pentachloronitrobenzene	58	30	130	83	60 - 110	0	0	29	10	2 - 30
Pentachlorophenol	68	40	130	86	49 - 118	0	0	34	9	0.02 - 41
Phenothrin	60	20	95	55	27 - 100	0	2	30	11	0.4 - 28
Phorate	60	13	114	89	53 - 170	0	8	30	7	0.2 - 15
Picloram	68	40	130	58	21 - 145	18	2	34	23	2 - 95
Piperonyl Butoxide	58	30	130	84	54 - 115	0	0	29	5	0.6 - 14
Prallethrin	50	30	130	55	39 - 70	0	0	25	8	0.2 - 22
Prodiamine	50	30	130	97	76 - 129	0	0	25	6	0.9 - 21
Prometon	58	59	161	87	61 - 126	0	0	29	8	0.3 - 43
Prometryn	58	60	160	85	67 - 109	0	0	29	4	0.4 - 12
Pronamide (Kerb)	58	74	150	87	68 - 122	7	0	29	5	1 - 12
Propargite	60	30	130	79	47 - 135	0	2	30	12	0.1 - 43
Propiconazole	54	40	130	118	79 - 182	0	12	27	4	0.009 - 22
Pyraclostrobin	54	40	130	114	88 - 138	0	4	27	3	1 - 14
Pyraflufen-ethyl	58	30	130	92	61 - 137	0	2	29	6	0.7 - 17

Analyte	LCS/LCSD recoveries (n)	Lower control limit (%)	Upper control limit (%)	Mean recovery (%)	Range of recoveries (%)	LCS/LCSD recoveries below control limits	LCS/LCSD recoveries above control limits	RPD (n)	Mean RPD (%)	Range of RPDs* (%)
Pyridaben	58	30	130	91	58 - 140	0	2	29	6	0.09 - 14
Pyrimethanil	54	40	130	109	87 - 147	0	4	27	6	0.1 - 19
Pyriproxyfen	54	40	130	135	87 - 182	0	30	27	4	0.2 - 18
Simazine	58	80	184	85	57 - 130	28	0	29	6	1 - 17
Simetryn	58	44	168	84	67 - 108	0	0	29	4	0.01 - 12
Specific Conductivity	9	95	105	99	99 - 100	0	0			
Spirotetramat	54	40	130	102	65 - 142	0	1	27	13	2 - 44
Sulfentrazone	57	30	130	73	13 - 140	8	3	28	18	0.9 - 70
Sulfometuron methyl	54	40	130	84	58 - 129	0	0	27	6	0.03 - 27
Tau-fluvalinate	58	30	130	97	62 - 152	0	6	29	5	0.09 - 18
Tebuthiuron	58	10	94	88	51 - 152	0	14	29	7	0.08 - 21
Tefluthrin	50	30	130	78	65 - 99	0	0	25	5	0.07 - 12
Terbacil	56	57	183	89	72 - 117	0	0	28	5	0.1 - 20
Tetrachlorvinphos	60	84	176	98	71 - 139	7	0	30	4	0.3 - 13
Tetrahydrophthalimide	50	50	150	59	36 - 88	9	0	25	8	0.3 - 29
Tetramethrin	50	30	130	74	38 - 89	0	0	25	6	0.4 - 30
Thiacloprid	54	40	130	105	79 - 124	0	0	27	5	0.03 - 27
Thiamethoxam	54	40	130	105	83 - 139	0	1	27	5	0.1 - 16
Total Suspended Solids	50	80	120	97	80 - 112	0	0			
Tralomethrin	50	30	130	97	52 - 183	0	7	25	10	1 - 31
Treflan (Trifluralin)	58	41	173	80	60 - 106	0	0	29	6	0.9 - 19
Triadimefon	58	74	166	85	66 - 116	9	0	29	4	0.08 - 13
Triallate	60	58	126	87	64 - 148	0	3	30	5	0.04 - 13
Triclopyr	68	40	130	121	76 - 169	0	20	34	8	0.1 - 39
Triclopyr-butoxyl	58	30	130	81	55 - 108	0	0	29	9	1 - 21
Triclosan	50	30	130	85	56 - 103	0	0	25	4	0.1 - 8
Trifloxystrobin	54	40	130	113	80 - 149	0	8	27	4	0.06 - 24
Zoxamide	54	40	130	99	73 - 133	0	1	27	7	0.6 - 35

*RPD control limit for all pesticide analytes is 40% and RPD control limits for TSS and conductivity is 20%.

There were a total of 8,107 spiked results from LCS and LCSD recoveries that were unqualified or qualified J. Overall, the mean recovery was 92% with a standard deviation of 23 µg/L. RPDs for those 4,022 LCS/LCSD pairs were below the 40% RPD control limit 99% of the time. The mean RPD for paired LCS/LCSD recoveries that were below the 40% RPD control limit was 7% with a standard deviation of 7 µg/L. The mean RPD for paired LCS/LCSD recoveries that were equal to or above the 40% RPD control limit was 63% with a standard deviation of 26 µg/L.

The percentage of analyte recoveries from LCS/LCSD samples that were above, below, or fell within the laboratory control limits are as follows:

- 3% of analyte recoveries fell below the control limits for LCS/LCSD samples,
- 93% of analyte recoveries were within the control limits for LCS/LCSD samples,
- 4% of analyte recoveries were above the control limits for LCS/LCSD samples.

Whenever the RPD or analyte recoveries fell outside of the control limits for a given analyte, all detections of that analyte in field samples that were associated with that analytical batch were qualified as estimates.

Field Data Quality Control Measures

In Eastern Washington, a Hach HydroLab MS5 field meter was used from March until July after which a YSI ProDSS field meter was used until the last sampling event. In Western Washington, a YSI ProDSS field meter was used every sampling event. The Hach HydroLab MS5 field meter was calibrated the morning of the first field day of the week according to manufacturer's specifications, using Ecology's *Standard Operating Procedure for Hydrolab® DataSonde® and MiniSonde® Multiprobes* (Swanson, 2010). The YSI ProDSS field meters were calibrated the evening before, or the morning of the first field day of the week according to manufacturer's specifications described in the *YSI ProDSS User Manual* (YSI, 2014). Meters that were used during a sampling week were post-checked at the end of the week.

Dissolved oxygen (DO) meter results were compared to results from grab samples analyzed using the Winkler laboratory titration method. DO grab samples for Winkler titrations were collected and analyzed according to the SOP (Ward, 2017). Winkler grab samples were collected at the first sampling site each day and at the last sampling site each day. Additionally, a replicate Winkler grab sample was collected per week at either the beginning or the end of one of the sampling days.

To check conductivity meter results, surface water grab samples were obtained and sent to MEL for conductivity analysis. Approximately 5% of the conductivity meter readings were checked with MEL conductivity results.

Streamflow measurements were taken with OTT MF pro flow meters and top-setting wading rods for both Eastern and Western Washington monitoring sites. Each flow meter was calibrated the morning of the first day of the week as described in the *OTT MF pro Basic User Manual* (OTT, 2015). A replicate streamflow measurement was taken once a week at a randomly selected site for each flow meter.

Measurement quality objectives (MQOs) for meter post-checks, replicates, and Winkler DO comparisons are described in Anderson and Sargeant (2009). Data that did not meet MQOs were qualified.

Field Data Collection Performance

Quality control results for several conventional water quality parameter replicates are shown below in Table 52b.

Table 52b – Quality control results for conventional water qualiter parameter replicates

Replicate meter parameter	MQO	Western Washington		Eastern Washington	
		Mean	Maximum	Mean	Maximum
Winkler and meter DO	10% RSD	2% RSD	14% RSD	1% RSD	3% RSD
Replicate Winkler's for DO	±0.2 mg/L	0.1 mg/L	0.2 mg/L	0.1 mg/L	0.5 mg/L
Conductivity (field meter vs. laboratory)	10% RSD	2% RSD	6% RSD	2% RSD*	3% RSD*
Streamflow	10% RSD	2% RSD	6% RSD	4% RSD	53% RSD

*Does not include the 1 MQO exceedance due to clerical error in the field.

The field meters met MQOs for laboratory conductivity comparisons for all monitoring locations for Western and Eastern Washington locations. There was 1 conductivity MQO exceedance that occurred at Marion Drain on June 26 with a laboratory conductivity result of 297 µS/cm compared to the field meter reading of 7.40 µS/cm, resulting in RSD of 95%. Despite the exceedance, all post sampling calibration checks passed data quality objectives (Table 53b). It was determined that there was a clerical error that occurred when the meter results were transcribed in the field. This entry was left out of the analysis in Table 52b.

During 2017, no MQO exceedances occurred between the Hach Hydrolab MS5 field meter or YSI ProDSS meter and DO Winkler analysis in Eastern Washington. YSI ProDSS meter results exceeded MQOs for DO Winkler comparisons 4 times in Western Washington:

- Upper Big Ditch, 14% RSD, Aug. 15 (Winkler: 1.31 mg/L & field meter: 0.99 mg/L)
- Lower Big Ditch, 13% RSD, Sept. 6 (Winkler: 14.34 mg/L & field meter: 10.96 mg/L)
- Upper Big Ditch, 12% RSD, July 18 (Winkler: 1.54 mg/L & field meter: 1.20 mg/L)
- Upper Big Ditch, 10% RSD, July 24 (Winkler: 2.58 mg/L & field meter: 3.16 mg/L)

Field notes from the September 6 sampling event at Lower Big Ditch states that Winkler samples were taken about 20 feet upstream from where the ProDSS readings were taken to avoid sampling kicked up sediment in the stagnant water. This could account for the disparity between the meter readings and the Winkler sample. Winkler samples taken during all 3 Upper Big Ditch samples were from water that was flowing at approximately 0 cfs and filled with decomposing vegetation that likely stratified the water column. Winkler and DO results for these MQO exceedances were reported and qualified as estimates for the listed dates.

The 2017 Winkler replicate values for both Eastern and Western Washington locations met the MQOs with the exception of the following locations and dates:

- Snipes Creek, difference 0.53 mg/L, June 19 (8.66 mg/L and 8.13 mg/L)
- Marion Drain, difference 0.25 mg/L, Oct. 30 (10.13 mg/L and 10.38 mg/L)
- Naneum Creek, difference 0.22 mg/L, June 13 (9.32 mg/L and 9.55 mg/L)

The 2017 streamflow replicate results for both the Eastern and Western Washington sites met MQO (Table 52b) except for the following site visits:

- Snipes Creek, 17% RSD, March 27 (15.08 cfs and 10.76 cfs)
- Marion Drain, 53% RSD, July 11 (29.99 cfs and 97.82 cfs)

Streamflow results for the Snipes Creek, March 27 sampling event was acceptable. Field notes indicate variable flow in Snipes Creek due to 2 canals discharging into the creek during the sampling event. Streamflow replicate results for the above sampling event were averaged and qualified. During the replicate streamflow measurement at Marion Drain, the staff gauge start depth was 0.77 feet deeper than the first streamflow measurements. The 2 measurements for this sampling event were not averaged because of the variability in flow depth throughout both measurements. The 97.82 cfs replicate measurement was chosen to represent this sites flow for the sampling event because water samples were taken immediately after this measurement.

Table 53b describes data quality objectives for field meter post-checks as described in the Quality Assurance Project Plan Addendum 3 (Anderson and Sargeant, 2009).

Table 53b – Data Quality Objectives for YSI ProDSS or other field meter post-checks

Parameter	Units	Accept	Qualify	Reject
pH	standard units	≤ ± 0.25	> ± 0.25 and ≤ ± 0.5	> ± 0.5
Conductivity[1]	µS/cm	≤ ± 5%	> ± 5% and ≤ ± 15%	> ± 15%
Dissolved Oxygen[2]	% saturation	≤ ± 5%	> ± 5% and ≤ ± 10%	> ± 10%

[1] Criteria expressed as a percentage of readings; for example, buffer = 100.2 µmhos/cm and YSI = 98.7 µmhos/cm; [(100.2-98.7)/100.2]*100 = 1.49% variation, which would fall into the acceptable data criteria of less than 5%.

[2] When Winkler data is available; it will be used to evaluate acceptability of data in lieu of percent saturation criteria.

Post-checks of the Westside and Eastside YSI and Hach Hydrolab MS5 meters met data quality objectives for all parameters except the following:

- Westside YSI meter pH 4.0 calibration, August 7 (pre-check pH 4.0 and post-check pH 4.29)

Field pH readings taken by the Westside YSI meter between the pre-check and post-check dates listed above were not lower than or greater than the statewide pH water quality standards so no field data was qualified.

Field Audit

The purpose of the field audit was to ensure sampling methodologies were consistent for all field teams. For field audits, both the Western and Eastern Washington field teams met at a surface water monitoring site. The teams measured general water quality parameters, streamflow, and Winkler grab samples. Results and methods were compared to ensure field teams were using consistent sampling methodologies resulting in comparable data.

On September 18, a field audit was conducted at Woodland Creek in Lacey. The Westside team calibrated their YSI ProDSS Multi-Meter on September 18 in Olympia, at the Natural

Resources Building in the Entomology Lab. The Eastside team calibrated their YSI ProDSS Multi-meter on September 13 at the WSDA Yakima office in the NRAS lab, located in Yakima. Both teams met to perform the field audit simultaneously. Table 54b displays the results.

Table 54b – Conventional water quality parameter and flow data from field audit

Equipment and location	Temperature (°C)	pH	Conductivity (µS/cm)	DO (mg/L)	DO (% sat.)	Streamflow (cfs)
Field meter – West	11.9	7.17	168.4	8.04	74.5	
Field meter – East	12.0	6.94	169.1	7.88	73.6	
Winkler – West				7.80		
Winkler – East				7.70		
Winkler – East Replicate				7.77		
Flow – West						9.77
Flow – East						9.90

All meter results and Winkler results were acceptable based on the Measurement Quality Objectives described in Anderson and Sargeant (2009). Table 52b shows some of the MQOs for conventional field parameters.

The Eastside YSI ProDSS was post-checked on September 20 and the Westside YSI ProDSS was post-checked on September 21. Both of the post-checks passed data quality objectives found in Table 53b.

Quality Assurance Summary References

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