Quality Assurance Project Plan

For

Water Quality Effects of Multifunctional Working Buffers for Seasonally Wet Farmland

2022-2025 Western SARE Research and Education Grant

November 28, 2022

QAPP prepared by James Watson, Lead Research Investigator

With support from Carrie Brausieck, Lead Investigator and Natural Resource Planner at Snohomish Conservation District and Steve Britsch, Snohomish County Surface Water Management.

Team Members:

Carrie Brausieck- Principal Investigator

Senior Natural Resource Planner & Agroforester, Snohomish Conservation District

703-407-8341 cbrausieck@snohomishcd.org

Kelsi Mottet

Senior Natural Resource Planner, Whidbey Island Conservation District

(360) 499-9558

kelsi@whidbeycd.org

James Watson- Lead Research Investigator

Natural Resource Planner, Whidbey Island Conservation District

(360) 499-9374

james@whidbeycd.org

Emmett Wild

Senior Natural Resource Planner, Skagit Conservation District

360-899-8761

emmett@skagitcd.org

Western SARE QAPP Draft

TABLE OF CONTENTS

Introduction

The Puget Sound region is experiencing rapid changes in growth, land use, and climate impacts. Increases in spring precipitation (Abatzoglou, 2014) and annual precipitation maxima are leading to productive agricultural lands becoming increasingly saturated or seasonally wet. Meanwhile, development pressure and competing natural resource management objectives have reduced available land for agricultural production. The USDA's Census of Agriculture has shown that in Skagit, Snohomish, and Island counties, total combined acreage in agricultural production has decreased by 12% from2012 to 2017 (Forecasting and Research Division, 2020). Simultaneously, large west-coast cities have grown by 9.1% overall in the past 10 years, and nearby small towns have grown 13.3% (USDA, 2020).

The Puget Sound region is home to many keystone species, including Southern Resident orca whales and several species of salmonids that are listed as threatened under the Endangered Species Act. Many of Washington's waterways suffer from poor water quality due to factors commonly associated with agricultural pollution sources (Rodgers, 2016; Borrelli et al., 2017). With communities struggling to address ocean acidification, waterway pollution, reduced water quantity for stream baseflows, and habitat degradation and loss, the farming industry has come under increasing pressure to adopt best management practices to protect our local waterways.

Perennial plantings in wet non-riparian areas can improve surface and subsurface water quality and increase carbon sequestration (Dabney, 2006), but farmers need to maximize land resources to remain economically viable. At the same time, Puget Sound area farms tend to be small, with the average farm being between 5 and 50 acres (Ostrom, 2013). This makes it difficult to set aside land for conservation or restoration without sufficient financial incentives, which are not always available.

Research Objectives

Objective 1: Measure water quality effects of three newly established working buffer trial plantings.

Objective 2: Identify possible benefits/limitations of young working buffer systems to improve water quality

Objective 3: Identify what changes are observable within the timeline of this grant and where further research is needed.

Project Start Date

August 1, 2022

Project End Date

July 31, 2025

Research Timeline

Our team will conduct research throughout the grant. Before beginning research, we will conduct desktop review. We will collect baseline data for one year after desktop review and continue to collect a similar data set until February of 2025. Water temperature loggers will run year-round. Soil and Water Laboratory Testing will include periodic and ongoing sampling.

Background and Project Description Summary

The scientific efficacy of working buffers is largely unknown due to a lack of scientific research providing soil- and water-quality data. It is the intention of this research to lay the foundation for obtaining the necessary metrics for both policy decision-makers and producers, to find a win-win situation between buffer regulation and production for farmers. As a result of changing climate, development, and the need for habitat protection is increasing pressure on US farmland. Climate-related changes in precipitation and drainage challenges are leading to areas of formerly productive agricultural lands becoming increasingly saturated, and regulations restrict the addition of new drainage. Meanwhile, the decreasing availability and rising cost of agricultural land is driving new farmers to purchase marginal land that often suffers from hydrologic issues. These factors especially impact socially and economically disadvantaged farmers, limiting their access to well-drained land.

Farming seasonally wet fields presents problems for annual crops and can have negative impacts on nearby water quality, but farmers must maximize land resources to remain economically viable. This makes it difficult to set aside land for conservation or restoration without sufficient financial incentives, yet existing incentive payments are often not large enough to offset production losses.

“Working buffers”–a perennial agroforestry cropping system that can be used on seasonally wet farmland–are a promising approach for farmers to both protect water and soil resources and generate income on marginal areas. To increase working buffer adoption, more research is needed to understand their economic feasibility and their effects on water quality and soil health in the Pacific Northwest.

This project is for Snohomish Conservation District (SCD), Skagit Conservation District (Skagit CD), Whidbey Island Conservation District (WICD), Snohomish County, and Washington State University (WSU) Extension to study the water quality effects of working buffers and conduct outreach to producers and agency staff. Our SARE research team aims to attain a picture of the viability of working buffers as a regional MP by understanding effects on water quality and soil health. It will coincide with a recently awarded Washington State Department of Agriculture (WSDA) Specialty Crops Block Grant (SCBG) that will establish a second set of trial sites and investigate the economic viability of working buffer systems.

The Conservation Districts (CDs) will work with three producers to establish on-farm working buffer trial sites—one in each CD service area—and conduct research on their effects on water quality. Given the extended timeline to establish perennial plantings, further research will be necessary to understand the full impacts of working buffers. This grant will implement trial sites for long-term research and education in the region and provide initial impressions of their effectiveness.

We will offer hands-on learning for stakeholders, including volunteer participation in site planting and establishment, and workshops across western Washington to present our results. Outreach will also include farm tours facilitated by our farmer-partners demonstrating how sites were established and how they function. Lastly, we will develop educational materials, including a training guide and a 5-minute video. By increasing producers’ understanding of working buffers and training agency, CD, and extension staff to provide technical support, we will develop a foundation for producers to draw from as they expand adoption of the practice in our region.

Research Plan

Measurements of soil and water resources in their existing condition, or quality, are typically collected within the top six inches of soils. These top six inches are the most important indicators for non-point source pollution runoff, where surface waters mix with soil. Runoff becomes more important relative to the nutrient load within seasonally-wet areas and other critical areas, where nutrient loading may be significant for aquifer recharge, transport via subsurface drainage, and/or downstream discharge into waterways.

During this three-year experiment, we intend to utilize three pilot sites, one within each of the Skagit, Snohomish, and Whidbey Island Conservation Districts' boundaries. In approximately the first six months of the grant, we will perform literature and desktop reviews to establish optimal location placement and equipment type for each individual pilot site, based upon hydrogeography and soil type, to maximize the efficiency of soil-and water-quality data collection. Prior to any field alterations we will install all research-related equipment, take appropriate samples, and collect a year of baseline data. Immediately following we will install agroforestry orchards within known seasonally-wet buffers on the commercial agricultural pilot sites, collect a year's worth of data downstream of the installed working buffer and continue collecting baseline data upstream of the altered area, as a control. In the last six months of the grant, with the first-ever data set collected, we will begin compiling data for future analysis at a later stage of research. Our long-term goal is to provide sufficient research in a multi-phased project, to obtain sufficient data and information over many years, to illicit local policy change for the benefit of both the environment and the producers.

We have selected three fields for this experiment based on the following criteria: 1) landowner willingness; 2) presence of wet areas; 3) geographic distribution for visibility across all conservation districts. We will conduct a desktop review to establish watershed characteristics including topography, drainage patterns, climate data, water table, and available geohydrology data. We will analyze pre-existing soil and/or water quality impairments for each site and highlight noted impairments in relation to current regional standards.

We will establish a twelve-month baseline dataset for each site prior to installation of working buffers. The intention of this objective is to measure soil- and water-quality changes downstream of the installed working buffer, to examine the hypothesis. Multi-species working buffers will have similar ecosystem functions as native riparian buffers (reduction in water temperature, decrease in nutrient levels and pollution, decreased in sediment load in water, increased sediment catchment).

We will collect samples in waterways, drainage pathways, or points of concentrated flow, with at least two (2) temperature and water-logger stations, one upstream and one downstream, and at least ten (10) soil sampling locations, at each pilot site. Soil-quality sampling stations will be located in-field or at drainage outlets, depending on the topography, as assessed in the desktop review. Each of these pilot sites are intended to be easily accessible to allow for year-round sampling, and to include at least one storm-event sampling at each pilot site, as well as meteorological data from the nearest WSU weather station.

Analysis of the weather stations, producer experience, baseline data, and constituent loads will determine whether the first year data represents a "typical" runoff event or is anomalous, potentially influenced by upstream activities. We will compare our findings with "typical weather" as defined by an analysis of 10 years' worth of data to establish prior information on a "typical" weather year, using the WSU agronomical weather stations, closest to each pilot site location.

While the overall goal is to assess whether working buffers are efficacious at reducing pollutants, this phase of the grant will focus on the collection of baseline data with descriptions of soil- and water-quality to be used statistically during later phases of continued research.

MONITORING PARAMETERS AND PROCEDURES

Parameters

Water Quality: 84 tests over 28 consecutive months of total nitrogen, pH, and alkalinity. 27 tests over a 28-month period (Jan/Apr/Jul/Oct) of total solid, suspended solids, total dissolved solids, nitrate plus nitrite-N, total phosphorus, and conductivity. 60 tests over 28-month period for Kjeldahl nitrogen (Jan, Apr-Oct 2023; Jan, April 2024-February 2025). Water quality samples will be collected using HDPE containers, with separate containers for solids and nutrients testing in accordance with Everett Environmental Lab standards. Continuous water temperature sampling will be collected every 15 minutes using HOBO V2 data logger.

Soil Quality: Each site will have 10 sampling locations within the experimental planting areas. Quarterly (Feb/May/August/November) soil sampling will be tested for nitrate ($N0^{3}$-N), ammonium (NH^{4}-N), total P, total K, suspended solids, and pH. Only the top 6" of soil will be tested using probes or shovels. Samples will be collected 10 at a time and mixed into buckets in accordance with Soiltest Farm Consultants.

Sampling procedures

Water quality samples will be turned over to Everett Environmental Labs at the end of each day for testing, and soil quality samples will be sent to Soiltest Farm Consultants within 48 hours of collection. Samples will be stored in coolers or refrigerators during transport or storage to reduce reaction of contents. Temperature and weather conditions data from the nearest WSU weather station will be collected at the beginning of each site visit for testing. Samples of both water and soil with be duplicated at a 10% rate for quality control practices. Every 10 samples collected at each water quality monitoring station and every 10 total samples of soil (10 buckets of mixed soil samples) per pilot site will be duplicated for testing.

Water Quality: Samples will be collected using HDPE containers, with separate containers for solids and nutrients testing in accordance with Everett Environmental Lab standards. Collection of water grab samples will be done at the location of the water logging equipment. Samples will be collected from the middle of the water column, or no deeper than 2 feet from the surface. Water depth will be collected using a stadia rod. Data from water temperature loggers will be collected at each water quality sampling site visit, and will require removal of the units from the water to connect and upload data to a laptop. Temperature will be recorded at 15 minute intervals. Water loggers will be plugged into appropriate base ports and data will be sent via USB cable to laptop. Duplicate copies of data will be created for backup. Data will be cleared from logger each time it is redeployed, and only after having written and digital copies of the data stored.

To collect a grab sample:

1. Open a sterile, narrow-mouth borosilicate glass or plastic bottle; grasp the bottle near the base, with hand and arm on the downstream side of the bottle.

2. Without rinsing, plunge the bottle opening downward, below the water surface. Allow the bottle to fill with the opening pointed slightly upward into the current.

3. Remove the bottle with the opening pointed upward toward the water surface and tightly cap it, allowing about 2.5 to 5 cm of headspace (American Public Health Association and others, 1998, p. 9-19; Bordner and Winter, 1978, p. 8).

Nutrients and solids sample bottles will be marked with labels describing the sample site by number and the date. Samples will be held under ice and transported to a certified laboratory by field sampling personnel within the 8-h holding time. A Chain of Custody form will be completed by the field personnel and submitted to the laboratory.

Soil Quality: Each site will have 10 sampling locations within the experimental planting areas. In order to maximize randomness, samples will never be collected from the same hole in the same year. Samples will be collected using probes or spades from the top 6” of soil. Samples will be collected 10 at a time and mixed into buckets in accordance with Soiltest Farm Consultants standards. Samples will be mailed in plastic bags, with at least 4 cups of material from each site sent for analysis.

Location

Final locations of water quality monitoring and sampling locations will be input into QAPP after installation in situ to maximize location data collection and allow for changes during installation.

Table 1 Sampling Locations for Western SARE Working Buffer Water Quality Study- Island, Skagit, and Snohomish Counties

Site ID	**Location**	**X Coordinate**	**Y Coordinate**
Isl-U1	**Sweetwater Farm Up**		
Isl-D1	**Sweetwater Farm Down**		
Sno-U1	**Swan’s Trail Slough Up**		
Sno-U1	**Swan’s Trail Slough Down**		
Ska-U1	**Tangled Thicket Up**		
Ska-U1	**Tangled Thicket Down**		

QUALITY CONTROL PROCEDURES

Field QC Procedures

Field personnel will be trained on soil- and water-quality QA/QC methodology, equipment operation, basic hydrology, and safety considerations. Field personnel will make monthly trips to the sites to collect data and retrieve soil and water samples. We will follow USGS runoff methodology and sampling protocol. Field sampling will use a standard protocol to avoid errors caused by disturbance of the substrate and to ensure representative sampling. Water and soil sample duplicates will be collected at a 10% rate as discussed above. Water quality sampling will be conducted in accordance with USGS National Field Manual for the Collection of Water-Quality Data (see team files). Soil sampling will be done in accordance with Soiltest Farm Consultants Routine Soil Sampling Guidelines and Techniques (see team files). Continuous water quality sampling will be conducted using HOBO V2 water loggers, and water depth will be hand collected 3 times using a stadia rod. Water samples will be submitted at the end of each day of collection, and soil samples will be mailed within 48 hours of collection.

Laboratory QC Procedures

Laboratory QC procedures will be conducted according to Everett Environmental Laboratory and Soiltest Farm Consultants, Inc. standard QC program.

Office QC Procedures

Water and soil quality data obtained from the laboratory will be entered into a Water Quality Database shared amongst partners. Printouts from the database (QC sheets) will then be checked against the laboratory data sheets to check for data entry errors. Errors will be corrected in the database and noted on the QC sheets.

Corrective Procedures

Corrective procedures will take place as they are warranted. The laboratory will be responsible for implementing corrective actions should problems arise with laboratory analyses. These procedures may involve control charts, recovery charts, and blank analysis charts to locate the source of the problem. The Project Co-Managers will be responsible for corrective actions regarding problems with field data and sample collection. These actions may include additional sample collection, field equipment training, equipment checks, calibration standard verification, and recalibration in the field. Office activities may include correction of the database, meetings with monitoring team members, instrument repair, and revision of procedures.

Data Quality Objectives

The goal of this program is to generate sufficient reliable data to locate areas where fecal coliform pollution is entering watercourses leading to Samish Bay. A secondary data quality goal is to generate data that will allow determination of a stream's status compared to state water quality standards.

Bias

The risk of introducing bias will be minimized through using standardized sampling procedures by experienced collectors, and testing of samples will be conducted by outside and trusted laboratories. Monitoring units will be checked prior to deployment for accuracy and longevity and will be used according to manufacturer's specifications. Samples will be stored and transported in accordance with lab requested protocol.

Precision

HOBO water temperature loggers have an accuracy of ±0.21°C from 0° to 50°C (±0.38°F from 32° to 122°F, Onset website.) Field collection of samples will be conducted using approved HDPE containers for water quality samples in accordance with lab standards. Soil will be collected using probes or spades no deeper than 6" from the surface, and batches of 10 samples will be mixed in appropriately large, clean buckets. 2-4 cups for each sample will be provided in plastic bags to the lab. Precision in data collection will rely on consistency and cleanliness of samples and equipment, as well as prompt delivery to labs. We are relying on the precision of our testing labs for quality assurance and will utilize results from duplicate tests to monitor precision.

DATA ASSESSMENT PROCEDURES

QA/QC Process

The Principal Investigator will review laboratory reports, field data, notes, and meet with project team members to validate lab findings from field samples and ensure consistency in field techniques. This will ensure completeness and validity of data, and reduce bias in results. Annual reports will be generated for the research portion of the project.

Data Entry and Review

As the first step in a multi-phased project, no conclusions will be identified as a result of one annum data set. We will submit our findings for peer review by policy, agency, stakeholders, and volunteer scientists. We will organize data by soil- and water-quality, and -quantity by laboratory code constituent concentrations. When we receive results, we will match them with time and location data for each individual pilot site. All information will be placed in a data-summary spreadsheet for each station, checked, and finalized at the end of each water year. A database will be created for the project partners to share amongst ourselves. Data will be entered into a spreadsheet directly from field data collection sheets. Entered data will be checked against field sheets and notes for accuracy in the database. Upon completion of the projects, data will be analyzed and reviewed to focus on parameters of interest. As these are baseline datasets, it is not expected that we will find trends in the data. However, the data will be analyzed using graphical formats and appropriate statistical tests. The level of experience and familiarity with lab standards for sampling amongst project team members is such that major issues with quality control are not expected. The ongoing meetings and annual review of data collection and lab results will ensure consistency and reduce bias in results. Data will be reviewed for acceptability based on review of field reports and communication with team members, as well as lab quality control reports. Errors in collection or lab quality control will result in the data being rejected. Data that has been listed with lab qualifiers will be included, though they will be noted and flagged.

Statistics

Appropriate statistical testing for detecting trends in water and soil quality data (such as the Seasonal Kendall's Test) will be used, and additional tests will be updated as appropriate in this QAPP as the project progresses. Standard summary statistics (mean, standard deviation, etc.) will be computed for listed parameters included in the annual and final reports. Final data will be submitted to USDA/Western SARE for use by other interested parties and public availability.

PROGRAM ASSESSMENT

Water and soil sampling strategy will be reevaluated on an ongoing basis, and the project will be managed to adapt to any unforeseen circumstances. Sampling locations may change depending on environmental factors such as flooding. Location changes will be recorded and reasoning will be noted. The project partners will assess project progress and effectiveness throughout the duration of the project. Assessment meetings will be performed quarterly. Through data analysis, we will identify unexpected results or data gaps that future research may need to address. Success of the research will be identified at this stage–e.g, were we able to successfully capture data in soil- and/or water-quality, as a direct result of the working buffer AND were the results repeatable at all three pilot sites. We will review the data to identify what changes are necessary in the next phase of the project, to ensure future success in identifying whether working buffers can sustain or improve soil- and water-quality while also increasing production margins for farmers; a check and balance to ensure that the research design is capable of meeting the objectives identified in this grant.

Citations

Western SARE - Water Quality Effects of Multifunctional Working Buffers for Seasonally Wet Farmland – Snohomish Conservation District - Citations

Abatzoglou, J. T., Rupp, D. E., & Mote, P. W. (2014). Seasonal Climate Variability and Change in the Pacific Northwest of the United States. Journal of Climate, 27(5), 2125–2142. https://doi.org/10.1175/jcli-d-13-00218.1

Borrelli, P., Robinson, D.A., Fleischer, L.R. et al. (2017). An assessment of the global impact of 21st century land use change on soil erosion. Nature Communications, 8, 2013 Cole, L.J., Stockan, J., Helliwell, R. (2020). Managing riparian buffer strips to optimise ecosystem services: A review. Agriculture, Ecosystems & Environment, 296,

Dabney, S. M., Moore, M. T., & Locke, M. A. (2006). INTEGRATED MANAGEMENT OF INFIELD, EDGE-OF-FIELD, AND AFTER-FIELD BUFFERS. Journal of the American Water Resources Association, 42(1), 15–24. https://doi.org/10.1111/j.17521688.2006.tb03819.x

Daniels, R. B., & Gilliam, J. W. (1996). Sediment and Chemical Load Reduction by Grass and Riparian Filters. Soil Science Society of America Journal, 60(1), 246–251. https://doi.org/10.2136/sssaj1996.03615995006000010037x Forecasting and Research Division. (2020, August). State of Washington 2020 Population Trends. Office of Financial Management. https://www.ofm.wa.gov/sites/default/files/public/dataresearch/pop/april1/ofm_april1_popt rends.pdf.

Galinato, S.P., Gallardo, R.K., Miles, C.A. (2011). Cost Estimation of Establishing a Cider Apple Orchard in Western Washington IMPACT Center. Washington State University Fact Sheet FS041E

Kaur, G, Singh, G, Motavalli, PP, Nelson, KA, Orlowski, JM, Golden, BR. (2020). Impacts and management strategies for crop production in Waterlogged/Flooded soils: A review. Agronomy Journal, 112, Nair, P. K. (2011). Agroforestry Systems and Environmental Quality: Introduction. Journal of Environmental Quality, 40(3), 784–790. https://doi.org/10.2134/jeq2011.0076

Ostrom, M. & C. Donovan. (2013). Profile of Small Farms in Washington State Agriculture WSU Fact Sheet FS072E.

Paudel, B.R., Udawatta, R.P.,Anderson, S.H. Agroforestry and grass buffer effects on soil quality parameters for grazed pasture and row-crop systems, Applied Soil Ecology, 48 (2011).

Rodgers, A. (2016, April). Agricultural Pollution in Puget Sound. Western Environmental Law Center. http://westernlaw.org/sites/default/files/Agricultural%20Pollution%20in%20Puget%20Sou nd%20-%20April%202016%20-%20Web.pdf. Data USA: Snohomish County WA (2021) https://datausa.io/profile/geo/skagit-county-wa Data USA: Skagit County WA (2021) https://datausa.io/profile/geo/skagit-county-wa Data USA: Snohomish County WA (2021) https://datausa.io/profile/geo/snohomish-county-wa

Trozzo, K.E., J.F. Munsell, J.L. Chamberlain Potential adoption of agroforestry riparian buffers based on landowner and streamside characteristics. Journal of Soil and Water Conservation. 69, (2014).

Udawatta, R. P., Garrett, H. E., & Kallenbach, R. (2011). Agroforestry Buffers for Nonpoint Source Pollution Reductions from Agricultural Watersheds. Journal of Environmental Quality, 40(3), 800–806. https://doi.org/10.2134/jeq2010.0168

Udawatta, R. P., Krstansky, J. J., Henderson, G. S., & Garrett, H. E. (2002). Agroforestry Practices, Runoff, and Nutrient Loss. Journal of Environmental Quality, 31(4), 1214–1225. https://doi.org/10.2134/jeq2002.1214

USDA/NASS QuickStats Ad-hoc Query Tool. (2020). https://quickstats.nass.usda.gov/.