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ONFARM Priority Subwatershed Project: Modelling Component Request for Proposals

Overall Project Timeframe

October 2019 to March 2023

Modelling Project Timeframe

July 2021 to February 2023

ONFARM Program Highlights

ONFARM is a four-year applied research program funded through the Canadian Agricultural Partnership (the Partnership). The Partnership is a five-year federal-provincial-territorial initiative intended to strengthen the agriculture, agri-food and agri-based products sector, and increase its competitiveness, prosperity and sustainability. There are three key activities within the ONFARM program:

- **Stakeholder engagement and demonstration**
- **Water quality monitoring, modelling and BMP assessment within priority subwatersheds**
- **Soil research and monitoring across Ontario**

The Ontario Soil and Crop Improvement Association (OSCIA) will be administering and coordinating the overall program, which includes:

- A technical working group (TWG)
- A stakeholder engagement working group (SEWG)
- Annual forum
- Continuation of the Priority Subwatershed Project (PSP)
- Modelling of Best Management Practice (BMP) effectiveness, including scenario analysis and extrapolation, both at the edge of field (EOF) and the subwatershed scale
- Development of a network of Soil Health Paired BMP Trials on 25 working farms
- BMP Cost-Benefit Analysis that includes data from both the PSP and the Soil Health sites
- Overarching Data Management Plan
- Project website to share results
- Establish memorandum of cooperation for a continuing Stewardship R&D farm network beyond life of agreement

ONFARM Priority Subwatershed Project

The value of the former Great Lakes Agricultural Stewardship Initiative's Priority Subwatershed Project (GLASI PSP) sites have been recognized not only by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), but also by several other partners who have prioritized funding to support outcomes for water quality and soil health within these focus areas.

ONFARM will be supporting continued water quality and soil health monitoring in the former GLASI PSPs. Supported activities will include coordination amongst the PSPs, water quality and quantity monitoring and, the collection of comprehensive land management activity data. The project also includes development of a functioning model to simulate water quantity and quality and assess the impact of existing or alternative land activities on these watershed flow and water quality

The data collected during ONFARM will be used to update and build up on previous modelling of these watersheds during the GLASI PSP, and to generate coefficients of Best Management Practice (BMP) effectiveness for reducing sediment and nutrient (phosphorus and nitrogen) loss both at the Edge of Field (EOF) and at the subwatershed level. Models will be updated to the IMWEBs (Integrated Modelling for Watershed Evaluation of BMPs), or an equivalent modelling application, to improve user friendliness and allow more rapid evaluation of BMP efficacies at site-specific locations within the watershed. The IMWEBs (or equivalent) modelling product will also need to incorporate an ability to complete an economic cost-benefit assessment of the management practices employed to reduce sediment and nutrient loss. The intent is for the developed BMP coefficients and associated cost-benefits of the selected BMPs from this project to be used to inform and assist with developing phosphorus loss estimates and remediation costs for larger geographies, such as the Lake Erie basin.

Ultimately, a program wide Cost-Benefit Analysis (CBA) to determine BMP cost/kg sediment, phosphorus and nitrogen reduced at a farm level will be completed. In recognition of the project timelines, the focus of the CBA may be placed on the near-term costs and benefits, with longer term BMP benefits being identified. The CBA will be conducted using data from both the PSP and the Soil Health components of the ONFARM project.

Ongoing ONFARM PSP Water Quality and Quantity Monitoring

- In partnership with Soil Resource Group and five participating Conservation Authorities representing six subwatersheds including:
    - Ausable Bayfield Conservation Authority, Gully Creek Subwatershed
    - Essex Region Conservation Authority, Wigle Creek Subwatershed
    - Lower Thames Valley Conservation Authority, Jeannettes Creek Subwatershed
    - Maitland Valley Conservation Authority, Garvey Glenn Subwatershed
    - Upper Thames River Conservation Authority, Upper Medway Creek and North Kettle Creek Subwatersheds
- Water quality and quantity monitoring began as early as October 24, 2019 according to the criteria shown in Appendix A
- Water quality and quantity monitoring is occurring both at select EOF sites within each PSP, and at the outlets of these subwatersheds
- Soil health testing is being completed at each EOF site

- Land management surveys, documenting timelines of field activities, are being completed throughout each PSP to collect land activity information.
- Profitability mapping will be completed for each EOF site, plus an additional 500ac within each PSP

Key Modelling Activities of the ONFARM PSP

The primary outcome of the ONFARM PSP Modelling component will be to establish and improve coefficients of BMP effectiveness in reducing nutrient and sediment loss both at the Edge of Field and subwatershed level. The cost effectiveness of these practices will also be assessed.

The target BMPs for evaluation are those promoted under the Lake Erie Agriculture Demonstrating Sustainability program and are listed as follows:

- Crop nutrient planning
- Cover crops
- Riparian buffer strips
- Windbreaks and wind strips
- Fragile land retirement
- Erosion control structures (e.g. grassed waterways, rock chutes, WASCoBs)
- Tillage and nutrient application equipment modifications
- Equipment modifications to reduce soil compaction
- Adding organic amendments
- Equipment modifications to improve manure application

The minimum set of BMPs to be evaluated through this modelling initiative are cover crops, conservation tillage options (Tillage and Nutrient Application Equipment Modifications) and one other from the list of promoted BMPs. Additional BMPs may be and are desired to be assessed pending the availability of funds. All assessed BMPs will be pre-approved by the TWG prior to initiating analysis.

The outcomes will be accomplished by completing the Core Activities and will be supported by the various Other Activities and Reporting Activities outlined below.

Modeler(s) will be required to collaborate with each of the five Conservation Authorities collecting water quality and quantity information. Site visits, virtual meetings and frequent discussion regarding project objectives, modelling data needs, data formatting needs and approaches, timelines for exchange of required information between parties, use and limitations of the resulting model for BMP selection and evaluation, and interpretation of model results are required throughout the project timeline.

Core Activities

- Use data collected by the participating Conservation Authorities (water quantity and quality, soils, Digital Elevation Models (DEMs), landuse data, etc.) to further inform, calibrate and validate the selected PSP models created during the GLASI program
- Upgrade the current GLASI models to IMWEBs (Integrated Modelling for Watershed Evaluation of BMPs) modelling platform, or an equivalent modelling application, to enhance modelling capabilities (completed by February 1, 2023, with a preliminary run completed and reported on by February 1, 2022)

- Collaborate with field data collectors and CAs to identify the type and extent of BMPs present on the watersheds to be modelled
- Use the calibrated and validated models to quantify BMP effectiveness, expressed in the form of BMP coefficients, for reducing nutrient (P and N) and sediment loss by the target BMPs
- At the minimum, effectiveness coefficients must be modelled for the target BMPs of cover crops, various forms of reduced tillage (e.g. strip till or no-till) and one other BMP that will be determined by the ONFARM TWG as informed by a review of current BMPs employed on the various watersheds. Coefficients for other BMPs used in the watershed but not identified that can be readily developed would also be encouraged, pending the availability of funds and pre-approval by the TWG
- Use the developed BMP coefficients to inform and assist with developing P and N loss estimates for larger geographies for a better understanding and estimate of sediment and nutrient loss and BMP effectiveness on a larger scale (i.e. Lake Erie Basin)
- Using the BMP coefficients to complete a Cost-Benefit Analysis (CBA) for the three target BMPs if applied in appropriate circumstances across the entire Lake Erie basin:
    - The CBA will be informed by the data collected as part of the PSP (see Appendix A), the land use management surveys, the profitability mapping and all soil health testing, including results from the Soil Health Paired BMP Trial sites.
    - Use the BMP coefficients to estimate the cost per kg of phosphorus and nitrogen reduced at the farm level by each of the three target BMPs
    - Use the estimated cost per kg of phosphorus and nitrogen reduced by each of the three target BMPs to estimate Return on Investment (ROI) to the producer, this should include comparison of the conventional practice to the new practice, and be informed by all site data, including the paired soil health trial site data and the land management survey data, Census of Agriculture data, other modelling studies completed in the Lake Erie basin etc.

Other Activities

- Participate in the Technical Working Group as requested to provide input or updates on:
    - The progress on the modelling component
    - Technical requirements such as soil health and water quality measurement criteria which would best inform the modelling, site selection for monitoring activities, frequency of monitoring activities, extent of monitoring needed to inform modelling, etc.
    - Participate in technical conference calls focused on PSP
- Present at the Annual Applied Research Monitoring and Demonstration Forum (2022 and 2023)
- Participate in the Stakeholder Engagement Working Group as may be required

Reporting Activities

- Brief quarterly update reports on financial expenditures and progress on key deliverables
- Contribute to the ONFARM Annual Technical Report in 2022 and 2023 by detailing the model set-up, scenario analysis and extrapolation of model outputs including the preliminary model run, completed to date. This will be accomplished through the submission of annual modelling reports for each of the selected PSP.
- A comprehensive final report, submitted February 1, 2023, that includes:

- A condensed summary report that highlights key findings for each individual PSP, including results from the CBA, suitable for posting to the project webpage
- Detailed modelling results for each PSP that provides the final coefficients of BMP effectiveness for reducing sediment, P and N loss for each of the 3 target BMPs, which is suitable for posting to the public webpage.
- All public facing reports will be reviewed by the TWG prior to being posted, and edits may be requested.

Required Proposal Content

To be considered for inclusion in the ONFARM Priority Subwatershed Project, a proposal that demonstrates how the project objectives will be completed, and at what cost, must be submitted to OSCIA no later than June 30, 2021.

The Proposal must include:

- A summary of the capacity, resources, experience, and skill that is available to complete the project, including identification of the primary contact for the project
- A description of how each of the "Core Activities" will be accomplished, and willingness to participate in the "Other Activities" as may be required
- A workplan and budget proposal that must include annual and total costs based on the fiscal year of April 1 to March 31 (maximum annual budget for this work is $180,000 per year, for a total of $360,000 for the completed models, CBA and reports. This includes all overhead and/or administrations fees)

The Proposal must also declare the following:

- The Canadian Agricultural Partnership funding will be acknowledged in all communications, and that it is understood that public facing communication materials must be sent to OSCIA for a Communications Review and OMAFRA approval before they can be released.

Proposal Submission Information

Proposals should be emailed to Karen Jacobs, Programs Coordinator for OSCIA, at kjacobs@ontariosoilcrop.org. Please submit all proposals no later than June 30, 2021. Proposals should be succinct, i.e. 5-10 pages in length including the proposed budget and workplan. Questions about the RFP can be submitted in writing to Karen Jacobs up until June 25, 2021 .

All questions and the associated answers will be posted at https://www.osciaresearch.org/onfarm-applied-research/onfarm-priority-subwatershed-project-modelling-component/. This webpage will be updated as required between June 14, 2021 and June 26, 2021.

Project Approval Information

Project approval will be at the discretion of OSCIA and will be reliant on the availability of funds. Proposals, or certain aspects of the proposals, may be assessed for merit by OSCIA staff and members of the Technical Working Group. Please expect some negotiation as efforts are made to equitably distribute funds and to maximize the impact of the project. Approval notifications should be released no later than July 31, 2021.

ONFARM Priority Subwatershed Project
Appendix A: Monitoring Criteria

1a. Required for all Priority Subwatersheds: Monitoring and Survey Data

Data/Information Need	Potential Source(s)	Frequency of Data Collection	Density of Data Collection
Weather:			
Rainfall	Dedicated weather station	15 minute	1 per watershed
Snowfall (or transect survey – see below)	Dedicated weather station	15 minute	1 per watershed
Total Precipitation	Dedicated weather station	15 minute	1 per watershed
Air Temperature	Dedicated weather station	15 minute	1 per watershed
Relative Humidity	Dedicated weather station	15 minute	1 per watershed
Wind Speed	Dedicated weather station	15 minute	1 per watershed
Solar Radiation	Dedicated weather station	15 minute	1 per watershed
Ground Temperature 5 cm	Dedicated weather station	15 minute	1 per watershed
Ground Temperature 15 cm	Dedicated weather station	15 minute	1 per watershed
Ground Temperature 30 cm	Dedicated weather station	15 minute	1 per watershed
Periodic snow transect surveys	Survey	Monthly and prior to melt events	
Field Activities Information:			
Fertilizer Application (form, time, method, rate)	Producer interviews, crop input supplier interviews	Interviews Y1 and Y4 of Study	By field (Note: a field is defined as a unique crop)
Manure Application (form, time, method, rate)	Producer interviews, crop input supplier interviews	Interviews Y1 and Y4 of Study	By field
Tillage (time, implement type, depth of operation, direction of travel, # of passes)	Producer interviews, in field/roadside data collection	Interviews Y1 and Y4 of Study	By field
Surface residue cover (prior to freeze -up and post planting)	Roadside data collection	2 times/year	By field
Planting (crop type or cover crop type, plant date, row spacing)	Producer interviews, in field/roadside data collection	Typically 1X/year but may be more if cover crops employed	By field
Visual evidence of erosion (Qualitative)	Field observations and/or assessments, air photo interpretation, producer interviews	Do field observations during seasonally significant hydrological events throughout study period	By field
Crop performance including yield	Producer interviews	Interviews Y1 and Y4 of Study	

Use of BMPs and their financial implications (i.e. cost and crop performance relative to normal practice/before BMP implementation) to inform models and BMP cost benefit analyses	Producer interviews or survey	Interviews Y1 and Y4 of Study	
Water Quantity:			
Stream flow	Flowmeter, or water level with established rating curve, flow detect devices, or field/roadside observations and recordings (e.g. trail cams)	Minimum continuous at outlet. Monitoring of events at key points in watershed, such as key brand confluences with the main watershed	Minimum of flow/no-flow at outlet. Ideally additional monitoring at key points in watershed such as key brand confluences with the main watershed (minimum no-flow/flow)
Stream Water Quality:			
Total suspended solids (TSS)	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.
Total Phosphorus (TP)	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.
Total Dissolved Phosphorus (TDP)	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.
Total organic P (orgP)	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.

Total nitrogen (TN)	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.
Nitrate-N	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.
Ammonia-N	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.
Organic-N	Water sampling/analysis	Runoff event based at outlet plus periodic baseflow through all seasons of year.	For events, minimum 1 sample early into storm, one at hydrograph peak and one along falling limb. Representative baseflow samples (if available) across all seasons of the year, with minimum target of 12 samples/year.

1b. Required for all Priority Subwatersheds: Data Layers

Data/Information Need	Potential Source(s)	Frequency of Data Collection	Density of Data Collection
Topography and Soils:			
Topography via Digital Elevation Model (2 to 5 cm vertical accuracy)	Pixal auto-correlation (MNRF), LiDAR, In field GPS surveying, other datasets	1 time unless changes made (e.g. Built WASCoB, changing flowpath)	1 to 3 m grid
Detailed Soil Mapping (based on DEM and field truthing)	Past soil surveys, Enhancements to past surveys (e.g. SWEEP, Black Creek example in Lake Simcoe, etc.)	1 time	1: 10,000 scale preferred
Hydrologic layers:			
Stream/water body layer	Land Information Ontario, MNRF, aerial photography, field truthed observations	1 time unless changes made or occur through time (man-made or natural), then modify	Within study watershed boundary. Include intermittent flow pathways*
Reservoirs, Ponds	Land Information Ontario, MNRF, aerial photography, field truthed observations	1 time unless changes made or occur through time (man-made or natural), then modify	Within study watershed boundary*

Municipal drainage layer (open) (include drain profiles)	Land Information Ontario, OMAFRA, municipal township office (drain reports), in-field data collection/producer interviews	1 time unless changes made or occur through time (man-made), then modify	Within study watershed boundary*
Municipal drainage layer (closed) (include tile diameter and grades)	Land Information Ontario, OMAFRA, municipal township office (drain reports), in-field data collection/producer interviews	1 time unless changes made or occur through time (man-made), then modify	Within study watershed boundary*
Tile surface inlet locations (include type of inlet, inlet diameter/dimensions)	aerial photography interpretation, OMAFRA, in-field data collection/producer interviews	1 time unless changes made or occur through time (man-made), then modify	Within study watershed boundary*
Subsurface tile drainage layer (include tile diameter, depth, spacing)	Aerial photography, in-field/roadside data collection/producer interviews	1 time unless changes made or occur through time (man-made), then modify	Within study watershed boundary*
**Recognize that conditions may change through time, necessitating updates to the hydrologic layers*			
Land use Layers:			
Non-agricultural land use boundaries/delineation	Aerial photography, in-field/roadside data collection/producer interviews	1 time unless changes made or occur through time (man-made or natural), unless changes made, then modify	Within study watershed boundary**
Land-based BMP layer (e.g. grassed waterway, WASCoB, buffer, windbreak, other)	Aerial photography, in-field/roadside data collection/producer interviews	1 time unless changes made or occur through time (man-made or natural), then modify	Within study watershed boundary**
Field Boundaries	Aerial photography, in-field/roadside data collection/producer interviews		
Agricultural Land use by field, Crop type, cover crop type	Aerial photography, in-field/roadside data collection/producer interviews	3 times over each growing season	Within study watershed boundary
***Recognize that conditions may change through time, necessitating updates to the land use layers*			

2a. Required for Edge of Field Sites: Monitoring Data

Data/Information Need	Potential Source(s)	Frequency of Data Collection	Density of Data Collection
Water Quantity Tile and or Surface Water	Flowmeter, or water level with established rating curve, flow detect devices, or field/roadside observations and recordings (e.g. trail cams)	Continuous	Edge of field capturing a defined catchment area
Water Quality	See requirements for subwatershed monitoring	See requirements for subwatershed monitoring	Located at water quantity monitoring station (1a)
Weather	See requirements for subwatershed monitoring	See requirements for subwatershed monitoring	See requirements for subwatershed monitoring (1a)

2b. Required for Edge of Field Sites: Soil Data

*Note: **Conservation Authorities are not expected to budget for the soil data.** Soil data collection will be completed by the Soil Resource Group (SRG) at the edge of field sites and the benchmark sites, with CAs facilitating relationships between landowners and SRG as may be required. The scope required data and the number of benchmark sites will be determined by the Technical Working Group. The following table identifies soil data that may be collected to inform the model. Additional criterial, including soil health sampling on select indicators, may be added by the Technical Working Group.*

Data/Information Need	Potential Source(s)	Frequency of Data Collection	Density of Data Collection
Field/Soil Characteristics:			
Soil P test (0-6")	In-field data collection, producer interviews (especially valuable if have historical data)	Twice (near beginning and end) preferably at a definite point in the field's crop rotation	Minimum 1 per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Soil K test (0-6")	In-field data collection, producer interviews (especially valuable if have historical data)	Twice (near beginning and end) preferably at a definite point in the field's crop rotation	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Potentially mineralizable N (0-6")	In-field data collection, producer interviews (especially valuable if have historical data)	Twice (near beginning and end) preferably at a definite point in the field's crop rotation	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Soil Organic Carbon (0-6")	In-field data collection, producer interviews (especially valuable if have historical data)	Twice (near beginning and end) preferably at a definite point in the field's crop rotation	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Soil pH (0-6")	In-field data collection, producer interviews (especially valuable if have historical data)	Twice (near beginning and end) preferably at a definite point in the field's crop rotation	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Soil CEC (0-6")	In-field data collection, producer interviews (especially valuable if have historical data)	Twice (near beginning and end) preferably at a definite point in the field's crop rotation	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Aggregate Stability	In-field data collection/lab analysis	Twice (near beginning and end) preferably in the spring. Avoid moisture extremes	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Active Carbon	In-field data collection/lab analysis	Twice (near beginning and end) preferably in the spring. Avoid moisture extremes	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Bulk Density	In-field data collection/lab analysis	Twice (near beginning and end)	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites
Soil Texture Analysis	In-field data collection (BD rings)/lab analysis	Twice (near beginning and end)	Minimum 1 per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites

Water Infiltration	In field data collection (double ring infiltrometer or GPI)	Twice (near beginning and end)	Minimum 1 value per field per mapped soil type in Edge of Field watershed and at additional benchmark field sites

3. Potential Additional Data

The Technical Working Group will establish if this data is critical for defining phosphorus loads or for watershed characterization.

Data/Information Need	Potential Source(s)	Frequency of Data Collection	Density of Data Collection
Weather			
Snow pack	Dedicated weather station	15 minute	1 per watershed
Farmstead Characteristics:			
Nutrient storages (e.g. manure storage, septic beds, fertilizer storages, livestock yards and yard/farmstead runoff pathways)	Aerial photography, producer interviews, in-field surveys	1 time, but modify annually if significant changes	Each farmstead within the boundary of the study watershed
Livestock housing capacity/ actual livestock numbers	Aerial photography, producer interviews, in-field surveys	1 time, but modify annually if significant changes	Each farmstead within the boundary of the study watershed
Point Sources:			
Point Discharges (e.g. municipal, greenhouse, septic tile to surface water)	In-field observations, air photo interpretation, producer interviews	Daily or event throughout the year	Identify each occurrence in watershed
Daily flow	Flow meter or discharge records		
Average daily concentrations for TSS, TP, TDP, orgP, TN, nitrate-N, Ammonia-N, Organic-N	Water sampling/analysis	Periodic depending on variability of discharge	For each point source identified as significant in the watershed