Grantee Information

Project Title: Water and Sediment Control Basins (WASCoBs) influence on Crop Yields and Water Quality near Atterberry, Illinois

Institution: Southern Illinois University

Primary Investigator: Dr. Jon Schoonover

NREC Project #

Is your project on target from an IMPLEMENTATION standpoint? ☒ Yes ☐ No
If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☒ Yes ☐ No
If you answered "no" please explain:

Based on what you know today, will you meet the objectives of your project on-time and on-budget? ☒ Yes ☐ No
If you answered "no" please explain:

Have you encountered any issues related to this project? ☐ Yes ☒ No
If you answered "yes" please explain:

Have you reached any conclusions related to this project that you would like to highlight? ☒ Yes ☐ No
If you answered "yes" please explain:
Our data suggest that WASCoBs are an effective tool at addressing water quality concerns in row crop agriculture fields dominated by surface runoff. WASCoBs trapped/attenuated ~98.5-99.8% of total suspended solids, ~83.8-97.4% of total phosphorus, ~32.0-59.6% of Nitrate-N, and ~42.3-82.9% of Ammonium-N. Following 3 years of adoption, cover crops have not shown a significant impact on water quality; however, with increased time and better establishment we would expect the trend to change.

Have you completed any outreach activities related this project? Or do you have any activities planned? ☒ **Yes** ☐ **No**

If you answered "yes" please explain and provide details for any upcoming outreach:
UCOWR conference in June 2021 and SIU Farm Field Day in July 2021.

Please write a detailed summary report that includes: Details of each objective and the progress made towards its competition, planned research activities for 2022, major accomplishments, any preliminary findings or data relevant to the project, relevant budgeting, and any publications or outreach accomplished from the research. Please **include a one page summary with relevant data tables or graphs and pictures related to the project that you would like included in the NREC end of the year report.**

Summary

In 2021, a total of 27 rain events have resulted in water samples. The samples were analyzed for concentrations of total phosphorus, dissolved reactive phosphorus, ammonium-nitrogen, nitrate-nitrogen, and total suspended solids. The total loads from each basin were determined using the concentrations of nutrients and sediment along with discharge data. Preliminary water quality data suggests that loading of sediment and nutrients are lower in the basins drained by WASCoBs than in the ephemeral gulley drained basins.

Table 1. Nutrient and sediment loading in pounds per acre, from January 2021 to December 2021 near Atterberry, IL.

Treatment†	Total P	DRP	Ammonium-N	Nitrate-N	TSS
	----------Pounds Per Acre----------				
WSCC	2.71	1.98	0.22	0.82	142.96
WSNC	7.97	5.35	0.94	1.41	886.00
EGNC	16.26	11.16	1.00	5.80	1570.22

†WSCC = Water and sediment control basin with a cover crop, WSNC = Water and sediment control basin without a cover crop, EGNC = ephemeral gulley without a cover crop

Because very few events yielded stacked pole samples, a preliminary estimate of trapping efficiency was determined using nutrient and sediment loads retained in the basin, based on soil sampling data in 2020, as well as the loads lost at the basin outlets during that time, determined by water quality data. Trapping efficiencies were highest for total suspended solids (98.5-99.8%) and total phosphorus (83.8-97.4%). Lower trapping efficiencies were estimated for the dissolved nutrients, ammonium-N (42.3-82.9%) and nitrate-N (32-59.6%). These results support the idea that WASCoBs are effective in trapping sediment and sediment bound phosphorus. In the future, trapping efficiencies will be calculated using water quality data from stacked pole samplers rather than soil data. New stacked pole samplers installed in the basins in 2021 are expected to sample more frequently, allowing a comparison between water quality in the basins and at the outlet to calculate trapping efficiency

Image 1. New stacked pole samplers to be used in calculating trapping efficiency.

Objective 1. Evaluate the influence of cereal rye cover crop in a corn-soybean rotation on nutrient losses, water quality (i.e., sediment, nitrogen and ammonium, and total phosphorus and dissolved reactive phosphorus), soil health (physical, chemical and biological soil properties), and crop yields in fields with or without WASCoBs.

The treatments we compared in this study were: 1) fields that are drained by WASCoBs, 2) fields with WASCoBs plus cover crops, 3) fields containing an ephemeral gully with a cover crops planted, 4) fields containing an ephemeral gully without WASCoBs or cover crops. The performance of WASCoBs over time for agronomic efficiencies was also compared among these treatments. This objective is currently in progress through 2023. Water samples from storm events are currently being collected and analyzed for water quality.

Study Progress

A timeline of the work done at the Atterberry site is shown in Table 2. Sampling of runoff from storm events is ongoing and will continue into 2022.

Table 2. Timeline of work done at Atterberry site.

Work Description	**Date Completed**
Drone footage of field recorded	5/23/2019
Burndown sprayed	6/7/2019
Control structures installed	6/11/2019
Soybeans planted	6/11/2019
Control structures installed, wooden platforms for ISCO's installed, and site surveyed for NRCS WinTR55 runoff modelling	6/18/2019
SIU survey to determine flume size on gullies	6/18/2019
ISCO stream samplers arrived at SIU	6/21/2019
Final construction of WASCoBs	7/11/2019
Soybean plant date	7/11/2019
Installation of solar panels and sampler platforms	7/9/2019
Installation of Parshall flume on east gully	7/23/2019
Spring 2019 surface soil sample analysis	7/24/2019
Shallow soil samples taken in basin	8/26/2019
Radio telemetry programmed	8/26/2019
Soybeans harvested	10/14/2019
Fall soil sampling of the entire field	11/4/2019
Annual rye cover crop planted	11/4/2019
Installation of Parshall flume on mid gully	12/9/2019
Pressure transducers installed in basins	2/28/2020
Re-seeding of berm with cereal rye	4/3/2020
Herbicide (Corn burn down. Main AI: Bicep II Magnum, Callisto, Glyphosate)	4/5/2020
Burn down of cover crop	4/7/2020
Erosion control practices	4/8/2020
Spring electrical conductivity measured of soil	4/10/2020
VRT DAP/Potash applied	4/21/2020

Nitrogen application (28% @ 160 units of N/ac)	5/10/2020
Corn planted (Wyffels @ 32,000. Split planter 7456, 7876. No-till.)	5/10/20
Rill erosion management practices	5/14/2020
Herbicide Corn post. Main AI: Atrazine, Callisto, Glyphosate	6/7/2020
Rain gauge installed	7/2/2020
Corn harvested (55-104 bu/ac)	11/4/2020
Cereal rye cover crop planted	11/5/2020
Fall soil sampling of the entire field	11/5/2020
Fall electrical conductivity measured	11/12/2020
Soil texture and bulk density determined from soil samples	3/22/2021
Bean burndown (Main AI: Prefix, 2,4-D, Glyphosate, AMS	4/16/2021
Soybeans planted	5/13/2021
Drone footage of field recorded	5/24/2021
Bean post application Main AI: Select Max, Enlist One, Sequence, AMS	6/18/2021
Soybeans harvested	10/23/2021
Fall soil sampling of the entire field	10/27/2021
Installation of new stacked pole samplers	10/30/2021
Cover crop planted	11/2/2021
Storm event sample collection and analysis	Continuous
Evaluate effectiveness of WASCoB	Continuous

Sediment and Nutrient Loading

In 2021, a total of 27 rain events have resulted in water samples. Waters samples were analyzed in the Forestry Water Quality Laboratory to determine concentrations of total phosphorus (TP), dissolved reactive phosphorus (DRP), ammonium-Nitrogen, nitrate-Nitrogen, and total suspended solids (TSS). These concentration data along with flow data were used to calculate total loads. Table 3 shows nutrient and sediment load for each basin during 2021.

Table 3. Nutrient and sediment loading in pounds per acre, from January 2021 to December 2021 near Atterberry, IL.

Treatment†	Total P	DRP	Ammonium-N	Nitrate-N	TSS
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WSCC	2.71	1.98	0.22	0.82	142.96
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†WSCC = Water and sediment control basin with a cover crop, WSNC = Water and sediment control basin without a cover crop, EGNC = ephemeral gulley without a cover crop

Soil Sampling

Thirty-two soil samples were taken on October 27, shortly after soybeans were harvested. Soil pH ranged from 5.5-8.2, K ranged 0.5-3.5%, NO3-N 0.5-5.7 ppm, and Bray I P ranged 3-30ppm (Table 4).

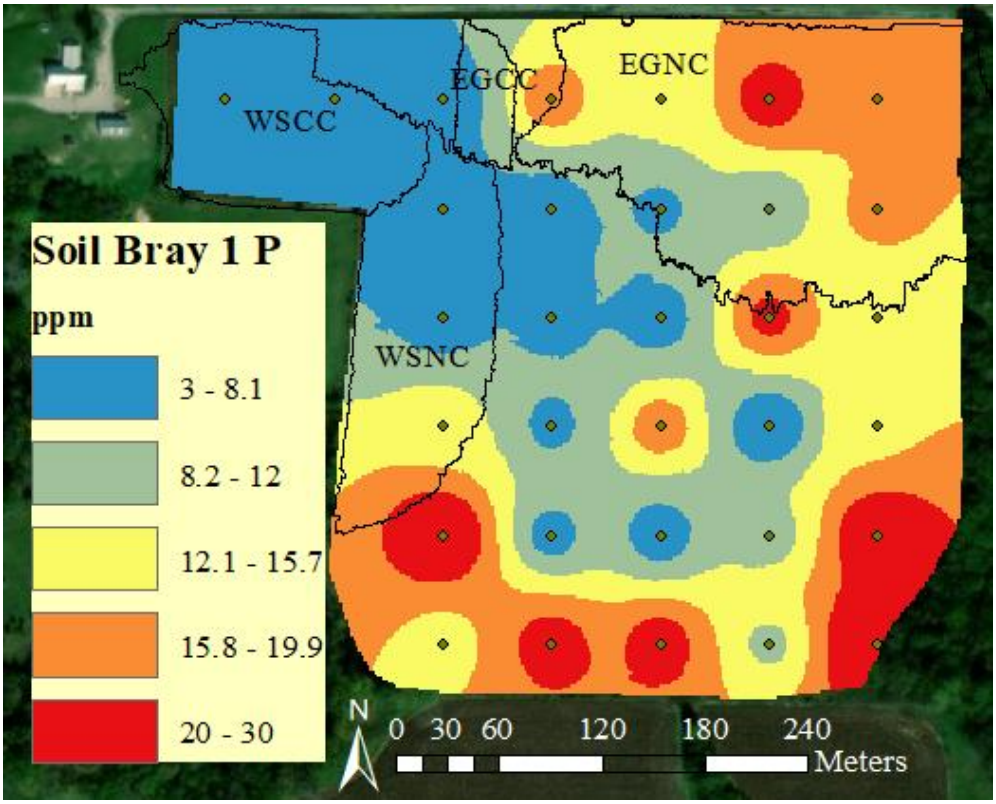
Table 4. Soil data from fall 2021 soil sampling at the Atterberry research site.

Sample Description #	**pH**	**K** (%)**	**Nitrate-N (ppm)**	**Bray I P (ppm)**
Maximum	8.2	3.5	5.7	30
Minimum	5.5	0.5	0.5	3
Average	6.8	1.8	2.8	13

WSCC = Water and sediment control basin with a cover crop, WSNC = Water and sediment control basin without a cover crop, EGNC = ephemeral gulley without a cover crop, EGCC = ephemeral gully with a cover crop

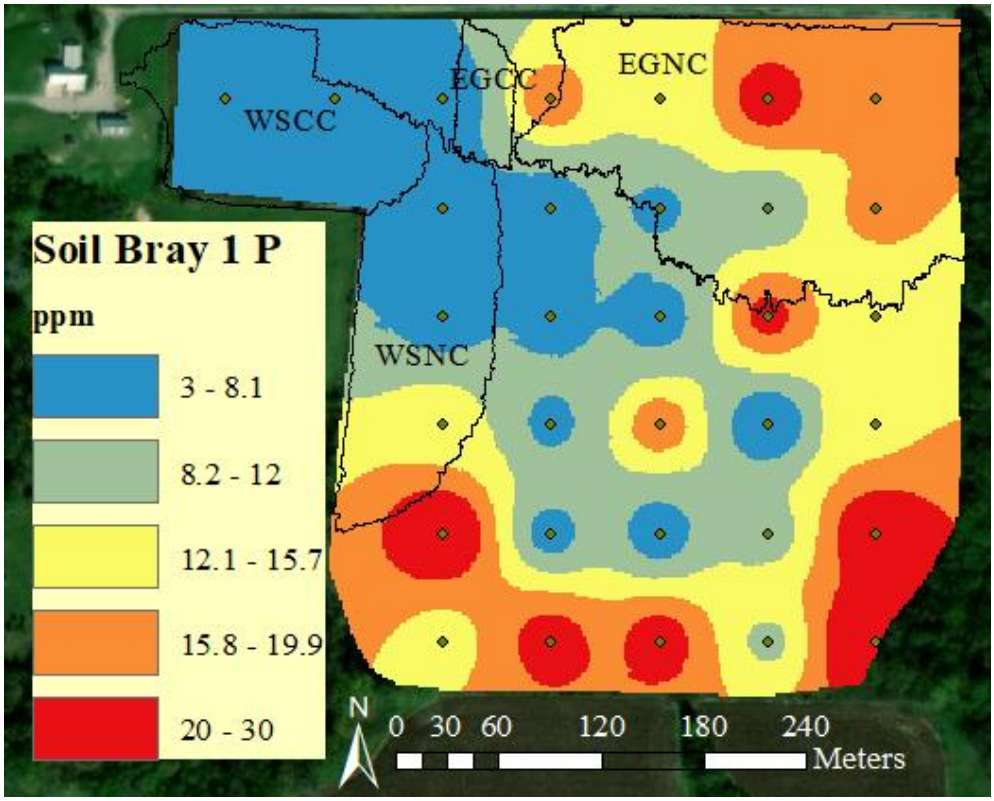
Image 2. Soil sampling locations from 2021 at the Atterberry IL WASCoB site.

Inverse distance weighing was used to visually analyze the soil nutrient content from data shown in Table 4 (ESRI 2020). Soil concentrations of Bray 1 P (Image 3) and Nitrate-N (Image 4) were relatively lower in the sub-watersheds containing WASCoBs compared to the gulley-drained sub-watersheds. The maximum concentration of Bray 1 P in either WASCoB drained sub-watershed was 15 ppm, and the maximum concentration in the gulley-drained basin was 23 ppm. The maximum Nitrate-N concentration in either sub-watershed drained by a WASCoB was 3.1 ppm, and the maximum within the gulley-drained area was 5.7 ppm.



WSCC = Water and sediment control basin with a cover crop, WSNC = Water and sediment control basin without a cover crop, EGNC = ephemeral gulley without a cover crop, EGCC = ephemeral gully with a cover crop

Image 3. The Bray 1 P concentrations of soil sampled in fall 2021.



WSCC = Water and sediment control basin with a cover crop, WSNC = Water and sediment control basin without a cover crop, EGNC = ephemeral gulley without a cover crop, EGCC = ephemeral gully with a cover crop

Image 4. The Nitrate-N concentrations of soil sampled in fall 2021.

Objective 2. Evaluate the performance of WASCoBs with or without cover crops over time for hydrologic modification, soil retention, and impacts on crop yields. This objective is currently in progress through 2023. Initial data has been collected to start the process of determining the performance of the WASCoBs.

Drone Surveying

Drone footage was taken of the field. Photogrammetry from the drone data will aid in determining the basin holding capacity (Image 5). This will aid in determining the total volume of water held in each basin at a particular stage.

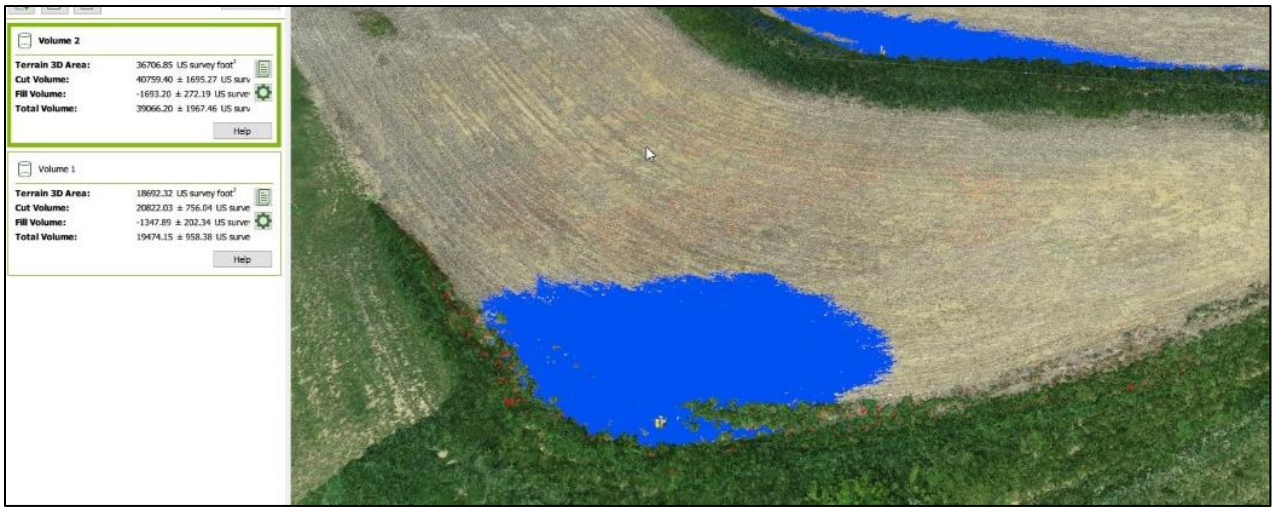


Image 5. Drone footage taken of WASCoB 1 (WASCoB CC) on May 24 will be used to calculate the total volume of each basin in the WASCoB. This is an image analyze by the Pix4Dmapper software.

Nutrient and Sediment Trapping from Water Samples

Stacked-pole samplers were installed in October 2021 and have sampled two rain events that paired up with the ISCO samples taken at the basin outlets. Improved stacked pole samplers have been installed in the basins (Image 1). The samplers collect water samples from the basins at different stages, allowing for the determination of nutrient and sediment trapping efficiencies of the WASCoBs. Previous stacked pole samplers were less reliable than the improved samplers.

Image 1. New stacked pole samplers installed in each basin.

Nutrient and Sediment Trapping from Soil Samples

Due to the lack of samples taken from the old design of the stacked pole samplers, trapping efficiency was calculated using loads retained in basins determined from soil sampling data from within the basins. Data for trapping efficiency suggests that WASCoBs are effective in trapping significant amounts of sediment and nutrients, particularly total suspended solids (98.5-99.8%) and total phosphorus (83.8-94.4%), while trapping efficiencies were lower for ammonium-N (42.3-82.9%) and nitrate-N (32.0-59.6%) (Table 4). This method utilized total loads accumulated in the soil of the basins and the total sediment and nutrient load lost by stormflow at the outlet, during that period. This method of looking at trapping efficiency resulted in higher efficiency estimates and is perhaps slightly overestimated. As previously mentioned, as additional stacked-pole data are added to the dataset a more accurate estimate of trapping efficiency will be calculated.

Table 4. Nutrient and sediment trapping efficiency of the WASCoBs near Atterberry, IL.

Treatment† / Parameter	Total P		Ammonium-N		Nitrate-N		Total Suspended Solids	
	Pounds Per Acre							
	WSCC	WSNC	WSCC	WSNC	WSCC	WSNC	WSCC	WSNC
Load retained in basin	10.88	27.48	2.41	5.44	0.98	1.96	24015.41	48103.26
Load lost at outlet	1.87	0.80	2.05	1.25	1.96	1.43	319.37	117.87
Percent retained	83.8%	97.4%	42.3%	82.9%	32.0%	59.6%	98.5%	99.8%

†WSCC = Water and sediment control basin with a cover crop, WSNC = Water and sediment control basin without a cover crop, EGNC = ephemeral gulley without a cover crop

Yield Analysis

Crop yield data was collected using a GIS yield monitoring system attached to the combine during harvest. Yield data from the 2020 corn harvest was analyzed in 2021 and showed a higher average yield in the ephemeral gullies (159.1 bushels per acre) than in the basins drained by WASCoBs (126.4 bushels per acre) (Image 6). The 2020 harvest was the first corn harvest after WASCoB construction. The soil data, and soil maps, reflect the large amount of soil disturbance during the construction phase of the WASCoBs and dry dams. N and P values are much lower in the WASCoBs than the ephemeral gullies. Continued yield monitoring of subsequent harvests will be used to evaluate the long-term impact of WASCoBs on crop yield. As soils begin to rebuild over time, and with the adoption of cover crops, we expect to see soil tests and yields slowly recover.

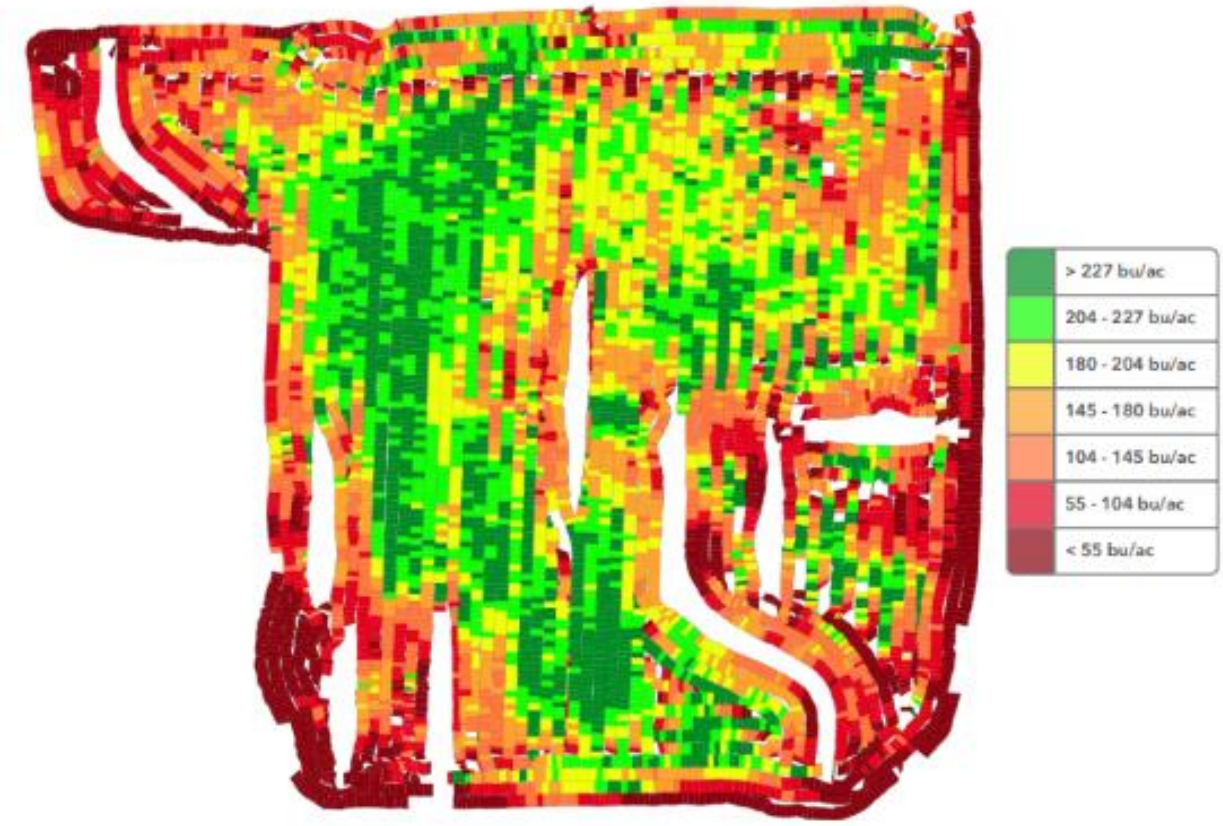


Image 6. Yield map of the 2020 corn harvest at the Atterberry site.

Objective 3. Disseminate results to farmers and stakeholders and include a final report at the conclusion of this project to address each of the objectives stated above. We will also publish in peer-reviewed literature, grower-oriented newspapers and/or magazines, and relay findings at meetings, conferences, and field days. A final report will be completed by the end of the study in 2023.

Preliminary data from this study was presented at the online UCOWR conference on June 10, 2021, as well as at an SIU Farm Field Day on July 9, 2021 attended by local farmers.

References

ESRI 2020. ArcMap 10.8. Environmental Systems Research Institute.