FINAL REPORT

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AGRICULTURAL DRAINAGE RESEARCH PLOTS FOR THE EVALUATION OF CONSERVATION PRACTICES

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PROJECT SUMMARY

This project created a series of twelve (12) research plots in which all surface and artificial subsurface (i.e. "tile") drainage can be gauged and sampled. The installation of the plots included securing individual equipment shelters ("enclosures") at each plot, customized on-site with shelving units to hold two automated water samplers and their flow modules. Best efforts were taken to hydrologically isolate each plot from the influence of surface and subsurface drainage in adjacent plots and buffer areas via the installation of a plastic barrier to a depth of approximately 4 feet around the perimeter of each plot, as well as being surrounded by raised berms to prevent mixing of surface drainage.

Outputs: Twelve (12) individual plots fully instrumented with autosamplers and flow modules, powered by solar panels, charge controller, and deep cycle batteries.

Outcomes: This is a unique plot setup done in a single, poorly drained field with considerable clay content, that will allow for future testing of many different agronomic practices and their implications for water quality and field crop production goals.

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1. PROJECT INTRODUCTION

Increasingly intense storms and more frequent freeze/thaw events due to changing weather patterns are making environmentally and economically sustainable crop production increasingly difficult (USGCRP, 2018). To survive the episodic periods of inundation and drought that will accompany these changes, farms will need to maximize precipitation infiltration to mitigate these risks which could result in substantial nutrient and sediment exports and crop failure. We installed a research location consisting of 12 plots that are designed and instrumented for year-round sampling of surface runoff and tile drainage. The field site will be used for the future evaluation of the impacts of agricultural practices and their impacts on water quality and field crop production; practices such as cover crops, no-till corn production, and manure application technologies. This project addresses many of the clean water goals in Objective 1 of the 2022 Opportunities for Action. These include reduced loading of phosphorus (P) and nitrogen (N) from cropland to surface waters (I.C.2) and whether current best management practices (BMPs) address multiple goals or additional BMP implementation is needed to address other environmental concerns (I.A.2), particularly given the challenges of changing precipitation patterns (I.D.2; II.A.2). Although not within the scope of the current project, future research objectives could incorporate additional water and air quality concerns including pesticide use and greenhouse gas emissions.

2. TASKS COMPLETED AND METHODOLOGY

FIELD SITE

The location for the research plots (Lat: 44.916846, Long: -73.489848) is a 5.8-acre agricultural field owned and operated by Miner Institute in the town of Champlain, Clinton County, NY and sits within the Chazy sub-watershed of the Lake Champlain Basin. The field site is located 3.0 miles from Miner Institute's main campus and laboratory facilities.

There are three dominant soil series in the field; transitioning from a somewhat poorly drained loam at the upslope position to a somewhat poorly drained silty clay loam at the midslope and ending with a poorly drained silty clay at the toeslope. The soil series are all classified within the D hydrologic soil group, though Peasleeville loam has a dual classification and is considered a B soil when tile-drained due to its upslope position. Figure A depicts the approximate location of the research plots in relation to the soil series as delineated by the US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) Web Soil Survey. The map unit symbol for each soil series present and their extent and basic drainage characteristics are listed in Table 1.

Figure 1. Soil series map from Web Soil Survey overlaid on approximate plot locations within the field (green boxes) depicting the approximate locations of the three soil series mapped within the field.

Table 1. Dominant soil series and drainage characteristics at the research field, listed in order of their position on the slope and beginning at the upslope position.

Map Unit Symbol	Soil Map Unit	Drainage Class	Approx. area of field as map unit area (%)	Hydrologic Soil Group
PeA	Peasleeville loam	Somewhat poorly drained	39	B/D
MwA	Muskellunge silty clay loam	Somewhat poorly drained	41	D
Ak	Adjidaumo silty clay	Poorly drained	20	D

The field was soil sampled (whole-field composite) in October 2022, prior to the onset of this project. There was 5.4% organic matter (OM) and 26.0 lb./acre of Morgan extractable P resulting from regular dairy manure applications, placing it in the middle of the high range for recommended soil test phosphorus (P) levels according to Cornell University and the University of Vermont guidelines.

DRAINAGE PATHWAY

The field drains naturally to a main ditch that travels due south across McBride Road to exit the property. This ditch then enters another property that borders an extensive marsh area that had multiple tree falls and siltation buildups prior to the commencement of this project. All of these restrictions have been removed, and drainage pathways will be routinely examined and maintained.

As the slope of the field was less than necessary to allow for gravity drainage, the installation of a pump station was required to sufficiently collect and remove drainage from the plots. To provide continuous access to the research site and power the pump station, a gravel roadway to the site was built and power lines were installed and buried from an existing transformer at the adjacent property. The road and power line installations were both approximately 1200 feet in length though they followed different routes to the research location.

The pump station consists of a deep circular concrete manhole installed at the toeslope of the field, directly adjacent to the primary drainage ditch along the western field boundary. Each plot was designed for all surface and subsurface drainage to collect in large drainage mains running parallel to the field slope, bisecting the two columns of plots. The manhole was outfitted with two alternating ¾" hp. submersible pumps (Liberty Pumps, Bergen, NY), though both run simultaneously if flow rates are sufficient to exceed the capacity of an individual pump.

PLOT INSTALLATION

We developed a plan for the drainage tile installation in conjunction with Barnes Excavating, Inc., as illustrated in Figure 2. The three alleys that run parallel to the slope, depicted in gray, are each 60 ft wide to accommodate large farm equipment. There is also a 40 ft alley that bisects the plots perpendicular to the slope to reduce driving distance. The remaining buffers between each plot serve to provide access to smaller vehicles and maintenance equipment, and to maintain separation between future experimental treatments.

Each research plot measures 90 ft by 90 ft, with the tile laterals in each plot spaced at 30 ft and installed perpendicular to the slope, which placed the outer laterals 15 ft from the upper and lower plot boundaries. Heavy gage plastic (6 mil) was inserted to a depth of four feet around the perimeter of each plot to prevent shallow subsurface water mixing among adjacent plots and buffer areas. The excess plastic was rolled over and partially buried at the soil surface.

Small surface drainage collection ditches were developed around the perimeter of each plot to ensure complete collection of all surface waters and when necessary, small culverts were buried to reduce the depth of these narrow ditches to better accommodate the entrance and exit of farm equipment. The outside edge of the perimeter ditches was elevated to create a berm that prevents the movement of water from adjacent land from flowing into and mixing with the plot drainage. The tile and surface drainage from each plot was directed into a 3 ft diameter manhole from which they can be individually gauged and sampled. The drainage from the manholes was then connected to the field's main drainage lines that bisect the field. The diameter of these main drainage lines was increased along the downslope direction to ensure sufficient drainage capacity for all plots, even under extreme flow events. These main lines were increased step-wise from 8" to 10" to 12" as the main line receives drainage waters from four, eight, and all twelve plots, respectively, before draining into the deep concrete manhole at the pump station.

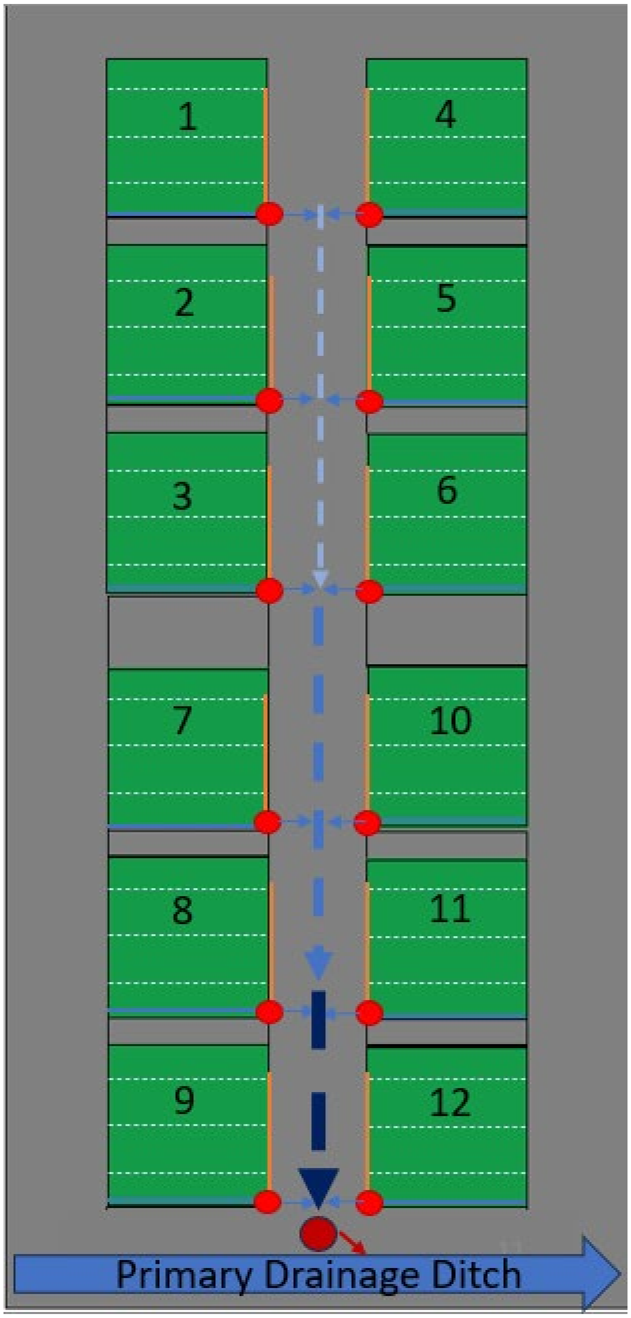

Figure 2. Schematic of drainage plots and associated equipment.

EQUIPMENT

Once the excavation and electrical work was completed, twelve (12) fiberglass enclosures were installed alongside each plot's manhole for monitoring equipment storage. Each enclosure was mounted on 2"x6" pressure-treated timber platforms that were secured to the ground via 3 ft-long ground "screws". Sonotubes filled with cement were used in the upslope locations when soil conditions were too rocky to allow for the usage of a ground screw.

After the enclosures were secured, custom-made shelving units were installed inside each enclosure. The top of the shelving unit holds two ISCO 6712 autosampler heads

(Teledyne ISCO, Lincoln, NE) on the top that dispense into 2L HDPE bottles located beneath the autosamplers in a turntable design. This setup enables staff to collect samples efficiently in both high and low flow conditions.

At the downslope corner of each plot, a 10 ft section of 3 ft diameter plastic culvert was installed vertically in the ground to create a manhole. Each manhole was installed to provide access to the surface and subsurface drainage outlets in which Thel-mar weirs (Thel-mar, Hamilton, OH) were installed. Each Thel-mar weir was connected to an ISCO 730 bubbler flow device via 1/8" PVC tubing. Finally, 3/8" I.D. PVC tubing was connected from each drainage outlet to an associated autosampler within the fiberglass enclosures.

Given the logistical constraints of installing buried power lines in a crop field and the significant cost it would have added to the project, each enclosure was outfitted with a solar power setup to run the sampling equipment. Each enclosure was equipped with a 100-watt solar panel, charge controller and deep cycle AGM-style battery (Renogy, Ontario, CA). The solar panels were attached to the south side of the enclosures with bolts and connected to the charge controller and deep cycle battery located within.

3. DELIVERABLES SUBMITTED AND CONCLUSIONS

The entire project was a field installation setup. As such, the primary deliverable was a fully instrumented research location with 12 drainage research plots with tile drains and surface ditching for each plot. This was achieved by first installing a main drainage line that connected to a pump station. After this was completed, each plot was mapped out, tile lines installed and surface ditching created. Each plot was then connected to the main line to finish the setup. All waters drain into a large, deep concrete manhole that has two ¾ hp pumps. The pump station was installed to discharge to a main ditch at the lower boundary of the field that exits the property in a southerly direction. This research location enables Miner Institute to conduct experiments with the goal of reducing nutrient and sediment export to Lake Champlain from dairy farm cropland and enhance the environmental, economic, and social sustainability of our region's dairy industry.

Project deliverables:

- Task 1 - List documenting equipment purchased and prepared for installation
- Task 2 - List documenting purchased equipment (for monitoring enclosures)
- Task 3 - List documenting purchased equipment (for solar power)
- Task 4 - Map of plots/tile locations
- Task 5 - Photographs documenting installation
- Task 6 - Quarterly reports and final report

4. PROJECT METRICS

Metric	Final value
Category of organization	Other NGO

Hours of staff time funded by the grant	20
Undergraduate students supported	1
Social media, blog, e-news, or news article posts	2