Clay County Drainage Site
2011-2015 Calibration Phase Assessment

Calibration Phase

The calibration phase of the Clay Drainage site consisted of five complete years of data collection (2011-2015) on six separately monitored subsurface drainage plots that were managed consistently (Figure 1). The intent of completing this calibration phase of the project was to ensure that future treatments applied were placed on plots that respond similarly when all other conditions are held constant.
In the process of analyzing the calibration data, the following is a list of important steps:

- Summarized data from 2011 to 2015 for each subsurface drainage plot (six plots) on a drainage event basis.
- Data included volume of drainage, nitrate load, nitrate flow weighted mean concentration (FWMC), total phosphorus load, and total phosphorus FWMC.
- Normality of the data was assessed using the Shapiro-Wilk test (Table 1) which determined whether log-transformed or raw data was used to run regression analysis to show the relationship between plots (Clausen & Spooner, 1993; Grabow, Spooner, Lombardo, & Line, 1999; Johnson, 2010).

Throughout the five years of data collected at this site, the three plots on the eastern part of this field produced 18 compete drainage events while the Clay County Drainage Site 2011-2015 Calibration Phase Assessment three plots on the west side produced only 14. In addition to differences in the number of drainage events produced, the east and west side also demonstrated marked differences in the timing that these drainage events occurred. In 2013 and 2014, the three subsurface drainage plots on the east side began flowing in March and April respectively. During these same two years the three subsurface drainage plots on the west side began flowing in June. Nearly a full two and three months later then the east side. In 2011, 2013, and 2015 the start of subsurface drainage was more consistent across all six subsurface plots. These observations from the calibration phase of the study indicate distinct differences in both the number and timing of events on the east and west side. For this reason, the east and west drainage plots were statistically analyzed separately.

Complete results from the normality assessment of the data collected from each plot and the regression model analysis used to determine strength of relationships between plots are included in appendix one and two. Based on a regression model analysis of every possible combination of eastern plots (Table 2), drainage plot number 2 and 3 have the overall strongest relationship for the volume, nitrate, and phosphorus variables tested. Performing this same regression model analysis on the western plots (Table 2), drainage plot number 4 and 5 show the overall strongest relationship.

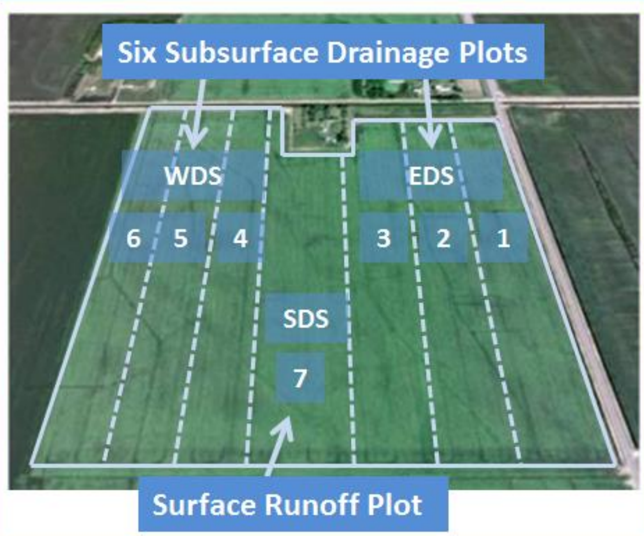

Figure 1. Clay County Drainage Site

Proposed Treatment Design

This statistical analysis of the calibration phase information indicates a paired plot design is the most appropriate experimental design for subsurface drainage plot treatments applied at this site. A paired plot experimental design does not assume the two plots are the same; it does assume the two plots respond in a predictable manner together. East drainage sites 2 and 3 will be paired and west drainage sites 4 and 5 will be paired, each pair has one control plot and one treatment plot. Treatment refers to a change in management that will be compared to the management of the control plot. During the treatment phase the water quality measured at the outlet of these plots will be compared to see if a change has occurred due to the treatment applied.

References

Clausen, J. C., & Spooner, J. (1993). *Paired Watershed Study Design. Technical Report 841-F-93-009.* Washington, D.C.: United States Environmental Protection Agency.

Grabow, G. L., Spooner, J., Lombardo, L. A., & Line, D. E. (1999). *Detecting Water Quality Changes Before and Ager BMP Implementation: Use of SAS for Statistical Analysis.* North Carolina Stat University Water Quality Group Newsletter: NWQEP Notes 93.

Johnson, G. (2010). *Whitewater River Watershed National Monitoring Program Project. Document wq-cwp8-12.* Saint Paul, MN: Minnesota Pollution Control Agency.

Table 1. Log-transformed data or raw data better representing normal distribution based on results from the Shapiro-Wilk normality test.

CDS Plot	Subsurface Flow (ft^3)	Nitrate Load (kg)	Nitrate FWMC (mg/L)	Total Phosphorus Load (kg)	Total Phosphorus FWMC (mg/L)
EDS1	Raw Values*	Log-Transformed*	Raw Values	Log-Transformed*	Log-Transformed
EDS2	Log-Transformed	Log-Transformed*	Raw Values*	Log-Transformed	Raw Values*
EDS3	Log-Transformed	Log-Transformed	Log-Transformed*	Log-Transformed	Log-Transformed
WDS4	Raw Values*	Log-Transformed*	Log-Transformed*	Raw Values*	Log-Transformed
WDS5	Raw Values*	Log-Transformed*	Raw Values	Raw Values*	Log-Transformed*
WDS6	Log-Transformed	Raw Values	Raw Values	Log-Transformed	Log-Transformed

*Indicates other form of data (log-transformed or raw) represent normal distribution based on Shapiro-Wilk test but not as well as indicated in the table. East Drainage site (EDS). West Drainage Site (WDS).

Table 2. Regression model results of relationship strengths between plots for plot drainage and nutrient loss.

Model	R^2	P-value	F-Ratio
Event Drainage (ft^3)			
EDS1_LOG_Q_FT3 = 2.067 + 0.471*EDS2_LOG_Q_FT3	0.252	0.034	5.393
EDS1_LOG_Q_FT3 = 2.682 + 0.346*EDS3_LOG_Q_FT3	0.127	0.147	2.328
EDS2_LOG_Q_FT3 = 0.867 + 0.846 * EDS3_LOG_Q_FT3	0.666	0.000	31.954
WDS4_Q_FT3 = -214.784 + 1.011 * WDS5_Q_FT3	0.904	0.000	113.38
WDS4_LOG_Q_FT3 = 2.326 + 0.376*WDS6_LOG_Q_FT3	0.363	0.022	6.851
WDS5_LOG_Q_FT3 = 2.007 + 0.460*WDS6_LOG_Q_FT3	0.669	0.000	24.242
Event Nitrate Load (kg)			
EDS1_LOG_N_KG = -0.134 + 0.828*EDS2_LOG_N_KG	0.520	0.001	17.345
EDS1_LOG_N_KG = 3.804 + 0.693*EDS3_LOG_N_KG	0.490	0.001	15.346
EDS2_LOG_N_KG = 0.099 + 1.221*EDS3_LOG_N_KG	0.802	0.000	64.813
WDS4_LOG_N_KG = -0.219 + 0.978*WDS5_LOG_N_KG	0.755	0.000	36.937
WDS4_LOG_N_KG = -0.179 + 0.328*WDS6_LOG_N_KG	0.156	0.162	2.224
WDS5_LOG_N_KG = -0.017 + 0.413*WDS6_LOG_N_KG	0.314	0.037	5.482
Event Nitrate FWMC (mg/L)			
EDS1 _N_FWMC = 0.483 + 0.776*EDS2 _N_FWMC	0.912	0.000	165.263
EDS1_LOG_N_FWMC = -0.027 + 0.884*EDS3_LOG_N_FWMC	0.512	0.001	16.796
EDS2 _N_FWMC = 2.025 + 0.742*EDS3 _N_FWMC	0.485	0.001	15.074
WDS4_LOG_N_FWMC = -0.116 + 0.909*WDS5_LOG_N_FWMC	0.907	0.000	117.383
WDS4_LOG_N_FWMC = -0.382 + 0.912*WDS6_LOG_N_FWMC	0.767	0.000	39.492
WDS5 _N_FWMC = 2.077 + 0.446*WDS6 _N_FWMC	0.716	0.000	30.224
Event Total Phosphorus Load (kg)			
EDS1_LOG_TP_KG = -1.217 + 0.424*EDS2_LOG_TP_KG	0.190	0.070	3.757
EDS1_LOG_TP_KG = -1.040 + 0.454*EDS3_LOG_TP_KG	0.183	0.077	3.577
EDS2_LOG_TP_KG = 0.331 + 1.025*EDS3_LOG_TP_KG	0.881	0.000	118.531
WDS4_TP_KG = 0.003+1.145*WDS5_TP_KG	0.399	0.015	7.969
WDS4_LOG_TP_KG = -1.337+0.398*WDS6_LOG_TP_KG	0.253	0.067	4.058
WDS5_LOG_TP_KG = -1.394+0.444*WDS6_LOG_TP_KG	0.521	0.004	13.063
Event Total Phosphorus FWMC (mg/L)			
EDS1_LOG_TP_FWMC = -0.381+0.808* EDS2_LOG_TP_FWMC	0.416	0.004	11.420
EDS1_LOG_TP_FWMC = -0.521+0.680* EDS3_LOG_TP_FWMC	0.765	0.000	51.948
EDS2_LOG_TP_FWMC = -0.594+0.513 * EDS3_LOG_TP_FWMC	0.682	0.000	34.390
WDS4_LOG_TP_FWMC = -0.027+0.879*WDS5_LOG_TP_FWMC	0.799	0.000	47.653
WDS4_LOG_TP_FWMC = -1.001+0.31*WDS6_LOG_TP_FWMC	0.219	0.092	3.360
WDS5_LOG_TP_FWMC = -0.855+0.489*WDS6_LOG_TP_FWMC	0.528	0.003	13.438

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