CIG EXECUTIVE SUMMARY

The field evaluation of drainage water management (DWM) for Midwestern row crop agriculture was completed by the Agricultural Drainage Management Coalition and its partners from the five states of Iowa, Minnesota, Illinois, Indiana and Ohio. The project entailed four paired field evaluations in each of the five states. The partners on this project included Purdue University, Iowa State University, Ohio State University, USDA-Agricultural Research Service, Minnesota Department of Agriculture, University of Minnesota and University of Illinois.

Drainage water management uses water control structures to raise the effective height of the water table, thereby managing the amount of drainage from a field. DWM is a practice that shows great promise for reducing nitrate loading in the Midwest while maintaining drainage intensity during critical periods of the crop production cycle.

This project demonstrated the impact of managing water table depths to reduce nutrient transport from subsurface drains during the fallow season and to reduce water deficit stress during the growing season. Changing the stop logs in the DWM control structure during the year is subject to the timing of the spring field operations and completion of fall field work. NRCS Practice 554 specifies a 30-day window for changes in the water table levels. All of the field evaluations were operated like the producers' normal farming operations with the exception of managing the control structures in the drainage systems.

The 20 field evaluations included data on nutrient reductions, crop yields, profitability, and timing of drainage water management, precipitation and drainage outflows from each field plot. The results from the different plots helped highlight the regional differences from state to state and, in some cases, fields within a state.

The state tables in this report list precipitation, drainage outflows, nutrient reductions and crop yields. Profitability of DWM is hard to quantify due to the inconsistency of yield information. However, a table of estimated installation costs and an equation to estimate annualized costs of implementation are included in this document.

The variable that could not be controlled in this project was precipitation – when it was received and the amount received. Precipitation was compared to the 30-year average at each location.

All of the field demonstration sites were retrofits with the exception of the Windom site in Minnesota which was designed specifically for drainage water management. Using retrofit drainage systems was somewhat challenging because the area of DWM impact was not always maximized and the tile installation maps were not always accurate. Some of the sites do not have any nutrient or yield data for 2007 year because their systems were being installed that year.

In reviewing the data from the individual state charts, it is apparent that reductions in nitrate outflow of 20 to 60% can be achieved, depending on the amount of precipitation received and when it occurs. There appears to be greater reductions in the southern part of the Corn Belt vs. the northern Corn Belt. This may be due to the frozen soils in the northern Corn Belt during the fallow season.

To implement this practice, a producer or landowner needs a good set of topographic maps in 6-inch contours to develop a plan for DWM. Many producers are already collecting this information through the use of GPS equipment on their tractors, combines or field sprayers. Sometimes this information can be supplied by a custom applicator of agricultural inputs or a drainage contractor with GPS-enabled equipment. With a good topo map, field map, existing tile maps and soils information, a technical service provider or drainage contractor trained in DWM design could produce a DWM system for the producer or landowner.

Equation to Estimate Annualized Cost of Installation

$$\frac{\text{(Cost of Materials + Installation Costs + Mobilization)} \div \text{\# of Acres}}{\text{Amortization schedule (Interest Rate + Number of Years)}} = \text{Annualized Costs}$$

Example: $$\frac{(\$715 + \$55 + \$58 + \$450 + \$150) \div 20 \text{ acres}}{(6\% \text{ interest / 15 years})} = \$7.35/\text{yr}$$

Estimated Cost of DWM Installation

Size of Tile Main	6"	8"	10"	12"
Control Structure	$ 617.00	$ 715.00	$ 803.00	$ 1,002.00
Anti-seep Collar	$ 55.00	$ 55.00	$ 55.00	$ 55.00
20' of DW Non-perf	$ 36.00	$ 58.00	$ 78.00	$ 107.00
Installation Costs	$ 450.00	$ 450.00	$ 450.00	$ 450.00
Subtotal	**$ 1,158.00**	**$ 1,278.00**	**$ 1,386.00**	**$ 1,614.00**
Mobilization Costs	$ 150.00	$ 150.00	$ 150.00	$ 150.00
Total if Retrofit Only	**$ 1,308.00**	**$ 1,428.00**	**$ 1,536.00**	**$ 1,764.00**

CIG Results by State

Indiana CIG Results

MD-Managed Drainage CD-Conventional Drainage

	Precipitation/inches			In/outflows/Type of system		% Reduction	Nitrate Loss lbs/acre		% Reduction	Yields		
Site/yr	**Average**	**Annual**	**Deviation**	**MD**	**CD**	**MD**	**MD**	**CD**	**MD**	**Crop**	**MD**	**CD**
Francisville	**30/yr**											
2007	37.4	46.16	7.76	0.12	2.28	95	NA	NA	NA	Corn	188	186
2008	37.4	43.56	6.16	2.49	2.07	-18				Corn	251	253
2009	37.4	41.97	4.57	4.57	2.75	-50				NA	NA	NA
Reynolds	**30/yr**											
2006	38.7									Corn	185	208
2007	38.7	27.78	-10.92	6.4	9.2	36	15.19	19.85	27	Corn	186	184
2008	38.7	42.77	4.07	11.5	13.6	17	40.71	45.73	12	Corn	202	202
2009	38.7	34.38	-4.32	11.1	10.1	-9	17.35	17.32	0	Corn	175	164
Wolcott	**30/yr**											
2006	38.7									Corn	192	187
2007	38.7	27.88	-10.82	16.3	16.1	-1	39.54	35.24	-12	Soyb	58	54
2008	38.7	45.03	6.33	11.2	13.2	17	38.04	37.54	-1	Corn	169	178
2009	38.7	43.35	4.65	13	13.6	4	17.09	16.88	-1	Soyb	57	60
Crawfordsville	**30/yr**											
2007	39.8	34.43	-5.37	17.6	18.6	6	35.2	31.53	-11	Corn	241	231
2008	39.8	48.99	9.19	17.8	20.2	13	39.31	43.81	11	Corn	136	129
2009	39.8	50.72	10.92	19.3	14.8	-26	29.9	23.44	-24	Corn	220	199

Iowa CIG Results

MD-Managed Drainage CD-Conventional Drainage

	Precipitation/inches			In/outflows/Type of system		% Reduction	Nitrate Loss lbs/acre		% Reduction	Yields		
Site/yr	**Average**	**Annual**	**Deviation**	**MD**	**CD**	**MD**	**MD**	**CD**	**MD**	**Crop**	**MD**	**CD**
Hamilton Cty	**10/yr**											
2007	34.6	41.3	6.7	11.43	10.98	NA	13.7	11.5	NA	NA		
2008	34.6	41.4	6.8	11.1	11	**NA**	12.5	8.4	NA	NA		
2009	34.6	34.9	0.3	3.93	6.15	**NA**	9.4	11.6	NA	Corn		
Story City	**40/yr**											
2006	32.79	34.47	1.68	8.34	6.5	22	17.58	21.72	19	Corn	173.2	163.95
2007	32.79	35.37	2.58	17.31	11.66	33	23.57	38.84	39	Soyb	64.03	57.14
2008	32.79	42.51	9.72	15.33	12.04	21	33.48	39.64	16	Corn	191.16	204.13
2009/nine mo's	27.78	24.35	3.43	8.74	7.57	13	11.26	12.5	10	Soyb	60.07	59.49
Crawfordsville	**10/yr**											
2007	34.63	40.31	5.69	7.05	10.14	30	14.86	20.87	29	Corn/Soyb	170.6/55.9	178.5/57.8
2008	34.63	36.15	1.52	9.15	12.07	24	6.23	22.53	72	Corn/Soyb	168.2/47.6	171.6/46.9
2009/10 mo.	31.34	45.69	14.34	13.94	23.11	40	14.29	14.53	2	Corn/Soyb	152.5/63.4	169.9/67.4
Pekin	**10/yr**											
2005	35.92	24.93	-10.99	1.39	3.58	61	NA	NA		Corn/Soyb	135.0/43.5	136.4/38.3
2006	35.92	22.84	-13.08	1.15	3.47	67	0.74	1.22	39	Corn/Soyb	NA	NA
2007	35.92	44.38	8.46	8.65	18.69	54	16.62	41.97	60	Corn/Soyb	141.7/45.7	139.3/43.7
2008	35.92	34.81	-1.11	6.25	16.6	62	10.65	28.58	63	Corn/Soyb	223.4/44	228.1/41.8
2009/11 mo.	34.46	36	1.54	13.65	25.29	46	2.18	10.13	78	Soyb	55.3	57.7

Ohio CIG Results

MD-Managed Drainage CD-Conventional Drainage

	Precipitation/inches			In/outflows/Type of system		% Reduction	Nitrate Loss lbs/acre		% Reduction	Yields		
Site/yr	**Average**	**Annual**	**Deviation**	**MD**	**CD**	**MD**	**MD**	**CD**	**MD**	**Crop**	**MD**	**CD**
Napoleon	**30/yr**											
2007	34.7											
2008	34.7											
2009	34.7											
Lakeview	**30/yr**											
2007	38.7									Popcorn	194.1	197.7
2008	38.7									Soyb		
2009	38.7											
Dunkirk	**30/yr**											
2007	35.2											
2008	35.2											
2009	35.2											
Defience	**30/yr**											
2007	35.2											
2008	35.2											
2009	35.2											

Minnesota CIG Results

MD-Managed Drainage CD-Conventional Drainage

	Precipitation/inches			In/outflows/Type of system		% Reduction	Nitrate Loss lbs/acre		% Reduction	Yields		
Site/yr	**Average**	**Annual**	**Deviation**	**MD**	**CD**	**MD**	**MD**	**CD**	**MD**	**Crop**	**MD**	**CD**
Dundas	**30/yr**											
2007*	31.64	8.6	-23.04	NA	NA					NA	NA	NA
2008	31.64	21	-10.64	2.37	2.56	7	4.11	6.54	37	Corn	185	180
2009	31.64	25.22	-6.42	0.29	0.35	17	1.55	4.47	65	Soyb	54	54
Hayfield	**30/yr**											
2007*	30.14	11.59	-18.55	NA	NA					Corn	204	204
2008	30.14	15.7	-14.44	8.1	7.4	-9	39.4	39.2	-1	Soyb	51	57
2009	30.14	24.55	-5.59	3.3	3.8	13	9.7	8.7	-11	Corn	207	197
Wilmont	**30/yr**											
2007*	27.79	7.56	-20.23	NA	NA					NA	NA	NA
2008	27.79	29.1	1.31	4.5	4.2	-7	12.3	13	5	Corn	168	173
2009	27.79	22.94	-7.36	0.6	2.4	75	0.02	8.4	98	Corn	173	175
Windom	**30/yr**											
2007*	29	NA		NA	NA					NA	NA	NA
2008	29	27	-2	NA	12.8	NA	NA	34.2	NA	Soyb	49	48
2009	29	27.37	-1.63	1.8	6.1	60	2.7	6.3	60	Corn	187	187

* Precipitation over cropping season April 1 - October 31

Illinois CIG Results

MD-Managed Drainage CD-Conventional Drainage

	Precipitation/inches			In/outflows/Type of system		% Reduction	Nitrate Loss lbs/acre		% Reduction	Yields		
Site/yr	**Average**	**Annual**	**Deviation**	**MD**	**CD**	**MD**	**MD**	**CD**	**MD**	**Crop**	**MD**	**CD**
Hume #1	**30/yr**											
2006	38.76	41.86	3.1	NA	NA	NA	NA	NA	NA	Soyb	60.2	57.2
2007	38.76	33.27	-5.49	NA	NA	NA	NA	N	NA	Corn	184.5	187.6
2008	38.76	53.36	14.6	11.26	22.88	50.8	33.03	95.67	65.47	Soyb	47.9	48
2009	38.76	53.12	14.36	11.58	31.35	63.05	19	100.63	81.12	Corn	184.1	174.6
Hume #2	**30/yr**											
2006	38.76	41.86	3.1	NA	NA	NA	NA	NA	NA	Soyb	59	53.7
2007	38.76	33.27	-5.49	NA	NA	NA	NA	NA	NA	Corn	189.4	182.3
2008	38.76	53.36	14.6	14.83	29.74	50.15	NA	NA	NA	Soyb	52.3	51.2
2009	38.76	53.12	14.36	8.39	24.16	65.27	17.71	82.34	78.49	Corn	181.6	186.7
Barry	**30/yr**											
2006	38.44	29.47	-8.97	NA	NA	NA	NA	NA	NA	**Corn**	122.9	140.6
2007	38.44	27.31	-11.13	NA	NA	NA	NA	NA	NA	Corn	123.5	135.7
2008	38.44	49.5	11.06	0.81	21.22	96.2	NA	NA	NA	Corn	168	160.3
2009	38.44	46.91	8.47	1.58	8.58	81.55	3.58	17.44	79.48	NA	NA	NA
Enfield	**30/yr**											
2006	45	45.12	0.12	NA	NA	NA	NA	NA	NA	**Corn**	**192.6**	**197.7**
2007	45	39.6	-5.4	NA	NA	NA	NA	NA	NA	Soyb	60.8	50.5
2008	45	47.05	2.05	24.9	32.6	23.62	NA	NA	NA	Corn	186.2	194.8
2009	45	51.56	6.56	8.46	13.13	35.56	14.07	21.73	35.27	NA	NA	NA

NA is entered where no data was available due to project start-up or installation timing, or data missing because of malfunction, Notes are provided in main document.

Recommendations

It is feasible to retrofit existing drainage systems up to 0.5% grade. Estimates of drained acres that will accommodate DWM could exceed 10 million acres or more.

If DWM designs were incorporated into the designs of new drainage systems or drainage systems that are being replaced because they are deteriorating, a greater percentage of each field could be utilized. By placing the drainage mains up the slope and installing the lateral drains across the slope, and using new, high-technology in-ground controls to manage the water table, DWM could be installed on grades up to 2%. This would increase the estimated drained acreage by an additional 50 million acres. The estimated cost of designing and installing a new system for DWM is 10% or less of the total drainage project cost. The economics of including upgrades to new system on a per-unit cost of nitrate reduction should be included in cost-share funding.

The size of the main dictates the coefficient of a drainage system, but the lateral spacing of the drainage pipes determine the level of the water table. One area of concern is the perched water table halfway between the lateral drainage lines. The perched water table can be reduced by using a smaller diameter pipe spaced closed together without changing the drainage coefficient. This would create more uniformity and allow producers to change the control settings to as much as 10 days prior to or after field operations, thereby reducing the total amount of outflows.

Though DWM can be used as a stand alone practice, producers could use it as one of a suite of drainage management practices that can also include constructed or natural wetlands, saturated buffers, bioreactors and crop production practices that can reduce nutrients and flows from the landscape. Many of these practices can be installed at the edges of fields to reduce impacts on cropping.

In order to provide the technical support needed to assist landowners and producers, a network of private and public trained personnel needs to be a high priority for implementation.

ADMC's Conclusions

The three-year DWM demonstration program yielded important insight on the environmental benefits and the practicalities of controlling drainage, as well as outreach efforts that made more than 1 million impressions on farmers, drainage experts and members of the environmental community through farm forums, outreach and publications. Even challenges encountered in quantifying yield effects provided important perspective on future study and observation of the practice.

We are significantly closer to understanding of how drainage water management can help address nutrient enrichment problems in surface waters throughout the Mississippi River watershed and into the

Gulf of Mexico. Such understanding will provide invaluable guidance in the development of policies and programs that incentivize drainage water management.