Edge or In-field Practice

Constructed Wetlands:

Constructed and/or restored wetlands are engineered nitrate, phosphorus and sediment treatment systems that function under a variety of conditions and when used in strategic watershed positions have the potential to significantly improve water quality in Iowa's agricultural watersheds (Figure 1; Table 1). US Midwest region research has measured wetland nutrient removal rates in drainage water of up to 68% for nitrate-nitrogen and 43% for phosphorus, although these outcomes vary considerably from site to site (Woltemade 2000).

Wetlands slow the movement of water and allow sediment in runoff to settle. Further, constructed wetlands intercept tile drainage water and microbially denitrifies nitrate-nitrogen, releasing it to the atmosphere as nitrogen gas. Perennial wetland vegetation, or as part of the planned buffer surrounding wetlands, have the capacity to remove excess phosphorus from wetlands and thus provide an opportunity for addressing phosphorus in drainage water. These systems also provide important habitat to all sorts of terrestrial, migratory and aquatic species (figure 1). A constructed wetland is scaled according to its treatment drainage area; typically, a 0.5% - 2% range in wetland/watershed area ratio is the standard. Maximum wetland depth is typically no deeper than 10 feet and edge depth will vary throughout the year. For a broad overview of wetland function and their use as a conservation practice, see Iowa Learning Farms (2014).

Figure 1: Constructed wetland system in Black Hawk County Soil and Water Conservation District, Iowa; http://blackhawkswcd.org/conservation-projects/.

Table 1. General use characteristics of Constructed Wetlands (Practice Code 656) and basic cost parameters.

Best Management Practice (NRCS practice standard code)	**General use of the BMP: For the most part this information comes directly from NRCS practice standard information.**	**Basic Cost Parameters: Varies considerably from site to site and depends on initial conditions, hydrology, soil, crop, practice design, and management characteristics.**
Constructed Wetlands (Practice Code 656)[1, 2]	Reduce nitrogen, phosphorous, pesticides, and sediment loading in intercepted tile drainage or stream systems Provides wildlife habitat Provides improved aesthetics	Site planning, design, engineering and preparation; excavation and soil movement; planting; seed costs (wetlands mix), tile redirection. Opportunity costs for foregone land rent or crop revenue.

1. Iowa NRCS Constructed Wetlands Practice Code 656: http://efotg.sc.egov.usda.gov/references/public/IA/Constructed_Wetland_656_SOW_2015-09.pdf

2. There are a number of wetland related conservation programs that may apply in certain situations. Ultimately, it is advisable that one contact their county or regional NRCS office and make inquiries regarding wetland cost share and other program opportunities: http://www.nrcs.usda.gov/wps/portal/nrcs/site/ia/home/

Wetland Cost Overview and Example:

The installation and long-term costs of a constructed wetland will vary considerably depending upon design and scale. The costliest components of constructed wetlands are typically associated with site planning and design, excavation activities, control structures required and the opportunity cost of any land removed from agricultural production (over the long term, opportunity costs in the form of foregone land rent or net revenues typically represent between 50% and 70% of the total costs of this practice). Depending on the context for wetland use, overall scale of the project or program tie-in (e.g., USDA CREP wetland program)[1], engineering planning and design costs can be significant upfront costs.

The average 2016 costs (first year costs and per acre per year) of an example one acre constructed wetland located on land with a high Corn Suitability Rating (CSR 80) treating about 100 acres of drainage, would cost just over $10,000 for design and installation, or just under $800 per acre per year when annualized (analyzed over a 40-year time period; wetlands have indefinite lifespans and are expected to be permanent landscape elements); see table 2 for a summary of this assessment. There are a number of EQIP and CRP programs associated with different types of wetlands in different construction/ reconstruction and landscape contexts. For example, in the context of the Conservation Reserve Program (CRP), which is administered by the USDA FSA, regional programming pays a minimum of 50% of direct wetlands restoration cost, a one-time sign up incentive, along with an annual rental payment to account for opportunity costs (i.e., foregone rent or profit loss from not growing crops). Contact your local NRCS/ FSA office for more specific information.

Table 3 below displays a comprehensive average cost breakdown for constructed wetlands in Iowa (2016$). All data adapted from Christianson et al. 2013.

Table 2. Cost example of a 1 acre constructed wetland treating about 100 acres of drainage area. Costs in 2016$.

First year per acre costs (Design and construction)	$10,022[1]
Annualized per acre costs over 40 year lifespan	$785 [2]

1. Costs can be quite variable depending upon initial site conditions, total wetland area/ drainage area, and initial design costs. This example has 1 wetland acre treating about 100 acres of drainage. The cost is for the wetland itself as well as a grassed buffer. The total area of the grassed buffer is typically 3.5% of the drainage area.

2. Calculated using standard discounted cash-flow procedures using a 4% discount rate and 20-year management horizon. Assumes 2016 state average land rent cost of $230/acre.

[1] Iowa CREP Program Overview: http://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Conservation/PDF/crepiafactsheet.pdf

Table 3. Comprehensive average cost breakdown for constructed wetlands in Iowa (2016$). Table adapted from Christianson et al. 2013 .

Upfront Cost Activities / items	Year cost incurred	Mean price (wetland acre)	Mean price per drainage (treated) acre	Notes
Wetland design cost (Engineer)	1	$1,000	$10.00	Assumption: 10 hours at $100/hr for a 1-acre wetland site (treating 100 acres of drainage). Information: Christianson, L. 2014. Personal communication. The total amount of this cost depend on the context for wetland use and or program tie-in (e.g., USDA CREP wetland program). Cost may be significantly reduced by working with the NRCS.
Constructing basin	1	$1,500	$15.00	Building ponds ~15 hours at ~$50/hr for 1-acre wetland (encompasses range of activities fc excavation, berm building, structure placement, etc.), not including buffer seeding time. Da source: Christianson et al. 2013.
Wetland plants (seeds and plugs) and planting	1	$640	$6.40	For shallow wetland systems, 100-150 plants per acre will help ensure sufficient establishn open water areas. A wetland seed mix that covers wetland banks (~1/3 of the basin area) is advisable. Wetland plant species plug regionally sell in bulk for about $1.00 to $2.00 per pl wetland seed mixes range $75 to $100 per pound of seed (~ 5 pounds, drilled). In certain a where wetland conditions are being restored, it is possible that there is a vaible wetland pla seed bed that would revegetate the wetland without additional seed/plants; such outcomes a uncertain and variable.
Wetland buffer seed	1	$131	$1.31	Total Wetland buffer area =3.5% of the total drainage area. Buffer area assumption: Helme 2014 Personal communication. Cost information: Plastina, A. and A. Johanns (2016). Aver Regional seed costs: $131.00/ac for CRP "economy" wetland Program Mix 15lb/ac; for 3.5 wetland buffer area. There are a number of companies that sell regional genotypic wetland and forb seed.
Seeding buffer (broadcast with tractor)	1	$40	$0.40	Data Source: Edwards, 2009 (Inflated to 2016$).
Weir Plate	1	$600	$6.00	Assumption: $30 per sq. ft for 200 sq. ft sheet pile plate, for 1 ac site; Information: Christia L. 2014. Personal communication.
Control Structure	1	$2,100	$21.00	One control structure ranging from 5 ft deep, 18 inch pipe ($1,300 per ac.) to 10ft deep, 24 pipe ($2,900 per ac) for 10 ac wetland site. Information: Personal communication with Agr Drain Corp. Adair, Iowa (www.agridrain.com)
Long-term management costs				
Time to manage (mowing buffer)	3-n [1]	$3.06	$0.03	Data source: Plastina, A. and A. Johanns (2016).
Replace control structure gates	Every 8 yrs	$15	$0.15	Data source: Christianson et al. 2013.

Land rent for wetland acre	0-n [1]	$230	$2.30	State wide average land rent for 2016 was $230 per acre. Note: this would be an annual cos reference, the present value of $230/ac/year over a 50-year period (the expected lifespan of wetland) @ 4% would be $35,113.
Land rent for buffer per ac of wetland (3.5 % of 1 ac)	1-n [1]	$8	$0.08	State wide average land rent for 2016 was $230 per acre, Plastina et al. (2016).
Control structure and weir replacement	~ 40	$935	$9.35	Financial data is presented undiscounted.
Conservation Reserve Program payments	1, 1-n [1]	Variable	Variable	Program parameters and payment schedules will vary. For example, with the USDA Farm Service Agency Wetland Restoration Initiative Conservation Reserve Program (CRP; utiliz Practice Standards CP23, CP23A for wetland Restoration, Inside/ outside the 100-year floodplain) a farmer might receive: 1) up to 50% cost share for wetland establishment; 2) th also a one-time practice incentive payment equal to 40 percent of the eligible costs of instal the practice; 3) annual rental payments for a 10- to 15-year period. The rental rate is based the weighted average dry-land cash rent; 4) one time, upfront CRP signing incentive payme range from $100 to $150 per ac. Contact your local NRCS/ FSA office for more informatio

Important caveat: Please note that the direct and indirect cost of any Best Management Practice can vary considerably from site to site and are largely contingent on: initial conditions, hydrology, soils, crop, practice design, management characteristics and experienced opportunity costs (which can be highly variable). As with all of these types of financial assessments, the costs presented here are simply baseline numbers and are meant to be informative rather than prescriptive.

General References:

Iowa Learning Farm (2015) Wetlands Implementation. Iowa Learning Farms, Iowa State University. Available at: http://www.extension.iastate.edu/ilf/sites/www.extension.iastate.edu/files/ilf/Wetlands_think-piece_revised_4-9.pdf.

Christianson, L., Tyndall, J.C., Helmers, M. (2013) Financial Comparison of Seven Nitrate Reduction Strategies for Midwestern Agricultural Drainage. *Water Resources & Economics*. http://dx.doi.org/10.1016/j.wre.2013.09.001

Plastina, A. and A. Johanns (2016) 2016 Iowa farm custom rate survey. Ag Decision Maker. File A3-10; FM 1698 (Revised, March 2016).

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Woltemade, C. J. (2000) Ability of restored wetlands to reduce nitrogen and phosphorus concentrations in agricultural drainage water. *Journal of Soil and Water Conservation*, *55*(3), 303-309.

This cost information may be cited as:

Tyndall, J., and T. Bowman (2016) Iowa Nutrient Reduction Strategy Best Management Practice cost overview series: Constructed wetlands. Department of Ecology & Natural Resource management, Iowa State University.