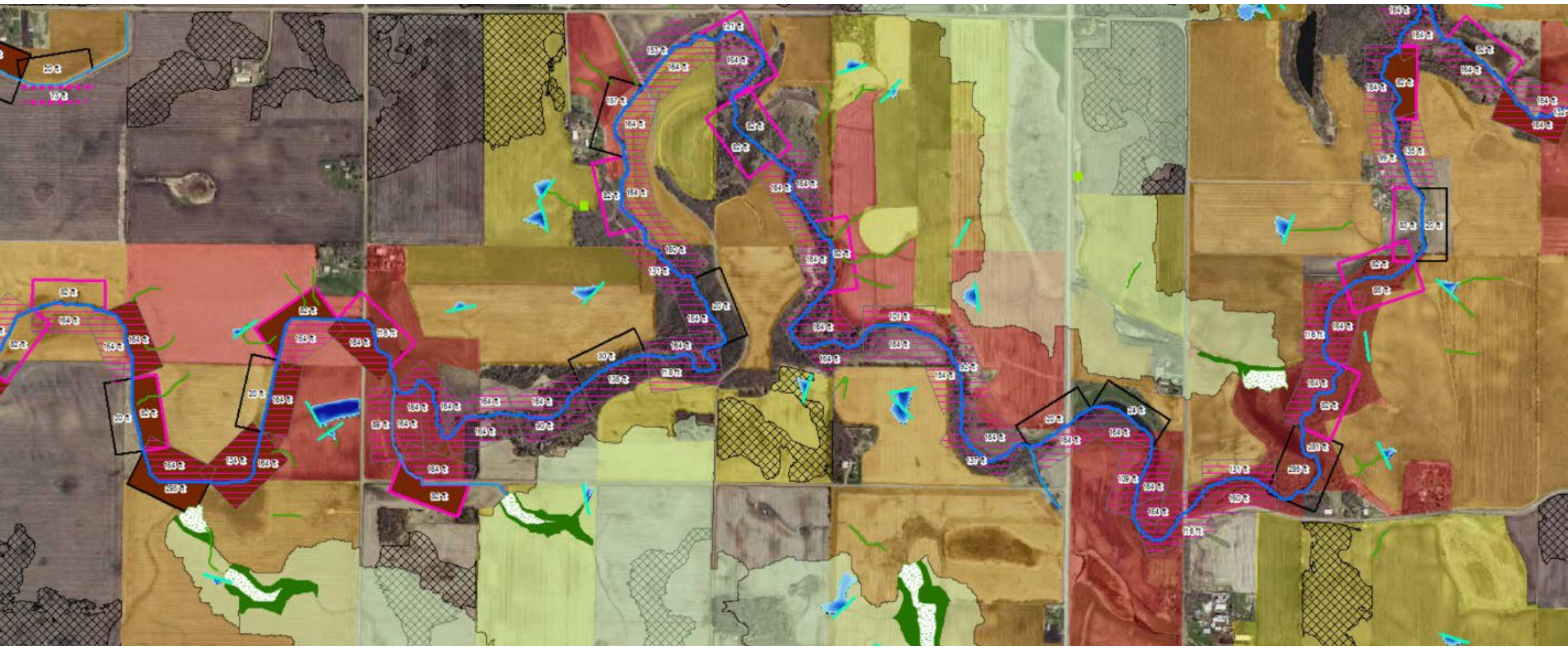
Agricultural Conservation
PLANNING FRAMEWORK



Landscape-Specific Adaptations of the ACPF

Guidance on Customizing
the Agricultural Conservation Planning Framework (ACPF) GIS Toolbox

2018

Jessica Nelson

Water Resources Center
UNIVERSITY OF MINNESOTA
Driven to Discover℠

Landscape-Specific Adaptations of the ACPF:
Guidance on Customizing the Agricultural Conservation Planning Framework (ACPF) GIS Toolbox

December 2018

by Jessica Nelson, for the University of Minnesota Water Resources Center.

With contributions from Ann Lewandowski (Water Resources Center, University of Minnesota), Joel Nelson (University of Minnesota), and Mark Tomer (USDA Agricultural Research Service)

Special thanks to reviewers:

- Karl Gesch (Iowa Soybean Association)
- Carrie Freeman (Widseth Smith Nolting)
- Dan Haug (Prairie Rivers of Iowa)
- Kent Pena (NRCS)
- Sarah Francart (Outagamie County Land Conservation Department)

Funding for the development of this document was provided by the USDA Natural Resources Conservation Service, through the USDA Agricultural Research Service National Laboratory for Agriculture and the Environment, Ames, IA.

About the author: Jessica Nelson is a Watershed Outreach & GIS Specialist for the Water Resources Center at Minnesota State University-Mankato where she has conducted ACPF analyses on watersheds across southern Minnesota, advised other GIS technicians on using the ACPF, and serves on the Southern Minnesota GIS User Group Steering Committee. Jessica has partnered on several locally-engaged watershed planning efforts in the Minnesota River Basin and works with ACPF practitioners across the Midwest.

CONTENTS

INTRODUCTION

The goal of this document is to provide guidance on subwatershed targeting efforts using the Agricultural Conservation Planning Framework (ACPF) watershed planning toolbox. The foundation of the framework is building soil health through non-structural practices such as conservation tillage, nutrient/manure management, and diversified crop rotations, then evaluate opportunities to control water within fields, below fields and within the riparian zone. The ACPF toolbox can be used within the ArcGIS environment to analyze soils, land use and topographic data to identify a broad range of opportunities to install conservation practices in fields and in watersheds. The suggestions highlighted in this document only include BMP siting tools that require user inputs and is not comprehensive of all conservation practices included in the ACPF toolbox. The user-specifications optimize development of tailored subwatershed strategies, although it requires some basic understanding of management practices as they apply to various landscapes. The user is encouraged to consult with knowledgeable field staff about characteristics of the land and appropriate BMP design considerations. For more information and technical guidance on how to use ACPF, where the framework has been applied, and to see examples visit the North Central Region Water Network website (https://acpf4watersheds.org/).

This document should be used to inspire and take advantage of the flexibility built into the ACPF toolbox for developing implementation strategies. There are several questions that the technician should consider when using the ACPF and selecting best management practice (BMP) siting criteria within the GIS toolbox:

- Are the soils poorly drained and extensive subsurface drainage networks have been implemented to manage for ponding and surface runoff; or are the soils sandier with good drainage and infiltration?
- Is the watershed relatively uniform with flat or steep slopes; or is the headwaters flat where ponding is common, and the outlet is deeply incised?
- What are the primary resource concerns?
- Common cropping practices?

Use the "Considerations" worksheet on the next page to answer these questions. This will guide users to develop meaningful strategies within the targeted subwatershed using the ACPF toolbox BMP siting outputs. It takes time to understand the complexities of the subwatershed and determine the combination of management practices that improves the health and quality of resources within and downstream of the targeted area.

Initially the watershed planner should familiarize themselves with the landscape characteristics throughout the targeted subwatershed through conversations with local field staff, driving around, and some initial review using aerial imagery and the base geodatabases provided by the ACPF developers. Pay attention to slopes, soil types and drainage classes, dominant crop and rotations patterns, and trends in water quality. All these factors help to characterize existing physical conditions and land stewardship throughout the watershed.

CONSIDERATIONS FOR DEVELOPING CONSERVATION PLANS TO MEET WATER RESOUCE GOALS

Before running the ACPF, consider the following characteristics of the watershed. These are not meant to be interpreted in a hierarchical sequence but rather as key considerations for developing meaningful conservation plans. Understanding watershed characteristics and management priorities supports users while evaluating the potential conservation practices to target from ACPF GIS toolbox outputs.

1) ***Ecoregions*** - defined by biotic, abiotic, terrestrial, and aquatic characteristics, along with correlation to human activity (McMahon et al. 2001). The EPA Ecoregion IV (See Figure 1) is one of several spatial frameworks designed to inform research, assessment, and monitoring of ecosystems. In addition, it is important to learn the unique ecosystem characteristics found within the targeted watershed through field surveys and landowner engagement.

Watershed ecoregion description: ____

____

2) ***Slope Characteristics*** - are indicative of farm management and resource concerns. For example, surface erosion is a challenge to manage in strongly sloping (>5%) landscapes and practices such as contour buffer strips and grassed waterways reduce erosion.

Identify predominant slopes:

- ☐ <1%
- ☐ 1-2%
- ☐ 2-5%
- ☐ 5-10%
- ☐ 10-15%
- ☐ >15%

3) ***Soil Attributes*** - determine how water moves in the watershed. In agricultural watersheds, ponding is common on poorly drained soils and a common management strategy to mitigate for ponding is subsurface drainage installations linked with transporting nutrient loads to downstream waterbodies.

Identify predominant hydric conditions:

- ☐ % Hydric
- ☐ Hydrologic soil groups (A, B, C, D and dual-drainage)

4) ***Priority Management Concerns*** - the resources and pollutants that are degrading subwatersheds can narrow down the types of BMPs and design to provide the most benefit to reaching water goals at a reasonable cost.

Identify predominant concerns:

- ☐ Floodplain reconnection / Restoring hydrology
- ☐ Sediment
- ☐ Nitrogen
- ☐ Phosphorus
- ☐ Wildlife
- ☐ Water Storage

5) ***Adoption Barriers*** - Farmers are unwilling to experiment with some practices without a financial incentive to reduce risk to their investment.

Identify available funding, technical assistance and barriers to practice adoption:

a. County, state, federal or private funding available ____________________
b. Practice requirements tied to using those program funds____________________
c. Construction and maintenance costs of BMPs ____________________
d. Land stewardship ethic and community characteristics that impact adoption and watershed organizing ____________________

6) ***ACPF Toolbox Practices*** – The following are conservation practice outputs available in the ACPF toolbox to guide targeting and quantification of pollutant load reductions in agricultural subwatersheds. Some will be more or less relevant to a specific watershed.

Identify most important practices:

- ☐ Cover Crops (Runoff Risk Table)
- ☐ Depression Identification
- ☐ Drainage Water Management
- ☐ Grassed Waterways
- ☐ Contour Buffer Strips
- ☐ Edge-of-Field Practices
- ☐ Conservation Tillage (Runoff Risk Table)
- ☐ Nutrient Removal Wetlands
- ☐ Riparian Management
- ☐ Water and Sediment Control Basins
- ☐ Saturated Buffers

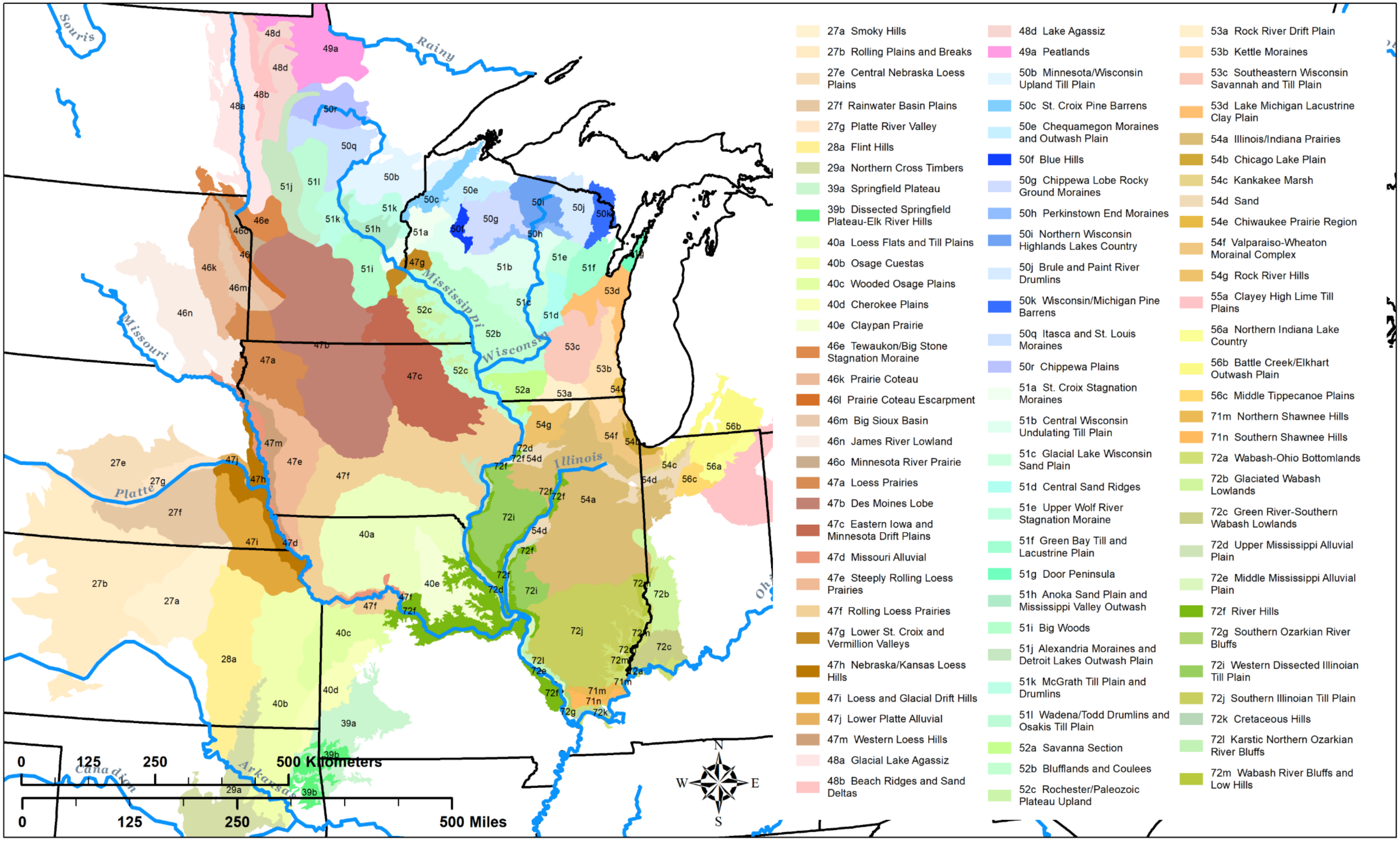


Figure 1. EPA Ecoregion IV spatial framework characterizing ecosystems overlapping with where ACPF base geodatabases are available in the Midwest. The Ecoregion IV dataset provides insight on common landscape features and can help determine subwatershed characteristics for improved targeting of conservation practices (EPA 2011).

DEVELOPING MEANINGFUL CONSERVATION PLANNING DATASETS

Working with the ACPF toolbox is easy, but getting meaningful results takes attention to the settings. This section provides suggestions for the starting point to determine most appropriate BMP sitings for these ACPF tools: depression identification, drainage water management, contour buffer strips, nutrient removal wetlands, and contour buffer strips. The user-specifications are based on NRCS practice standards where each practice is identified by a unique three-digit code. The priority management concerns addressed by certain conservation practices vary based on design specifications and landscape. The ACPF toolbox was developed to provide a process for conservation planning to improve water quality in agricultural watersheds using precision technologies (Tomer et al. 2013).

The list of suggestions included in this document is based on guidelines outlined in specific programs, NRCS guidance, user experiences, and the ACPF Toolbox User Manual (Porter et al. 2017). Users are encouraged to take the suggested values outlined in this document as a baseline, followed by reviewing the results and adjusting as needed using an iterative process to generate outputs tailored to the unique watershed characteristics. Some common tools in ArcGIS to aid in reviewing datasets include Layer Properties (Figure 2), Join & Relates function (Figure 3A), Tools toolbar (Figure 3B), and Effects toolbar (Figure 3C). Landowner engagement is one of the most effective steps to understand the unique conservation planning challenges within each watershed and groundtruthing GIS datasets.

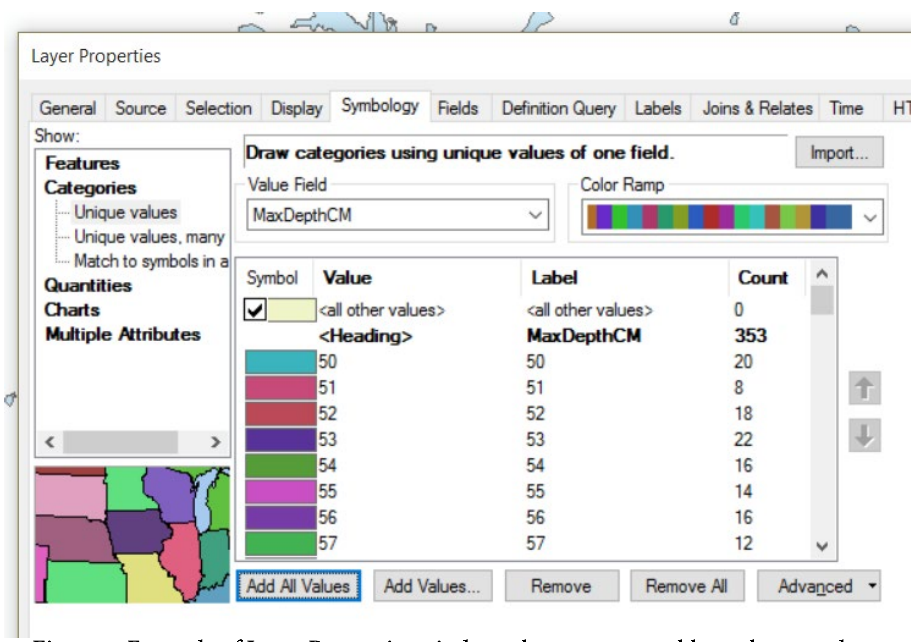


Figure 2. Example of Layer Properties window where users are able to change colors, symbols, and distribution of features to visualize attributes.

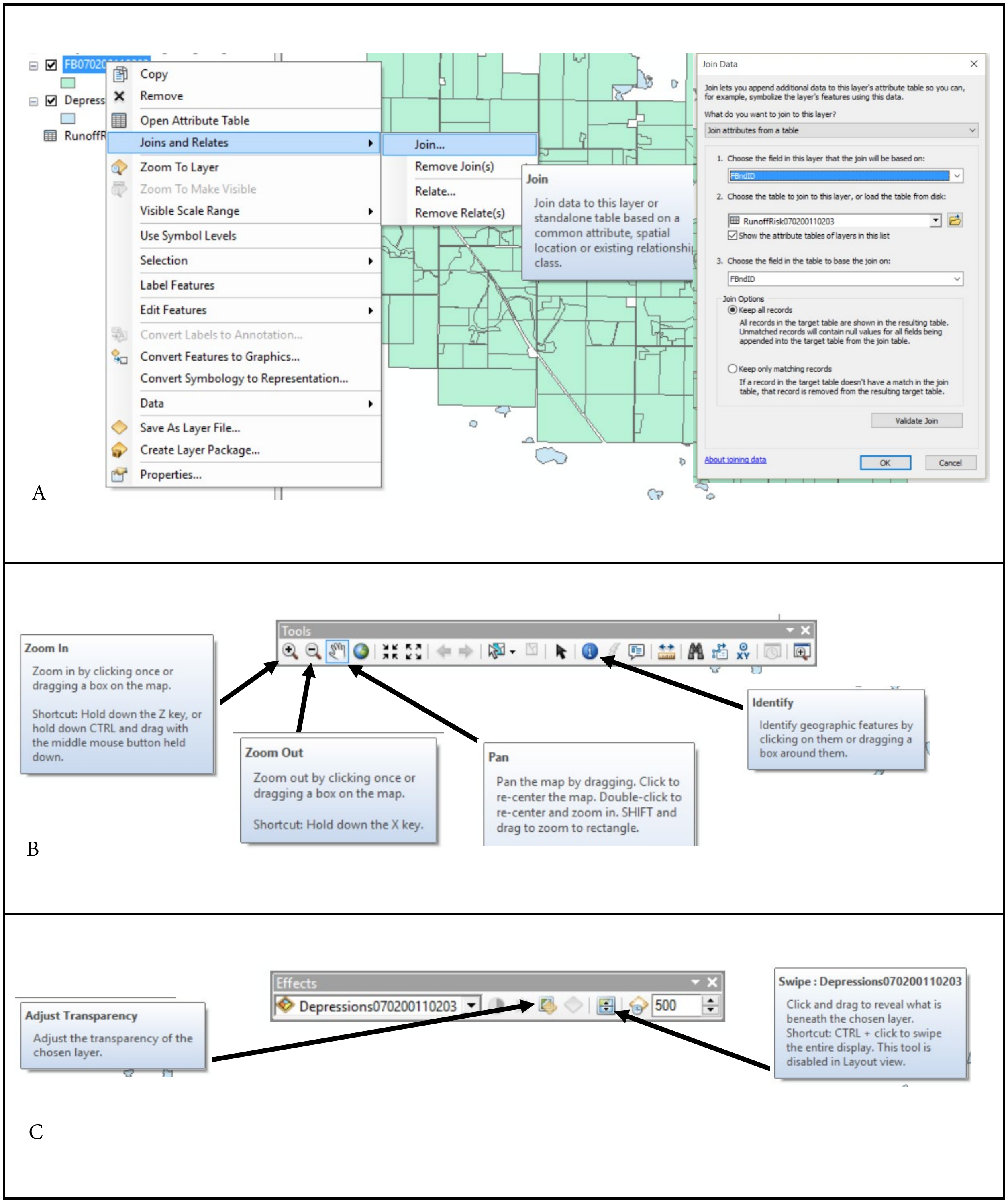


Figure 3. Common GIS tools and functions to visualize feature layer and raster datasets. (A) Join & Relates function to visualize calculations in tables, where tables can be joined to a shapefile by a unique ID. Example of joining field boundary layer with runoff risk table using unique field boundary ID. (B) Tools toolbar with features to help zoom in and out, move around in the map and identify features selected. (C) Effects toolbar with features to adjust transparency of selected layer and swipe the layer to only display a portion of the dataset.

TOOL 3A. DEPRESSION IDENTIFICATION

When defining the settings for depressions, consider your conservation goals and drainage class across the landscape within the subwatershed. These factors will dictate the quantity of depressions matching the user-specified surface area and depth, and the ACPF GIS Toolset will only produce features matching these criteria. Low-lying areas suitable as a restorable basin are common in glacial landscapes. Poorly drained and hydric soils are common in depressions, and most suitable for wetland restorations. Locations of depressions in agricultural fields may be suited for several types of conservation practices, including practice standards for wetland restoration/creation (657) and underground outlet (620). Depending on design and placement in the watershed, the following priority management concerns may be addressed:

- Floodplain reconnection / restoring hydrology
- Water storage
- Sediment
- Nitrogen
- Phosphorus
- Wildlife

Wetland restoration/creation (657)

Wetland restorations provide many benefits for water quality and restoring hydrology, plant communities, and degraded soils in wetlands that have been drained (MDA 2017). The wetlands are designed to mimic natural wetland hydrology and vegetation by building embankments around depressional features with >60% of hydric soils landscape (Porter et al. 2017). There are several types of wetlands that provide various environmental benefits. Managing for water quality benefits doesn't necessarily provide optimal conditions for wildlife habitat, therefore specific site design should be based on conservation and landscape goals.

Suggested user inputs for Depression Identification tool

If there are no programmatic requirements limiting site identification, then the tool can be run with the default minimum for percent hydric, depth and surface area (Figure 4). The resulting polygon will have detailed attributes contained in the table where users can apply filters and modify symbology on the back end to visualize depressional sitings matching subwatershed plan priorities. The following are examples of user inputs based on programmatic requirements for Minnesota's easement program, Conservation Reserve Enhancement Program (CREP), and Todd County's Reinvest in Minnesota (RIM) easement program.

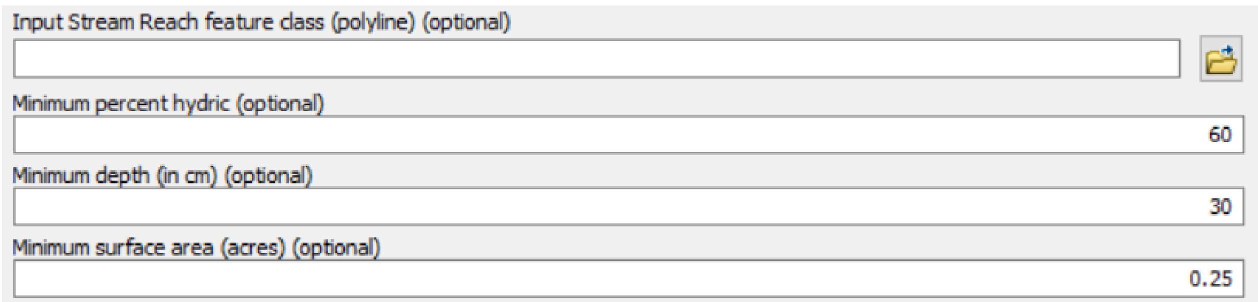


Figure 4. Default values for siting depressions in watershed using Depression Identification tool.

Minnesota Conservation Reserve Enhancement Program (CREP) III: >= 8-Acre Surface Area

Minimum percent hydric: 60
Minimum depth (cm): 30
Minimum surface area (acres): 8

Todd County, MN – Reinvest in Minnesota (RIM) Program: >5 Acres Surface Area

Minimum percent hydric: 60
Minimum depth (cm): 30
Minimum surface area (acres): 5

Identify prairie potholes suitable for blind inlets, perennial cover, or small wetland or oxbow restoration

(Source: Iowa Soybean Association, 2018)

	Des Moines Lobe Watersheds	*Other Iowa Landforms*
Minimum percent hydric:	50	50
Minimum depth (cm):	36	18
Minimum surface area (acres):	0.5	0.5

TOOL 3C. DRAINAGE WATER MANAGEMENT

In the ACPF toolbox, the 'Drainage Water Management' tool identifies suitable locations for controlled drainage (554) projects. Since incorporation of control structures isn't suitable in all landscapes, the user-specifications are very limited to drainage and slope characteristics and land stewardship ethic within the watershed. The drainage intensity can vary throughout the year depending on the management strategy. Controlled drainage projects are suitable in landscapes with <2% slopes and where infiltration drainage systems are common, such as poorly drained soils with extensive subsurface drainage networks (NRCS 2016). Depending on design, the following priority management concerns may be addressed:

- Sediment
- Nitrogen
- Restoring hydrology

Drainage water management (554)

Controlled drainage systems enable the operator to manage the water table in tile drained fields (Figure 5). The system works by periodically holding back water within the root zone by adjusting depth of the drainage outlet using control structures in a main, submain, or lateral drain (Frankenberger 2005). To achieve an economical and efficient system, each control structure should manage large sections of the field. The ideal sites are flatter fields with slope <1%, to minimize control structures installed and manage the water table for many acres. Some farms have been able to manage drainage control structures economically in fields with slopes up to 2% (NRCS 2016).

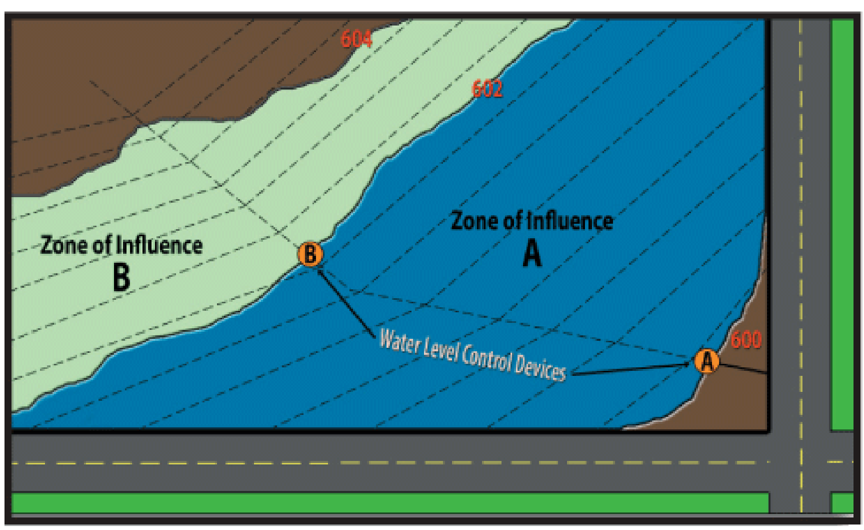


Figure 5. Illustration of drainage management zones impacted by two control structures, contour intervals are 2 feet (NRCS 2013).

Suggested user inputs for Drainage Water Management tool

The default settings populated in the Drainage Water Management tool (Figure 6) evaluate field suitability based on contour intervals of 1 meter and minimum of 20 acres treated by control structure within the 1-m contour interval. Users have the flexibility to identify fields by the minimum number of acres treated by a control structure, or the minimum percentage of a field draining to the control structure, but not both. In order to go back and forth between the two, clear the values in “minimum acreage within field” so that the “minimum percent of field” option is unlocked. Based on NRCS guidance the management sweet spot for placement of control structures ranges between 0.3 and 0.6 meter contour intervals.

A higher contour interval value relies on more control gate structures, whereas a lower contour interval value is more limiting and targets flat fields. The following are examples of user inputs based on slope field characteristics, drainage class, and level of management required. A range is presented below, although only one value may be inputted, and the user is encouraged to run this as an iterative process to determine the best siting representation.

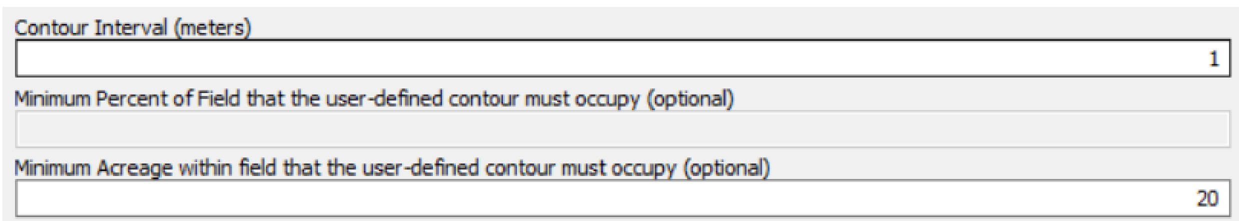


Figure 6. Default settings for Drainage Water Management tool.

Suitability for controlled drainage systems in approximately 1/3 of field

Contour Interval (meters): 0.3 - 0.6

Define settings for either percent or acres of field:

-Minimum Percent of Field that the user-defined contour must occupy: 30

-Minimum Acreage within Field that the user-defined contour must occupy: ___

Economical suitability for controlled drainage systems

Contour Interval (meters): 0.3 - 0.6

Define settings for either percent or acres of field:

-Minimum Percent of Field that the user-defined contour must occupy: ___

-Minimum Acreage within Field that the user-defined contour must occupy: 20

Suitability for controlled drainage systems in majority of fields (restrictive)

Contour Interval (meters): 0.3 - 0.6

Define settings for either percent or acres of field:

-Minimum Percent of Field that the user-defined contour must occupy: 60

-Minimum Acreage within Field that the user-defined contour must occupy: ___

TOOL 3F. CONTOUR BUFFER STRIPS

Contour buffer strip (332) widths are determined by evaluating slope and conservation goals for the watershed. These factors determine sites along the contour in areas of the watershed with high slopes (>4%) and high runoff potential (NRCS 2016). The strips are planted in-field perpendicular to the slope to intercept runoff and reduce erosion. Contour buffer strips are common in old glacial landscapes of the Midwest. The ACPF Toolbox User's Manual provides thorough guidance to classify in-field slope steepness and determine appropriate buffer strip spacing (Figure 7; Porter et al. 2017). Depending on design and placement in the watershed, the following priority management concerns may be addressed:

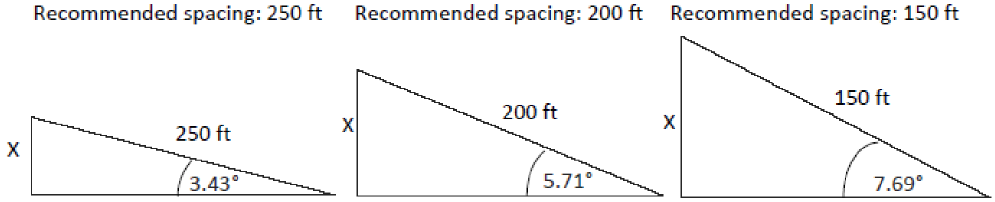
- Sediment
- Nitrogen
- Phosphorus
- Wildlife management

3rd quartile slope (%) value of field	Suggested spacing (feet)	Representative slope used to determine contour interval	Contour Interval (to achieve suggested spacing (ft in elevation)
4 – 8	250	6	14.75
8 – 12	200	10	19.8
12 - 15	150	13.5	20.1

Example 1:
3rd quartile slope range: 4–8%
Representative slope: 6%
6% slope = 3.43°
Recommended spacing: 250 ft

Example 2:
3rd quartile slope range: 8-12%
Representative slope: 10%
10% slope = 5.71°
Recommended spacing: 200 ft

Example 3:
3rd quartile slope range: 12–15%
Representative slope: 13.5%
13.5% slope = 7.69°
Recommended spacing: 150 ft



Contour interval = X
Sin(3.43°) = X / 250 ft
X = 14.75 ft

Contour interval = X
Sin(5.71°) = X / 200 ft
X = 19.8 ft

Contour interval = X
Sin(7.69°) = X / 150 ft
X = 20.1 ft

Contours ***that have a length of at least 100 meters*** are selected and buffered to a user-specified width (buffer strip width).

Figure 7. Guidance to determine appropriate buffer width (Porter et al. 2017).

Contour buffer strips (332)

Contour buffer strips are filter strips of perennial vegetation that are planted perpendicular to the slope alternating with cropland. Buffer strip width can range from 15-150 ft. and depends on slope length of cultivated strips and most suitable on uniform slopes ranging from 2-10%, although can be incorporated on steeper slopes (NRCS 2007). For wildlife benefits, a minimum buffer width of 30 ft. is required. The most optimal cropped strip width ranges from 100-400 ft. along the slope length (NRCS 2011).

Suggested user inputs for Contour Buffer Strip tool

There are default settings populated in the Contour Buffer Strip tool (Figure 8) that can be modified based on conservation planning goals and localized design considerations for contour buffer strips. The following are examples based on NRCS recommended spacing and conservation goals.

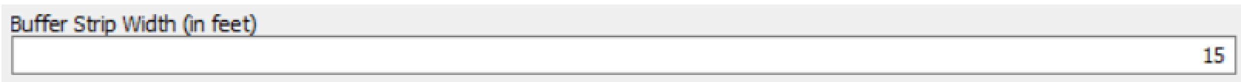


Figure 8. Default settings for Contour Buffer Strips tool.

Contour buffer strip in landscape where representative slope = 6%

Buffer Strip Width (in feet): 15

Contour buffer strip in landscape with representative slope = 10%

Buffer Strip Width (in feet): 20

Contour buffer strip for wildlife management (minimum)

Buffer Strip Width (in feet): 30

TOOL 4A. NUTRIENT REMOVAL WETLAND

The Nutrient Removal Wetland tool delineates depressional areas ideal for constructing treatment wetlands (332) and restoring wetlands (657), following Iowa CREP Wetland program criteria as the foundation for siting fields most suitable for implementation. Watersheds with the hydrologic characteristics of poorly drained soils with extensive subsurface drainage and slopes <2% are where these practices provide the benefit to water quality goals. Depending on conservation goals and hydrologic characteristics, a use may include a stream reach and roads to avoid sitings that interfere with these features. Some users apply major roads, while leaving out township roads since some have been abandoned and the roads layer isn't always the most recent dataset for the work area.

The impoundment height will vary depending on depressional contours found in landscape and appropriateness to build a berm for permanent pool storage. The wetland buffer height is dependent on conservation goals and landscape. Typically, these treatment wetlands are designed to be shallow to maintain necessary vegetation for optimal nutrient removal, although variable storage capacity can be added to detain/attenuate peak flows. The sediment reduction benefits are relatively nominal and can impede nutrient removal efficiencies if not designed well and maintained diligently. Depending on design and placement in the watershed, the following priority management concerns may be addressed:

- Nitrogen
- Phosphorus
- Restoring hydrology
- Water storage
- Sediment

Constructed (treatment) wetland (332)

Treatment wetlands are specifically engineered for removal of pollutants in water runoff from surface and subsurface flow paths. Sites ideal for restoring wetlands overlap with constructed wetlands, with poorly drained soils and dominantly hydric soils. They are typically smaller than restored wetlands and offer less detention storage for flood reduction, but can offer higher efficiencies in removing excess nutrients, sediment, and other pollutants. Emergent vegetation and wet prairie species are characteristic of treatment wetlands (MDA 2017). In Iowa, the targeted sites for CREP wetlands are low-lying areas near public ditch systems and designed to cover a minimum of 1% of contributing drainage area (IDA 2009).

Suggested user inputs for Nutrient Removal Wetland tool

There are default settings populated in the Nutrient Removal Wetland tool (Figure 9) that can be modified based on conservation planning goals and localized design considerations for constructed treatment wetlands. The following are examples based on programmatic requirements for Iowa Conservation Reserve Enhancement Program (CREP) easement program for nutrient treatment, as well as identification of sites suitable for temporary water storage. The wetland buffer height is increased when considering the addition of increasing capacity of the treatment wetland for temporary water storage.

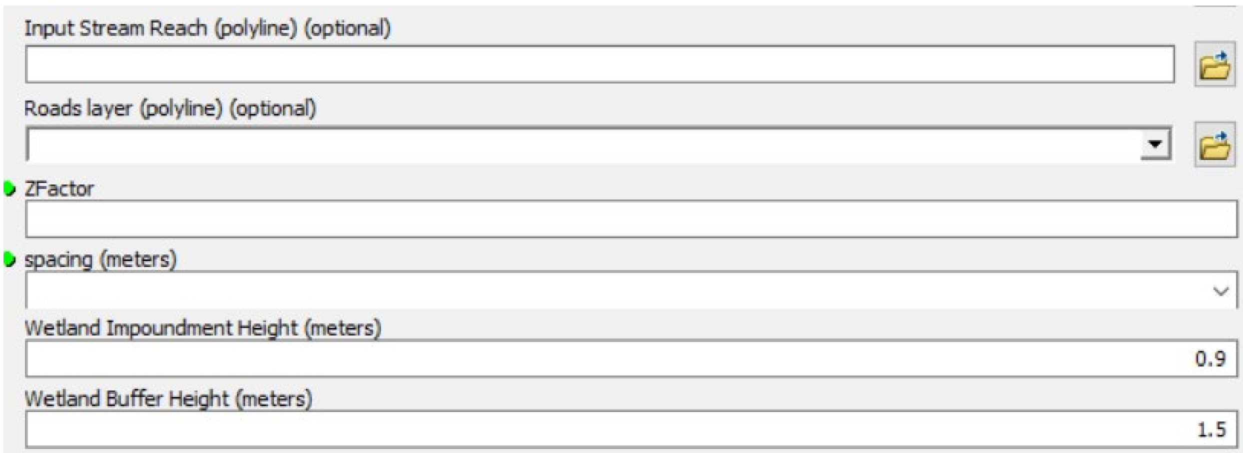


Figure 9. Default settings for Nutrient Removal Wetland tool.

Iowa CREP wetland (idals, 2009)

Input Stream Reach (polyline) (optional): *See guidance in ACPF User's Manual*

Roads layer (polyline) (optional): major roads

Spacing (meters): *See guidance in ACPF User's Manual*

Wetland Impoundment Height (meters): 1.2

Wetland Buffer Height (meters): 1.2

Constructed (treatment) wetlands (656 & 658) with flood storage capacity

Input Stream Reach (polyline) (optional): *See guidance in ACPF User's Manual*

Roads layer (polyline) (optional): major roads

Spacing (meters): *See guidance in ACPF User's Manual*

Wetland Impoundment Height (meters): 0.9

Wetland Buffer Height (meters): 1.5

TOOL 4B. WATER AND SEDIMENT CONTROL BASIN (WASCOB)

WASCOBs (638) are sites on landscapes based on embankment height suitability of user-specified values. The structures are constructed perpendicular to concentrated flowpaths on sloping lands with high runoff potential and poorly drained soils. Embankment height is dependent on hydrologic characteristics along the slope length where the most concentrated flows occur along the flow network.

Water and sediment control basin (WASCOB; 638)

WASCOB structures are embankments designed to temporarily store water and slowly release surface runoff through an intake feature along the structure. These structures are designed to reduce erosion in steeply sloping landscapes (NRCS 2017). Depending on design and placement in the watershed, the following priority management concerns may be addressed:

- Sediment
- Phosphorus
- Water Storage

Grade stabilization (410)

Grade control structures are constructed to manage in-channel grade and headcutting stabilization. Embankment dams are designed with a height <15 ft (4.6 m) and can prevent the advancement of gullies and reduce erosion in ravines (NRCS 2014). Depending on design and placement in the watershed, the following priority management concerns may be addressed:

- Sediment
- Phosphorus
- Restoring hydrology

SUGGESTED USER INPUTS FOR WASCOB TOOL

The default setting populated in the WASCOB tool is 1.5 (Figure 10) and can be modified based on conservation planning goals and localized design considerations for reducing surface erosion. The following are suggested user inputs for WASCOB embankment height based on user experience and in-field slope characteristics.

Figure 10. Default settings for WASCOB tool.

WASCOB in flat landscape (< 2% slope)

Embankment height of WASCOBs (meters): 1.0

WASCOB in dissected landscape (2 < x < 5 % slope)

Embankment height of WASCOBs (meters): 1.2

WASCOB in high slope landscape (> 5%)

Embankment height of WASCOBs (meters): 1.3

Grade Stabilization – watersheds where ravine and gully erosion are primary resource concern

Embankment height of WASCOBs (meters): 4.5

REFERENCES

Frankenberger J.R., E.J. Kladivko, G. Sands, D. Jaynes, N. Fausey, M. Helmers, R. Cooke, J. Strock, K. Nelson, and L. Brown. 2006. Questions and answers about drainage water management for the Midwest. Drainage Water Management, Purdue Extension Publication, pp. 1-8. WQ-44. https://www.extension.purdue.edu/extmedia/wq/wq-44.pdf

Iowa Department of Agriculture & Land Stewardship. 2009. Iowa Conservation Reserve Enhancement Program (CREP): Landowner Guide to CREP. https://www.iowaagriculture.gov/waterResources/pdf/LandownerGuide.pdf

Iowa State University. Iowa Conservation Reserve Enhancement Program. https://www.iowacrep.org/

McMahon, G., S.M. Gregonis, S.W. Waltman, J.M. Omernik, T.D. Thorson, J.A. Freeouf, A.H. Rorick, and J.E. Keys. 2001. Developing a spatial framework of common ecological regions for the conterminous United States. Environmental Management 28(3):293-316.

MDA. 2017. Agricultural BMP Handbook for Minnesota. https://bbe.umn.edu/sites/bbe.umn.edu/files/agricultural-best-management-practices-handbook-for-minnesota-second-edition.pdf

Porter, S.A., M.D. Tomer, and D.E. James, and K.M.B. Boomer. 2017. Agricultural Conservation Planning Framework ArcGIS Toolbox User's Manual Version 2.2. USDA Agricultural Research Service, National Laboratory for Agriculture & the Environment, Ames, IA. https://acpf4watersheds.org/toolbox/

Schilling K.E., C.F. Wolter and E. McLellan. 2015. Agro-hydrologic landscapes in the Upper Mississippi and Ohio River basins. Environ Manageme 55(3); 646-56. https://www.ncbi.nlm.nih.gov/pubmed/25479705

Tomer, M.D., S.A. Porter, D.E. James, K.M.B. Boomer, J.A. Kostel, and E. McLellan. 2013. Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning. Journal of Soil and Water Conservation 68:113A-120A. http://www.jswconline.org/content/68/5/113A.full.pdf+html

Todd SWCD. RIM – Reinvest in Minnesota Program. https://www.co.todd.mn.us/departments/soil_water/rim_reinvest_minnesota_program

USDA NRCS. Drainage Water Management Practice Code: 554. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/?cid=nrcs144p2_027166.

USDA NRCS. 2007. Natural Resource Conservation Service. Conservation Practice Standard Contour Buffer Strips Code 332. https://efotg.sc.egov.usda.gov/references/public/MN/332mn.pdf

USDA NRCS. 2010. Natural Resource Conservation Service. Conservation Practice Standard Wetland Restoration Code 332. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026340.pdf

USDA NRCS. 2011. Iowa Job Sheet: Contour Buffer Strips. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_006620.pdf

USDA NRCS. 2013. Drainage Water Management Plan Fact Sheet. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/il/newsroom/factsheets/?cid=nrcs141p2_031323

USDA NRCS. 2014. Natural Resource Conservation Service. Conservation Practice Standard Grade Stabilization Structure Code 410. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263175.pdf

USDA NRCS. 2016. Natural Resource Conservation Service. Conservation Practice Standard Drainage Water Management Code 554. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026409.pdf

USDA NRCS. 2017. Natural Resource Conservation Service. Conservation Practice Standard Water and Sediment Control Basin Code 638. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1255205.pdf