Technical Memorandum

La Crescent Watershed: Spatial Data Development using the Agricultural Conservation Planning Framework ArcGIS Toolbox Version 3.0

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SUBJECT: Spatial data outputs for the Shingle Creek, Lake Onalaska-Mississippi River, and Pine Creek HUC 12 watersheds.

Project Background

Saint Mary's University of Minnesota, GeoSpatial Services (GSS) was contracted by Winona County, Minnesota to produce the spatial outputs using the Agricultural Conservation Planning Framework (ACPF) ArcGIS Toolbox Version 3.0 for the following watersheds in Winona and Houston Counties in Minnesota;

- Shingle Creek (HUC 070400060101),
- Lake Onalaska-Mississippi River (HUC 070400060103), and
- Pine Creek (HUC 070400060501).

The Agricultural Conservation Planning Framework ArcGIS Toolbox

The ACPF is a set of planning tools based on geoprocessing models that are organized into an ArcGIS toolbox. The ACPF Toolbox was developed by the U.S. Department of Agriculture's (USDA) Agricultural Research Service in partnership with the Natural Resources Conservation Service (NRCS) to provide spatial data that can be used to support agricultural watershed planning (NCRWN 2019). These planning tools use a high-resolution digital elevation model (DEM) to identify the specific locations of opportunity where conservation practices could be installed in small watersheds (NCRWN 2019).

In addition to the DEM, the planning tools in the ACPF toolbox require watershed-specific data on land cover, land use, watershed boundary, and soils. These data are available for the watersheds in the project area through the ACPF Watershed Database Land Use Viewing and Data Downloading website (https://benson.gis.iastate.edu/ACPF/dwnldACPF.html). A separate file geodatabase containing the required tool inputs was downloaded from this site for each watershed.

The planning tools in the ACPF ArcGIS Toolbox require a specific file geodatabase structure and naming convention (Porter et al. 2018). The name of each file geodatabase needs to end with the 12-digit HUC ID number. Porter et al. (2018) also state that the output of the tools should be written back to the original file geodatabase. It is also recommended that the file names for these outputs end with the 12-digit HUC ID number. The data delivery of the project follows these recommendations and requirements.

Project Deliverables

Data Structure and File Naming Conventions

The final products of the project are various vector, raster and data table outputs of the planning tools in the ACPF Toolkit. These outputs are stored in a separate file geodatabase for each watershed. Figure 1 demonstrates how the data have been organized for delivery. A file geodatabase for each watershed containing the planning tools inputs and data outputs is located in the ACPF_Outputs folder. The planning tools were run using a duplicate of the original file geodatabase downloads as a precaution, so as not to damage the integrity of the original data. The original file geodatabase downloads containing tool inputs have been provided in the deliverables in the ACPF_BaseData folder. Each file geodatabase has been named according to the required convention, using descriptive text followed by the HUC 12 ID number.

File Geodatabase Schema

The individual file geodatabases' vector data (polygons, polylines, and points) outputs from the various tools are located in feature datasets. All raster and table outputs are located within the root directory of the file geodatabase. Each feature dataset is associated with one of the toolsets within the ACPF Toolkit. For example, the vector data outputs from the tools within the *Develop Stream Network and Catchments* toolset are found in the T2_StreamNetworkandCatchments feature dataset (Figure 2). There is no feature dataset for the *Field Characteristics* tool output, as all outputs are raster dataset or data tables, which cannot be added to a feature dataset. Table 1 provides a crosswalk of the feature dataset associated with each of the ACPF planning tools.

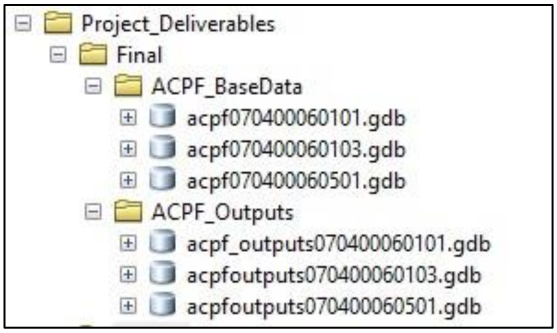


Figure 2. Deliverables organization.

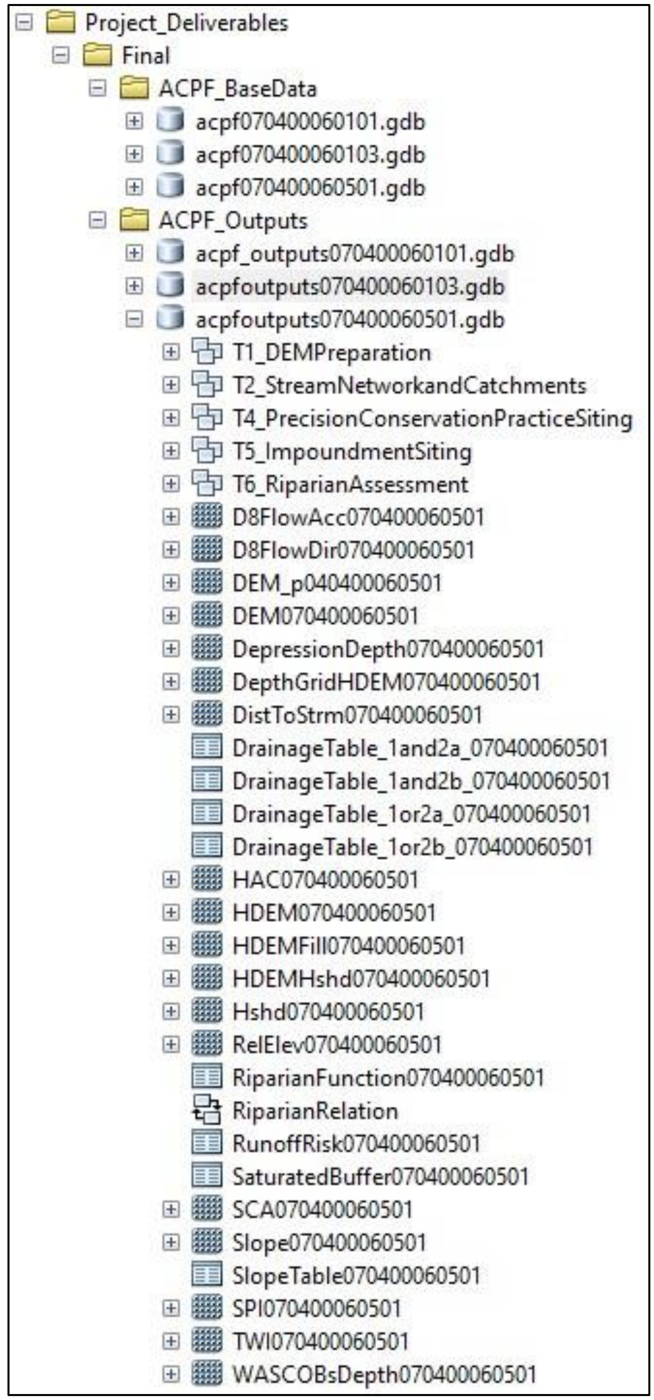


Figure 1. File geodatabase structure

Table 1. Crosswalk between the individual ACPF Toolsets and the file geodatabase feature dataset names.

ACPF Toolset	Feature Dataset
DEM Preparation	T1_DEMPreparation
Develop Stream Network and Catchments	T2_StreamNetworkandCatchments
Field Characterization	Not Applicable[1]
Precision Conservation Practice Siting	T4_PrecisionConservationPracticeSiting
Impoundment Siting	T5_ImpoundmentSiting
Riparian Assessment	T6_RiparianAssessment

[1] The outputs of the *Field Characterization* toolset are raster datasets or data tables; therefore, there is no feature dataset for this toolset.

Methodology

The methods described in Porter et al. (2018) were used to derive all the spatial data outputs or intermediate datasets on a watershed-by-watershed basis. A minor adaption to this was used by GSS to derive the data outputs for the *DEM Preparation* and *Develop Stream Network and Catchments* tools. A DEM for the entire extent of the three (3) HUC 12 watersheds was downloaded from the MnTOPO web application. This larger DEM was hydro-corrected according to the method described under the DEM Preparation toolset, and the outputs were then clipped to the respective HUC 12 buffered boundaries and exported to the relevant HUC 12 file geodatabase. This hydro-corrected DEM was also used to derive the outputs under the *Develop Stream Network and Catchments* toolset. These outputs were then also clipped to the individual buffered boundaries and exported to the relevant HUC 12 file geodatabase.

User-Defined Inputs

A number of the tools in the ACPF toolkit have data inputs that can be defined by the user. Unless otherwise noted in the metadata, all default setting or settings recommended in Porter et al. (2018) were used to derive the tool outputs. If a setting other than the default was used, the metadata explains what setting was used for the output data and the rationale as to why a setting other than the default was used.

Multiple Outputs

In a number of instances, multiple outputs were possible, through either different combination of user-defined outputs or different methodology approaches within the toolsets. In the *Develop Stream Network and Catchments* toolset, a stream network can be derived using either the Flow Network Definition – Area Threshold or Flow Network Definition - Peuker-Douglas tools. Stream networks derived by each method are included in the delivered dataset. However, the stream network derived using the Flow Network – Area Definition was used as inputs for all successive tools requiring a stream flow network based on the recommendation in Porter et al. (2018) that this method is recommended for watersheds formed in the more recent glacial landscapes.

A second instance multiple outputs were derived was the Tile Drainage Classification tool in the *Field Classification* toolset. This tool estimates the likely location of fields that have tile drains installed based on a combination of user-supplied inputs of slope condition and two different hydric soil conditions. The hydric soil condition could be defined by either the hydric soils attribute and/or the drainage hydrologic group attribute in the soil survey. For this tool, all possible combinations of slope and hydric soil were used to generate four (4) drainage tables. The output of each table was joined to the field dataset supplied in the base data and visually inspected against the available aerial imagery to determine which condition best represented on-the-ground conditions. It was determined by GSS interpreters that the combination of the slope condition and hydric soils as indicated by the hydric soil attribute in the soil survey, best represented on-the-ground conditions in all watersheds. This drainage table was used in subsequent tools that required the drainage table as an input.

The last case where multiple outputs could be derived was where the Drainage Table generated by the Tile Drainage Classification tool were required tool inputs. In these cases, the tool was run four times, each using a different Drainage Table as input.

Data Issues

During the application of the methodology, two distinct data issues surfaced that needed to be addressed. These issues both dealt with why certain tools would run, but no output was produced. After investigating the potential reason for this lack of output, GSS analysts identified two distinct causes for these occurrences. These reasons are discussed in the following paragraphs.

Field Boundary Delineation

The Field Boundary (FB + inHUC) dataset is a required input for the majority of the ACPF tools. This dataset is based on parcel boundaries, but has been edited to no longer represent discrete ownership, but rather represent the crop-specific land use that is consistent with the actual land cover. This land cover dataset is derived from the NASS Crop Layer dataset and aerial photography and is provided as part of the base data available from the ACPF Watershed Database Land Use Viewing and Data Downloading website.

In the data downloaded for the Shingle Creek (HUC 070400060101) and Lake Onalaska-Mississippi River (HUC 070400060103) watersheds, the field boundary dataset did not have any data for the area of the watersheds that are within the State of Minnesota. In order to run the ACPF tools, this data had to be developed. This data requires specific attribution and the development of a one-to-one relationship with look-up tables based on a unique identifier. Porter et al. (2018) provides specific directions and tools for editing/updating the provided field boundary dataset. This process is described under the *Utilities* tools section of Porter et al. (2018). The field boundary dataset was edited by GSS Analysts to include the crop-specific land cover polygons using the CropLand Data Layer provided by ACPF and the 2018 NAIP aerial imagery web service from the ArcGIS Online Living Atlas. Once completed, the Update Edited Field Boundaries tool was run to add the unique identifier, complete the required attribution and repair the relationships with the look-up tables.

Tool Outputs

There are three types of tools in the ACPF toolbox. The ACPF toolbox contains geoprocessing tools that create watershed-wide data based on the data inputs. It also contains geoprocessing tools that create data based on specific criteria. These criteria are assessed at the watershed level or by field boundaries. As stated earlier in this memorandum, the various tools were run for each of the watershed, however in some cases there was no tool output. The instances where conditions did not satisfy the requirements of the ACPF tools was limited to the *Precision Conservation Practice Siting* and *Impoundment Siting* tools. Table 2 provides and overview of the datasets that were not created, by watershed, and the reason why no output was generated. In most cases, either the tool did not identify any locations within the watershed or field boundaries that met the selection criteria (NF code in Table 2) or the tool created a derivative of a previous tool output where no output was generated (Nx code in Table 2).

Table 2. Overview of the tools that did not produce output.

Tool Output	HUC 070400060101	HUC 070400060103	HUC 070400060501
Precision Conservation Practice Siting			
Depression polygons (Depressions+inHUC)	NF	NF	D
Depression Depth raster (DepressionDepth+inHUC)	Nx	Nx	D
Depression Drainage Area polygons (Depress_Wsheds+inHUC)	Nx	Nx	D
Drainage Management polygons (DrainageMgmt+inHUC0	NA	NA	NA
Grassed Waterway polylines (GrassWaterways+inHUC)	NF	NF	D
Contour Buffer Strips (CBS+inHUC)	NF	D	D
Bioreactor feature class (Bioreactor+inHUC)	NF	NF	Opportunities identified only for Drainage Conditions 1 or 2a and 1 or 2b
Impoundment Siting			
Nutrient Removal Wetland polygons (NRW+inHUC)	NF	NF	D
Nutrient Removal Wetland Drainage Area polygons (NRWDrainageAreas+inHUC)	Nx	Nx	D

NF - No locations met criteria

Nx – Required input not available. Input not created due to no locations meeting criteria

NA – Potential opportunities identified, none meet final selection criteria

D – Tool output generated

Next Steps/Recommendations

A number of the tools in the ACPF toolkit rely on user-defined inputs that essentially calibrate the tool outputs to local watershed conditions. In deriving the ACPF outputs for the Shingle Creek, Lake Onalaska-Mississippi River, and Pine Creek HUC 12s, GSS analysts accepted the default values for these inputs as defined in the ACPF User's Manual (Porter et al. 2018). In addition, with the exception of the derivation of a stream reach feature class using the *Develop Stream Network and*

Catchment tools, no review of the data outputs from the tools was conducted. The reliance on the acceptance of the default values, with little to no incorporation of familiarity with the watersheds or incorporation of local knowledge was strictly due to the budgetary constraints for the project. These constraints were also the reason behind the lack of review/field verification of the data outputs.

Even with these constraints, some data output review of the stream reach outputs was necessary. An iterative process of running and reviewing the output of the Flow Network Definition – Area Threshold tool was conducted to produce the final stream reach feature class. The Flow Network Definition – Area Threshold output was compared to the published Minnesota Department of Natural Resources (DNR) streams dataset and rerun using new flow accumulation thresholds until an output that best approximated the extent of the DNR feature class was obtained. This feature class was then used as the basis of determining whether a given reach in the derived stream network was perennial or intermittent/ephemeral.

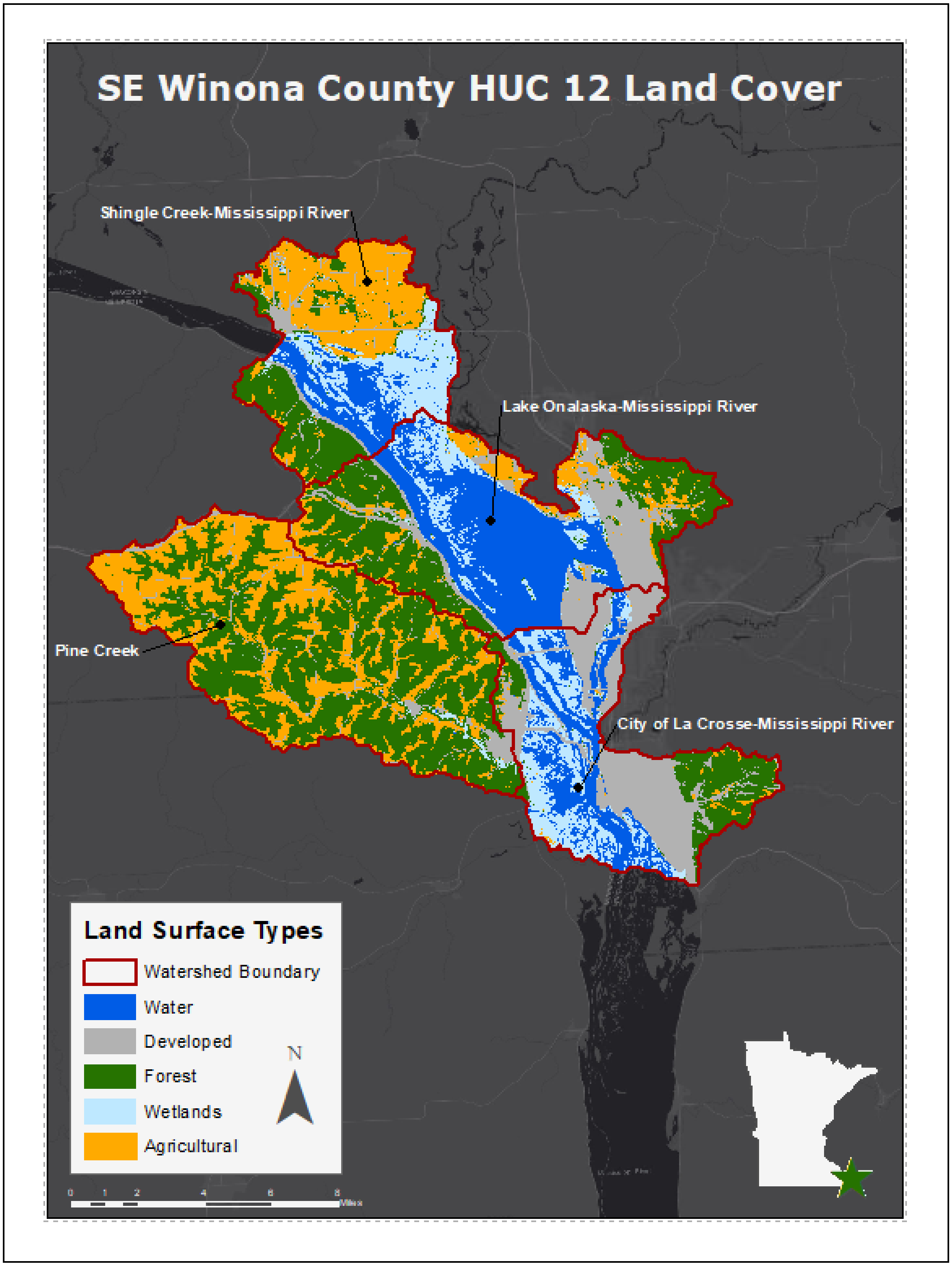
The incorporation of a field verification/data refinement process in the hydro-enforcement process of the DEM and the incorporation of local knowledge in the selection of all user-defined data inputs would have a significant impact on the accuracy and precision of the data outputs from the ACPF toolset. The process for hydro-enforcing the DEM is essentially the removal of digital barriers (dams) that obstruct the flow of water across the DEM surface. These digital dams are artifacts in the DEM created during the development of the DEM. The most common of these digital dams are culverts under roads or bridge decks. Digital dams can also be remnant vegetation (such as overhanging trees) that were not removed during the development of the DEM. These digital dams must be breached to reconnect the flow of water. The ACPF User's Manual and tools provide the data and process for identifying and breaching these digital dams. However, in certain settings, the identification of a digital dam and how to reconnect the flow path cannot be accurately determined solely from the available data. This is particularly true in streams that have been culverted under major road interchanges or within developed areas. In these cases, field verification of the existence of the digital dam, its location and the breach line required to reconnect the upstream and downstream channel is necessary. The misplacement or a missing digital dam breach line can have a significant effect on the derived stream network. The incorporation of field verification of suspect digital dam locations or breach lines should be incorporated in any refinement of the datasets for these watersheds or the application of the ACPF tools on new watersheds.

The incorporation of local knowledge of the watersheds in the determination of the user-derived inputs would add value to the derived ACPF data outputs. This would allow the tool outputs to be fine-tuned or calibrated to local watershed conditions. A better understanding of local watershed conditions and incorporating local knowledge into the user-defined tool inputs has the potential to create more accurate outputs for use in watershed planning. In addition, these user-defined inputs set the criteria that must be satisfied in order for the tools to generate output. Manipulation of these inputs based on watershed and agricultural best practices knowledge could produce data outputs that are missing from the current dataset.

References Cited

North Central Region Water Network (NCRWN). 2019. About ACPF. Available at https://acpf4watersheds.org/about-acpf/

Porter, S.A., M.D. Tomer, D.E. James, J.D. Van Horn, and K.M.B. Boomer. 2018. Agricultural Conservation Planning Framework: ArcGIS®Toolbox User's Manual, Ver. 3. USDA Agricultural Research Service, National Laboratory for Agriculture and the Environment, Ames Iowa. Available at http://northcentralwater.org/acpf/



Land Use of the Mississippi River-La Crescent Watershed: The La Crescent Watershed in Minnesota consists of four HUC-12 subwatersheds. The City of La Crosse-Mississippi River HUC 12 was not assessed using ACPF as its percentage of Agricultural lands is insignificant.