IOWA BEST MANAGEMENT PRACTICES (BMP) MAPPING PROJECT HANDBOOK

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1. INTRODUCTION AND BACKGROUND

The 2008 Gulf Hypoxia Action Plan set a goal for Iowa and other upper Mississippi River Basin states to reduce nutrient loads of nitrogen and phosphorus reaching the Gulf of Mexico by 45%. The Iowa Best Management Practices (BMP) Mapping Project is a priority in Iowa and other upper Mississippi River Basin states because it creates the baseline inventory of common conservation practices needed to assess progress and reach the goal target. This project has potential positive impacts for every agricultural producer in the state. Several public agencies and private organizations are contributing funds to the project to develop technologies to inventory and monitor conservation practices that could potentially meet nutrient reduction targets for Iowa watersheds.

The Iowa BMP Mapping Project addresses an underlying need for conservation managers and practitioners to understand which conservation efforts exist on the landscape, track and manage those assets over time, lay a foundation to manage their effectiveness and plan/prioritize future conservation efforts. This dataset provides resource managers and land stewards with a comprehensive view of existing BMPs on the landscape at a HUC 12 watershed scale, without distinguishing between private and public investment. It provides an inventory of statewide conservation investment and can show areas with differing levels of investment but also areas of potential opportunity.

This statewide dataset of six conservation practices, referred to as the 2010 baseline inventory dataset, is a framework for viewing past and current management practices as well as creating an evidence based approach to planning for future conservation efforts. The 2010 baseline inventory dataset will further contribute to the conservation goal of “the right practice in the right place,” by showing the existing practices in combination with conservation planning tools such as the Agricultural Conservation Planning Framework (ACPF) Toolbox. Adding existing 2010 baseline inventory data to models used to estimate nutrient load reduction would provide a more robust analysis as well.

Collaboration and partnerships are important factors that have led to the success of this project. The project began in early 2015 with seed funding from the Iowa Department of Natural Resources (IDNR) as a pilot project to complete 40 watersheds throughout the state. As the project developed, GIS Facility staff, gathered input from staff at the IDNR, Natural Resource Conservation Service (NRCS), the Iowa Department of Agriculture and Land Stewardship (IDALS) and members of the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) to develop the geodatabase structure and methodology for digitizing each practice. As funding allowed, the project goal has grown to encompass evaluating all the 12-digit Hydrologic Unit Codes (HUCs) in Iowa. The project has been sustained by funding collaboration and partnerships between Iowa State University, IDNR, INRC, Iowa Nutrient Research Center, IDALS, and industry partners at the Iowa Nutrient Research and Education Council (INREC).

The primary focus of this project is to create the 2010 baseline inventory dataset, covering a period from 2007-2010 by digitizing conservation practices using aerial imagery and LiDAR derivative data. As the initial project progressed, interested parties funded several other companion projects. The handbook describes three of these additional projects. The handbook also provides suggestions for building partnerships for sustaining support, budget estimates, and documents for project tracking and automation.

The first companion project, *Historic Occurrence Evaluation*, uses the 2010 baseline inventory dataset as a reference and examines whether or not a particular conservation practice is evident in the imagery of the 1980s. The second project, *Tracking Conservation Changes*, uses the 2010 baseline inventory dataset as a reference point and compares the baseline to newer imagery (2016 imagery) to determine changes in conservation practices (additions or removals) since the time the baseline dataset was inventoried. The third project, *Identifying Tile Drainage*, uses aerial imagery to help determine and inventory areas that are tile drained, recording locations of the tiles. This third project does not directly use the 2010 baseline inventory dataset, but was included because of its connection to creating a baseline understanding of tile drainage, which can further inform conservation efforts and help us better understand the movement of water and nutrients through the landscape.

This project is providing a freely available, uniform, consistent database of conservation practices for the state of Iowa. It is monitoring the presence of conservation practices rather than programs. The strength of this project lies in that it was created from publicly available data sources. This handbook will provide instructions for others looking to create a conservation inventory for their state or region.

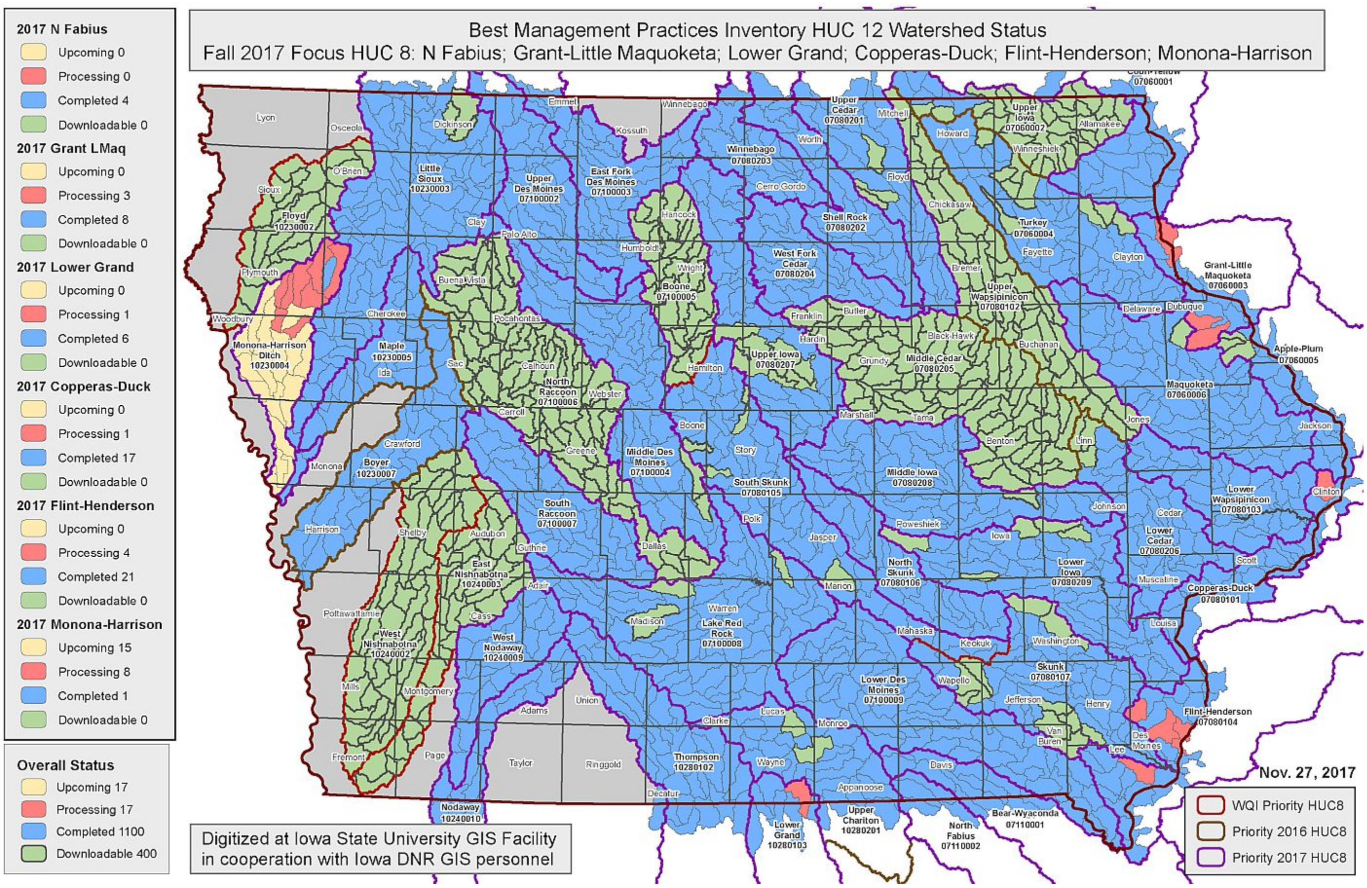
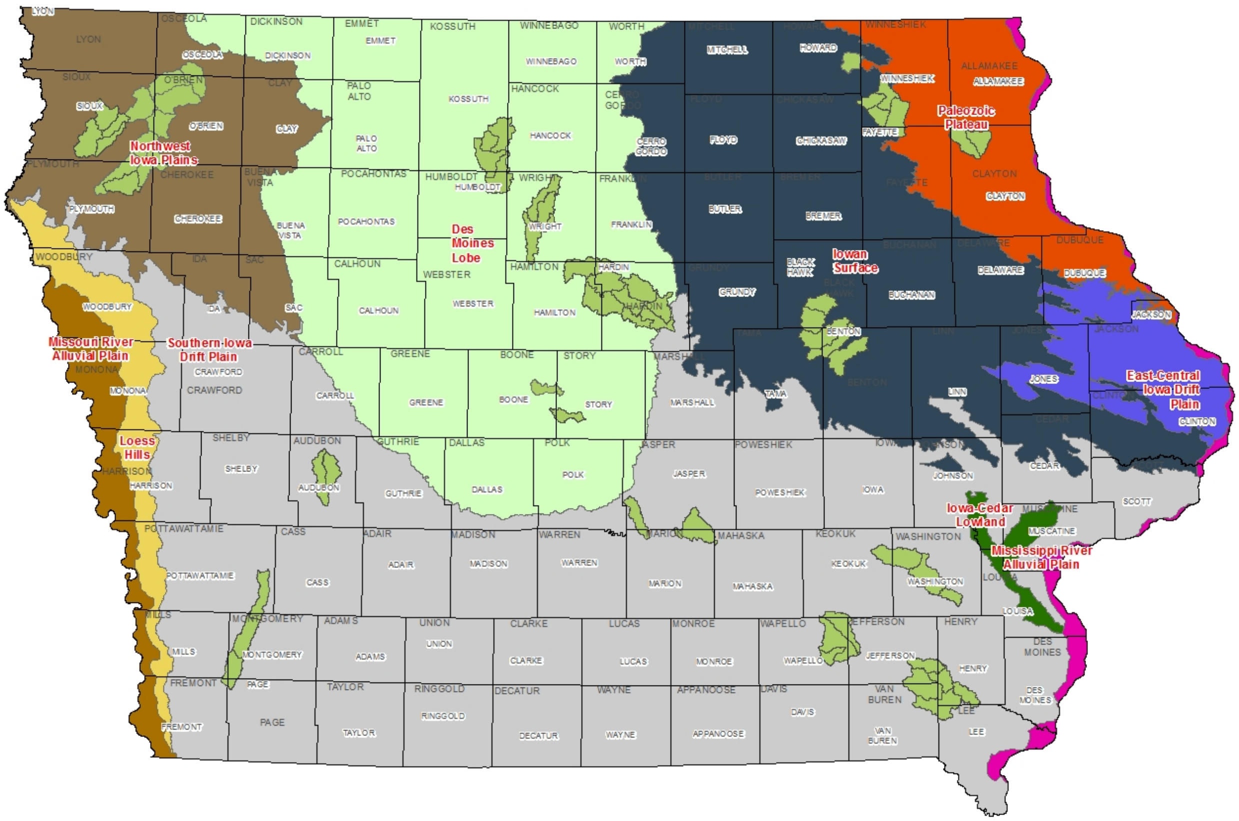


Figure 1: Major Landform regions of Iowa overlaid with the original 40 Water Quality Initiative watersheds.



Iowa has a very diverse landscape with some of most productive farmland in the world. Iowa has eight major landform regions (Figure 1), caused by differences in soil, topography, glaciation, climate, and water drainage. Just as the landforms vary across the state, so do the conservation practices. To illustrate this variation, we will examine the difference in slope of landform regions as well as numbers and figures showing presence or absence of conservation practices in the different regions.

Figure 2 shows the average slopes in five of the major landform regions. This average number gives a relative difference between the regions. Slopes vary considerably by region from the Des Moines Lobe, with an average slope of 1.8%, to the Paleozoic Plateau, with a steep average slope of 10.5%. This change in slope, along with soil structure and morphology, and environmental factors, results in varied conservation practices across the landscape. As the landforms change, so do the environmental challenges and conservation solutions.

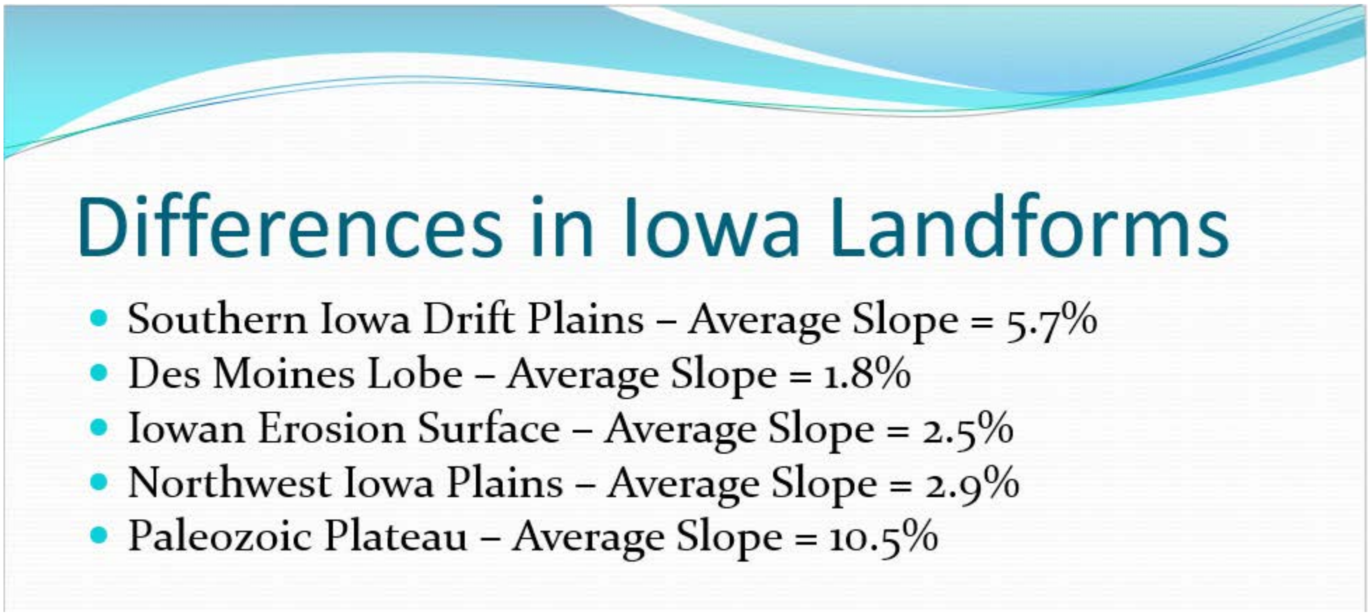


Figure 2: Average Slope in Selected Iowa Landforms (image provided by IDNR staff).

Examining the data from the 2010 BMP baseline inventory dataset, conservation trends begin to emerge. The map below shows the distribution of grassed waterways by landform, as normalized by the total acres of the landform that has been mapped to date. Alluvial areas and the Des Moines Lobe have fewer grassed waterways as the relief does not create enough power to erode the fields along flow paths as it does in other areas of the state. Please refer to Appendix pages 30-32 for additional conservation practice maps.

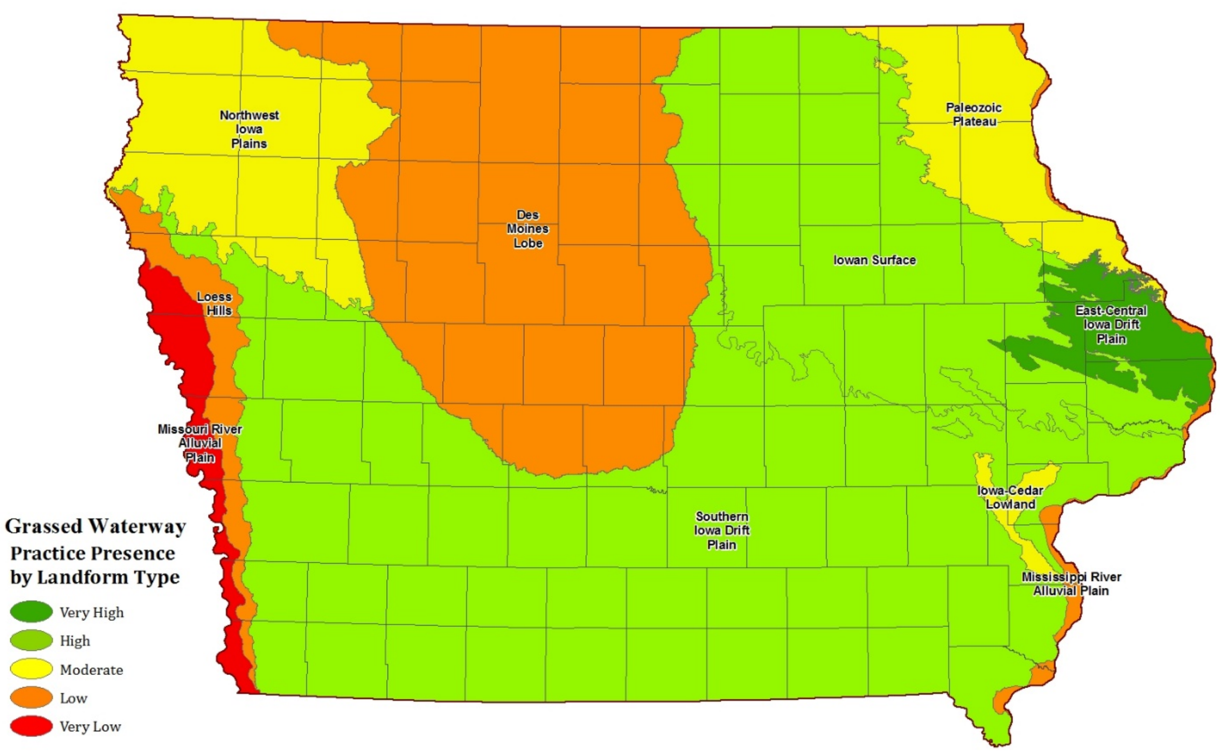


Table 1: BMP Features by Iowa Landform region (as of November 10, 2017).

Landform	HUC Acres Mapped	HUC 12 Mapped	Pond Dams (number)	Grassed waterways (ac)	Terraces (number)	Terraces (mi)	WASCOBs (number)	WASCOBs (mi)	Contour Buffer Strips (ac)	Stripcropping (ac)
Des Moines Lobe	7,469,412	318	2,115	19,424	7,363	1,348	9,910	783	21,676	2,995
East-Central Iowa Drift Plain	924,189	41	2,208	12,994	2,354	355	3,077	116	61,130	13,455
Iowa-Cedar Lowland	193,422	8	130	823	325	44	416	19	1,785	149
Iowan Surface	6,100,700	271	2,642	67,280	11,503	1,986	11,885	973	62,819	14,272
Loess Hills	244,121	10	576	351	13,357	1,442	4,947	189	352	83
Mississippi River Alluvial Plain	79,866	6	238	151	390	60	126	5	1,432	1,742
Missouri River Alluvial Plain	72,081	2	22	0	316	38	343	14	0	0
Northwest Iowa Plains	1,932,270	88	925	11,957	28,491	5,732	6,426	642	14,234	1,237
Paleozoic Plateau	1,650,167	80	3,763	12,958	23,015	3,788	4,900	234	104,725	31,488
Southern Iowa Drift Plain	12,882,042	550	71,630	153,767	246,473	43,351	142,363	6,738	178,724	17,463
Total	31,548,270	1,374	84,249	279,705	333,587	58,142	184,393	9,714	446,877	82,885

The table above shows a summary of the 2010 BMP baseline inventory dataset summarized by landform region as of November 10, 2017. Some striking differences in conservation practice use become apparent. Pond dams are a widely used practice in the Southern Iowa Drift Plain, while very sparse in the alluvial plains. Terraces and WASCOBS are a prominent landscape feature in the Loess Hills. Contour buffer strips and stripcropping are favored in the Paleozoic Plateau, East-Central Iowa Drift Plain, and Mississippi River Alluvial Plain.

2. DATA STRUCTURE AND INPUT DATA

GEODATABASE

The initial 2010 BMP baseline inventory dataset focuses on identifying six in-field practices commonly found on the landscape in Iowa at the HUC 12 scale. Each HUC 12 has a file geodatabase named Final_[12-digit-HUC-code].gdb. Each geodatabase contains seven feature class files: the HUC 12 boundary and six conservation practices: contour buffer strips, grassed waterways, pond dams, stripcropping, terraces, and water and sediment control basins (WASCOBs). The table below shows an example of the attributes found in the geodatabase table for the six conservation practices and provides a brief description of each field. Completed file geodatabases can be accessed and downloaded at: https://athene.gis.iastate.edu/consprac/consprac.html.

Field Name	Data Type	Description
SHAPE	Geometry (Polyline or Polygon)	This describes whether the feature class is a polygon or a line feature class. *Contour buffer strips, stripcropping, and grassed waterways are polygon feature classes. Terraces, WASCOBs, and pond dams are line feature classes.*
PRACTICE	Text	This is an automated field that is filled in when the feature is made. It is the name of the conservation practice.
NRCS_CODE	Text	This is the 3-digit Natural Resource Conservation Code for the specified conservation practice. This field automatically populates when a new feature is created.
DATE_CREATED	Date	This is the date that the feature was created, entered manually by the digitizer.
HUC_12	Text	This field identifies the HUC 12 number. This field is empty by default but should be populated, if used with conservation practices of differing HUC 12 boundaries.
COMMENTS	Text	This field is for entering comments about features.
CREATOR_NAME	Text	This field identifies the initials of the individual who created the feature.
LAST_EDITOR	Text	This field identifies the initials of a secondary editor of the feature. It is generally left empty unless edits are needed.
LAST_EDIT_DATE	Date	This field identifies the date of the last edit if changes were made to the original dataset.
LENGTH	Double	This field calculates the length of the perimeter of the polygon feature or the length of a polyline feature. This field is automatically populated when the field is created.
AREA	Double	This field is the area of the polygon feature. This field is automatically populated when the field is created.
PRESENT_[Date]	Text	This field records the presence or absence of conservation practice in specific year of imagery. The table is set up with the following domain of values: No = 2 Yes =1.

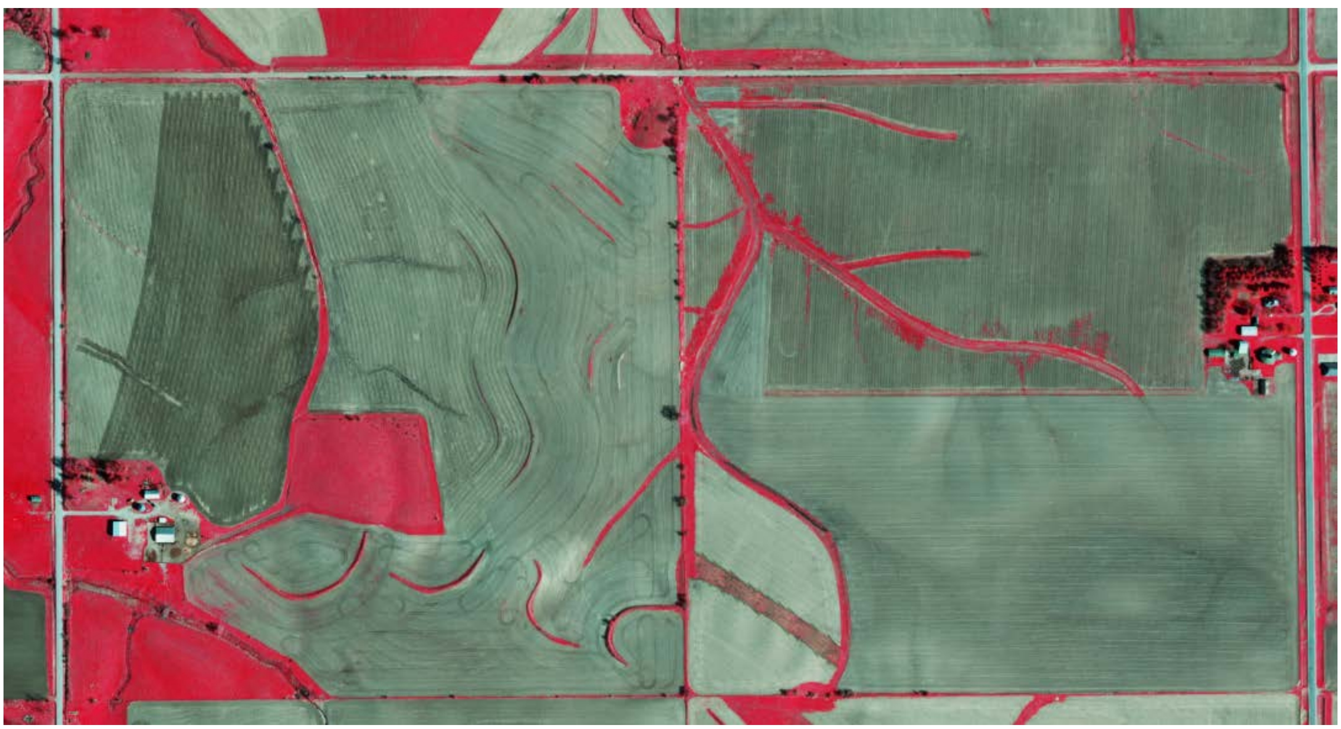
ASSOCIATED DATA LAYERS

There are a number of other layers needed to create the 2010 baseline inventory dataset: high resolution LiDAR hillshade (1-meter), high resolution aerial imagery (2-meter or better, preferably spring, color infrared and summer natural color), stream centerlines, watershed boundaries, and county boundaries. The table below provides a description of these layers and how they are used in the digitizing process as well as suggested sources for acquiring the layers.

Name	Type	Description
ortho\ LiDAR_hs	raster, map service	1-Meter LiDAR Hillshade; this layer is important for finding terraces, pond dams, and WASCOBS as well as helping verify areas of change in slope and other physical geographic features on the landscape. Suggested resource: *Most states have some LiDAR. This layer is necessary for inventorying terraces and WASCOBs.*
ortho\ ortho_2007_2010_cir, nc	raster, map service	This raster layer is 2-foot, leaf-off spring imagery available in both color infrared and natural color; it is the primary layer for determining conservation practices. Iowa had a LiDAR and aerial imagery program that was flown for the state between 2007-2010.
Iowa USDA NAIP 2011; 2010; 2009; 2008; 2007	raster, map service	These raster layers are 1- meter, summer aerial photography. The USDA National Agriculture Imagery Program (NAIP) has been providing periodic imagery for US states with a 3-year cycle for new imagery. *Suggested resource: USDA NAIP Images are available as rest services at: https://gis.apfo.usda.gov/arcgis/rest/services or images can be downloaded from the USDA Geospatial Data Gateway: https://datagateway.nrcs.usda.gov/GDGHome_DirectDownLoad.aspx.*
Centerlines_inHUC	Line, map service	Stream centerlines for the HUC 12. The IDNR created a revised stream centerline layer for Iowa which provided additional accuracy for our project. Suggested resource: *This data can be downloaded from the USGS National Hydrography Dataset or used as a map service: https://nhd.usgs.gov/.*
ws_boundary	Polygon	HUC 12 boundaries for Iowa, provided by the IDNR. Suggested resource: *This data can be acquired from the USGS National Hydrography Dataset - Watershed Boundary Dataset: https://nhd.usgs.gov/.*
County	Polygon	This polygon layer shows the county boundaries for the state of Iowa. Suggested resource: US Census: https://www.census.gov/geo/maps-data/data/tiger-cart-boundary.html.
Other Helpful Layers		
LiDAR_blocks	Polygon	This polygon layer shows the LiDAR image blocks (mosaics) based on the date the data was captured. *This layer should be a product available with the LiDAR layer.*
LiDAR_dates_2007_2010	Polygon	This polygon layer shows the month and year each area was

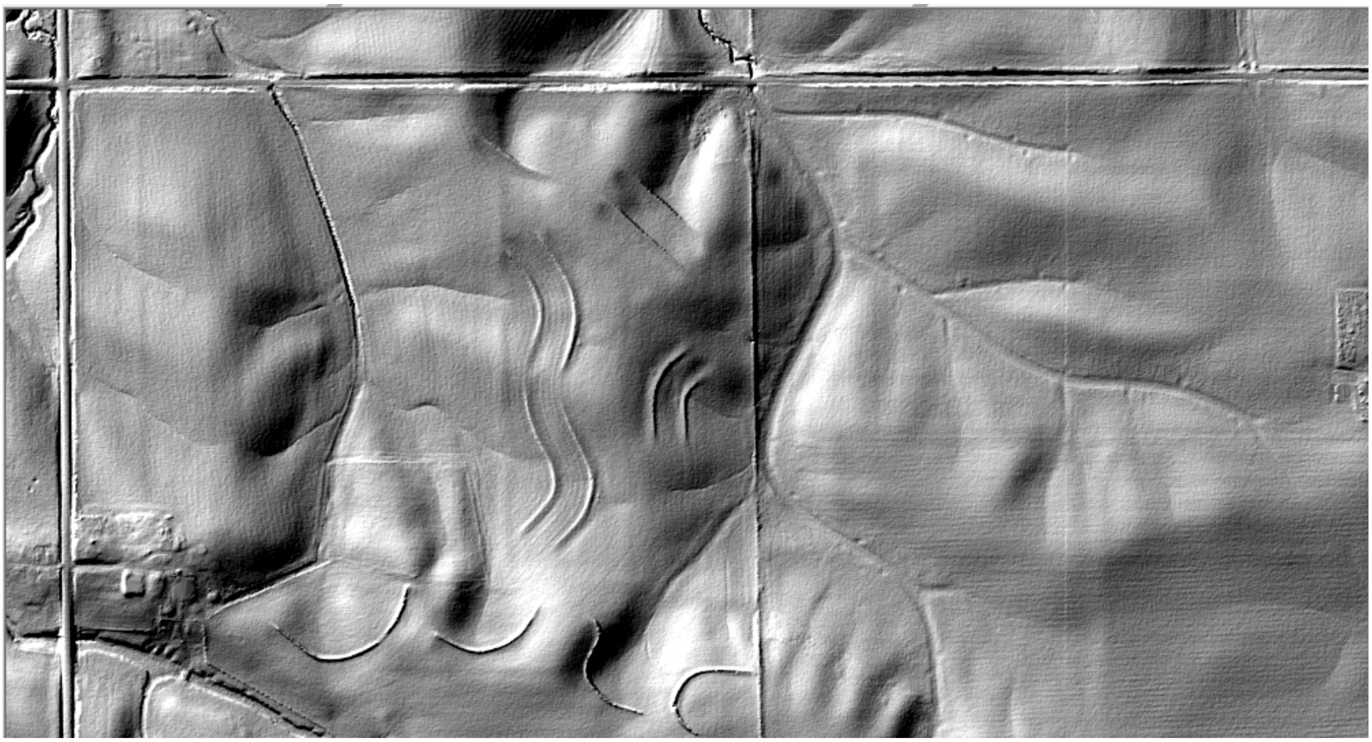
		flown for LiDAR and aerial photography. This layer is useful for determining which years of imagery to use for digitizing. *Note: Iowa's LiDAR was flown in three sections; sometimes it is necessary to use multiple years of imagery within the same HUC boundary because of the way the LiDAR was flown. *This layer should be a product available with the LiDAR layer.*
Land Cover 2009	Raster, map service	This raster layer shows 1-meter high resolution land cover. This layer was created by the IDNR. It is used as an additional source layer for determining land cover and practices. Suggested resource: *The USDA National Agricultural Statistics Service (NASS) provides a CropScape – Cropland Data Layer: https://nassgeodata.gmu.edu/CropScape/. The resolution of USDA NASS layer may be too general to find most practices.*

EXAMPLES OF IMAGERY



This is an example of color infrared imagery. Color infrared imagery is used in remote sensing to help distinguish actively growing vegetation. Growing vegetation shows up in the image as red and bare soil is gray. Color infrared is most useful when used with spring imagery (before the crops have been planted) because of the contrast of vegetation. This is especially helpful for spotting grassed waterways, contour buffer strips and stripcropping. Notice the grassed waterways and terraces in the image above.

This is an example of natural color imagery and is most like what we see with our eyes. For example, vegetation appears green and water is blue or black. The National Agriculture Imagery Program (NAIP) imagery is flown during the growing season so the most useful color combination for this project is natural color. This imagery provides contrast to the spring imagery and can reinforce the decision about the existence of a particular practice. It is helpful for reviewing grassed waterways that might have been newly established in the spring imagery.



This is an example of LiDAR hillshade. Hillshade shows the relief on the landscape, structural enhancements (terraces, WACOBS, and pond dams), areas of depression (grassed waterways), and channeling. This is useful for identifying terraces and WASCOBs which are not always easily detected using aerial imagery alone. Hillshade also reveals the pond dam edge. Using the hillshade can help distinguish a grassed waterway from riparian area by shape and depth of the channel. Contour buffer strips and stripcropping can often be seen in a hillshade image.

3. CREATING THE BASELINE INVENTORY DATASET

INTRODUCTION TO THE SIX BASELINE CONSERVATION PRACTICES

The conservation practice descriptions provided below are from the Natural Resource Conservation Service (NRCS- Iowa) literature describing these practices. These descriptions are a guide in helping determine various practices found on the landscape.

I. CONTOUR BUFFER STRIPS

Figure 3: Aerial view of a contour buffer strip.

Figure 4: Ground view of a contour buffer strip.

– Photos courtesy of USDA NRCS

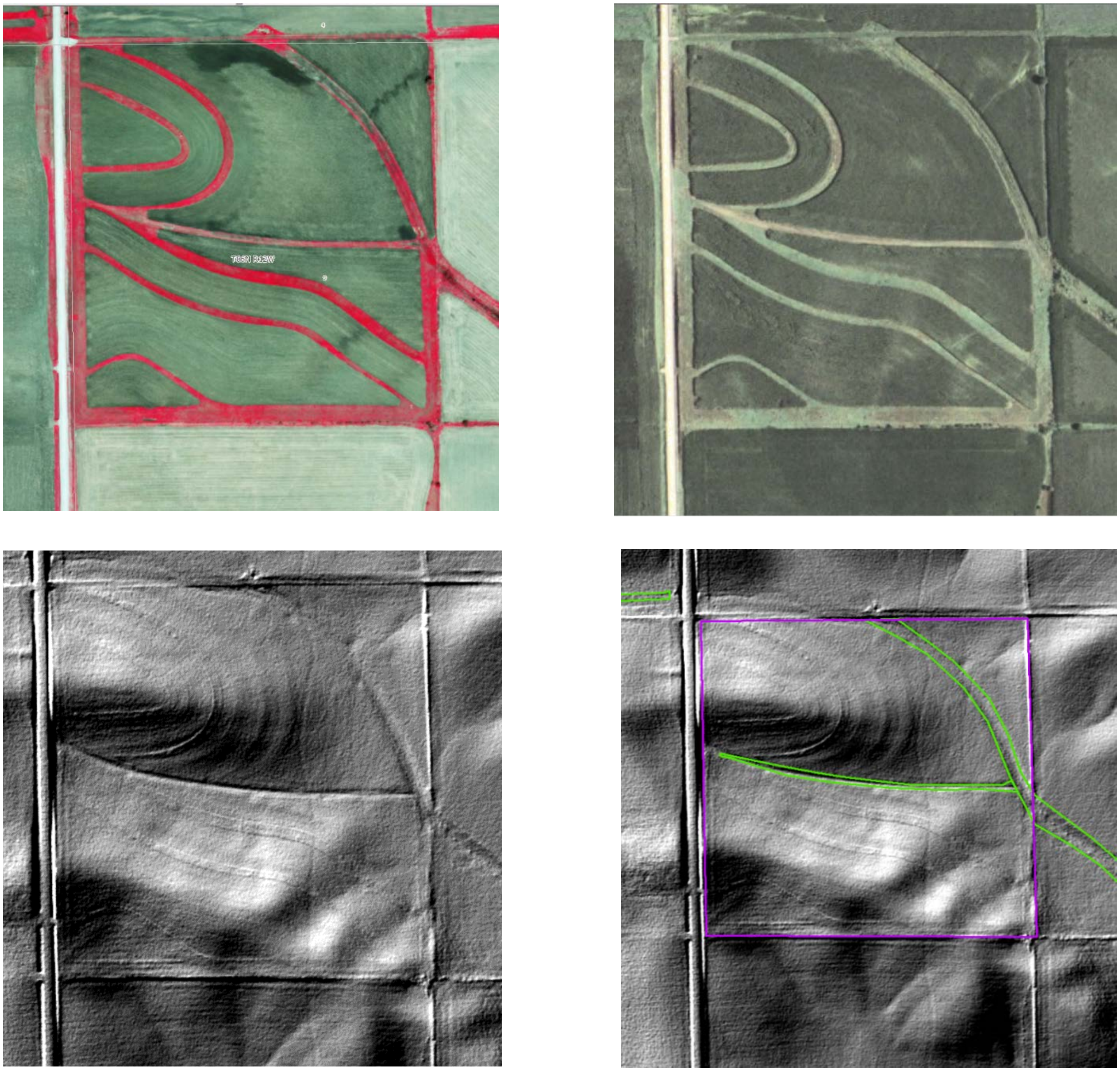
DESCRIPTION OF PRACTICE: Contour buffer strips are rows of perennial vegetation alternated down a slope with wider cultivated rows farmed on the contour. Contour buffers strips are usually narrower than the cultivated strips. Vegetation in the strips consists of adapted species of grasses or a mixture of grasses and legumes. (NRCS – Iowa)

PURPOSE: Contour buffer strips established on the contour of a hill can significantly reduce sheet and rill erosion. Vegetated strips slow runoff and trap sediment. As runoff passes through the buffer strips, they remove sediment, nutrients, pesticides, and other contaminants. Buffer strips may also provide food and nesting cover for wildlife. (NRCS – Iowa)

REQUIRED REFERENCE LAYERS: Color infrared, natural color

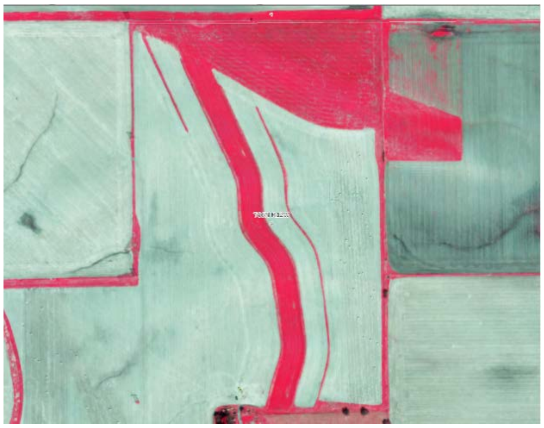
DIGITIZING METHOD AND CONSIDERATIONS: To capture this practice, draw a polygon outlining the perimeter of the whole field in which the contour buffer strips occur. The field boundary is digitized because this practice reduces the sediment load of the whole field.

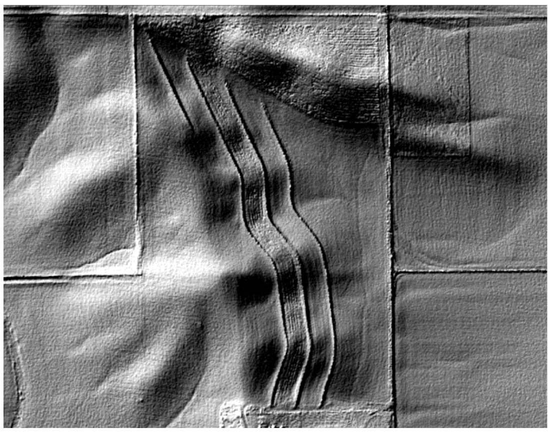
When digitizing contour buffer strips, the width of the perennial strip should be smaller than the crop strip. Contour buffer strips are generally easy to spot on color infrared imagery because the alternating pattern of grass and crop pops out with bright red against a gray background as seen in Figures 5-8. However, they can also occur with only one or two strips (Figures 9-12) or in complex networks as seen in the examples below (Figures 13-14).

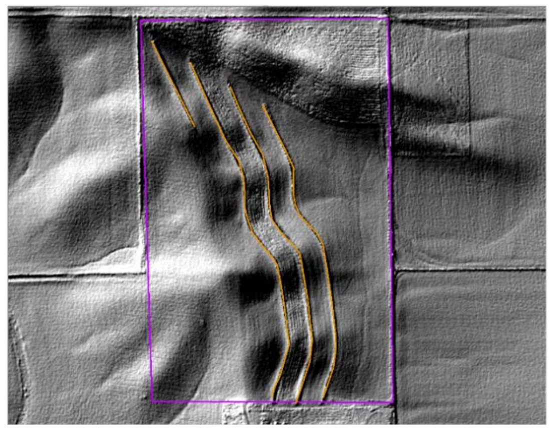


Figures 5 - 8: The image in the top left shows a field with spring color infrared photography (CIR). The top right image is summer natural color photography. The bottom left image is LiDAR hillshade. The bottom right image is LiDAR hillshade with the digitized contour buffer strip in purple and a grassed waterway in green.

It is important to examine the hillshade to determine if the pattern is on a hillside or in a depression. Without examining this, it is easy to assume that the field is just a series of contour buffer strips. The example above shows a field of contour buffer strips but also has a grassed waterway. It is common to find contour buffer strips on the hillside with grassed waterways in the low-lying areas.







Figures 9-12: The image in the top left shows the field in spring CIR with a single contour buffer strip and several terraces. The image in the top right is summer natural color photography. The bottom left image is LiDAR hillshade. The image in the bottom right shows LiDAR hillshade with the digitized contour buffer strip in purple and terraces in orange.

Figure 13: The left image shows a spring CIR image with contour buffer strips running left to right and grassed waterways intersecting vertically through them.

Figure 14: The right image shows a natural color photo of contour buffer strips with intersecting grassed waterways.

II. GRASSED WATERWAYS

Figure 15: Example of grassed waterway.

Figure 16: Example of a grassed waterway – Photos courtesy of the USDA NRCS.

DESCRIPTION OF PRACTICE: Grassed waterways are constructed graded channels seeded to grass or other suitable vegetation. During a rain event, the permanent vegetation slows the water and the grassed waterway brings the water to a stable outlet, ideally at a slower, non-erosive velocity. (NRCS – Iowa 2012)

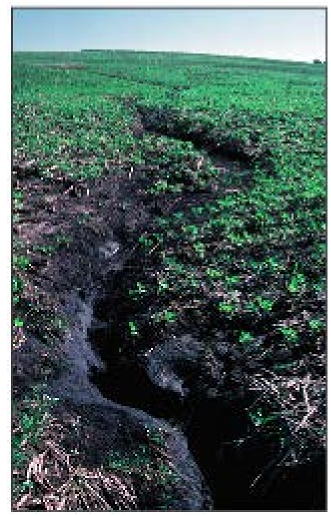


Figure 17: Gully erosion – Photo courtesy of USDA NRCS.

PURPOSE: Grassed waterways are a conservation solution for gully erosion. The most common areas for gully erosion are in draws between hills and other low-lying areas on slopes where water concentrates as it runs off a field. Grassed waterways also can convey runoff from terraces, diversions, or other sources of water concentrations to a stable outlet. (NRCS – Iowa 2012)

REQUIRED REFERENCE LAYERS: Color infrared, Natural Color, Hillshade

DIGITIZING METHOD AND CONSIDERATIONS: To capture grassed waterways, draw a polygon for the main channel and then draw separate polygons for each of the branches. When digitizing grassed waterways, look for a branching network. On the color infrared photography, you will notice the grassed waterways will be a redder color, indicating perennial vegetation. Occasionally when a grassed waterway has recently been installed or reshaped, it will look black or disturbed. Using natural color imagery and other years will help to better define the boundaries. Also, review the hillshade layer; you should notice a nice smooth, rounded depression indicating the grassed waterway signature rather than a gully or channel.

Figure 18: CIR photo of a grassed waterway.

Figure 19: Natural color photo of a grassed waterway.

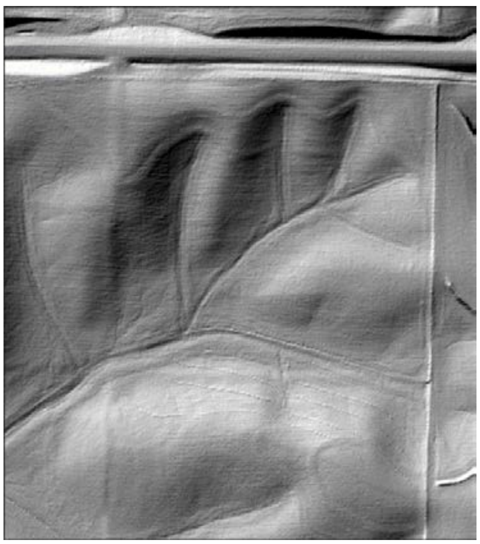


Figure 20: LiDAR hillshade showing a grassed waterway.

III. POND DAMS

DESCRIPTION OF PRACTICE: A pond dam is a pool of water formed by a dam or pit. There are two types of ponds - embankment ponds, which are water impoundments made by constructing an embankment, and excavated ponds, which are formed by excavating a pit or dugout. (NRCS - Iowa)

PURPOSE: Pond dams prevent soil erosion by eliminating gullies. Pond dams protect water quality by collecting and storing runoff water. Another benefit a pond dam can provide is water for livestock, fish and wildlife, recreational opportunities, and fire control. A pond dam adds value and beauty to a farm or farmstead. (NRCS - Iowa)

Figure 21: Example of a pond dam – Photo courtesy of the USDA NRCS.

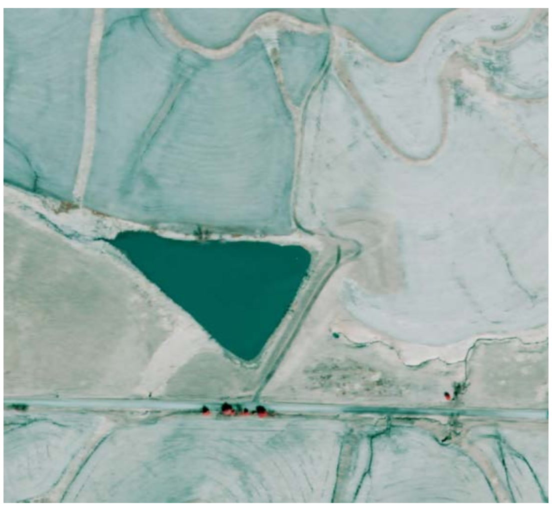


Figure 22: CIR photo of a pond dam.

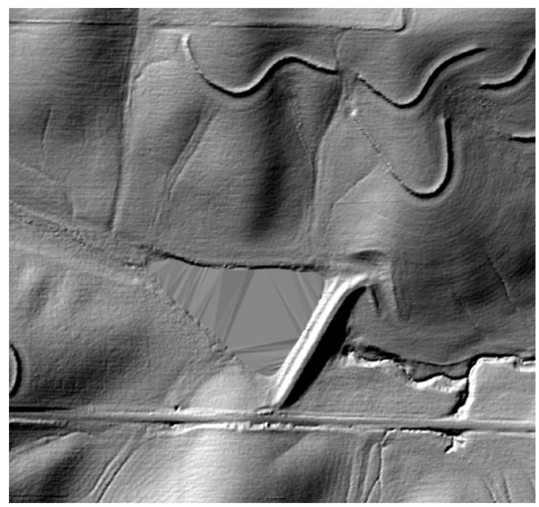


Figure 23: LiDAR hillshade showing a pond dam.

REQUIRED REFERENCE LAYERS: Color Infrared, Natural Color, Hillshade

DIGITIZING METHODS AND CONSIDERATIONS: To capture a pond dam, draw a line across the structural embankment. Most pond dams are easily seen in aerial photography. Sometimes it can be challenging to spot the embankment; use the hillshade layer to help verify the embankment. The water should be pooling behind a man-made structure.

Figure 24: Example of stripcropping – Photo courtesy of USDA NRCS.

DESCRIPTION OF PRACTICE: Stripcropping is a system of growing crops in approximately even width strips or bands on the contour to reduce soil erosion. A strip of permanent grass or close growing crop alternates with a strip of row crop (NRCS – Iowa).

PURPOSE: Stripcropping is very effective at reducing sheet and rill erosion. It can reduce soil loss as much as 75%, depending on the type of crop rotation and the steepness of a slope. Strips planted to meadow can provide food and cover for wildlife (NRCS – Iowa).

Figure 25: CIR photo of stripcropping with grassed waterways.

Figure 26: Natural color photo of stripcropping with grassed waterways.

REQUIRED REFERENCE LAYERS: Color Infrared, Natural Color, Hillshade

DIGITIZING METHOD AND CONSIDERATIONS: To capture contour stripcropping, review aerial photography for the strip pattern, then draw a polygon outlining the perimeter of the field. This practice reduces soil loss for the whole field. Do not forget to look for other practices such as grassed waterways within the larger contour stripcropping practice.

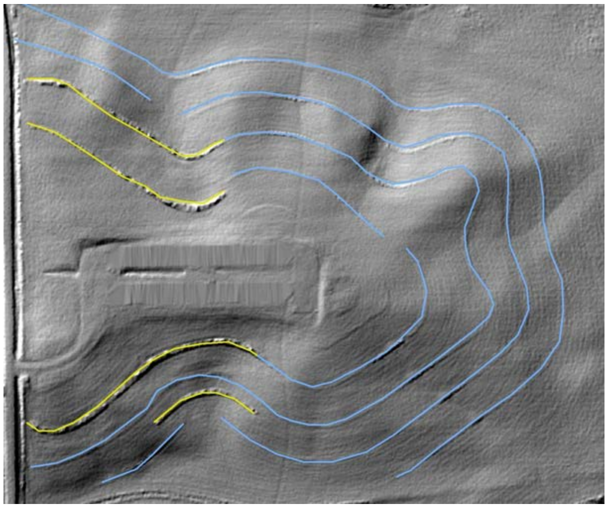


Figure 27: LiDAR hillshade image showing areas that had been digitized as terraces but were really stripcropping.
Figure 28: Historical black and white aerial photo showing stripcropping.

Consider the field as a whole and understand how past farming practices will affect the current situation. In the images above, notice that the contour stripcropping (blue lines) was mistakenly digitized as terraces (yellow). When a field has been stripcropped for years, sometimes soil builds up between the different strips and this can look like terracing.

V. TERRACES

Figure 29: Example of a terrace – Photos courtesy of USDA NRCS.

Figure 30: Example of terraces.

DESCRIPTION OF PRACTICE: Terraces are earthen structures that intercept runoff on moderate to steep slopes. They transform long slopes into a series of shorter slopes. Terraces reduce the rate of runoff and allow soil particles to settle out. The resulting cleaner water is carried off the field in a non-erosive manner.

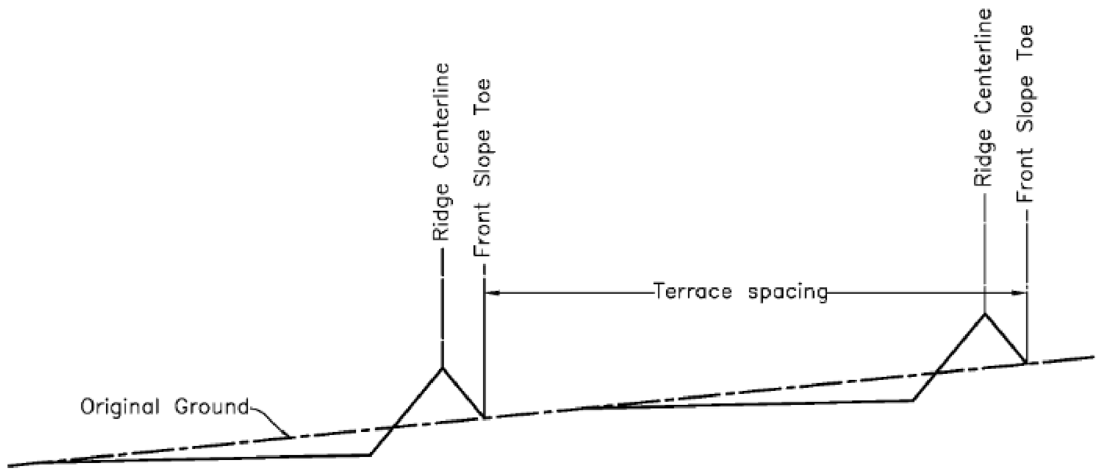


Figure 31: This diagram shows the general structure of a terrace. (NRCS – Iowa, 2014).

PURPOSE: Terraces reduce sheet and rill erosion and prevent gully development. Terracing reduces sediment pollution of lakes and streams, and traps phosphorus attached to sediment particles. Storage terraces collect water and store it until it can infiltrate into the ground or be released through a stable outlet. A gradient terrace is designed as a channel to slow runoff water and carry it to a stable outlet like a grassed waterway.

For this project, there is no distinction made between terrace types in the dataset. However, visually there are two distinctive types of terraces.

1) *Narrow base terrace* - 2:1 slopes on both the front slope and back slope. Perennial grasses are on both front and back slope.

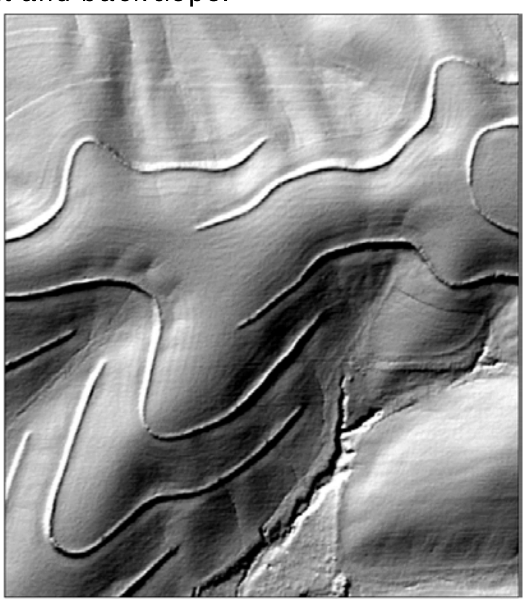


Figure 32: LiDAR hillshade image showing narrow base terraces.

Figure 33: CIR photo of showing narrow base terraces.

2) *Broadbase terrace* – a flatter looking terrace farmed on both slopes. It should not be built on land slopes greater than 8 percent.

Figure 34: LiDAR hillshade image showing broadbase terraces.

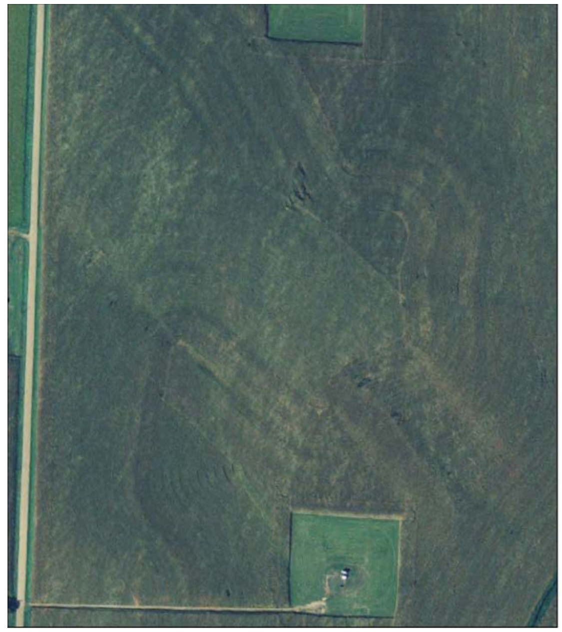


Figure 35: Natural color photo showing broadbase terraces.

3) *Historic terraces* – These terraces are often very faint.

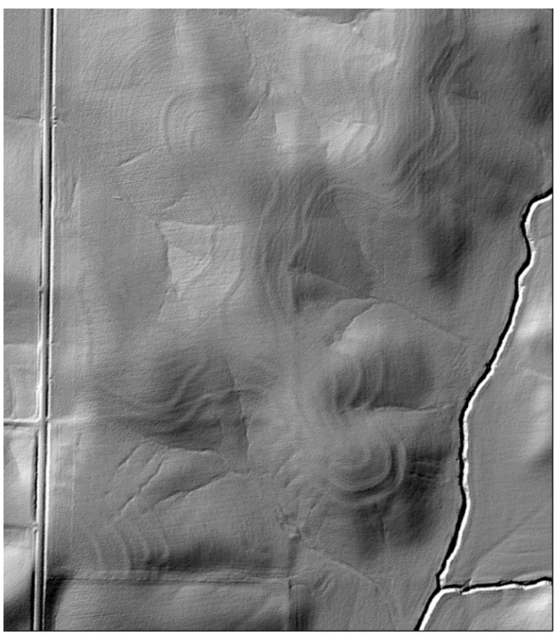


Figure 36: LiDAR hillshade image showing historic terraces.

Figure 37: Historic photo showing historic terraces.

REQUIRED REFERENCE LAYERS: Hillshade, Color Infrared, Natural Color, Historic Imagery

DIGITIZING METHOD AND CONSIDERATIONS: To capture terraces, review the hillshade layer for terrace structures and then draw a line along the top of the terrace ridge. As you find historic terraces, remember to add text in the comments field signifying 'old terrace'. It is not necessary to differentiate between broad and narrow based terraces.

VI. WATER AND SEDIMENT CONTROL BASINS (WASCOBS)

Figure 38: Example of a WASCOB. Photo courtesy of MN NRCS.

DESCRIPTION OF PRACTICE: An earth embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet.

PURPOSE: This practice helps control water on the land and prevent gully erosion. WASCOBs can also help trap sediment and runoff.

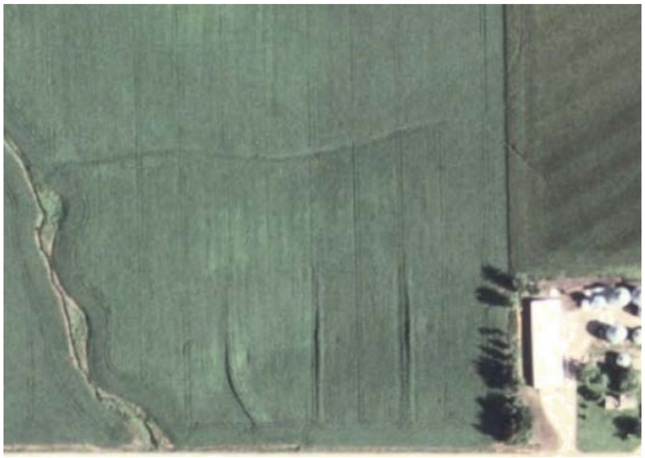


Figure 39: Natural color photo showing WASCOBs.

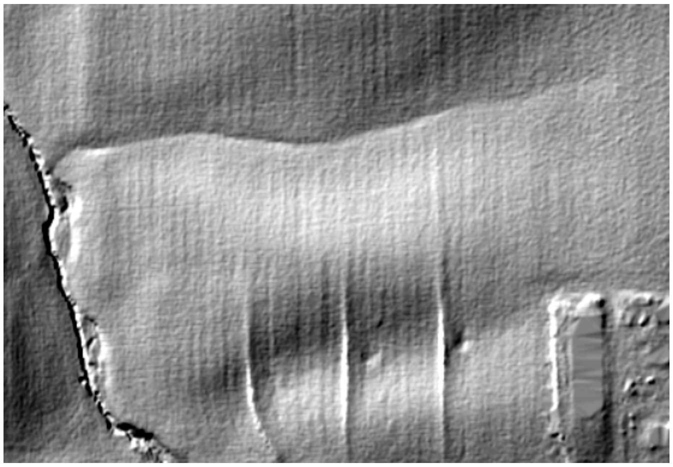


Figure 40: LiDAR hillshade image showing WASCOBs.

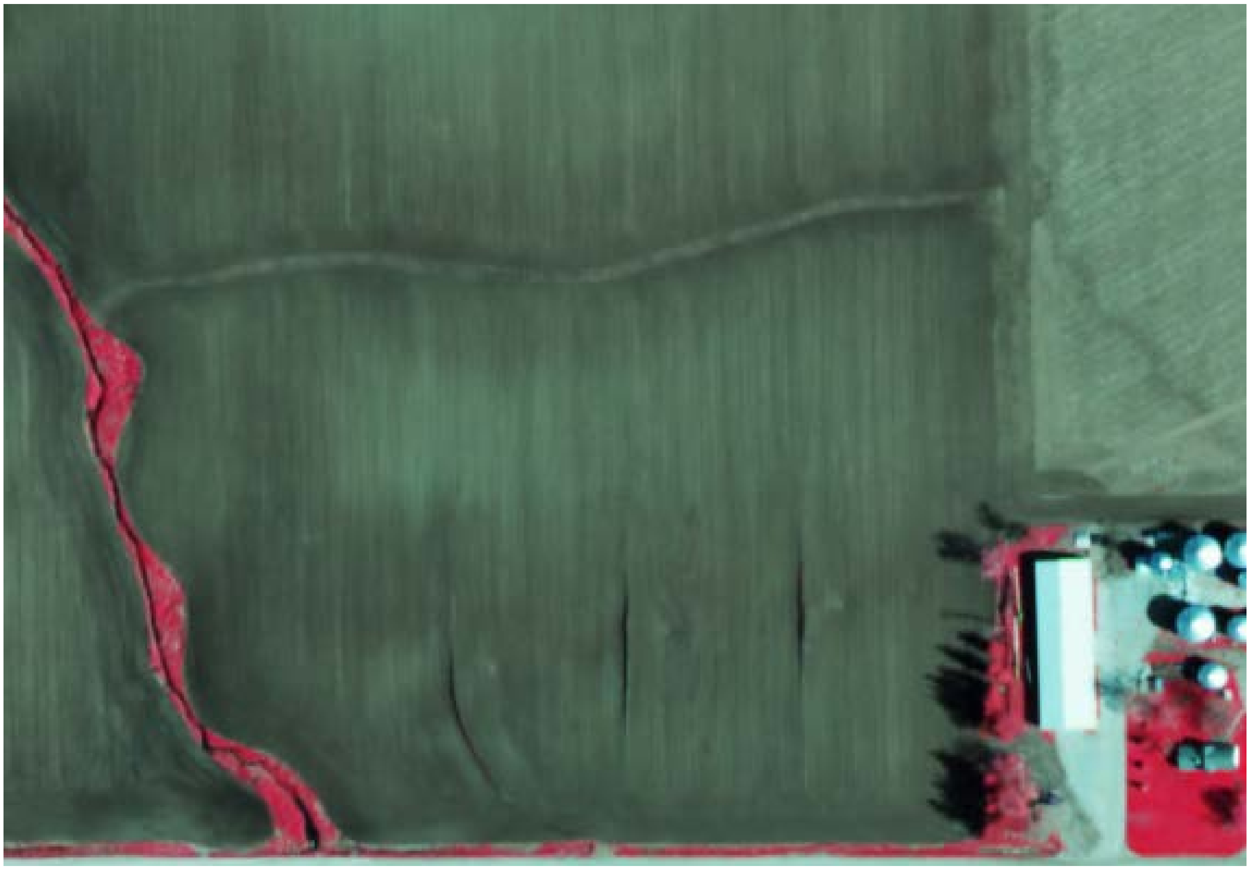


Figure 41: CIR photo showing WASCOBs.

REQUIRED REFERENCE LAYERS: Hillshade, Color Infrared, Natural Color, Historic Imagery

DIGITIZING METHOD AND CONSIDERATIONS: To capture WASCOBs, review the hillshade layer for WASCOB structures and then draw a line along the top of the WASCOB ridge.

Sometimes it can be challenging to distinguish between a WASCOB and a terrace. WASCOBs are usually shorter and straight, while terraces vary in length and follow the contour of a hill. WASCOBs are usually found in areas with a depression; terraces are usually placed along hill slopes.

4. THE IOWA CASE STUDY

This project has evolved over time. It started as a 40 watershed pilot program, employing seven staff and has grown into a statewide project that has employed dozens of staff. This project has been a valuable resource for allowing researchers to gain a baseline understanding of conservation in Iowa. There has been a need for better and more complete conservation data. Before the creation of baseline inventory, there was not a comprehensive picture of conservation but only segmented snapshots based on the conservation efforts of one organization or program. Another challenge that made documenting past conservation efforts difficult in a GIS were privacy concerns. Organizations were reluctant to share data because it might expose information about their constituents. This project looks at every watershed in the state without knowledge of who installed the practices of who paid for them. The intent of the project is not to draw conclusions about the status of a watershed but provide data so researchers and managers can develop their own conclusions.

This project began as a small part of a larger pilot project using remote sensing techniques to study 40 Water Quality Initiative watersheds. When this project began in winter 2014-15, ISU GIS Facility staff along with Iowa Department of Natural Resources (IDNR) and Natural Resources Conservation Service (NRCS) staff developed a list of six conservation practices to digitize as well as a methodology and data infrastructure for capturing them. In February 2015, five students were hired to begin the digitizing process and went through training with GIS Facility and IDNR staff. Over the course of the spring, the digitizing process and database structure began to solidify as questions arose and were answered and data needs were better understood. As students finished HUCs, the data were sent to IDNR for quality assessment and quality control (QA/QC) review. This is an important step in the process and it was decided that full-time trained IDNR staff would complete this review. Students are trained to do the data creation but project staff felt it was important to have at least one additional review of the data by professionals before releasing the data for use.

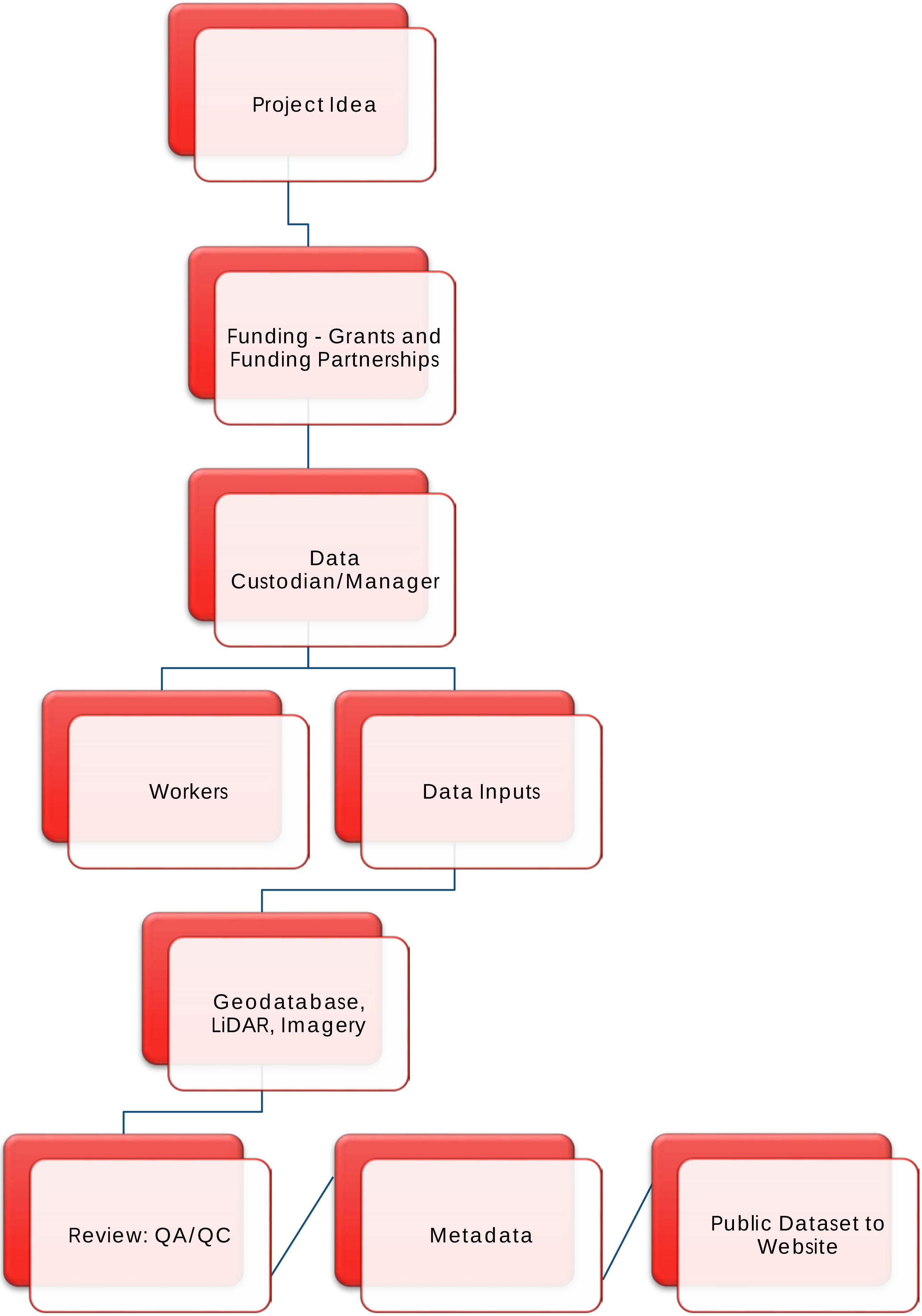
As the project progressed, additional funding was secured to continue the project through summer 2015 with support from the AmericaView Consortium. The IDNR took an interest in the project as an additional dataset for nutrient management assessment work being completed at the HUC 8 level. Partners at the US Department of Agriculture – Agricultural Research Service (USDA-ARS) contributed additional funding to help the project continue through fall 2015. This funding moved the digitizing efforts to a group of watersheds in central Iowa. For that project, ten watersheds were evaluated for practice existence in the 80s and 90s using the inventory features as a reference baseline. The Iowa Department of Agriculture and Land Stewardship (IDALS) became a partner and helped fund watershed digitization and used this data to track some of their conservation efforts. A second round of funding was secured through an Iowa Nutrient Research Center (INRC) grant to complete the digitizing of a HUC 8 in northwest Iowa and to begin a companion project to test the feasibly of using new imagery (2016) to update the baseline inventory. Staff time and funding support has continued from IDNR and AmericaView.

In 2016, staff for the ISU GIS Facility and IDNR continued to develop relationships with the Iowa Nutrient Research and Education Council (INREC). INREC is a private nonprofit group that strategically brings together major farm and commodity organizations, major fertilizer and crop production companies, agricultural retailers and crop advisors in a formal organization to help lead environmental efforts related to agriculture in Iowa. INREC saw the value of the baseline dataset and also began investing in having additional watersheds throughout the state inventoried. Their main focus has been getting the 80s historic evaluation completed while acknowledging that the baseline inventory has to happen first. Funding for the project continued through 2017 with a goal to complete the initial inventory by late spring

2018. To follow the progress of this project, visit the project website: https://www.gis.iastate.edu/gisf/projects/conservation-practices.

Funding for the project progressed in a piecemeal fashion as the value of the data was recognized and partners were added to the original group. As was mentioned earlier, there was no one funding source and very little of the final total was committed at the beginning of the work. Interested agencies and organizations reallocated portions of their budgets to this work once the process was developed and they saw quality data being produced. Most of the funding was provided through contracts but some was awarded through three grants. Those interested in beginning this type of dataset creation should contact similar state agencies and organizations and should find the funding amounts below helpful as a starting place to develop their own project budget.

The baseline inventory project is estimated for completion in June 2018 and funds used over the three years of the project just for student and staff time for data creation, inclusive of administrative and overhead fees, will be right at $250,000. Funding full-time staff for the quality assessment/quality control portion will total $100,000 but is not slated for completion until spring 2019. Since Iowa chose to perform the historic 80s and 2016/2017 evaluation on 25% of the total state HUC 12s, the cost for that review is a smaller portion of the total budget; having a well-trained student do that evaluation also reduces the cost when compared to the salary of a full-time staff professional. It is projected that the historic and current practice evaluation will be done by summer 2019 since is dependent on the QA/QC being completed first; the estimated cost for this portion is $34,000.


Project Idea
Funding - Grants and Funding Partnerships
Data Custodian/Manager
Workers
Data Inputs
Geodatabase, LiDAR, Imagery
Review: QA/QC
Metadata
Public Dataset to Website

5. BEYOND THE BASIC BASELINE – ADDITIONAL RESEARCH PROJECTS

HISTORIC OCCURRENCE EVALUATION

The *Historic Occurrence Evaluation* project is a companion project using the 2010 baseline inventory dataset to track if a particular conservation practice is evident in imagery from the 1980s. Researchers chose the 1980s for this evaluation because during that decade in Iowa, there had been an increase in funding for agricultural conservation programs and researchers were interested to see how many of the baseline inventory practices were present in the 1980s. The goal of this project is to assess a representative sample (25%) of HUC12s across Iowa in order to determine the trends in overall changes in practice levels from the 1980s to 2010.

The project uses the 2010 baseline inventory dataset and then compares every conservation practice record to 1980s historical aerial imagery to determine presence or absence of the feature in the 1980s. An additional attribute field called PRESENT80s is in the attribute table. A domain is associated with the field; this allows the user to quickly type a numerical value and have it appear as text thus reducing errors. The presence of a conservation practice in the 1980s is indicated by a 1 = YES and absence is indicated by a 2 = NO. Practices partially existing in the 1980s are split at the relevant location and each piece is identified with the necessary status. No new practices are added from the 1980s imagery; only practices existing in the baseline inventory are evaluated.

The evaluation procedure is being done on 25% of the entire state's HUC 12 collection; random sampling is done by HUC 8 to choose which HUCs are processed. After a HUC 12 has QA/QC performed for the initial baseline inventory, it is then evaluated for 1980s presence or absence.

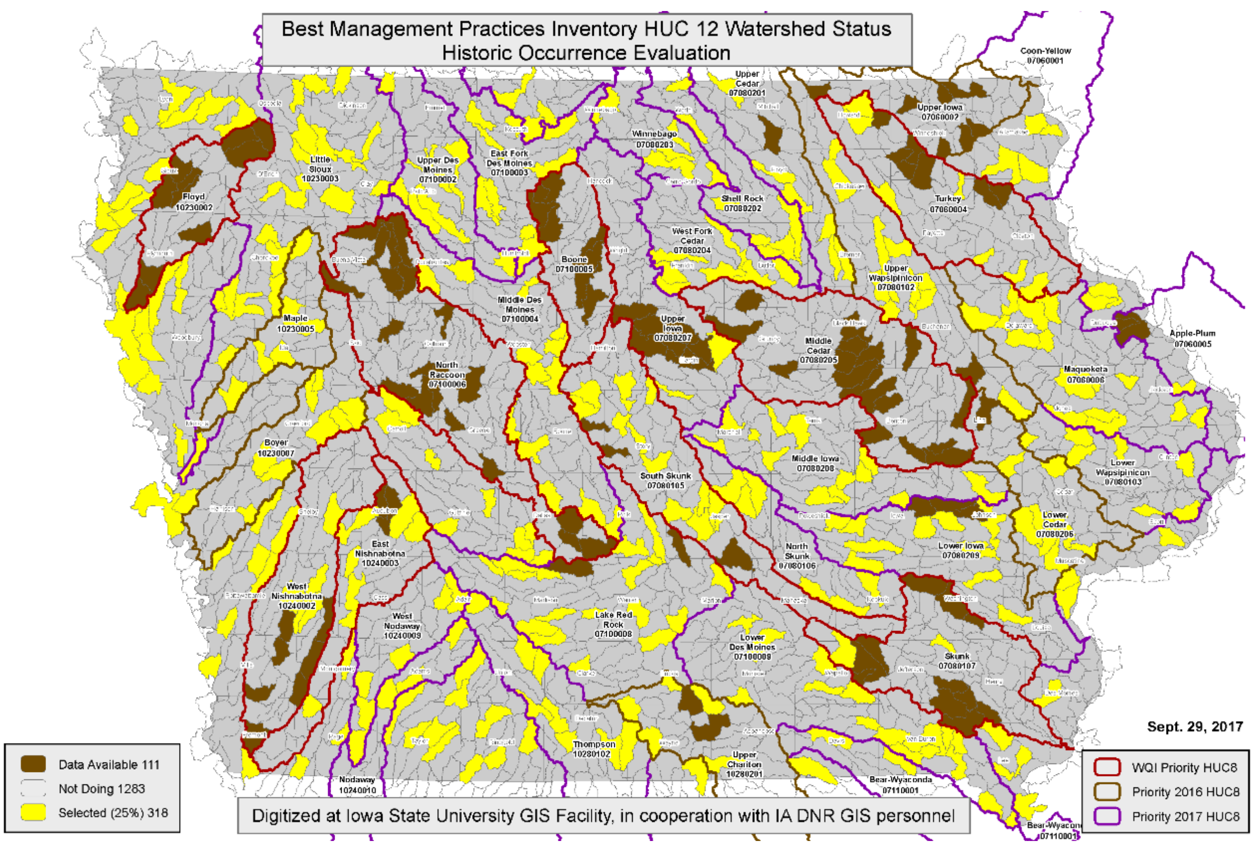


Figure 42: Historical Occurrence Evaluation Status Map as of Sept 29, 2017.

TRACKING CONSERVATION CHANGES INTO THE FUTURE

Tracking Conservation Changes is another companion project that uses the 2010 baseline inventory dataset as a reference for tracking the persistence of conservation practices into the future. The goal of this project was to determine if it was possible to identify new conservation practices with color aerial photography alone, as a new LiDAR flight is not available.

In 2016, five HUC 12s in eastern Iowa's Middle Cedar River basin were chosen for a pilot study to determine the feasibility of using high resolution imagery alone to update the baseline inventory. Six-inch spring imagery was collected for the five selected HUCs. The 2010 baseline inventory dataset was used to review the new imagery, looking for changes. The project proved to be a success with both positive and negative changes being identified. Two attribute fields were added to the attribute table called PRESENT10 and PRESENT16. A domain was set up for the fields; this allows the user to type in a numerical value and it will be recorded as text. The presence of a conservation practice is indicated by 1 = YES and absence is indicated by 2 = NO. Practices that are identified as partially existing in 2016 are split at the relevant location and each piece is identified with the necessary status. New practices are also digitized from the 2016 imagery. After the pilot project was completed in early 2016, Iowa Homeland Security funded a leaf off, 4-band spring flight for eastern Iowa; that imagery became available late in the year and that has been used to evaluate current practices in watersheds covered by the imagery. The rest of the state was flown in spring 2017 with imagery becoming available in late fall 2017.

IDENTIFYING TILE DRAINAGE

The third research project, *Identifying Tile Drainage*, uses high resolution aerial imagery (12" or better) to observe drying patterns in crop fields caused by underlying drainage tiles. This research was carried out by staff and students at the Iowa Geological Survey in Iowa City, and the Iowa State University GIS Facility in Ames, with funding from the USEPA Region 7, Wetland Development Grant Program (CD97731601) and funding from AmericaView.

Depending on the composition and drainage characteristics of the soils, different criteria are used to plan the aerial imagery acquisition in the spring, before crop canopy hides the ground from view. Thick clayey soils derived from younger glacial tills require heavier amounts of rainfall to saturate the soil profile, from 4-7 inches over a 7 to 10 day period, while older glacial soils with a loess cover saturate faster allowing the tile drying patterns to be observed with less rainfall, usually 1" or more in a 24-hour period. Climate reporting websites like the Iowa Environmental Mesonet (http://mesonet.agron.iastate.edu) must be followed daily to track where conditions meet the desired rainfall criteria. In the research project, two aerial imagery contractors were available for rapid response flights - one a traditional aerial imagery company, and the other specializing in agricultural clients. Because of the large amount of rainfall needed to observe tile patterns at the central Iowa test areas, many acquisitions were not successful. Records of the past 10 year rainfall events only showed an average of 1 or 2 events per spring that were in the required range. The research indicated that large area regional mapping would require an abnormal amount of luck to be mostly successful. However, smaller operations, perhaps using UAVs over field based projects could have decent success.

The tile mapping pilot project and associated tutorial presented here have the unusual feature of using three dates of imagery: 1980, 2007 and 2013. Again, this is unusual because two of the three sets were random chance acquisitions, not intended as tile mapping missions, just general purpose imagery. The mapping process also makes use of a LiDAR derived DEM, drainage patterns and depression depth grids. These layers provide insight into how the drainage tiles were intended to function within the landscape.

A fair degree of artistic license is expected in determining tile locations as well as common sense guesswork and interpretation of multiple lines of evidence. However, the pilot project results appear reasonable, and will give staff and students practice using many photo-interpretation skills.

A separate Photo Interpretation Manual for identifying tile patterns is also provided by the EPA research project; this document can be found on the IowaView website: www.iowaview.org. The document offers other situations where tiles make themselves known besides drying overlying soils, types of drainage tile patterns, and examples of "faux" tiles that can cause confusion.

6. REFERENCES AND ACKNOWLEDGEMENTS

References:

Natural Resources Conservation Service (NRCS) – Iowa. *Conservation Choices: Your Guide to 32 Conservation and Environmental Farming Practices*. Retrieved from United States Department of Agriculture, NRCS Iowa, Publications and Factsheets Webpage: https://www.nrcs.usda.gov/wps/portal/nrcs/main/ia/newsroom/factsheets/.

Natural Resources Conservation Service – Iowa (NRCS – Iowa). (2012*). Grassed Waterway – Iowa Fact Sheet.* Des Moines, IA: USDA NRCS – Iowa.

Natural Resources Conservation Service – Iowa (NRCS – Iowa). (2014). *Natural Resources Conservation Service – Conservation Practice Standard – Terrace (Ft.) Code 600.* Des Moines, IA: USDA NRCS – Iowa.

Acknowledgements:

Thank you to all the student workers who helped make this project possible.

Thank you to all our funding partners and collaborators.

AmericaView, https://americaview.org/

Iowa Department of Natural Resources, http://www.iowadnr.gov/

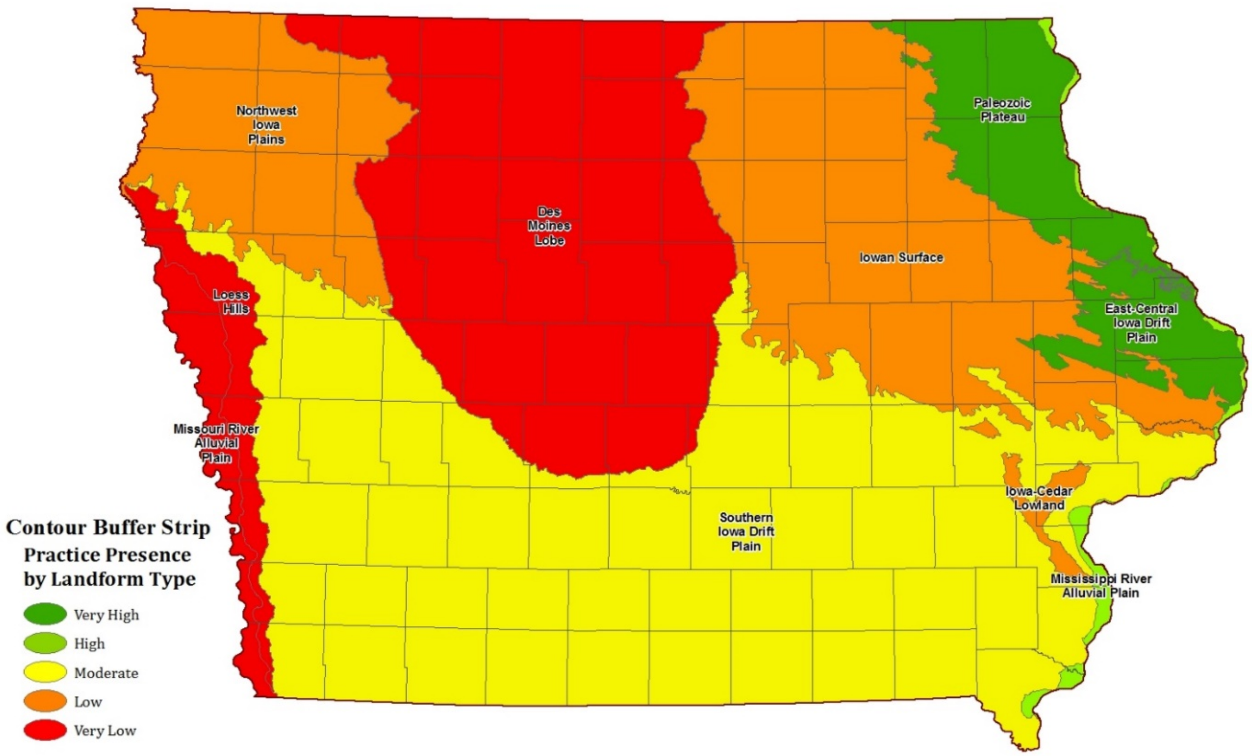
Iowa Department of Agriculture and Land Stewardship, http://www.iowaagriculture.gov/

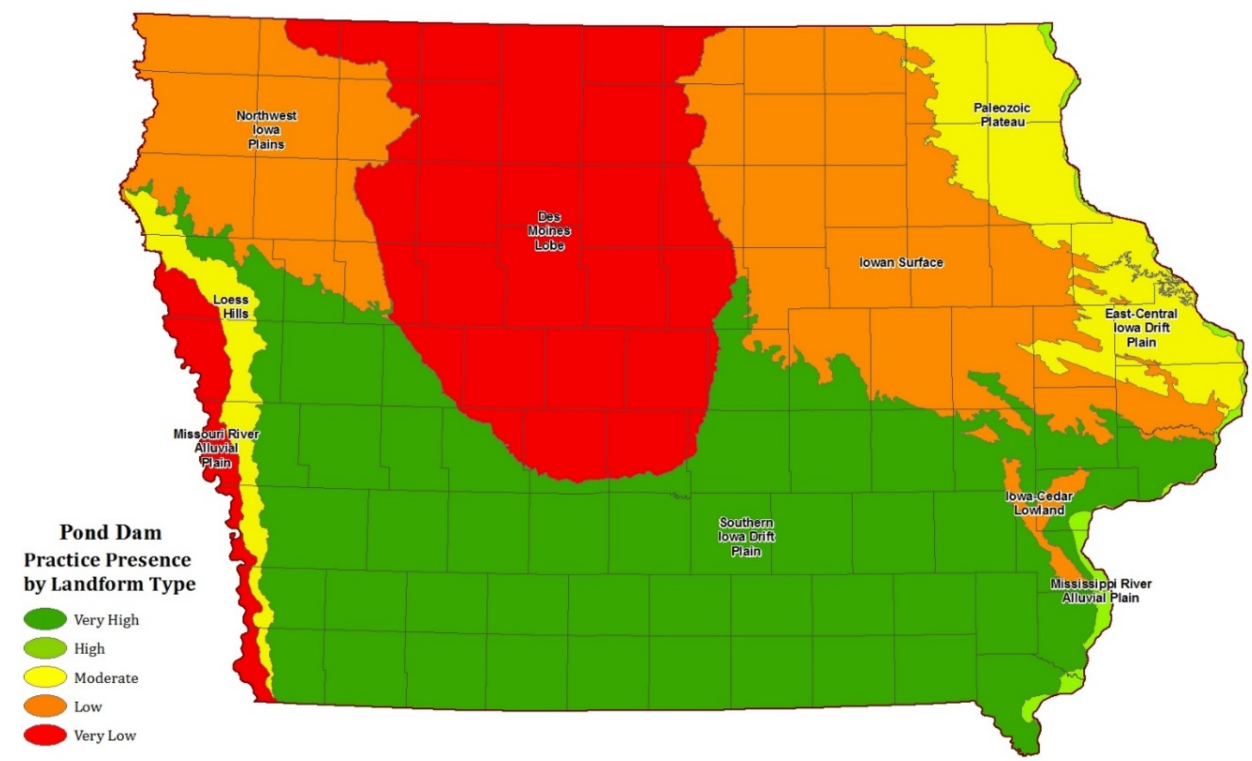
Iowa Nutrient Research Center at Iowa State University, https://www.cals.iastate.edu/nutrientcenter

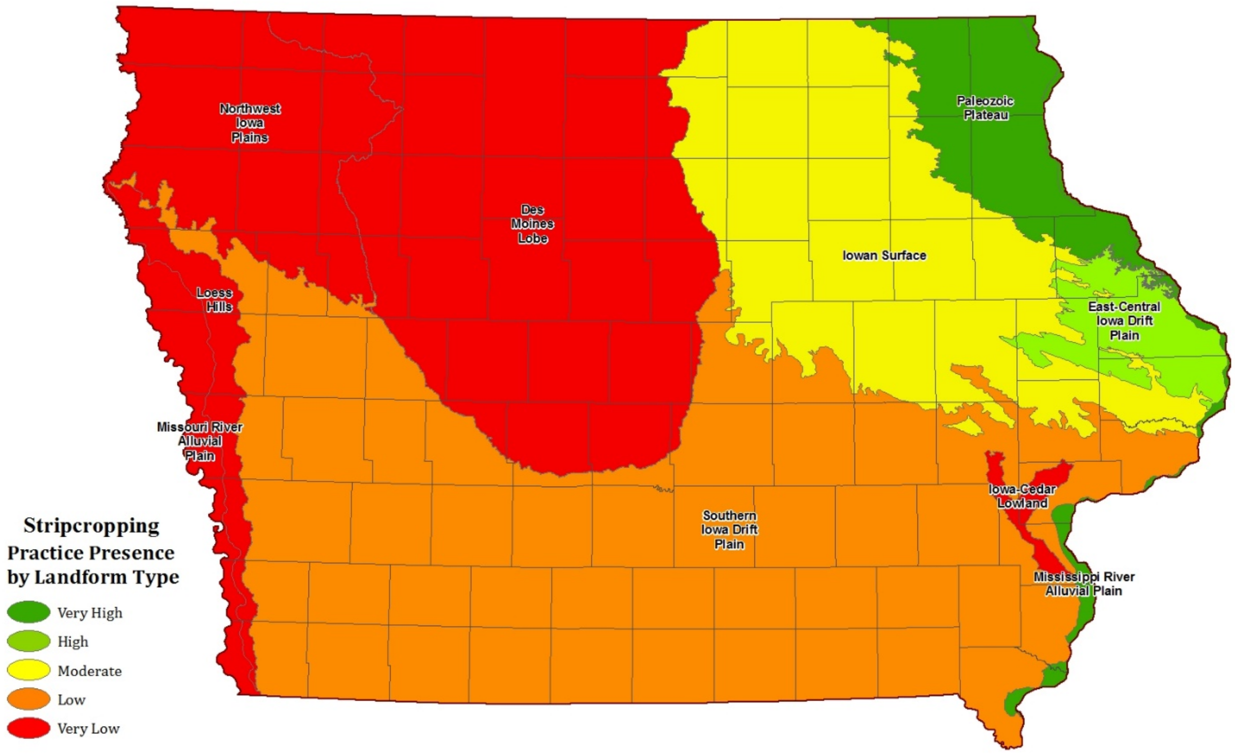
National Laboratory for Agriculture and The Environment, https://www.ars.usda.gov/midwest-area/ames/nlae/

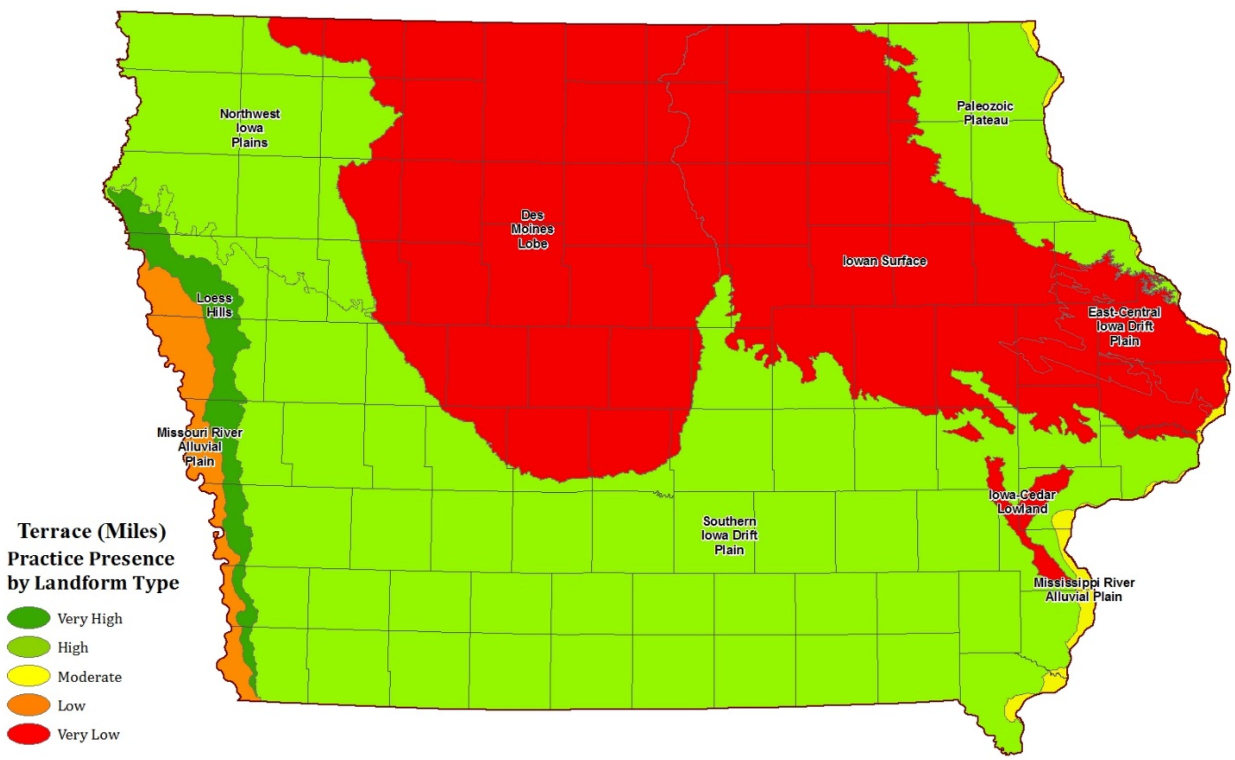
Iowa Nutrient Research and Education Council, http://iowanrec.org/

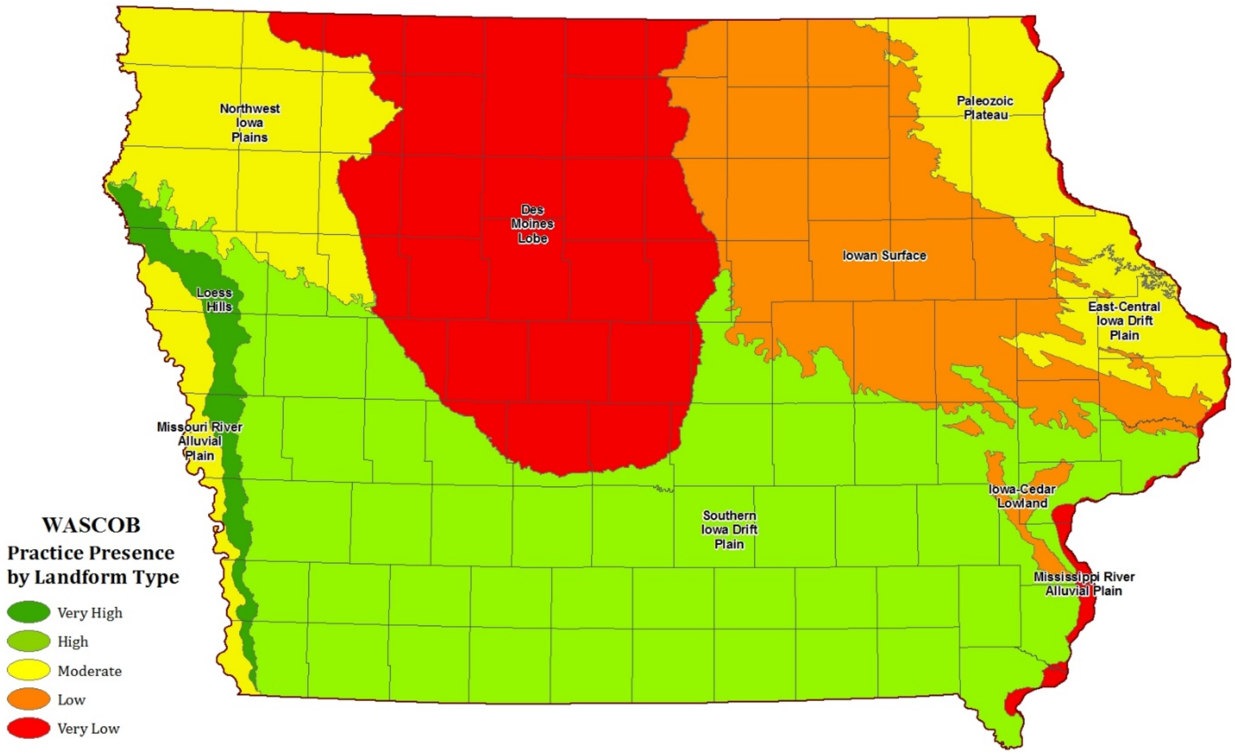
ADDITIONAL MAPS: PRACTICE PRESENCE BY LANDFORM TYPE






Northwest Iowa Plains
Des Moines Lobe
Paleozoic Plateau
Iowan Surface
East-Central Iowa Drift Plain
Loess Hills
Missouri River Alluvial Plain
Iowa-Cedar Lowland
Southern Iowa Drift Plain
Mississippi River Alluvial Plain
Stripcropping Practice Presence by Landform Type
Very High
High
Moderate
Low
Very Low


Northwest Iowa Plains
Des Moines Lobe
Paleozoic Plateau
Iowan Surface
East-Central Iowa Drift Plain
Loess Hills
Missouri River Alluvial Plain
Iowa-Cedar Lowland
Southern Iowa Drift Plain
Mississippi River Alluvial Plain
Terrace (Miles) Practice Presence by Landform Type
Very High
High
Moderate
Low
Very Low


Northwest Iowa Plains
Des Moines Lobe
Paleozoic Plateau
Iowan Surface
East-Central Iowa Drift Plain
Loess Hills
Missouri River Alluvial Plain
Southern Iowa Drift Plain
Iowa-Cedar Lowland
Mississippi River Alluvial Plain
WASCOB
Practice Presence
by Landform Type
Very High
High
Moderate
Low
Very Low

A. WATERSHED ASSIGNMENT DOCUMENT

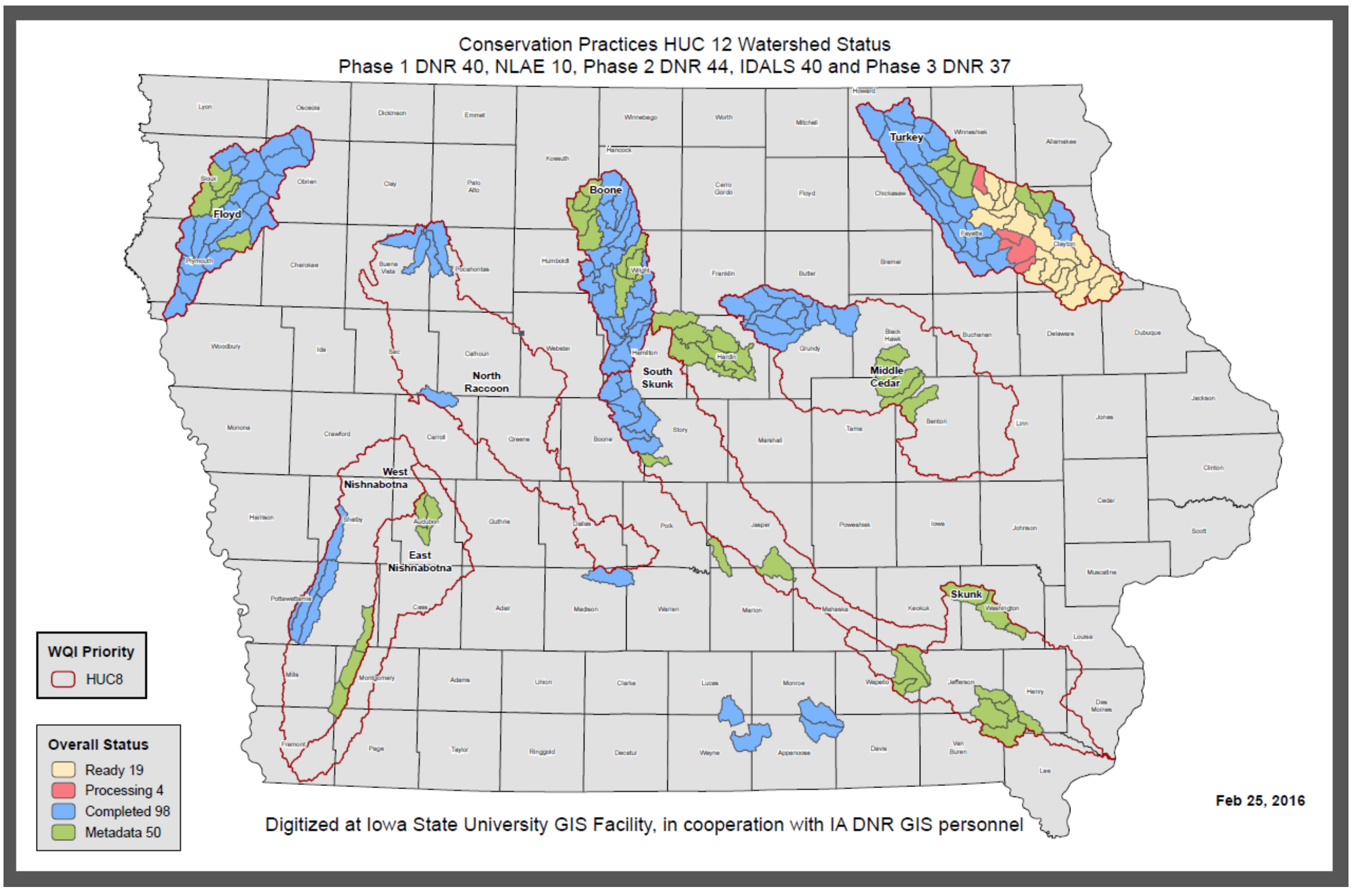
The Watershed Assignment Document is a spreadsheet for tracking digitizing progress by HUC 12.

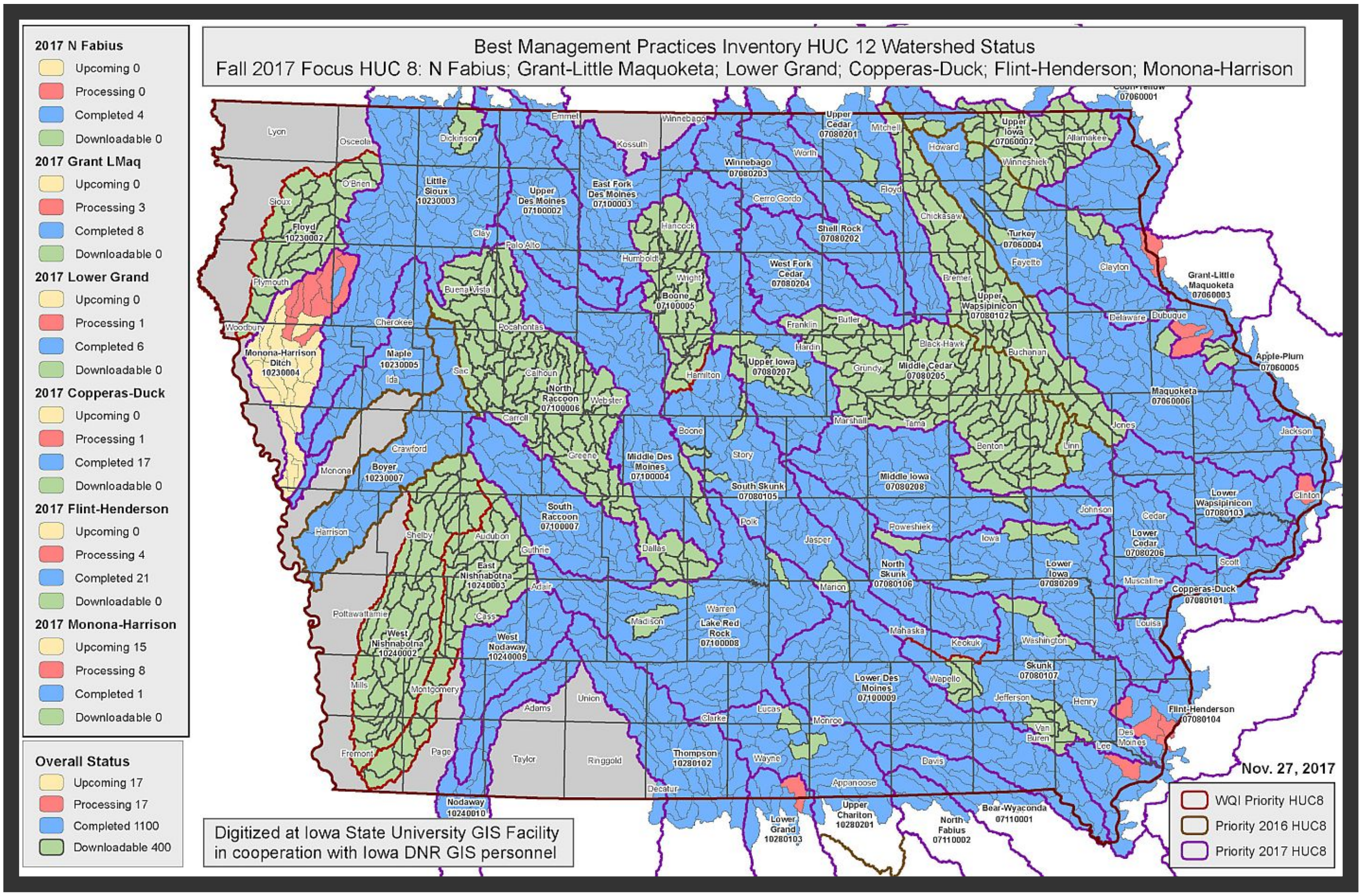
Field Name	Description
SPONSOR	This field identifies the source of funding for this portion of the project.
PRIORITY	This field allows data managers to prioritize the sequence for assigning HUCs.
HUC_12	This field identifies the HUC 12 number for the HUC as assigned by the Watershed Boundary Dataset.
HUC_12_NAME	This is the name for the HUC 12 as given by Iowa Geological and Water Survey during development of HUC coverages. Meet USGS naming criteria.
HUC8_NAME	This is the name of the HUC 8 as given by Iowa Geological and Water Survey during development of HUC coverages. Meet USGS naming criteria.
NAME	This field identifies the name of the employee or employees responsible for working on this HUC 12.
BEGUN	This field records the date that the employee began working on the assigned HUC 12.
COMPLETED	This field records the date that the employee finished the HUC.
REVIEWER	This field identifies the person responsible for the QA/QC check of the HUC.
SENT2REVIEW	This field records the date that the HUC is sent for QA/QC review.
RCVDREVIEW	This field records the date that the HUC is returned by the QA/QC reviewer.
METADONE	This field records the date the metadata was completed for the HUC. When the metadata is completed, the HUC is then ready for public release.
COMMENTS	This field records reminders, notes, or any irregularities that may have occurred during the digitizing process. Examples: “Empty, redo 10/30/2017”, “Need Missouri data use Putnam County”, “Reminder: just do Iowa side of the watershed”

B. STATUS MAPS

Status Maps visually communicate the progress of the project. These maps provide information about the status of HUCs. Our terminology is as follows:

- Upcoming (previously Ready) – the HUC is in the queue; the file geodatabase is created, and it is ready to be assigned.
- Processing – the HUC is assigned and is currently being digitized.
- Completed – the HUC has been digitized and is ready for quality assurance/quality control (QA/QC) review.
- Downloadable (previously Metadata) - the HUC has been digitized, had QA/QC review, and had metadata created for it. The file geodatabase is available to the public through the project website.





C. SUMMARY STATISTICS DOCUMENT

The Summary Statistics Document is a spreadsheet with summary statistics of the six conservation practices both in total number and total length or area of the practice. The spreadsheet has tabs for each HUC 8 containing the individual HUC 12s within the HUC 8. It is useful to generate the summary for each HUC 12 twice; initially run it right after completing the HUC 8 to check for zeros in all categories and this indicates data was not completed as thought or not copied from a student computer to the project network location. Run the summary again after QA/QC to get final numbers for reporting.

Field Name	Description
HUC_12	This field identifies the HUC 12 number as assigned by the Watershed Boundary Dataset.
GWW (segments)	This field identifies the number of grassed waterway segments present in the HUC 12.
GWW Area	This field identifies the total surface area in square meters covered by grassed waterways in the HUC 12.
Pond Dams	This field identifies the number of pond dams present in the HUC 12.
PD Length	This field identifies the total length of pond dams in meters in the HUC 12.

Terraces	This field identifies the number of terraces present in the HUC 12.
Terr Length	This field identifies the total length of terraces in meters in the HUC 12.
WASCOBs	This field identifies the number of WASCOBs present in the HUC 12.
WASCOB Length	This field identifies the total length of WASCOBs in meters in the HUC 12.
Contour Buff (fields)	This field identifies the number of fields that contain contour buffer strips in the HUC 12.
BF Area	This field identifies the total surface area in square meters of the fields affected by contour buffer strips in the HUC 12.
Stripcropping (fields)	This field identifies the number of fields that contain stripcropping in the HUC 12.
Strip Area	This field identifies the total surface area in square meters of the fields affected by stripcropping in the HUC 12.

There is also a tab called HUC8Summary. This tab is structured similarly to the individual tabs but instead combines all the data of the individual watersheds into a compilation by HUC 8. The HUC8Summary table also includes the name of the HUC 8 as well as the number. This spreadsheet was used to produce the summary data table on page 7.

AUTOMATED PROCESSING SCRIPTS

As the 2010 baseline BMPs project progressed, four scripts were developed to automate the creation of new mxds, create/attach metadata, and run statistics for each HUC12 within a HUC8. Each script is described below; for questions or more information, please contact Josh Obrecht, jobrecht@iastate.edu.

1) MXD Creation – This script accomplishes two things when given a list of HUC12s. First, it creates the geodatabase for each of the listed HUCs. This is the geodatabase that will contain the digitized practices. Second, it creates the map document for each HUC that will be used by the digitizer.
2) Save WS Metadata – Given a list of HUC12s, this script creates the metadata to be used for the BMP feature classes. It takes default metadata that has been created and replaces placeholders with the HUC12 number.
3) Import WS Metadata – This script is to be run after the Save WS metadata file. Given a list of HUC12s, this script imports the metadata created in the Save WS Metadata script into the BMP feature classes.
4) WS Statistics – This script runs statistics on each BMP practice within a HUC8. The statistics are run on each HUC12 within the HUC8. Statistics are also calculated for landform based on the location of the HUC12 centerpoint. The statistics calculated are the number of features and the total area/length, dependent on whether the feature class is a line or a polygon file, within the HUC12. The script produces a *.csv file by HUC8 with one line of statistics per HUC12. The *.csv is imported into Excel for summarizing; this project has a summary spreadsheet for data by HUC8 and by Iowa landform region.