Meudt Creek and Knight Hollow Sub-watershed 9 Key Element Plan Report

Iowa County Land Conservation Department, Iowa County University of Wisconsin Extension, Michael Fields Agricultural Institute

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IOWA County WISCONSIN GOVERNMENT

Land Conservation Department

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Table of Contents

List of Tables

List of Figures

Section 1

Background and Purpose

The Uplands Farmer Led Watershed Group started in 2016. That same year, the group decided to create a cultural relationship with Gulf fishermen, which generated considerable press and interest, as we invited fishermen to join us for a seafood dinner celebrating conservation practices and then traveled to the Gulf the following spring. The group's adopted "brand" of always serving some form of Gulf seafood at our public events has helped us reinforce our message of the downstream significance of farming practices within our watershed, including with a statewide episode of Wisconsin Foodie devoted to this relationship. In subsequent years, supported by grants from the Wisconsin Department of Agriculture, Trade, and Consumer Protection's (DATCP) Producer-Led Watershed Protection program and federal funding sources, farmers in the group have planted cover crops, created stream buffers, stream crossings, installed a no-till drill that farmers in the area can rent, and created a citizen-based Water Action Volunteers program for stream monitoring. From the start, Uplands Watershed Group farmers have sought to maintain a diverse mix of farmers, from large to small, organic to conventional, including dairy, livestock, cash grain, hay, and fresh market produce farms.

This diversity of background, practices, and thought gives this group an opportunity to communicate among and with a broader set of farmers, including our work to draw in conventional farmers to engage them in the vigorous dialogues among Uplands farmers. This may be one reason the Wisconsin Department of Natural Resources (DNR) reached out to us to create a plan for two of the sub-watersheds in the Uplands watershed area of influence.

The purpose of this plan largely is centered around the mission of the Uplands Farmer-Led Watershed Group; that is, to build community and dialogue among producers and community members alike around how best to protect our watersheds and stream systems we all enjoy for recreation, beauty, and resources. Mindfulness of producers' needs from the watershed as well as how our practices impact communities outside of our own is also an underlying message behind this plan. Coupled with this purpose, our goals are to evaluate current conditions of the watershed, identify best practices and critical, highly vulnerable areas, and work with producers to develop a plan that helps them reduce our collective loading of nutrients, sediment, and other pollutants.

Plan Development

This plan was assembled and overseen by various community partners, county conservation and agriculture agents, Wisconsin DNR staff, and other watershed stakeholders. The following people significantly contributed to the plan's development, along with the many helpful hands from local producers, community leaders, and organizational/agency partners.

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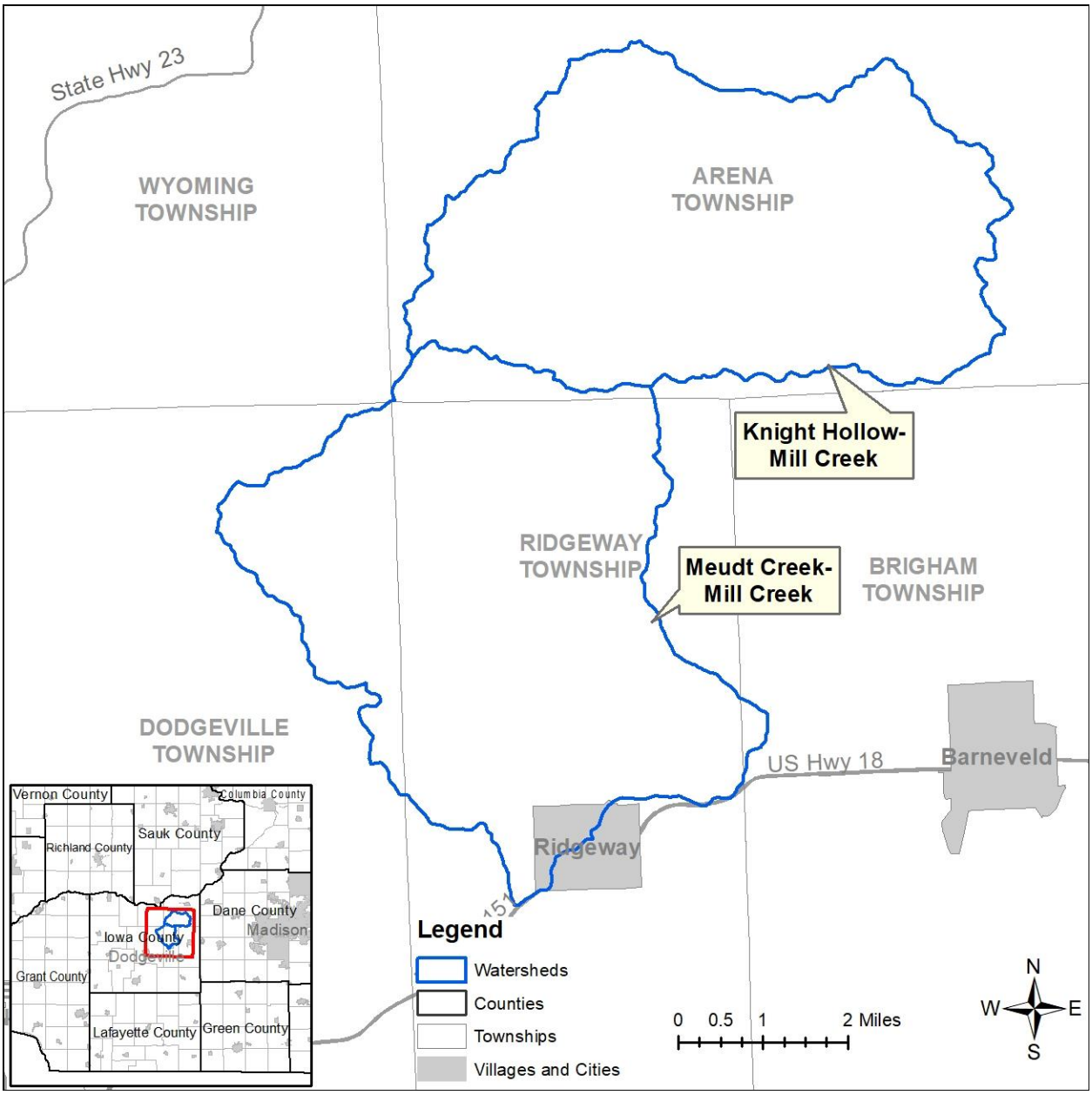


Figure 1. Location map of Meudt Creek and Knight Hollow

Section 2
Watershed Characterization

Section 2.1: Recognition of Indigenous Lands

> *"Territory acknowledgement is a way that people insert an awareness of Indigenous presence and land rights in everyday life. This is often done at the beginning of ceremonies, lectures, or any public event. It can be a subtle way to recognize the history of colonialism and a need for change in settler colonial societies.*
>
> *However, these acknowledgements can easily be a token gesture rather than a meaningful practice. All settlers, including recent arrivants, have a responsibility to consider what it means to acknowledge the history and legacy of colonialism. What are some of the privileges settlers enjoy today because of colonialism? How can individuals develop relationships with peoples whose territory they are living on in the contemporary Canadian geopolitical landscape? What are you, or your organization, doing beyond acknowledging the territory where you live, work, or hold your events? What might you be doing that perpetuates settler colonial futurity rather than considering alternative ways forward for Canada? Do you have an understanding of the on-going violence and the trauma that is part of the structure of colonialism?*
>
> *As Chelsea Vowel, a Métis woman from the Plains Cree speaking community of Lac Ste. Anne, Alberta, writes:*
>
> *'If we think of territorial acknowledgments as sites of potential disruption, they can be transformative acts that to some extent undo Indigenous erasure. I believe this is true as long as these acknowledgments discomfit both those speaking and hearing the words. The fact of Indigenous presence should force non-Indigenous peoples to confront their own place on these lands.' – Chelsea Vowel, Métis, Beyond Territorial Acknowledgements"*

The land outlined by both Meudt Creek and Knight Hollow were once occupied by the Miami, Ho-Chunk, and Meskwaki Nations. A brief introduction to each of the Nations is as follows:

Miami

The Miami Nation territory stretched from Wisconsin and Indiana to Michigan and Ohio, surrounding the Great Lakes region. They were considered to be a part of Mississippian, mound-building, culture with extensive regional trade networks and maize-based agriculture systems. As of today, most of their people were forcibly removed to what is now known as Kansas and then Oklahoma, where The Miami Tribe of Oklahoma, the only currently recognized Miami tribe, resides.

"In the Miami language, the Miami Tribe's name for itself is Myaamia, which means "the Downstream People." The story of the Myaamia begins at a place we call Saakiiweeyonki, near where the St. Joseph's River empties into Lake Michigan. At some point in our distant past, our ancestors first emerged onto our homelands at Saakiiweeyonki. From the village at Saakiiweeyonki, they descended into the Waapaahšiki Siipiiwi (Wabash River) valley building communities at major confluences and portages from Kiihkayonki (Ft. Wayne, Indiana) downstream to Aciipihkahkionki (Vincennes, Indiana). Together these villages maintained a common language, hunting and farming cultural practices. They often came together to collectively defend themselves and negotiate peace with neighboring tribes and Europeans.

Over generations, the Myaamia extended their cultural roots deep into the soil of the Wabash River Valley. The people drew their sustenance from the wetlands, prairies, woodlands, river bottomlands, and the plants and animals that lived in these places … These vital cycles of planting, harvesting, hunting, gathering, and processing governed the lives of the Myaamia for generations. The rhythms of these cycles reflect an ecologically-based existence in an ancestral homeland we call Myaamionki (Place of the Miamis)."

– Miami Tribe of Oklahoma

Ho-Chunk

The Ho-Chunk Nation is one of two federally recognized tribes, once singularly known as the Winnebago Tribe, who stretched from the southern half of Wisconsin to the northernmost counties of Illinois. Their name is derived from the word "Hochungra" meaning "people of the big voice." In the late 1700s, white miners began encroaching upon Ho-Chunk territory, despite having signed peace treaties with the federal government, beginning the loss of tribal rights and land. A series of treaties starting as far back as the 1820s and the Black Hawk War of 1832 led to their forced removal from their homeland to reservations in Iowa, Minnesota, South Dakota, and Omaha, Nebraska. However, in the face of forced removal, small groups returned to Wisconsin, with the largest settlement at the time establishing itself in Jackson County. The Ho-Chunk people in Wisconsin today are descendants of those who chose to resist and stay on their homelands. Outside of Wisconsin, a tribe in Nebraska exists today, descendants of those

forcibly removed from South Dakota reservations. Today, the Ho-Chunk have reclaimed over 2,000 acres in twelve counties in Wisconsin, slowly reestablishing land, community, and practices that are rightfully theirs.

Meskwaki

The Meskwaki Nation historically is from the St. Lawrence River Valley, Michigan, Wisconsin, Illinois, Missouri, and Iowa. In an effort to defend their land from European settlers, the Meskwaki and Sauk tribes allied together in 1735, eventually moving southward from Wisconsin to Illinois, Iowa, and Missouri. Following the Black Hawk War of 1832, the United States combined the two tribes for treaty making purposes into the "Sac & Fox Confederacy." In 1845, the Sauk and Meskwaki formally lost their lands in a series of land concessions and were forcibly removed to a reservation in Kansas. Few stayed in Iowa, hidden in resistance, allowing other tribe members to slowly move back to their homeland over the following years. By 1865, the State of Iowa enacted a law allowing tribe members to stay on the land that was rightfully theirs. Over time, the Meskwaki were able to formally purchase land as a sovereign nation in Tama County, where they are able to operate outside of federal and state policies. Today, the Meskwaki own over 8,100 acres in Tama, Marshall, and Palo Alto Counties in Iowa, have nearly 1,400 enrolled tribal members, and are the largest employers of Tama County, employing over 1,200 people.

Section 2.2: Ecology and Native Habitat

Meudt Creek and Knight Hollow fall on the southeastern most tip of the Western Coulee and Ridges ecological landscape in Wisconsin, part of the larger Driftless region. This landscape is the largest of Wisconsin's 16 ecological landscapes, covering 6,170,674 acres, or 17% of the state. It runs along the western edge of Wisconsin and has a predominant land use mix of forests (41%), agriculture (36%), grassland (14%), wetlands (5%), and urban/developed land (1%). The native and primary forest cover is oak-hickory, making up 51% of forests in the landscape, with Maple-basswood making up 28% and bottomland hardwoods in floodplain environments covering another 10% of forest cover. Other tree species that reside in this landscape include varieties of birch, aspen, ash, elm, cottonwood, pine, and hemlock. The landscape is also home to dozens of species of aquatic, terrestrial, and amphibious insects and animals unique to the region. Dry prairies off of steep rocky bluffs, including cliff and talus slopes with exposed bedrock, are common throughout the area, creating pockets full of diverse native flora and fauna unseen around most of the rest of the state.

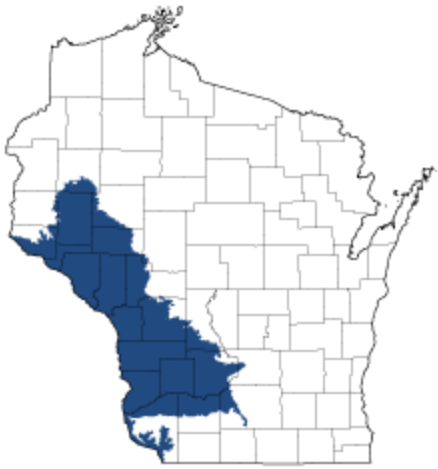


Figure 2. Map of Western Coulee and Ridges Ecological Landscape

Section 2.3: Climate

Because this region encompasses a long portion of the state, from Northern to Southern Wisconsin, the climate can vary quite a bit. While it is favorable to agriculture growing conditions, with the mean growing season lasting 145 days of the year, this variability in temperature and climate alters the growing season depending on latitude. With these variations in mind, the annual mean temperature is 43.7° with 32.6 inches of annual rainfall and 43 inches of annual snowfall. The variation in topography along the rugged landscapes and valleys has also created an abundance of microclimates and microhabitats that exist within valleys and rivers with broad, complex floodplains, establishing highly diverse habitats of plant and wildlife.

Section 2.4: Geology and Topography

As mentioned above, this region is largely defined by rough, irregular landscapes full of valleys and ridges. The landscape is largely composed of highly eroded, unglaciated topography, with steep slopes and cliffs, high gradient headwaters streams, and large rivers to small creek systems with complex floodplains and terraces. The region lies mostly on Paleozoic sandstones and dolomites of Cambrian and Ordovician age. Thin beds of shale and other sedimentary rocks can be found in some areas, as well as large cliffs and talus slopes with exposed bedrock.

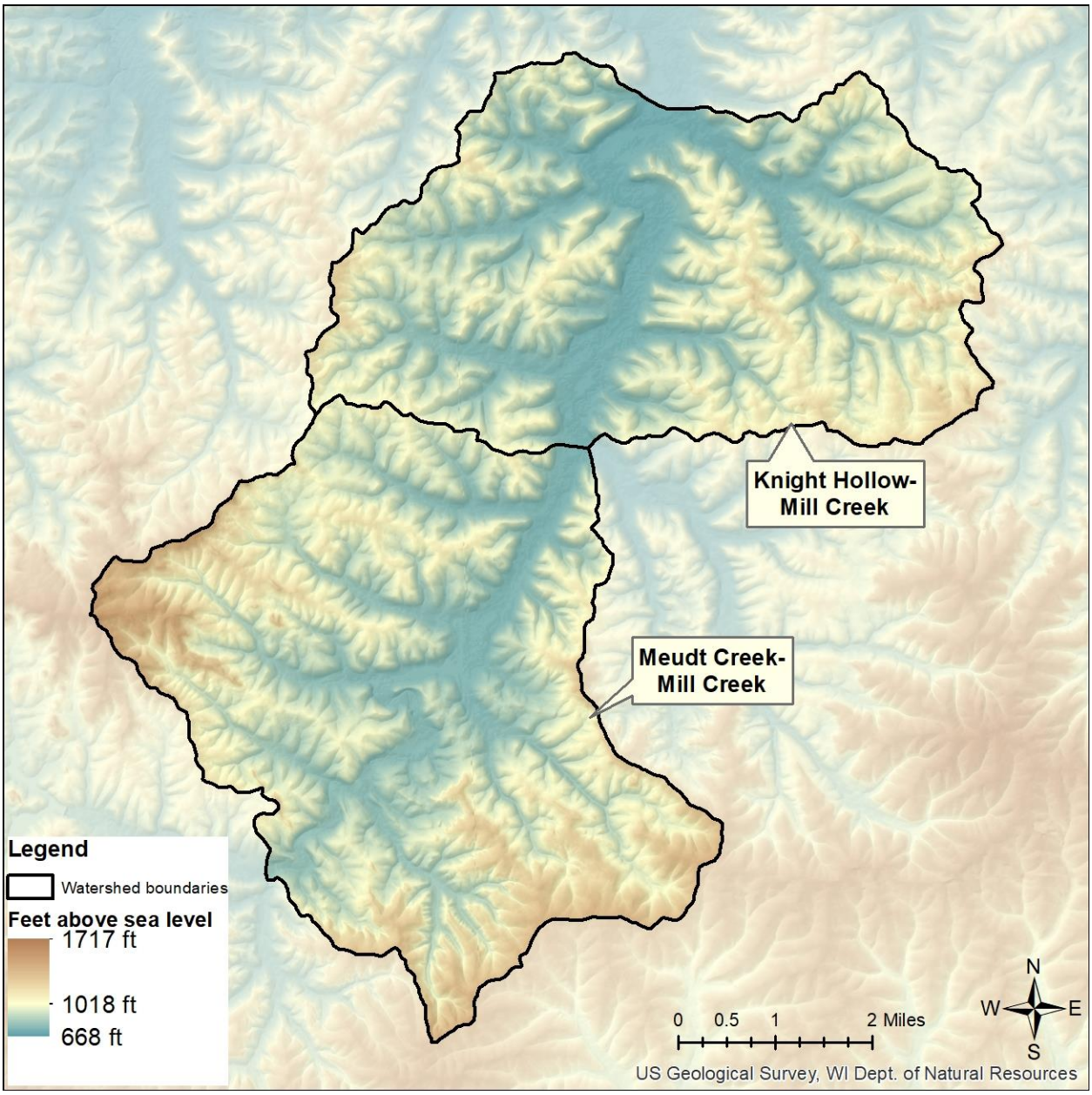


Figure 3. Digital Elevation Model with Hill Shade

Section 2.5: Watershed Basin

The Meudt Creek (HUC 070700050703) and Knight Hollow (HUC 070700050704) sub-watersheds fall within the Mill and Blue Mounds Creek watershed (LW15). This watershed is located along the western edge of Dane County and most of northeastern Iowa County, partially including the Wisconsin River outwash plain, and borders the northern edge of the

Southwest Savanna ecoregion. The basin is 187 mi^2 large, containing 383 miles of streams, 107 acres of lakes, and 6,587 acres of wetlands. Due to the rough terrain typical of the Driftless region, the amount of land in agricultural production is minimal compared to the land use categories across most of the rest of Wisconsin. Broad-leaf, deciduous forests cover most of the basin, including grasslands and a small percentage of wetlands and wet meadows along small streams and rivers. Most of these large rivers, namely the Wisconsin, Mississippi, Chippewa, Black, and Kickapoo rivers, border or flow through the edges of the basin.

Many of the waterbodies in this basin are listed in good condition, with 57% of fish and aquatic life in rivers and streams reporting good quality waters. Although there are many positive condition reports in this basin, 43% of these waters' quality are unknown and untested, and there are 33.3 reported miles of impaired streams in 7 steam systems. Many of these habitats support rare plant and animal communities that are in fair condition. These habitats include dry cliff, dry prairie, moist cliff, oak opening, pine relict, sand barrens, sand prairie, southern dry-mesic forest, southern mesic forest, ephemeral pond, emergent aquatic, forested seep, shrub-carr, southern sedge meadow, and fast, cold and hard stream. They are also home to a range of rare plant and animal species, including 1 species of beetle, 5 species of birds, 4 species of dragonflies, 14 species of fish, 1 species of frog, 9 species of mussels, 44 plant species, 1 mammal species and 2 species of leafhoppers.

Section 2.6: Sub-watershed Hydrology

Both Meudt Creek and Knight Hollow share the Mill Creek stream system and its many tributaries. The stream itself flows for 15.78 miles, in and out of the two sub-watersheds, and the section of the creek in Knight Hollow is listed as impaired. Mill Creek was assessed biennially between the years of 2012 and 2018 and was categorized as impaired, the total phosphorous loading of the sampled data exceeding the WisCALM (Wisconsin's Consolidated Assessment and Listing Methodology) listing criteria for fish and aquatic life use. However, the available biological data did not indicate impairment all four years for which data was collected, due to no macroinvertebrate or fish Index of Biotic Integrity (IBI) scoring in the "poor" condition category. Regardless of the IBI scoring, it's clear that there is an excess of phosphorous loading occurring in this creek system because of run-off from the neighboring land. Table 38 in Section 8.2 of this plan outlines the current data we have available for total phosphorus concentrations in both sub-watersheds, as well as our target concentration values and short-long term goals. Figure 4 shows Meudt Creek and Knight Hollow HUC 12 watersheds and TP impaired stream segments.

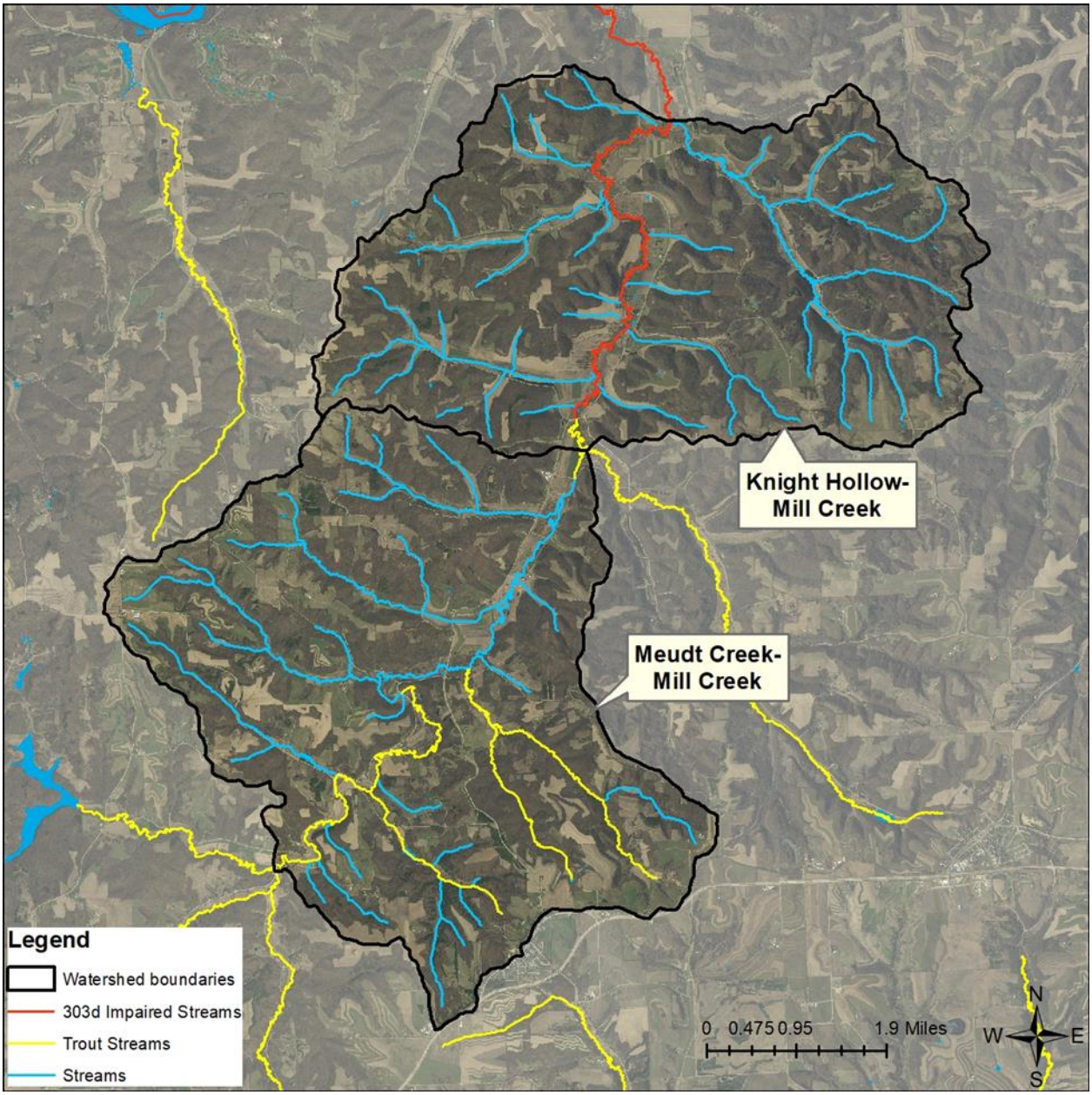


Figure 4. Water Resources Map

Outside of Mill Creek, the Meudt Creek sub-watershed is also home to Love (3.9mi), Strutt (2.2mi), and Meudt (3mi) Creek. The Knight Hollow sub-watershed is home to White Hollow Creek (3mi). Both sub-watersheds contain miles of multiple tributary waterways flowing into Mill Creek throughout various valleys. As seen in figure 4, there are also several trout streams, primarily in Meudt Creek and flowing out of Knight Hollow.

Section 2.7: Soil Types and Characterization

The Driftless region is home to windblown loess soil types of varying thicknesses, and alluvium soil types in the floodplains. Organic soils, particularly peat soil types, are rare to the area. Most hilltops and sideslopes are composed of loamy to clay-like residue with silt to sandy loam textures, ranging from well drained to moderately well drained. Narrow valleys soil drainage rates range from well drained to very poorly drained, many of them being subject to periodic flooding. Sideslopes, particularly on south and west facing slopes, can be dry and highly erodible due to their shallow depths to bedrock. However, most other soils across the region are highly to moderately productive.

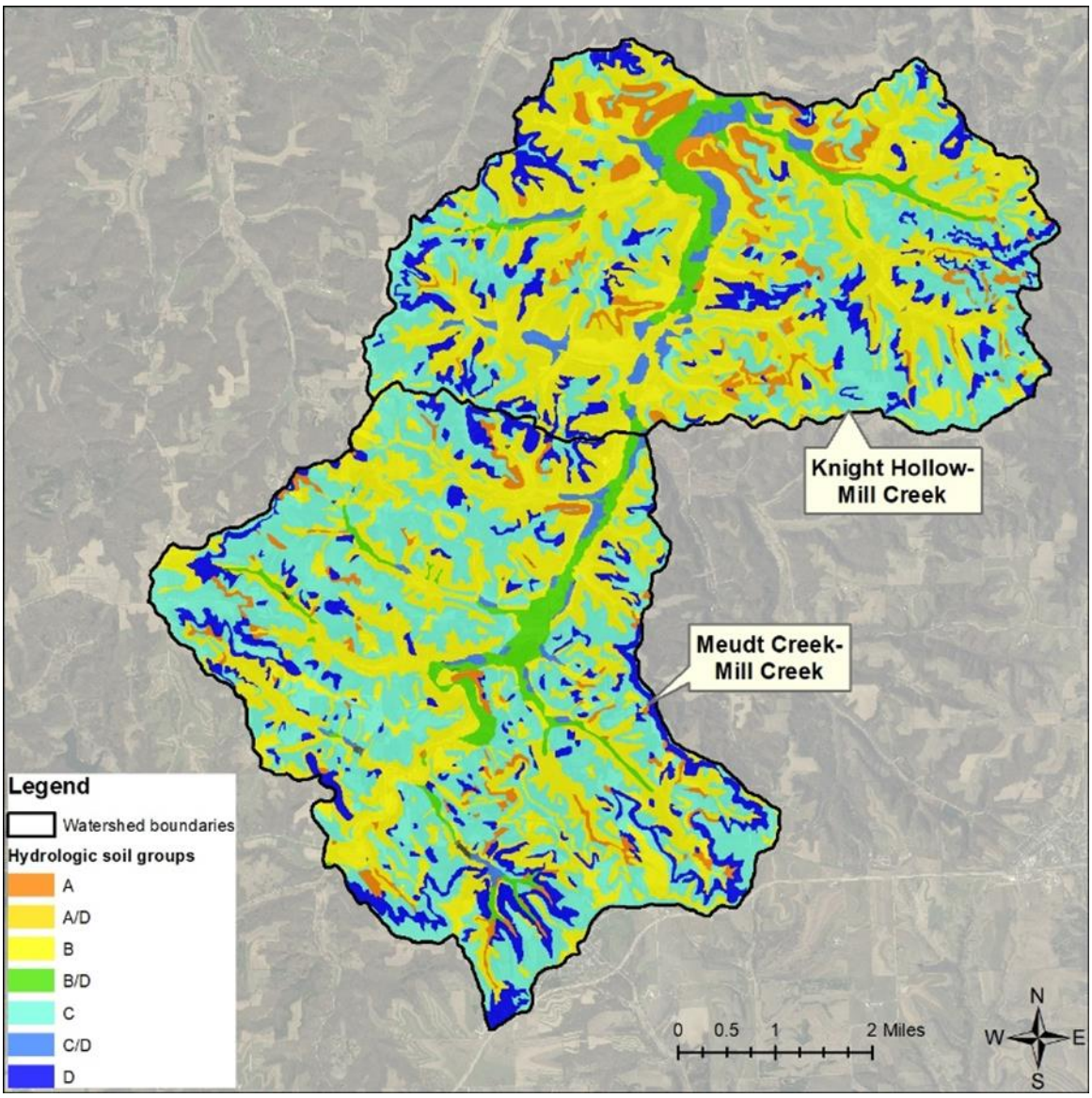


Figure 5. Map of Hydrological Soil Groups

Soils within the Meudt Creek and Knight Hollow sub-watersheds vary greatly due to the ridged and constantly changing landscape. Many of the soils are highly eroded due to the steep slopes common to the watershed, however much of the upland and lowland soil are highly productive silt loam-like soil types. Lowland soils are more susceptible to flooding, although most tend to have high to moderate water storage capacity. Understanding the soil types in this particular watershed is critical to selecting the appropriate conservation practices. The varying slopes, deep valleys, and differing soil textures and structures define how water interacts with the land and informs producers of the appropriate practices to adopt on their fields. Figures 5 and 6 convey the hydrologic soil groups and soil erodibility (K Factor) classes within each sub-watershed.

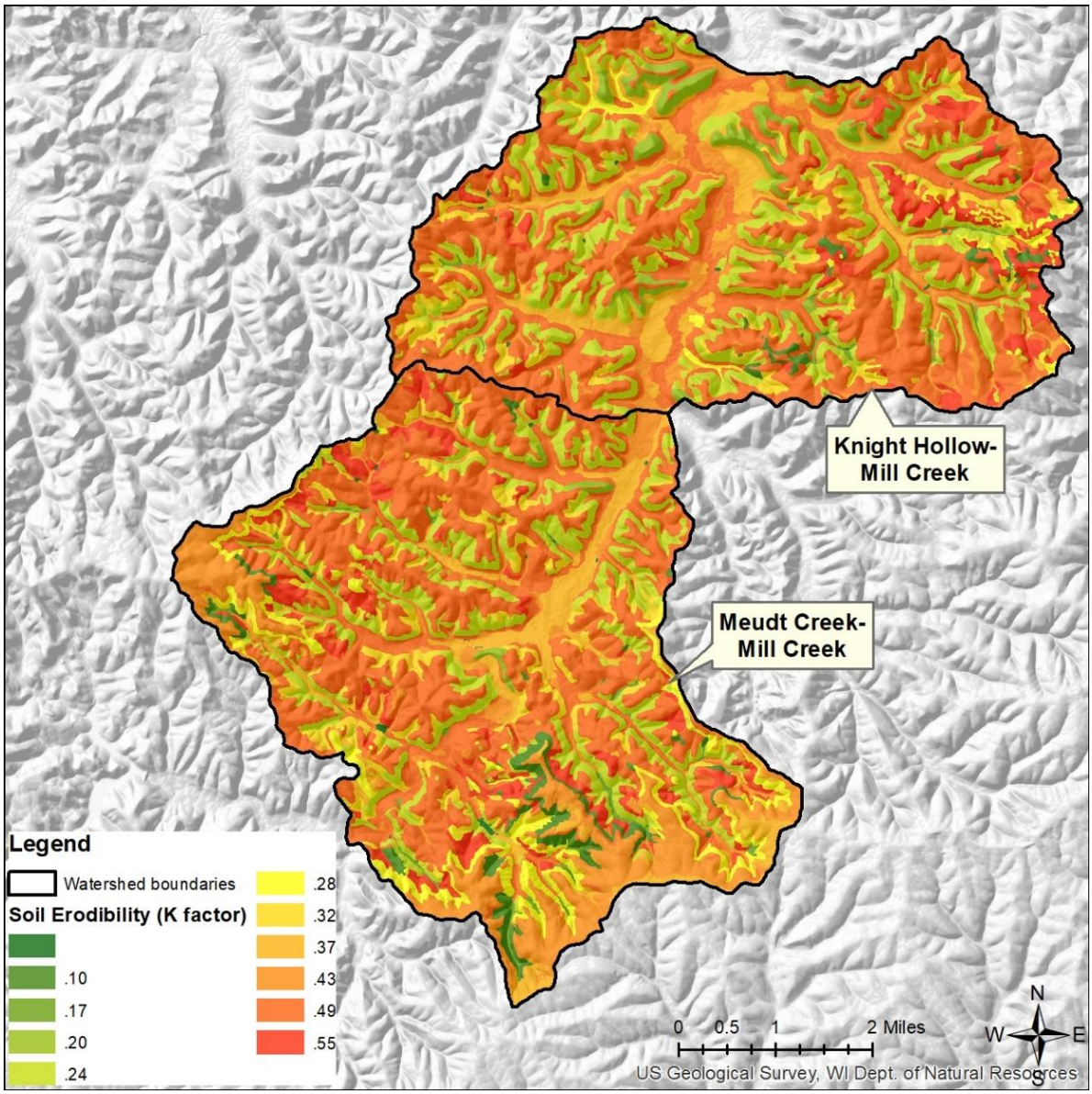


Figure 6. Soil Erodibility Map with Hill Shade

The following list describes the 3 most common soil types present on agriculture production land in both sub-watersheds.

<u>Meudt Creek Most Abundant Agriculture Soil Types</u>

- Pepin Silt Loam (Soil Code 125)
    - *National Map Unit Symbol: 2t7zs*
    - *Farmland Classification: Farmland of statewide importance*
    - *Depth to Bedrock: 59 – 76 inches to lithic bedrock*
    - *Natural Drainage Class: Well drained*
    - *Depth to Water Table: More than 80 inches*
    - *Available Water Storage: High (~11.2 inches)*
- New Glarus Silt Loam (Soil Code 144)
    - *National Map Unit Symbol: 2t7zj*
    - *Farmland Classification: All areas are prime farmland*
    - *Depth to Bedrock: 39 – 59 inches to lithic bedrock*
    - *Natural Drainage Class: Well drained*
    - *Depth to Water Table: More than 80 inches*
    - *Available Water Storage: Moderate (~7 inches)*
- New Glarus Silt Loam (Soil Code Ds)
    - *National Map Unit Symbol: 2t7xw*
    - *Farmland Classification: All areas are prime farmland*
    - *Depth to Bedrock: 10 – 25 inches to strongly contrasting textural stratification, 20 – 39 inches to lithic bedrock*
    - *Natural Drainage Class: Well drained*
    - *Depth to Water Table: More than 80 inches*
    - *Available Water Storage: Low (~4.2 inches)*

<u>Knight Hollow Most Abundant Agriculture Soil Types</u>

- Pepin Silt Loam (Soil Code 125)
    - *National Map Unit Symbol: 2t7zs*
    - *Farmland Classification: Farmland of statewide importance*
    - *Depth to Bedrock: 59 – 76 inches to lithic bedrock*
    - *Natural Drainage Class: Well drained*
    - *Depth to Water Table: More than 80 inches*

    - *Available Water Storage: High (~11.2 inches)*

- New Glarus Silt Loam (Soil Code 144)
    - *National Map Unit Symbol: 2t7zj*
    - *Farmland Classification: All areas are prime farmland*
    - *Depth to Bedrock: 39 – 59 inches to lithic bedrock*
    - *Natural Drainage Class: Well drained*
    - *Depth to Water Table: More than 80 inches*
    - *Available Water Storage: Moderate (~7 inches)*
- Ettrick Silt Loam (Soil Code 629)
    - *National Map Unit Symbol: 2wtqy*
    - *Farmland Classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season*
    - *Depth to Bedrock: More than 80 inches*
    - *Natural Drainage Class: Poorly drained*
    - *Depth to Water Table: 0 – 6 inches*
    - *Available Water Storage: Very high (~13.8 inches)*

Section 2.8: Land Cover / Land Use

Meudt Creek and Knight Hollow share similar land use categories and values. Forests account for the just over 60% of the land cover of both watersheds, largely due to the inability to develop and produce crops on parts of the landscape. Meudt Creek's southern edge is located along U.S. Highway 151, where there is more development of residential and business corridors, which doubles the number of urban land use acres. Cropland acres within the two sub-watersheds are similar (appx 2,000 acres), although Knight Hollow has almost 1,000 more acres of pastureland than the Meudt Creek sub-watershed. Figures 7 and 8 and tables 1 and 2 convey land use map, land use categories, and crop rotations for each sub-watershed. Comparing the two sub-watersheds reveals how similar they are to each other and also reflects the opportunity for agricultural producers to adopt similar strategies, categories, and rates of conservation practices to improve soil health and water quality.

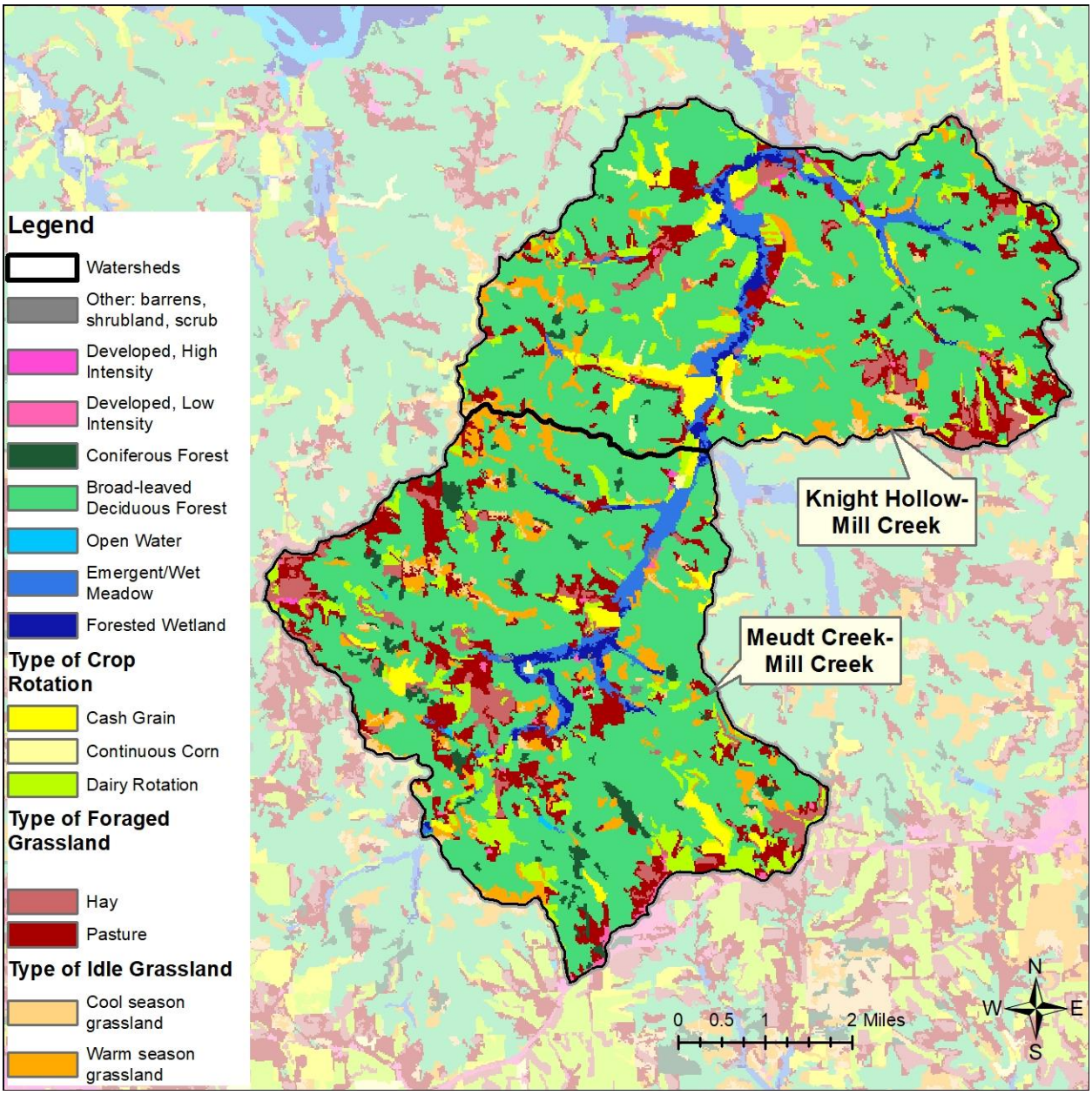


Figure 7. Land Use Map

Table 1. Land Use Categories

Watershed	Urban	Cropland	Pastureland	Forest	User Defined[1]
Meudt Creek	120 ac	2044 ac	1830 ac	9229 ac	1693 ac
Knight Hollow	60 ac	1923 ac	2614 ac	9068 ac	1367 ac

[1]User Defined: wetland, grassland, and barren acres

Section 2.9: Crop Rotations and Tillage

Figure 8 and table 2 below are estimates we received from the Wisconsin DNR's 2010 – 2015 crop rotation analysis for each sub-watershed, using satellite imagery. Defining the crop rotations being practiced within both sub-watersheds is critical to estimate current and future watershed conditions and to understand what agricultural practices producers may or may not be implementing on their fields throughout the watershed. As with land use, each sub-watershed has similar crop rotations and acreage. Identifying common practices among certain crop or pasture/hay rotations helps us discover what's being practiced where and acknowledge where the gaps may reside in producers adopting relevant conservation practices. Although Figure 8 does not convey the extent and types of tillage practices within the watershed, the crop rotations within each sub-watershed can be used to infer this information. For example, a typical dairy rotation has several years of perennial alfalfa hay (no tillage) followed by 1-3 years of corn (with tillage); a pasture hay/grassland rotation has no tillage to maintain the perennial hay/pasture. Approximately 90% of the crop rotations within each sub-watershed consist of pasture/hay/grassland or dairy crop rotation; very little acreage follows a crop rotation that uses annual tillage practices.

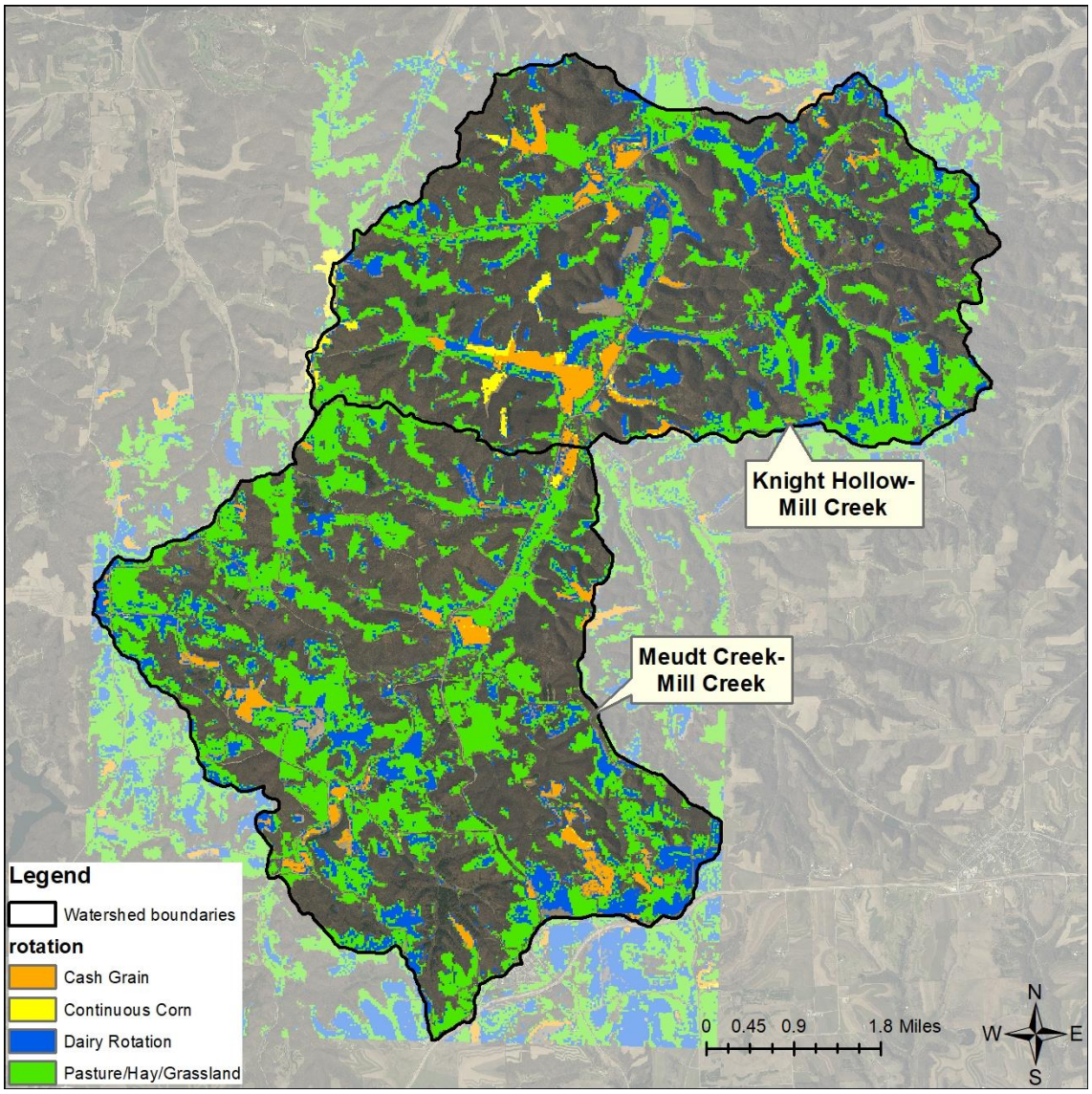


Figure 8. Crop Rotations Map

Table 2. Crop Rotation Acres

Watershed	No Agriculture	Pasture / Hay / Grassland	Dairy	Cash Grain	Continuous Corn
Meudt Creek	8,591 ac	4,423 ac	1,561 ac	381 ac	15 ac
Knight Hollow	8,659 ac	3,101 ac	1,359 ac	412 ac	142 ac

Section 2.10: Jurisdiction per Sub-watershed

Meudt Creek and Knight Hollow together reside within the townships of Ridgeway and Arena, and slightly into Dodgeville as well. Officials in each of these townships can play a significant role in outreach efforts about this plan and should be included in all outreach / education work with producers, residents, and other stakeholders in the community. The officials of each township currently are as follows:

- Arena
    - Chairman David Lucey
    - Board Supervisors: Bill Gauger and John Wright
- Ridgeway
    - Chairman Joe Thomas
    - Board Supervisors: Deane Judd and Ed Bures
- Dodgeville
    - Chairman: Curt Peterson
    - Board of Supervisors: David Gollon, David Blume, Peter Vanderloo, and Kyle Levetzow

Section 2.11: Community Demographics

The community demographics within the sub-watersheds can play a significant role in our outreach and education efforts. The demographics for the towns within the boundaries of the Meudt Creek and Knight Hollow sub-watersheds are shown in table 3.

Table 3. Community Demographics

	Arena	Ridgeway	Dodgeville (town)
Description	**Measure**	**Measure**	**Measure**
Population	1,496	600	1,708
Median Age	45	49.1	46.5
Percent High School Graduate or Higher	90.1%	98.2%	96.6%
Income	$62.917	$75,500	$75,063
Percentage Below Poverty Level	7.2%	6%	5.9%

Racial Demographic			
White	1,446	570	1,689
Black or African American	9	0	0
American Indian or Alaskan Native	20	0	0
Asian	0	10	7
Hawaiian and Other Pacific Islander	0	0	0
Two or More Races	7	14	4
Hispanic or Latino	11	3	3

Section 2.12: Prior & Current Watershed Work

Outside of the Wisconsin DNR's efforts to begin monitoring the quality of streams within the Meudt Creek and Knight Hollow sub-watersheds, we found no other projects specifically within these two sub-watersheds addressing water quality and land management practices. However, these two sub-watersheds are included in other County- or area-wide plans, such as the Iowa County Land and Water Resources Management Plan, the DNR's Wildlife Action Plan, local conservation non-profits' conservation planning, County and Township Comprehensive Plans, Driftless Area Restoration Effort strategic plan, Grow Southwest Wisconsin plan, and the Southwestern Wisconsin Regional Planning Commission Regional Plan. While these plans may not specifically mention these sub-watersheds, many of their respective goals are compatible with this watershed plan, including protecting surface and ground water quality.

Section 3

Element 1: Causes and Sources

Section 3.1: Point Source Pollution

Point source pollution is a category of pollutant loading where discharges into the environment can be traced back to a single point. Whether it be a drainage pipe, a specific property, or another discharge source, these pollutant sources are often the most apparent and identifiable sources of pollution. The list of point source pollutants in the Meudt Creek and Knight Hollow sub-watersheds are as follows.

Wastewater and Septic Systems

Failing or poorly managed septic systems can discharge unfiltered wastewater into nearby waterways or contaminate groundwater within a watershed. Similarly, domestic and non-domestic wastewater can create similar water quality problems. Domestic wastewater is derived from bathroom, kitchen, and laundry discharges. Non-domestic wastewater includes discharges from other sources, including manufacturing or processing operations and other commercial land uses. Although there are no wastewater treatment plants in the area, there is a cheese making facility that discharges whey wastewater. Our plan will look further into how this whey is discharged into or out of the watershed.

Feedlots within 300 Feet of an Open Body of Water

It is not a recommended practice to build feedlots within 300 feet of an open body of water due to the amount of condensed waste feedlot areas produce and may discharge if not properly managed or appropriately designed. Nitrogen loading to surface waters, in particular, can create acute water quality problems in a watershed. We estimate that there are 16 feedlots that exist in both sub-watersheds which fall under this category.

Processing Plants

The Knight Hollow sub-watershed contains a single cheese processing plant within its boundary. Wastewater discharge from this plant can include whey byproduct and other pollutants harmful to the environment if not managed properly. Noting this plant and learning about its wastewater discharge strategies and treatments will play an important role in protecting water quality in the area.

Section 3.2: Non-Point Source Pollution

Non-point source pollution is the leading cause behind water quality issues across Wisconsin and within the Mill Creek Watershed. Rainfall and snowmelt moving above and below the soil transports natural and man-made pollutants into the surface waters or, via recharge, into groundwater aquifers. Nonpoint source pollutants include fertilizers and other nutrients (e.g. animal manure), oil, sediment, bacteria, and other pollutants generated from agricultural, urban, and residential areas. This plan will focus upon reducing sources of nitrogen, phosphorus, and sediment loading from cropland and pastureland within each sub-watershed.

1. <u>Agricultural Sources</u>
    a. Soil Nutrients
        i. *Tillage*
        While tillage may help producers cultivate their crops in the short term, the practice also contributes to soil erosion and reduces soil health. Tilling the soil and leaving it exposed to weather events can lead to sediment and nutrient runoff from cropland or pastures into nearby bodies of water, which, if repeated over time, can overload them and cause or contribute to poor water quality and reduced aquatic habitat.
        ii. *Compaction*
        As a result of tillage and operating heavy machinery over the soil, the soil can become compacted, destroying the soil's structure and pore space that allow soil to absorb water and nutrients. When soil infiltration is reduced by repeated compaction (and tillage), soil erosion and nutrient runoff from upgradient cropland can increase and cause or contribute to water pollution and impaired waters.
        iii. *Lack of Stream Buffers*
        When producers plant to the very edge of streams, streambanks cannot protect streams from upland runoff and pollutants flowing into it. Without streambank vegetation or buffers, streambanks are more likely to erode, and fertilizers, pesticides/herbicides, and various other agricultural sources of pollution from upland areas have a higher risk of discharging into a stream system. In addition to serving as catchment basins, stream buffers also serve to protect the integrity of streambanks, preventing soil loss and erosion over time.
        iv. *Woody Invasives/Weeds Along Streambanks*
        Woody invasives and/or other weedy plants, such as Box Elder and Black Willow trees, can be problematic to the streambank environment. They

shade out native vegetation and invite livestock to shady areas near the stream, where excessing grazing and animal foot traffic can threaten the streambank physical integrity, wildlife, and plant diversity.

b. *Fertilizer Nutrients*
Over fertilization in addition to slow soil water infiltration leads to excessive run-off rates. When these nutrients are unable to be used by the plants they're intended for, they run-off into surrounding waterbodies or accumulate in the soil, over-saturating it with unnecessary nutrients.

2. Legacy Phosphorous Sources
Legacy phosphorous is the accumulation of phosphorous in the soil that goes unused by crops. When fertilizer and manure applications exceed crop nutrient needs, soil phosphorus concentrations remain in the soil and increase over time. When cropland soils receive rainfall/snowmelt and erode, soil phosphorus is delivered, via runoff, to surface waters. Streambank erosion along cropland and pastureland, either due to the depletion of soil structure and/or extreme weather events, can also deliver soil-based phosphorus into stream systems. Another source of legacy phosphorus within these sub-watersheds may be accumulated sediment within stream channels (generated primarily from historical soil erosion from upland areas). Examples of this can be observed in figures 10 – 12.

3. Livestock Sources
Livestock can be both helpful and destructive to water quality within a watershed. If managed properly, livestock manure nutrients can be used to fertilize crops and improve soil organic matter. If mismanaged, however, livestock manure application to cropland or unrestricted livestock grazing along or within streams can be a significant source of water pollution and environmental degradation. Table 4 below shows the estimated number of livestock we believe are in both sub-watersheds. These numbers were estimated through various methods, ranging from ground truthing, record collection, and surveying. The extent of livestock manure application to cropland and unlimited access to streams/streambanks within each sub-watershed is not clear and will need to be evaluated repeatedly during this plan's ten-year implementation schedule.

Table 4. Livestock Estimates

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Chicken
Meudt Creek	1215	765	70	52	520
Knight Hollow	990	840	5	52	150

a. *Feedlots*

Feedlots can be a highly concentrated source of pollutant loading to surface or ground water. Without the proper management, the accumulation and runoff of animal feed and waste can lead to significant pollutant-loading issues to nearby waterbodies or ground water systems. The closer a feedlot is to a body of water, the more of a threat it potentially is to the quality of that water system. During plan development, we identified several potentially problematic feedlots in both sub-watersheds that will need immediate attention / verification. We expect some poorly managed feedlots will require adoption of improved waste collection and management systems to allow for effective use of the nutrients for fertilizing crops or pasture grasses

b. *Livestock Access to Streams for Water*

Alternative water supplies are an important management practice for limiting and/or preventing livestock access to streams. Unlimited access to streams can result in trampling of vegetation and degradation of streambank integrity that frequently leads to increased erosion, nutrient rich sediment, and pollutant loading to surface waters. Cattle having unlimited access to streams also allows them to deposit their waste directly into the stream.

c. *Manure Spreading*

Dairy operations with confinement systems need to collect and spread the cattle's manure. Proper amount, timing, and location of spreading are critical to reducing nutrient losses to the water. Poor manure management can often result in significant nutrient-laden runoff entering surface waters within these two sub-watersheds, particularly with the Driftless area topography. Winter manure spreading, due to limited or no manure storage capacity, can be particularly risky, as it can cause runoff to surface waters and significantly reduce water quality.

Section 4

Elements 2-3: Nutrient Loads, Reductions from Practices, and Critical Areas

Section 4.1: Current Nutrient Loading

Estimate Challenges

When we began work to meet Element 2 in this 9 Key Element Plan, it became clear that we would face a number of unique challenges in collecting the data necessary for us to move forward with accurately modeling the land use practices and estimating current and future nutrient loading occurring in the Meudt Creek and Knight Hollow sub-watersheds. Through community outreach, data collection and compiling, and various creative strategies listed below, we were able to either collect the land use and practices data we needed or make well educated estimates of their values. While we believe that the values reflect the current conditions/nutrient loading within each sub-watershed well, we recognize the numbers should be adjusted over the course of this 10-year plan. As we continue to build relationships with residents, land owners, producers, organizations, and others in these sub-watersheds, we hope to gain more information about actual practices, which we will use to affirm or adjust this plan's pollutant load estimates and ensure the modeling is as accurate as possible.

Listed below is an outline of the strategies and challenges we faced in collecting our land use data for this plan. The maps and figures featured in these sections outline how we identified critical and highly erosive areas in both sub-watersheds, and where specifically we will need to confirm their condition.

1. Photo Interpretation

   Our group used photo interpretation to collect data through two methods: 1) ground truthing, and 2) satellite images. These methods helped us confirm various land use practices throughout both sub-watersheds and helped us confirm data from existing maps and Nutrient Management Plans within the sub-watersheds.

   a. *Ground Truthing Photos/Observations*

      On multiple occasions, our team drove through each sub-watershed, taking snapshots of all visible parcels of land and recording general observations of common practices. While this process proved to be very informative, a significant portion of these observations were made during the early-to-mid-winter months, when light snow had just begun to cover the fields we were observing. While most practices, such as fall tillage and crop selection, were

clear to identify through the thin layer of snow, others were more difficult to identify for certain and will require further confirmation over this plan's ten-year schedule. Within years one and two of the plan, we will conduct additional ground-truthing efforts, especially near feedlots and streambanks.

The following figures represent examples of how we collected and analyzed our data while ground-truthing the quality of streambanks. Figure 9 is a map we created outlining the streambank buffer quality along public roads we were able to access and observe from. Points in red are locations with nonexistent, minuscule, or highly eroded streambanks; points in green represent quality, stable streambanks; the remaining points in orange are conditions somewhere between the two.

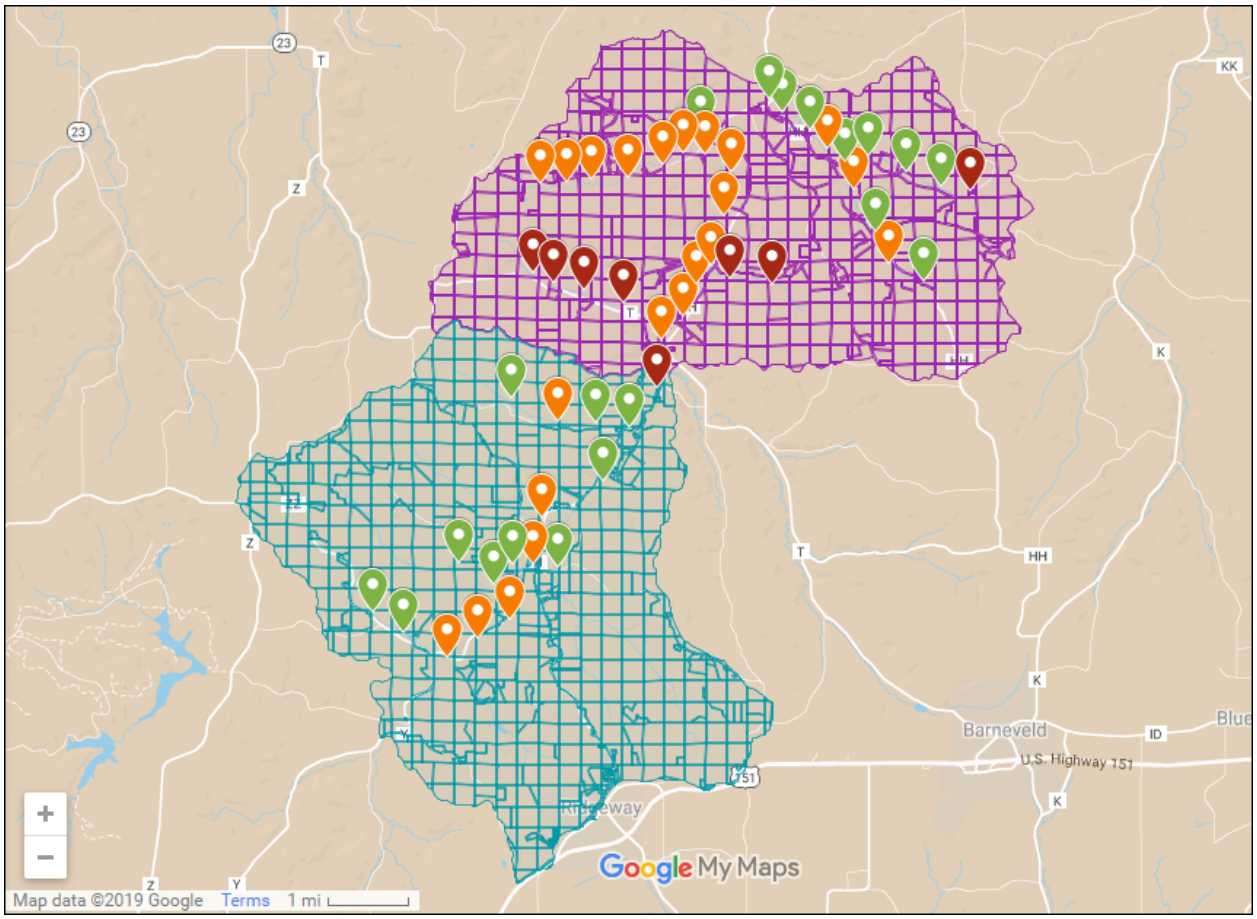


Figure 9. Streambank Buffer Quality Observations

Figures 10 – 12 illustrate examples of the condition of many streambanks we observed in figure 9. These images are indicative of some of the most common problems we observed throughout streams in the watershed.

Figure 10. Streambank Buffer Quality Observations 1

Figure 11. Streambank Buffer Quality Observations 2

Figure 12. Streambank Buffer Quality Observations 3

b. *Satellite Images*

Our group used satellite images on multiple occasions to identify practices such as contour farming, barnyard placement, and even livestock number estimates within each sub-watershed. Similar to the ground-truthing photos, most practices captured in satellite images were unmistakable and easily identified. Only a limited number of practices were less clear and will require further confirmation. Figures 13 and 14 are examples of how the difference in stream buffer quality can be observed from satellite images. Streams with limited buffers, as observed in figure 14, were identified, helping inform where to focus our ground-truthing efforts. Figures 16 and 17 also show how we identified problematic feedlots within 300 ft of streams through analyzing GIS data overlaid upon satellite imagery. Each of the circles in figure 17 identify where approximately 4-6 barnyards are located within both sub-watersheds.

Figure 13. Quality Stream Buffer Example

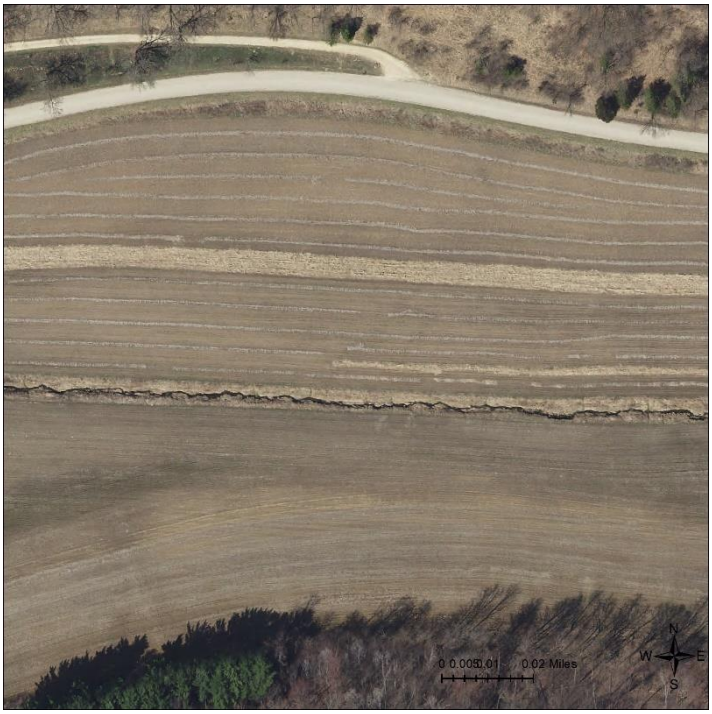


Figure 14. Problematic Stream Buffer Example

Figure 15. Contour Farming Example

Figure 16. Problematic Feedlots Example

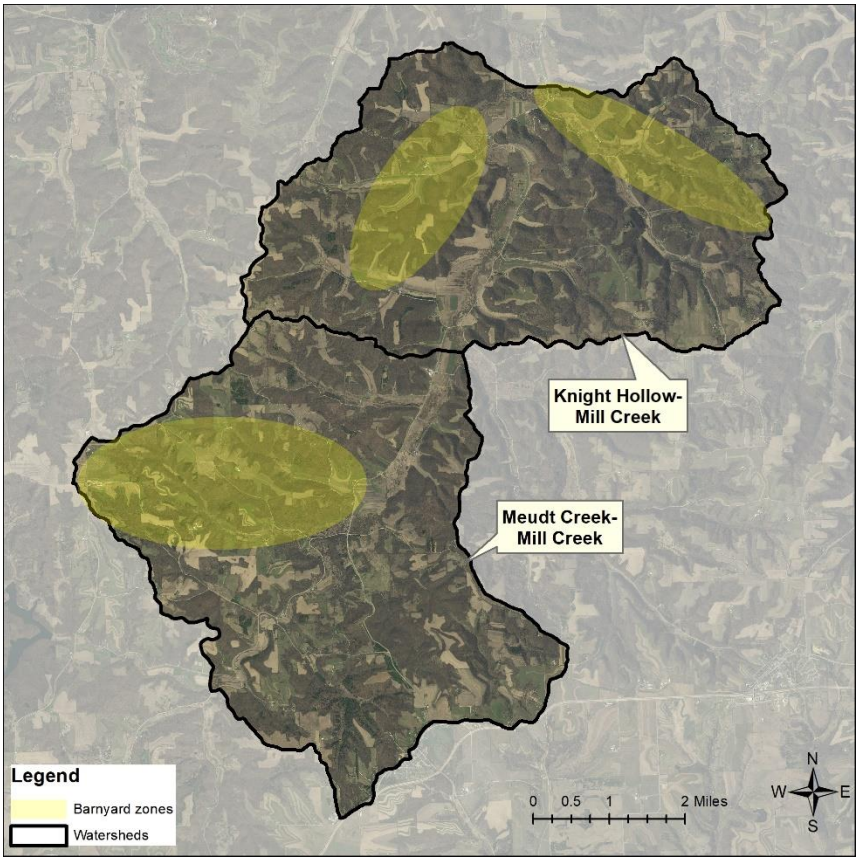


Figure 17. Problematic Feedlot Locations

2. Topography and Visibility
   Unlike most of Wisconsin, the Driftless region of Wisconsin is filled with ridged hills, valleys, dense forests, and winding roads. This topography limited observation of land use practices along public roads. Again, we recognize the topography of each sub-watershed will require further confirmation of current cropland and pasture-based practices.

3. Farmer Speculation and Insight
   To continue our ground-truthing efforts, our group reached out to the Uplands Farmer Led Watershed Group of Iowa County (www.uplandswatershedgroup.com), local town officials, and a handful of other leaders and community members who may know more about land use practices in their neighborhood. Unfortunately, but understandably, our inquiries were met with hesitation, since farmers and community members were uncomfortable speculating about their neighbors' specific practices. While we weren't able to learn much about current practices though these conversations, we were however able to gain insight about future strategies and practices that may best fit producers' needs in the area.

4. Record and Spatial Data Collection
   While searching for records on practice adoption rates, farm sizes, livestock numbers, land use spatial data, and various other data points, we found it quite challenging to compile clear results with the information available to us. The records we did find were often inconclusive to determine the practices relevant to modeling pollutant loads for each sub-watershed. Much of the data was often held and highly protected by public agencies and/or private organizations. Nonetheless, we were able to gather enough information to provide input data for the Spreadsheet Tool for Estimating Pollutant Load (STEPL) model. As mentioned above, we do plan to continue compiling new or revising existing information about current practices in each sub-watershed as outreach efforts are completed with agricultural producers and other landowners over this ten-year plan.

   Figures 18 and 19 below are examples of some of the spatial data we collected and analyzed. These maps overlay crop and pasture rotations over three of the highest K factor (soil erodibility) values, helping identify the most vulnerable agricultural land to erosion in both sub-watersheds. However, it's important to note that these maps do not include the extent of conservation practices being adopted in these highlighted areas. In order to truly identify these areas' susceptibility to erosion, over the next two years we will identify which cropland parcels are actively practicing conservation measures (NMP's, reduced tillage, etc.) and which parcels are still in pasture, and their condition.

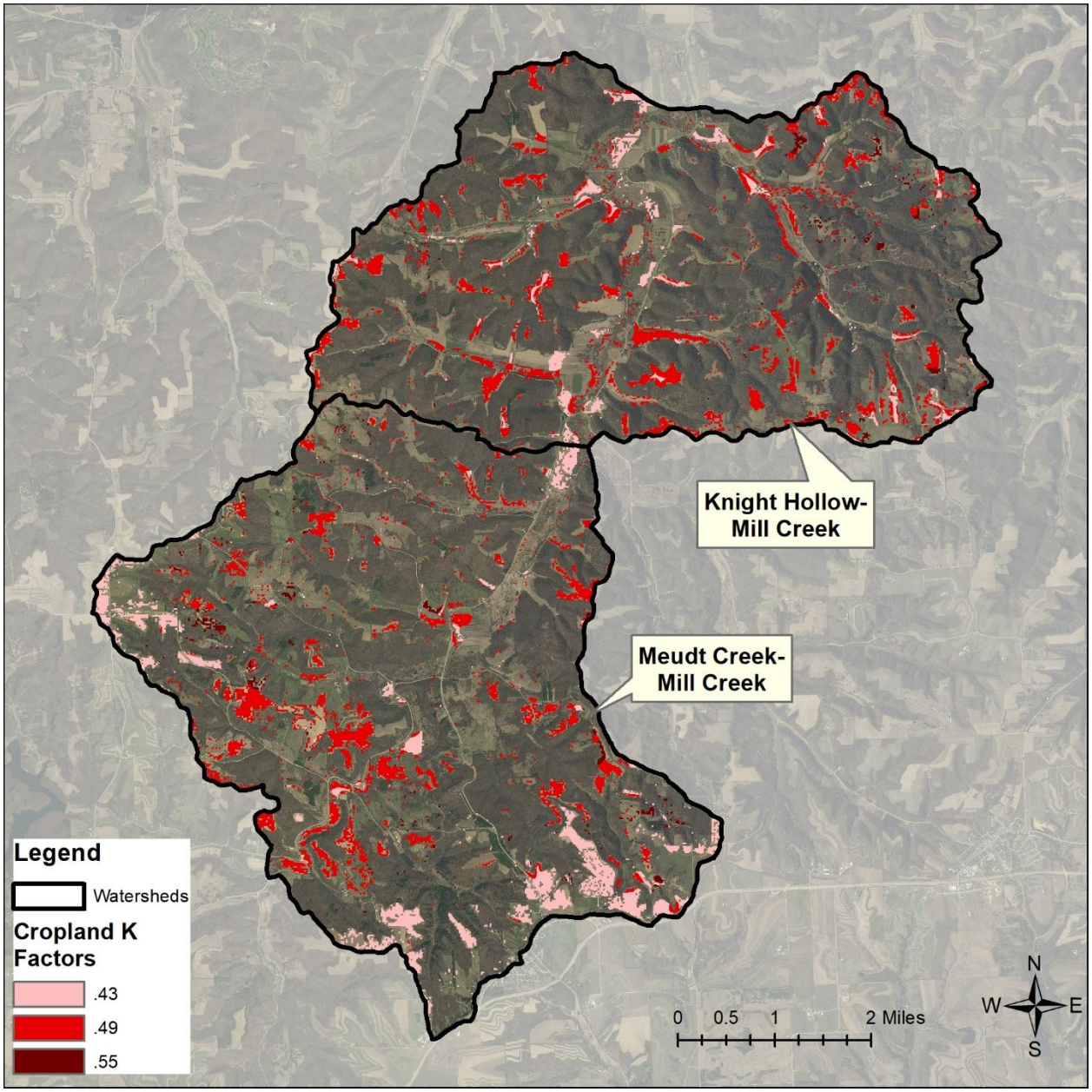


Figure 18. Highly Erodible Cropland

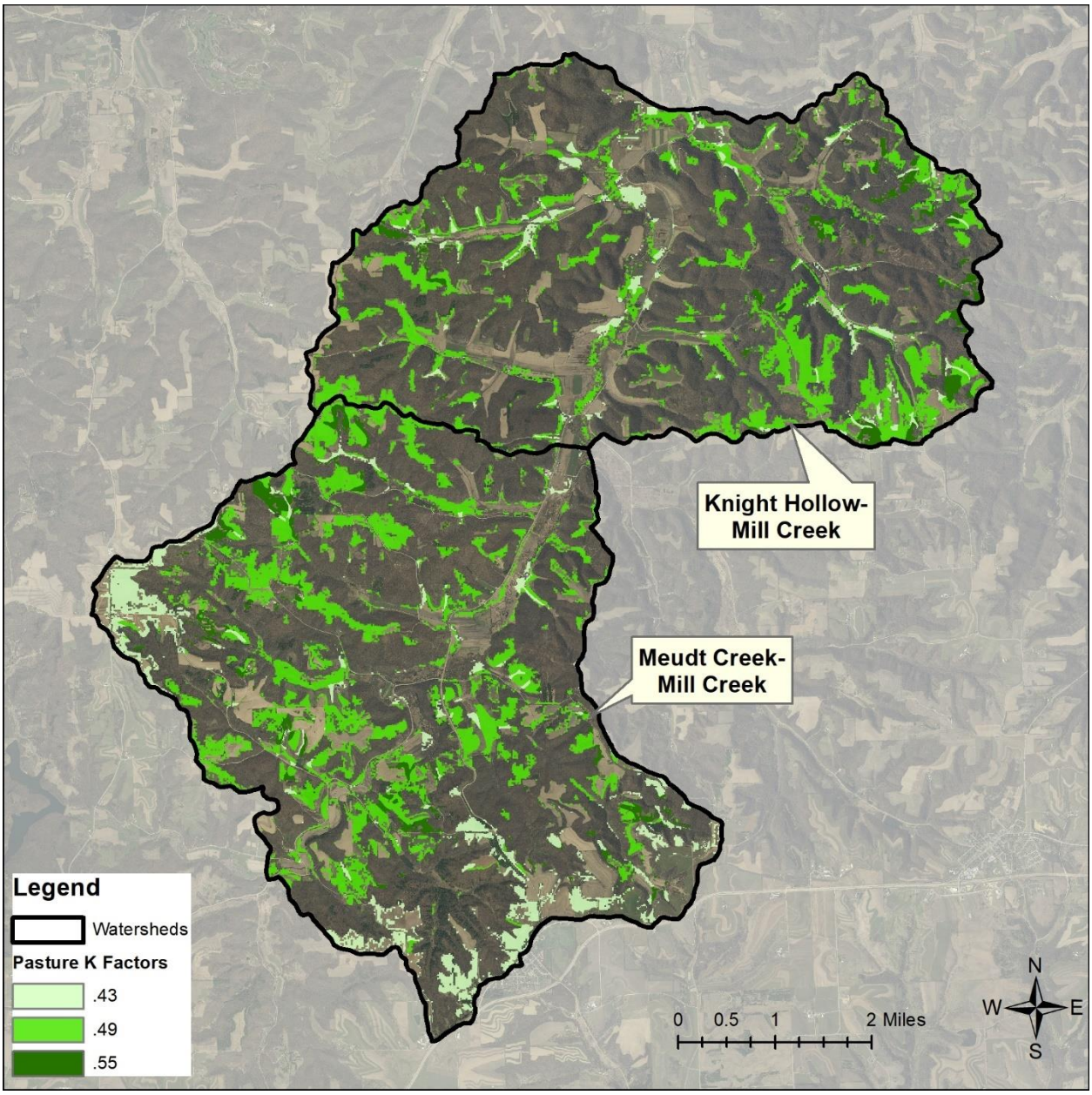


Figure 19. Highly Erodible Pastureland

Ground-Truthing Process

Ground-truthing areas within the watershed played a significant role in determining the input values used in this plan's nutrient loading estimates. Outside of the outreach strategies listed above, most of our ground-truthed data was collected from driving around the watershed, mapping the practices we observed and recording other observations. We started this process in the last week of December, 2017. Our team drove to various fields across the watershed and began identifying the best ways to observe and record farming practices. Iowa County Agriculture Agent, Gene Schriefer, worked with the rest of our team to help us learn to identify crops grown, livestock, and land management practices – namely different tillage methods. Over the following month or two, our group mapped every single parcel of land visible from the public roads throughout both watersheds. Using My Google Maps, we were able to take notes and pictures of every parcel visible to us. After reviewing the pictures and notes we took, we were able to better identify many practices that were adopted within each sub-watershed, helping us better inform our model.

Additionally, once the snow melted, we spent more time driving around the watershed observing various other practices including tillage, contour farming, and soil quality/exposure. On a separate date, we spent a day mapping the quality of buffers along the streambanks across both sub-watersheds, which significantly informed our conversation around buffer strip BMPs and legacy phosphorus. These and other findings can be observed in figures 9 – 12 above.

STEPL and Total Combined Load per Land Use

In order to estimate nutrient and sediment loading in the Meudt Creek and Knight Hollow sub-watersheds, the Wisconsin DNR recommended using a program called STEPL (Spreadsheet Tool for Estimating Pollutant Load) to interpret the watershed data we collected. STEPL is a Microsoft Excel-based program that uses simple algorithms to calculate pollutant loads for a specific watershed. STEPL pollutant loads are based on annual rainfall, watershed size, land use, predominant soil disturbance level, soil phosphorus concentration, animal numbers, fertilizer spreading frequency, and current Best Management Practices (BMPs) adopted in the watershed. Annual loading calculations are based on concentrations of pollutants in run-off from varying land management practices. For sediment loading, STEPL uses the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. For this plan, we focused on STEPL's nitrogen (N), phosphorous (P), and sediment (Sed) loading estimates. Table 5 below, shows STEPL derived total pollutant load values for both sub-watersheds.

Table 5. Current Total Combined Pollutant Load per Land Use Category w/ Existing BMPs

Sources	Nitrogen Load (lb/yr)	Phosphorus Load (lb/yr)	Sediment Load (t/yr)
Urban	1,055.92	175.01	25.35
Cropland	26,091.12	7,349.05	1,268.02
Pastureland	24,557.62	5,624.48	1,570.21
Forest	4,826.58	2,892.04	460.34
Feedlots	66,334.12	11,843.74	0.00
User Defined	88.42	72.95	27.63
Septic	390.16	152.81	0.00
Gully	0.00	0.00	0.00
Streambank	0.00	0.00	0.00
Groundwater	0.00	0.00	0.00
Total	123,343.95	28,110.08	3,351.55

<u>Land Management Practice Adoption Rates</u>

Based on the information gathered from our ground truthing efforts, data compiled from Nutrient Management Plans, and general knowledge of producer trends in the area from expert agriculture/conservation agents, we recognized that the data on paper didn't necessarily reflect the reality of land management practices being adopted across the watershed. This became evident from the amount of tillage, particularly fall tillage, we observed first hand in the early winter and spring months. Listed below are the adjusted numbers used within the STEPL model for Nutrient Management Plans, Conservation Tillage, and Contour Farming practice adoption rates, to better reflect watershed's current conditions.

- Nutrient Management Plans (determined rate and additional considerations)
    - While there were many producers with these plans, we estimate that only 20% of them were accurately following them.

- Conservation Tillage (≥ 60% residue)
    - Based on the amount of tillage we observed across each sub-watershed, we estimate that 85% of producers who claim to practice conservation tillage are accurately following the practice.
- Contour Farming
    - Through the same process, we estimate that 50% of producers that claim to practice contour farming are accurately following the practice.

Table 6 below illustrates each of the baseline and future BMPs in this plan, and their respective efficiency values.

Table 6. BMP Codes and Efficiency Values

BMP	Land Use	Nitrogen (N) Reduction	Phosphorus (P) Reduction	Sediment Load (Sed) Reduction
Grass Buffer (35')	Cropland	0.593	0.917	0.848
Conservation Tillage 2[1]	Cropland	0.25	0.687	0.77
Contour Farming	Cropland	0.279	0.398	0.341
Cover Crop 2[2]	Cropland	0.196	0.07	0.1
Nutrient Management Plan 2[3]	Cropland	0.247	0.56	N/A
Streambank Stabilization and Fencing	Cropland	0.75	0.75	0.75
Alternative Water Supply	Pasture	0.133	0.115	0.187
Grass Buffer (35')	Pasture	0.868	0.766	0.648
Grazing Land Management[4]	Pasture	0.43	0.263	N/A
Livestock Exclusion Fencing	Pasture	0.203	0.304	0.62
Prescribed Grazing	Pasture	0.408	0.227	0.333

[1] Conservation Tillage 2: ≥ 60% residue

[2] Cover Crop 2: Group A traditional normal planting time, high till only for TP and Sediment

[3] Nutrient Management Plan 2: Determined rate and additional considerations

[4]Grazing Land Management: Rotational grazing w/ fenced areas

BMP Codes and Efficiency Values

The STEPL model assigns N, P and Sediment reduction efficiency values per agricultural practice, meaning that some Best Management Practices (BMPs) are more effective at removing/prohibiting certain pollutant loads than others. The higher the decimal value is on the efficiency, the more effective that practice is at reducing a pollutant. STEPL also allows users to reflect how some ag. producers use multiple practices on the same field by adjusting BMP efficiency values via its "BMP Calculator" tool. This tool helps a user add practices together to create new efficiency values. While there are a number of producers who adopt a singular practice, our group was able to identify a trend of common Combined BMPs that most producers in the watershed practice at once.

Table 7 describes the BMPs and corresponding BMP reduction efficiency values used in this plan. Table 7 also explains a code we assigned to different BMP combinations. The BMP codes with a number following them represent cropland practices, while the codes with a lowercase letter following them represent pastureland practices. Some of these codes were used to model current practices in each sub-watershed, while others were used to model future practices in each sub-watershed to estimate pollutant reductions over this plan's ten-year schedule.
We expect there will be a range of practices adopted within the watershed over time. The practices shown below are an attempt to account for this variability.

Table 7. BMP Codes and Efficiency Values

BMP Code	BMP Description	Nitrogen (N) Reduction	Phosphorus (P) Reduction	Sediment Load (Sed) Reduction
BMP1	Nutrient Management Plan 2[1] + Conservation Tillage 2[2] + Contour Farming	0.593	0.917	0.848
BMP2	Nutrient Management Plan 2[1] + Conservation Tillage 2[2]	0.435	0.862	0.770
BMP3	Nutrient Management Plan 2[1] + Contour Farming	0.457	0.735	0.341
BMP4	Conservation Tillage 2[2] + Contour Farming	0.459	0.812	0.848
BMP5	Streambank Stabilization and Fencing + Grass Buffer (35')	0.835	0.859	0.883
BMP6	Nutrient Management Plan 2[1] + Conservation Tillage 2[2] + Cover Crops 2[3]	0.546	0.872	0.793
BMPa	Prescribed Grazing + Livestock Exclusion Fencing	0.528	0.462	0.747
BMPb	Alternative Water Supply + Grazing Land Management[4]	0.506	0.341	0.187
BMPc	Prescribed Grazing + Livestock Exclusion Fencing + Grass Buffer (35')	0.938	0.874	0.911
BMPd	Alternative Water Supply + Grazing Land Management[4] + Grass Buffer (35')	0.935	0.847	0.714

[1]Nutrient Management Plan 2: Determined rate and additional considerations

[2]Conservation Tillage 2: ≥ 60% residue

[3]Cover Crop 2: Group A traditional normal planting time, high till only for TP and Sediment

[4]Grazing Land Management: Rotational grazing w/ fenced areas

Current Total BMP Acres

While there generally was overlap between BMPs adopted by producers in Meudt Creek and Knight Hollow sub-watersheds, their rate of adoption per practice varied enough to distinguish the two from each other. After collecting the practices data, ground-truthing similar or related practices, and adjusting those values based on the estimated ratio of producers who were implementing each BMP, we reached an estimated total cropland and pasture acres with BMPs that are currently being implemented, per sub-watershed. Tables 8 and 9 summarizes our current cropland and pasture BMP findings.

Table 8. Meudt Creek Current BMP Acres (Cropland and Pasture)

BMPs	Acres
BMP1	141.88
BMP2	58.92
BMP3	36.49
BMP4	567.52
Conservation Tillage 2	85.08
Contour Farming	254.11
BMPa	300
Current BMP acres	**1444**

Table 9. Knight Hollow Current BMP Acres (Cropland and Pasture)

BMPs	Acres
BMP1	80.67
BMP2	62.54
BMP3	31.18
BMP4	322.69
Conservation Tillage 2	142.75
Contour Farming	515.46
BMPa	300
Current BMP acres	**1455.29**

Current Total Load Values (w/out BMPs)

In order to understand how much each sub-watershed's current BMPs were reducing nutrient loading, STEPL calculates the amount of nutrient loading that would occur in each watershed without any BMPs. Table 10 represents the no-BMP pollutant load condition for each sub-watershed. Meudt Creek has slightly higher nitrogen and phosphorous loads and lower sediment loads, likely due to the additional acres of feedlots near creeks present in the watershed. The higher sediment loading in Knight Hollow sub-watershed is also likely due to the presence of less pasture/hay acres than Meudt Creek – see table 1.

Table 10. Current Total Load Values (w/out BMPs)

Watershed	Nitrogen Load (lb/yr)	Phosphorus Load (lb/yr)	Sediment Load (t/yr)
Meudt Creek	85,389.9	20,780.9	2,787.1
Knight Hollow	53,145.1	16,407.9	3,232.4

Table 11. Crop Rotation Acres

Watershed	No Agriculture	Pasture / Hay / Grassland	Dairy	Cash Grain	Continuous Corn
Meudt Creek	8,591 ac	4,423 ac	1,561 ac	381 ac	15 ac
Knight Hollow	8,659 ac	3,101 ac	1,359 ac	412 ac	142 ac

Current Total Load (w/ BMPs) and Reduction Values

Table 12 depicts the current nitrogen, phosphorous, and sediment loads per sub-watershed with BMPs. These values represent the most accurate snapshot of pollutant loading for each sub-watershed and constitute the baseline condition/values that this plan aims to improve over a ten-year time period. The columns showing reduction and percent values represent how much current adopted BMPs within each sub-watershed are reducing pollutant loads.

Table 12. Current Total Load (w/ BMPs) and Reduction Values – Baseline Condition

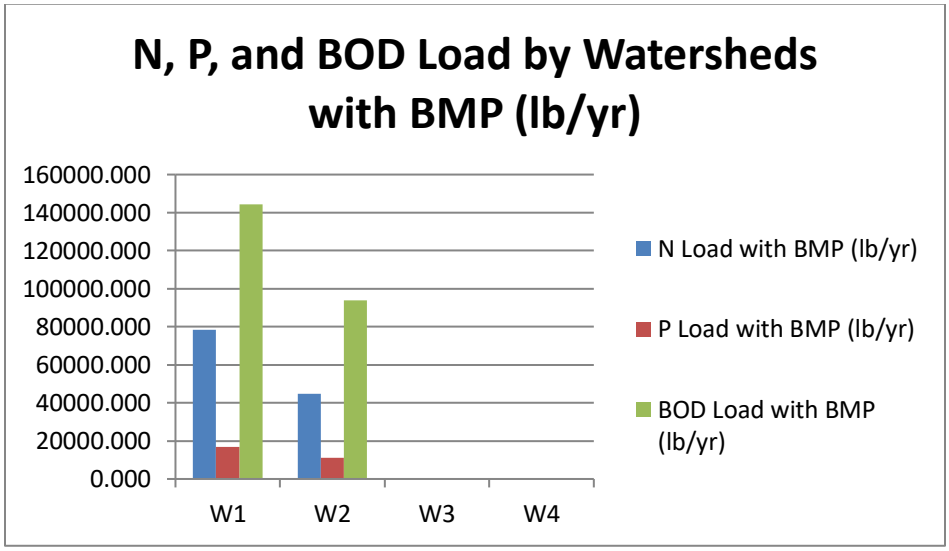
Watershed Name	Nitrogen Load (lb/yr)	N Reduction (lb/yr) and Percent	Phosphorus Load (lb/yr)	P Reduction (lb/yr) and Percent	Sediment Load (t/yr)	Sediment Reduction (t/yr) and Percent
Meudt Creek	78,462.6	4,395 (5.3%)	16,852.3	1,839.4 (9.8%)	1,665.5	330.3 (16.5%)
Knight Hollow	44,881.3	4,800.5 (9.7%)	11,257.7	2,293 (16.9%)	1,686.1	464 (21.6%)

STEPL Graphs of Current Practices

To summarize each sub-watershed's current pollutant load conditions, we have included the following graphs and charts, created by STEPL. W1 represents Meudt Creek, and W2 represents Knight Hollow. BOD represents the biochemical oxygen demand in the open water bodies.

The nitrogen load in Meudt Creek is significantly higher than Knight Hollow, which is likely due to the presence of more acres of feedlots near stream systems in Muedt Creek. While these feedlots account for most to the amount of nitrogen and phosphorus loading, pastureland acres in both sub-watersheds accounts for a majority source of sediment loading. This plan will, accordingly, focus on pastureland-based practices to reduce this source of sediment load.

Table 13.



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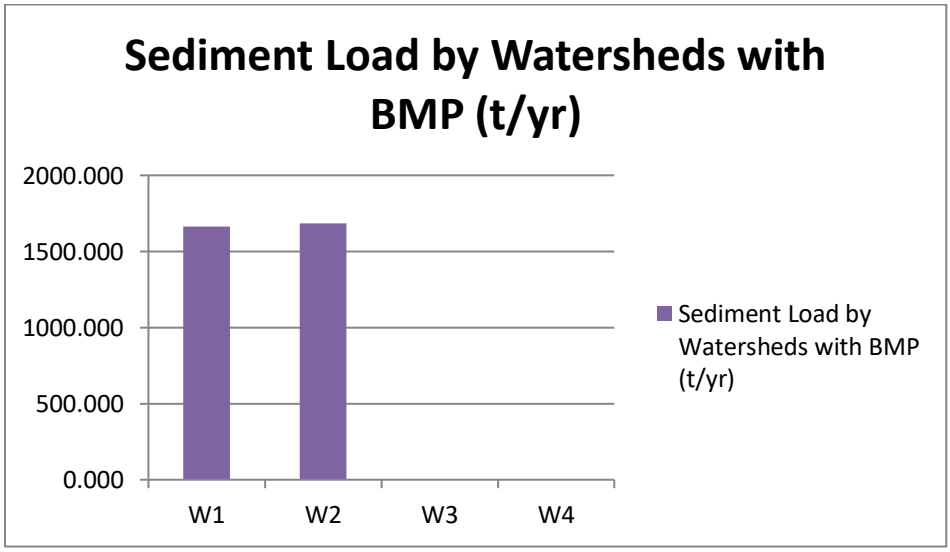

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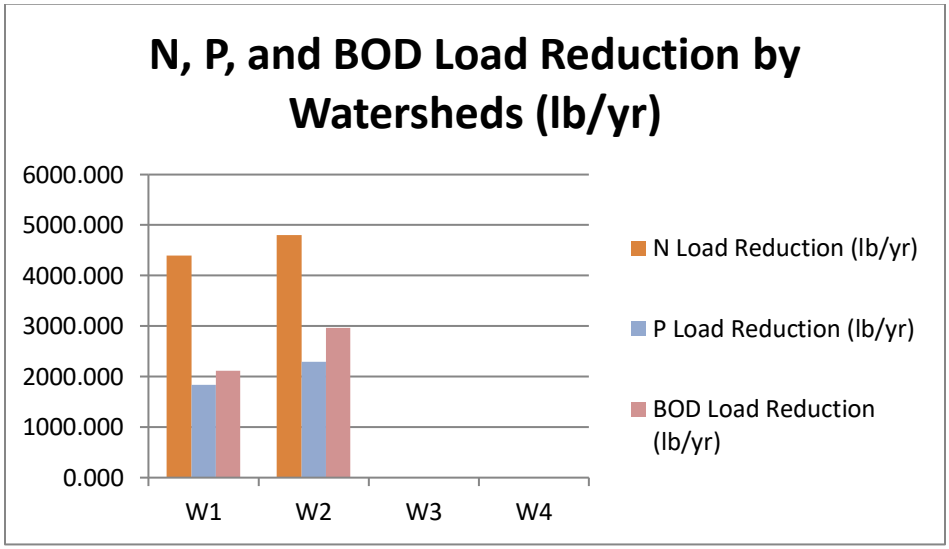

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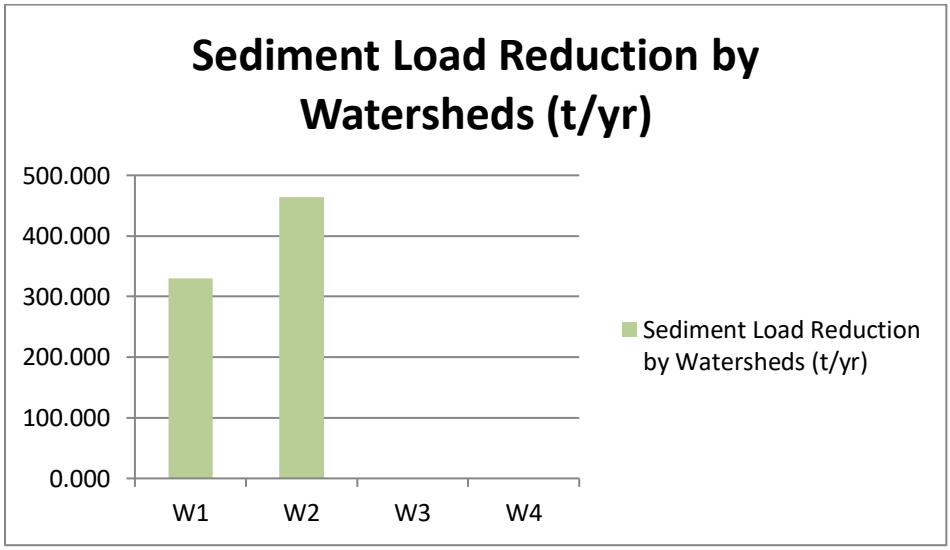

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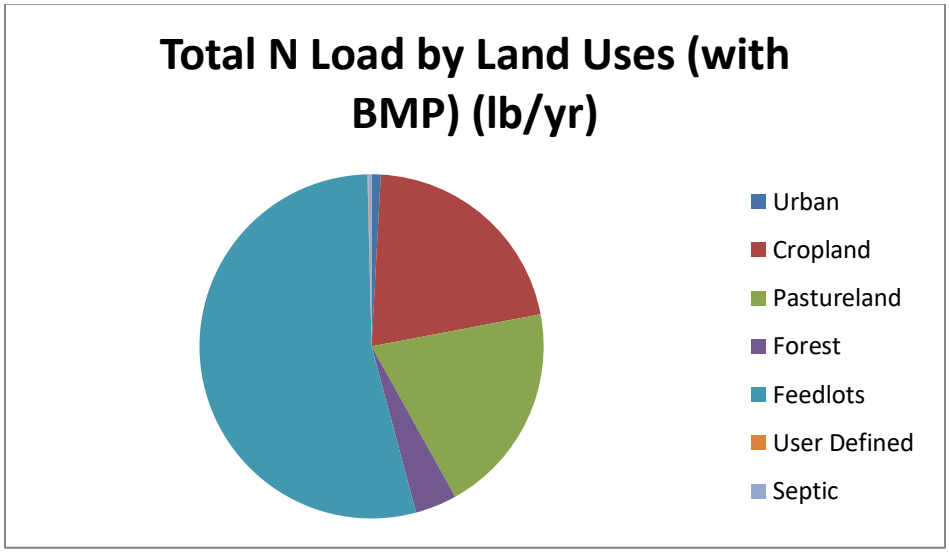

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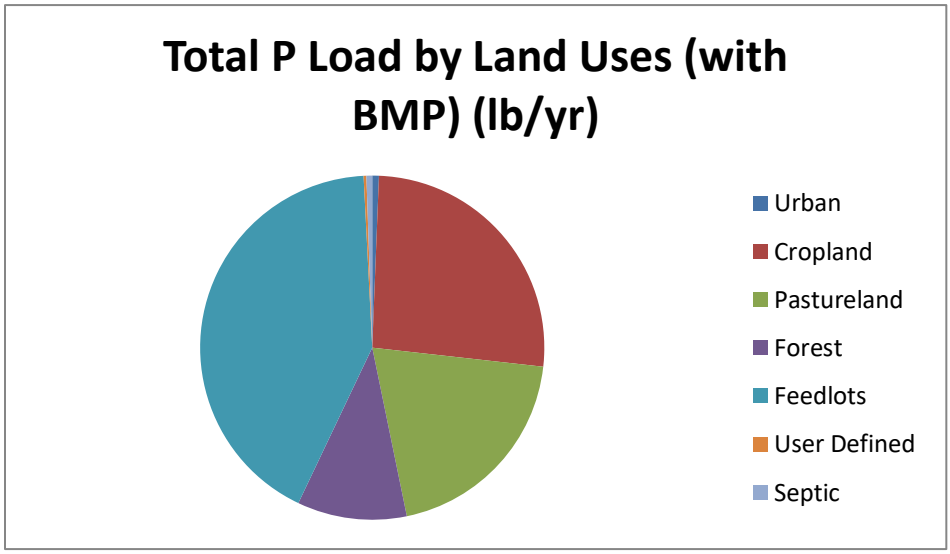

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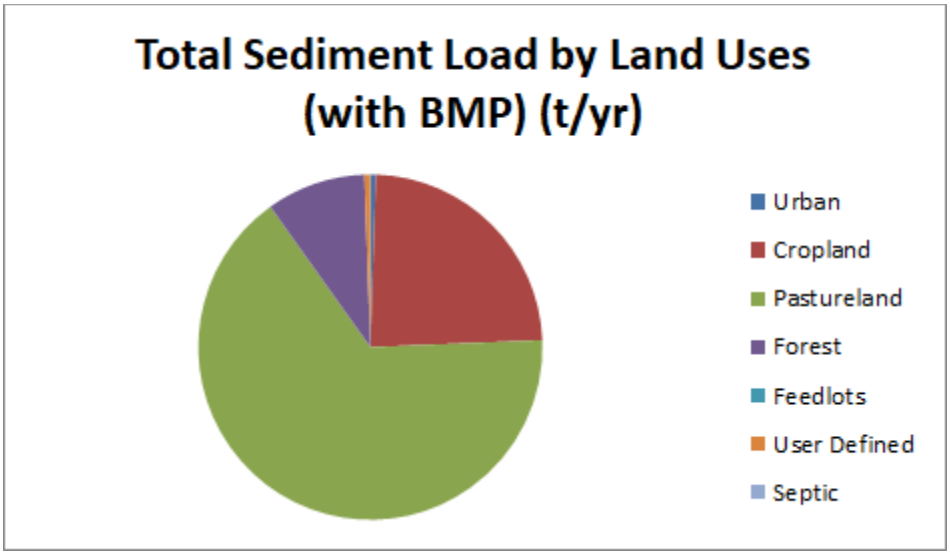


Section 4.2: Reduction Strategies and Goals

BMP and Reduction Goal Selection Strategy

After modeling current/baseline practices and pollutant loads, we focused upon establishing some realistic/achievable reduction goals for this plan. To do that, we reached out to producers in the community's Uplands Farmer Led Watershed Group and requested their feedback on which BMPs they believed were most effective and realistic for them to implement within their watershed. The following list outlines the BMPs our team and farmers in the watershed identified as adoptable practices, along with a short explanation behind each to explain their benefits. These BMPs were then used to model future pollutant loads in each sub-watershed and to establish this plan's ten-year pollutant reduction goals.

Adoptable BMP List and Descriptions

- Cropland
    - **Nutrient Management Plan 2 (determined rate plus additional considerations)** Having and implementing a Nutrient Management Plan (NMP) is a practice that many producers had already signed up for in the watershed. The plan will work to increase the number of producers signing up for plans, and ensure that producers who already have an NMP are following the plan. Having more NMPs

also makes it easier to keep records of what's going on where and will help better track plan implementation over time with up-to-date data.

- **Conservation Tillage 2 (equal or more than 60% residue)**
  Some producers in the watershed are seeing value and feasibility in adopting conservation tillage. It is slowly gaining popularity across Wisconsin and other Midwestern states as well. Adoption of the practice over a crop rotation is important to this watershed due to the rigid topography that is more susceptible to soil erosion, and which shapes and/or surrounds the land producers cultivate crops or raise animals upon. Minimizing tillage over a crop rotation will also significantly reduce the amount of sediment-loading across the watershed and increase the amount of water retention capacity in the soil.
- **Streambank Stabilization and Fencing**
  Although streambank stabilization and fencing is a relatively expensive practice, targeting certain critical areas within each sub-watershed was determined to be a solution that reflects the Driftless area terrain/environment and is well worth the expense and effort. This practice will not only strengthen the physical integrity of vulnerable stream systems and improve water quality and biotic health, but also may help prevent the loading of legacy phosphorus from upland areas to enter downstream water systems. This plan seeks to reduce streambank erosion by using this BMP in combination with buffer or grass filter strips, which will also help reduce phosphorous laden runoff from upland areas that directly enter nearby streams.
- **Buffer - Grass 35'**
  The 35-foot grass buffer BMP is a good match for the Driftless environment and was found to be one of the most efficient BMPs to reduce nutrient and sediment loading – particularly for some pastureland acres within the watershed. This practice protects streambank integrity by limiting the amount of compaction and pollutant run-off associated when producers cultivate crops and/or graze animals against the very edge of a stream or creek. With mindful planting, it also is our goal to establish grass buffers as suitable native pollinator habitats. While grass buffers serve well as a catchment and filter system for pollutants running off upland/upgradient fields, it's important that we ensure that the grass strips don't become a problem themselves. Too much upgradient loading without filtering out the excessive nutrients can fill in soil pore spaces within the grass buffer and may result, over time, in the buffer becoming itself a phosphorus source to the adjacent stream. Legacy phosphorus soils entering the stream are already a source of pollution within Meudt Creek and Knight Hollow sub-watersheds, and it's for this reason that these buffers must be managed

carefully. A primary goal to ensure grass buffer strips work as designed and intended in this watershed will be to, a) get more buy-in from farmers, b) plant equal parts of native and cool season grasses, and c) allowing limited haying to reduce weeds and trees, allowing them to naturally reestablish again. *Since STEPL does not include a non-rotational pasture management option, we interpreted the grass buffer practice on pastureland to reflect practices that would bring about improvements to pasture management and forage quality, which act as a form of a buffer.*

- Pastureland
  - **Prescribed Grazing**
    This BMP was identified as an existing practice that producers value in each sub-watershed. Instead of setting a goal to increase prescribed grazing acres in this plan, we will focus on the grazing land management BMP as described below.
  - **Grazing Land Management (Rotational Grazing)**
    Rotational grazing, referred to as grazing land management in STEPL, is a necessary BMP for each sub-watershed to achieve this plan's pollutant reduction goals. This practice can reduce nitrogen, phosphorus and sediment loading and pastureland from being over-grazed. Combined with buffer strips and livestock alternative water supply practices, it became clear that this was the most effective combination of practices identified by our team of experts and producers to realistically reduce pollutant loads in each sub-watershed.
  - **Livestock Exclusion Fencing**
    Much of the pastureland in both sub-watersheds runs directly along stream systems and allows unlimited animal access. Without protecting the vegetation and underlying soil along these streams, livestock can overgraze and cause erosion of streambanks, which directly contributes nutrient and sediment loading into the stream. Similar to the streambank stabilization BMP, this practice is integral to protecting the water quality along streams neighboring pastureland.
  - **Alternative Water Supply**
    After ground-truthing practices in the sub-watersheds, we observed a significant number of streams that flowed through pastureland being used as a water source for livestock. Consequently, the streambank edges were often bare and/or eroded due to frequent/excessive livestock presence in or near the water and their grazing and trampling of vegetation. This lack of vegetation along streambanks threatens streambank integrity via soil erosion, allowing direct loading of nutrients from livestock in the streams. This also helps make these

areas more susceptible to invasive woody species, such as Box Elder.

- Feedlots
    - **Diversion & Run-off Management**
      Water diversion strategies around feedlots are important to prevent discharges of feedlot nutrients into surface waters. Diversion methods can vary, from gutters along feedlot roofs, to routing clean surface water from entering feedlot areas, and collecting or filtering dirty water leaving feedlots during rain events. Collecting dirty feedlot water through a management system and filtering and/or treating it can play a critical role in managing water quality. Although these systems can be expensive, they are well worth the reduction in nutrient loading they bring.
    - **Reduction of Feedlot Acres Near Streams**
      Through satellite imagery, we identified 16 potential barns (see figure 17) with feedlots within 300 feet of streams in both sub-watersheds. Seven of these barns were located in the Meudt Creek area, totaling 23 acres, and 9 barns were located in the Knight Hollow area, totaling 10 acres. We estimate these barns/feedlots are responsible for contributing the most nutrient loading values per land use in the watershed, particularly nitrogen and phosphorus. Addressing problematic feedlots will be an effort to achieve this plan's reduction goals across both sub-watersheds.

<u>Pollutant Load Reduction Goals</u>

Before ground-truthing and then adjusting this plan's practices, we set a preliminary goal to reduce nitrogen, phosphorus, and sediment loading per watershed by at least 20%. Each of the above BMPs interacts with each other differently, as observed in our Combination BMP codes (Table 7).

For **cropland**, we discussed the need to work closely with landowners to implement streambank stabilization and grass buffer BMPs together, in addition to establishing this combined practice along critical areas (see figure 17) at a rate of half a mile per watershed per year. Due to its high reduction efficiency, we identified the need to increase acres of grass buffer BMP across a quarter of each sub-watershed as a singular practice for producers to adopt. To reduce sediment loading (and increase the number of producers following a conservation plan) we identified at least half of the total acres of cropland per sub-watershed need conservation tillage and Nutrient Management Plan BMPs. 125 of those acres may also include cover crops in addition to 125 more acres of cover crops being adopted on their own. Our group chose to not focus upon implementing additional contour farming acres, as the size

of the equipment along the watershed's rough terrain reduces the feasibility of implementing this practice.

For **pastureland**, we identified that a combined BMP with rotational grazing, alternative water supply, and grass buffers is needed across half of each sub-watershed to reduce their nutrient and sediment loads. As outlined above, the largest contributor to nutrient loading, namely nitrogen and phosphorus, is due to the presence of 16 feedlots within 300 feet of streams in both sub-watersheds. We identified feedlots through satellite images, searching for images of buildings, barnyards, and cattle within a GIS-generated, 300-foot zone around all streams. While we were able to confirm their locations, we were unfortunately unable to confirm if they were still in use. Out of the 16 feedlots located, our preliminary estimate is that at least three are no longer in use, and 13 remain active. Due to the expensive nature of implementing diversion and run-off management systems on barnyards, we identified the need to improve five feedlots in total over this plan's ten-year schedule. We estimate that working to correct five of the 13 active barnyards identified was realistic and would help decrease the amount of problematic feedlot acres in each sub-watershed.

Section 4.3: New Management Measures

The following tables, graphs, and charts reflect the future practices for this plan that we adjusted to meet our goal of reducing at least 20% of nitrogen, phosphorous, and sediment loading for the Meudt Creek and Knight Hollow sub-watersheds. Refer to Appendix A for the adjusted total BMP acres of cropland and pastureland in each sub-watershed.

<u>Additional Acres per BMP</u>
Tables 20 and 21 reflect the additional acres it will take to meet or exceed this plan's 20% pollutant reduction goal, excluding the BMPs that have already been adopted in each sub-watershed. Once again, the similar nature of both sub-watersheds is reflected here, with the only significant difference being the additional amount of conservation tillage acres within the Knight Hollow sub-watershed.

Table 20. Additional Cropland Acres per BMP

BMPs	Meudt Creek Cropland Acres	Knight Hollow Cropland Acres
Conservation Tillage 2	83.53	335.1
Nutrient Management Plan 2	894.4	912.11
Contour Farming	0	0
Streambank Stabilization & Fencing	21.2	21.2
Grass Buffer 35'	511	430.75
Cover Crops 2	250	250

Table 21. Pasture Additional Acres per BMP

BMPs	Meudt Creek Pasture Acres	Knight Hollow Pasture Acres
Livestock Exclusion Fencing	0	0
Prescribed Grazing	0	0
Grass Buffer 35'	1,215	1,607
Alternative Water Supply	915	1,307
Grazing Land Management	915	1,307

Projected Total Load (w/ BMPs) and Reduction Values

After implementing the additional BMPs across the number acres shown in tables 20 and 21 above, table 22 shows the corresponding reductions in nutrient and sediment loads compared to the existing pollutant load values, per sub-watershed. Overall, if all the new/additional practices described above are implemented, we estimated each sub-watershed will exceed the 20% nutrient reduction goal of this plan. Better yet, phosphorus and sediment reductions are more than double the 20% reduction goal. When comparing Meudt Creek and Knight Hollow's

nitrogen and phosphorous percent reduction results, the spike in percentages can be credited to Meudt Creek's housing twice as many acres of problematic feed lots. Addressing these feedlots will not be easy to achieve, as the BMPs needed to reduce feedlot loading come with a heavy price. This plan has a manageable goal of reducing problematic feedlot acres by 50% over the course of our 10-year schedule.

Table 22. Projected Total Load (w/ BMPs) and Reduction Values

Watershed Name	Nitrogen Load (lb/yr)	N Reduction (lb/yr) and Percent	Phosphorus Load (lb/yr)	P Reduction (lb/yr) and Percent	Sediment Load (t/yr)	Sediment Reduction (t/yr) and Percent
Meudt Creek	55,737.9	22,723 (29%)	10,726.4	6,126 (36.4%)	1,053.5	612 (36.7%)
Knight Hollow	31,606.4	13,275 (29.6%)	7,666.2	3,591 (32%)	1,170.6	516 (30.6%)

<u>STEPL Graphs of Projected/Future Practices</u>

Tables 23-29 convey graphs and charts generated through the STEPL model. W1 represents Meudt Creek, and W2 represents Knight Hollow.

Table 23.

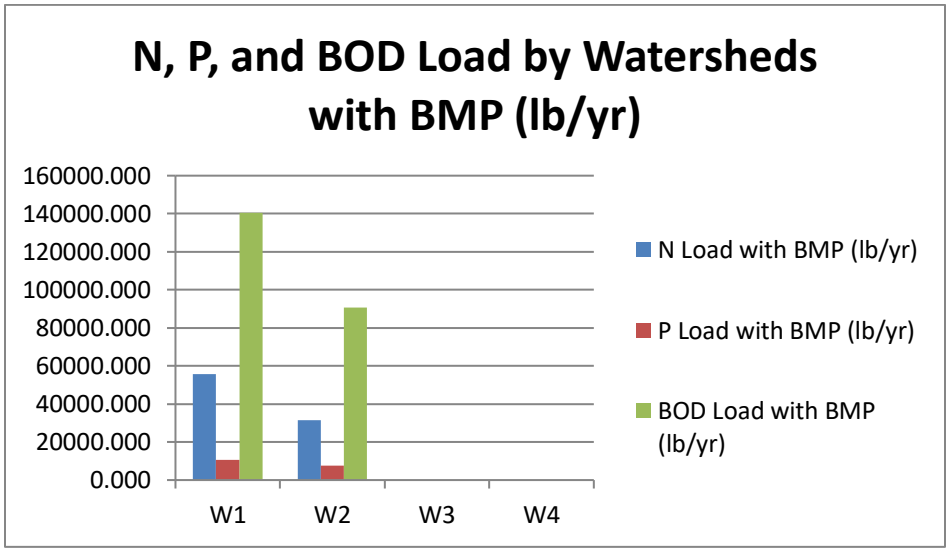


Table 24.

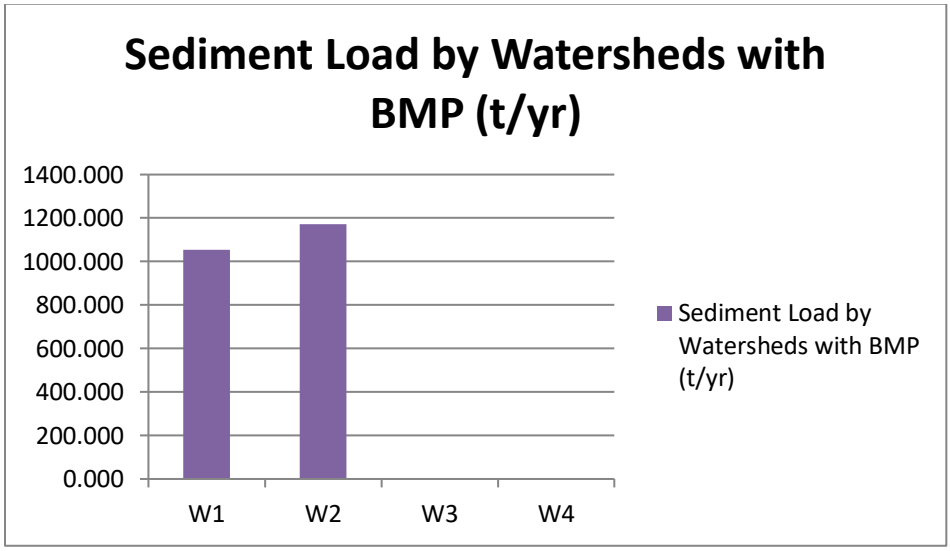


Table 25.

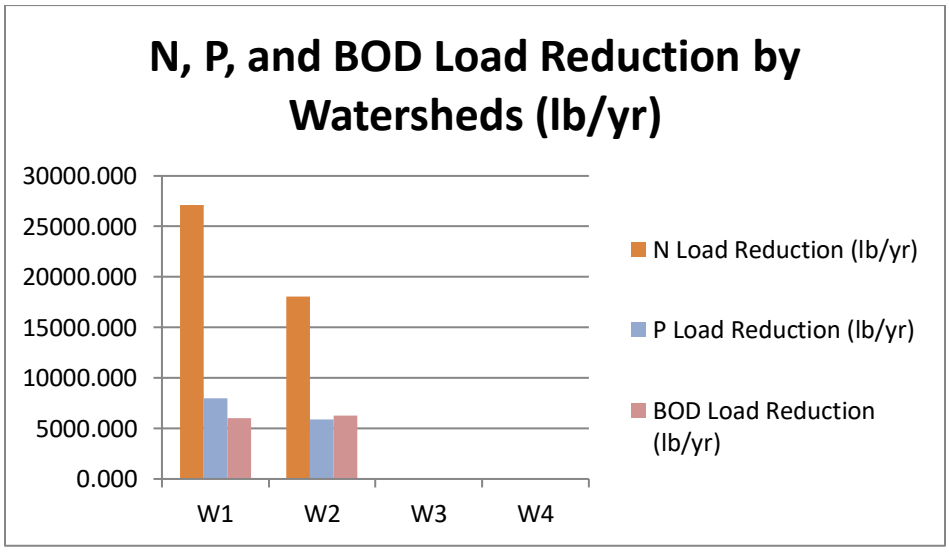


Table 26.

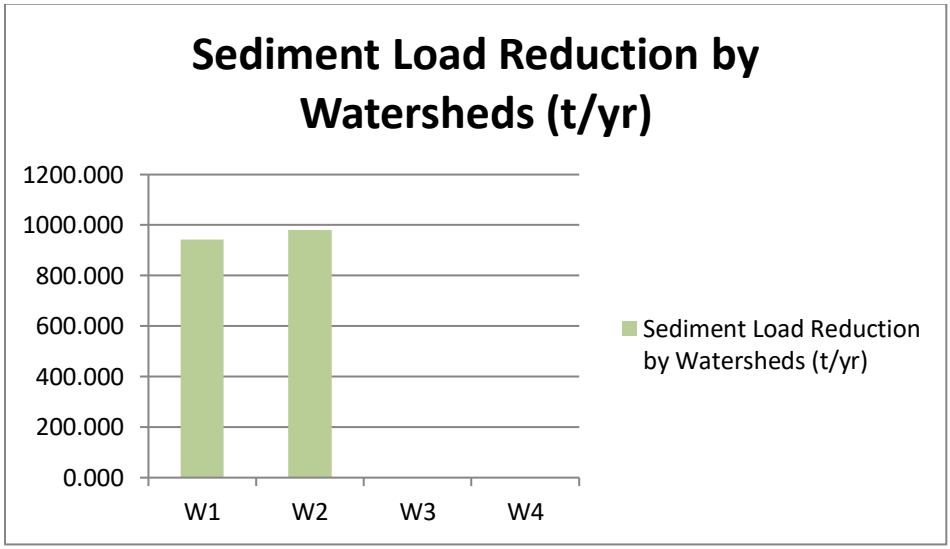


Table 27.

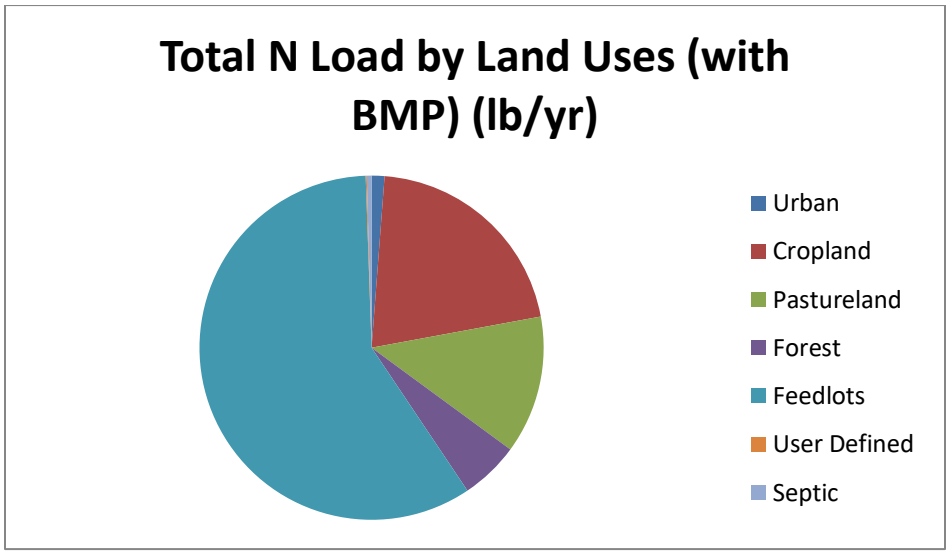


Table 28.

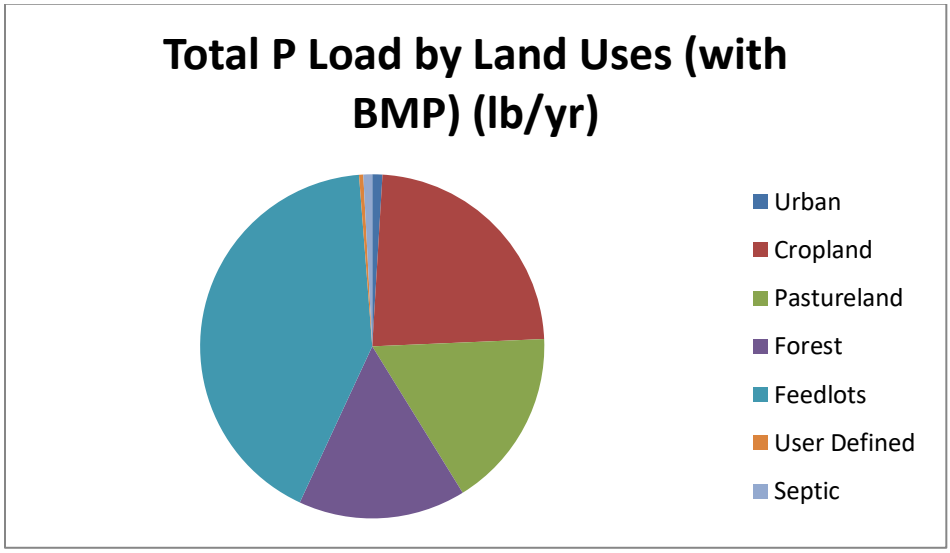
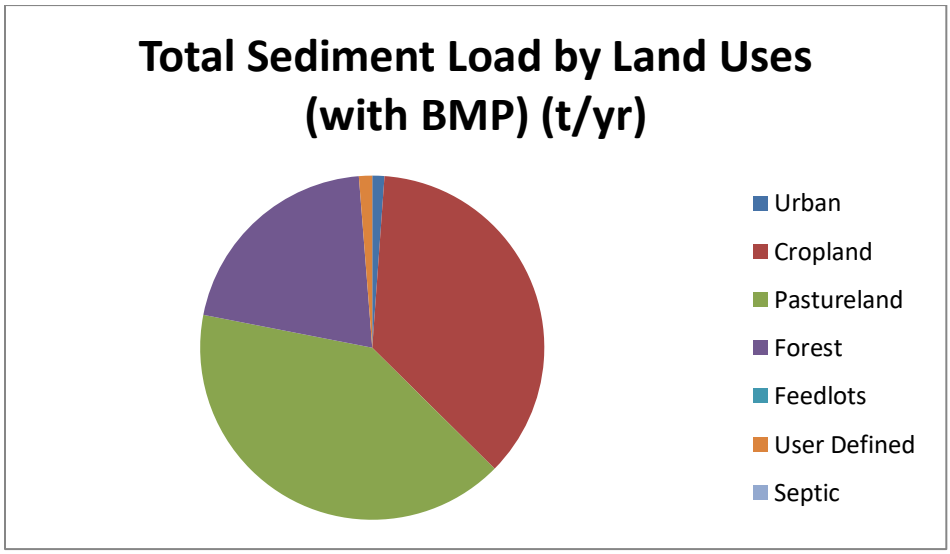


Table 29.



Section 5

Element 4: Cost Analysis and Authorities

Section 5.1: Cost Analysis Summary

We estimated BMP costs based on current NRCS EQIP and Iowa County cost share rates, actual costs of recent NRCS and Iowa County projects, and rough averages of project sizes. Costs of course will vary depending on specific site characteristics, resource needs, and landowner preferences. Costs will also vary over time as cost-share rates are adjusted and material costs fluctuate.

Technical assistance costs were estimated based on average time needed for initial site visits, survey (if needed), planning or design, contracting, installation oversight, and landowner communication during a project, except for Nutrient Management Planning which is based on time to review a plan once a landowner or crop consultant has submitted it. Average salary and benefits were estimated at $35 per hour.

Summary of costs:

- $6,042,049 for cost installation.
- $285,215 for salary and benefits for technical staff
- $60,500 for information and education

Landowners will be required to sign a contract for each project that is cost-shared, which outlines maintenance requirements and the life span of each project (often 3-4 years for 'soft' practices and 10 years or more for 'hard' practices). With Nutrient Management Planning, the landowner is committing to continuing compliance, which will require making annual updates of the plan and completing soil tests every four years with no further cost-share.

The tables below outline our cost estimates per practice, including incentive and cost-share estimates, project totals, and hours.

Table 30. Meudt Creek Cost Analysis Matrix

Practice	Quantity	Unit	Cost per Unit	Total Estimated Cost	Incentive or 70% Cost-share per Unit	Cost-shared amount (NRCS or County)	Remain-der of Cost	Hours per Project	Number of Projects	Total Hours	NRCS Hours	County / Other Time
Conservation Tillage	168.61	ac	$22.16	$3,735.92	$15.51	$2,615.14	$1,120.77	3	3	9	4.5	4.5
Nutrient Management Planning	894.4	ac	$25.71	$22,998.86	$18	$16,099.20	$6,899.66	5	9	45	22.5	22.5
Streambank Stabilization								40	17	680	340	340
Banks 4-7’	13,193	ft	$35.04	$462,265.20	$24.53	$323,612.03	$138,653.18					
Banks 7’ or More	13,193	ft	$45.16	$595,735.61	$31.61	$417,014.93	$178,720.68					
Obstruction Removal (trees, brush, etc.)	10	ac	$2,451.96	$24,519.57	$1,716.37	$17,163.70	$7,355.87					
Fencing	26,385	ft	$1.79	$47,229.15	$1.25	$32,981.25	$14,247.90	20	17	340	170	170
Cropland Grass Buffer 35’								12	15	180	90	90
Filter Strip Introduced	255.5	ac	$188.16	$48,074.15	$131.71	$33,651.91	$14,422.25					
Filter Strip Native	127.8	ac	$180.46	$23,062.42	$126.32	$16,143.70	$6,918.73					
Pollinator Mix	127.8	ac	$1,125.66	$143,858.98	$787.96	$100,701.29	$43,157.69					
Pastureland Grass Buffer 35’								12	35	420	210	210

Practice	Quantity	Unit	Cost per Unit	Total Estimated Cost	Incentive or 70% Cost-share per Unit	Cost-shared amount (NRCS or County)	Remain-der of Cost	Hours per Project	Number of Projects	Total Hours	NRCS Hours	County / Other Time
Filter Strip Introduced	607.5	ac	$188.16	$114,305.46	$131.71	$80,013.83	$34,291.64					
Filter Strip Native	303.8	ac	$180.46	$54,822.88	$126.32	$38,376.02	$16,446.86					
Pollinator Mix	303.8	ac	$1,125.66	$341,974.64	$787.96	$239,382.25	$102,592.39					
Cover Crops								8	15	120	60	60
Single Species	125	ac	$91.14	$11,392.50	$63.80	$7,975	$3,417.50					
Multiple Species	125	ac	$106.46	$13,307.14	$74.52	$9,315	$3,992.14					
Alternative water Supply								24	10	240	120	120
Spring Development	5	ea	$4,329	$21,644.93	$3,030.29	$15,151.45	$6,493.48					
Stream Crossing (5 x 2,500ft^2)	12,500	ft^2	$2	$25,000	$1.40	$17,500	$7,500					
Grazing Land Management$_1$	915	ac	$785.71	$718,928.57	$550	$503,250	$215,678.57	50	30	1500	750	750
Barnyard System$_2$	2	ea	$50,000	$100,000	$35,000	$70,000	$30,000	48	2	96	48	48
Totals				***$2,772,855.98***		***$1,940,946.70***	***$831,908.83***		***153***	***3,630***	***1,815***	***1,815***

$_1$Cost is an average that includes planning, fencing, well, pipe, tanks, and/or forage planting as needed

$_2$Cost is an average that includes concrete, basin wall, waste settling structure, vegetated treatment area, gutters, and/or water diversions as needed

Table 31. Knight Hollow Cost Analysis Matrix

Practice	Quantity	Unit	Cost per Unit	Total Estimated Cost	Incentive or 70% Cost-share per Unit	Cost-shared amount (NRCS or County)	Remain-der of Cost	Hours per Project	Number of Projects	Total Hours	NRCS Hours	County / Other Time
Conservation Tillage	477.85	ac	$22.16	$10,587.79	$15.51	$7,411.45	$3,176.34	3	10	30	15	15
Nutrient Management Planning	912.11	ac	$25.71	$23,454.26	$18	$16,417.98	$7,036.28	5	9	45	22.5	22.5
Streambank Stabilization								40	17	680	340	340
Banks 4-7’	13,193	ft	$35.04	$462,265.20	$24.53	$323,612.03	$138,653.18					
Banks 7’ or More	13,193	ft	$45.16	$595,735.61	$31.61	$417,014.93	$178,720.68					
Obstruction Removal (trees, brush, etc.)	10	ac	$2,451.96	$24,519.57	$1,716.37	$17,163.70	$7,355.87					
Fencing	26,385	ft	$1.79	$47,229.15	$1.25	$32,981.25	$14,247.90	20	17	340	170	170
Cropland Grass Buffer 35’								12	15	180	90	90
Filter Strip Introduced	215.4	ac	$188.16	$40,529.05	$131.71	$28,370.33	$12,158.71					
Filter Strip Native	107.7	ac	$180.46	$19,435.23	$126.32	$13,604.66	$5,830.57					
Pollinator Mix	107.7	ac	$1,125.66	$121,233.27	$787.96	$84,863.29	$36,369.98					
Pastureland Grass Buffer 35’								12	45	540	270	270

Practice	Quantity	Unit	Cost per Unit	Total Estimated Cost	Incentive or 70% Cost-share per Unit	Cost-shared amount (NRCS or County)	Remain-der of Cost	Hours per Project	Number of Projects	Total Hours	NRCS Hours	County / Other Time
Filter Strip Introduced	803.5	ac	$188.16	$151,184.26	$131.71	$80,013.83	$45,355.28					
Filter Strip Native	401.8	ac	$180.46	$72,507.68	$126.32	$38,376.02	$21,752.30					
Pollinator Mix	401.8	ac	$1,125.66	$452,289.04	$787.96	$239,382.25	$135,686.71					
Cover Crops								8	15	120	60	60
Single Species	125	ac	$91.14	$11,392.50	$63.80	$7,975	$3,417.50					
Multiple Species	125	ac	$106.46	$13,307.14	$74.52	$9,315	$3,992.14					
Alternative water Supply								24	10	240	120	120
Spring Development	5	ea	$4,329	$21,644.93	$3,030.29	$15,151.45	$6,493.48					
Stream Crossing (5 x 2,500ft^2)	12,500	ft^2	$2	$25,000	$1.40	$17,500	$7,500					
Grazing Land Management$_1$	1307	ac	$785.71	$1,026,928.57	$550	$718,850	$215,678.57	50	44	2200	1100	1100
Barnyard System$_2$	3	ea	$50,000	$150,000	$35,000	$105,000	$30,000	48	3	144	72	72
Totals				***$3,269,243.25***		***$2,173,003.17***	***$873,425.49***		***185***	***4,519***	***2,259.5***	***2,259.5***

$_1$Cost is an average that includes planning, fencing, well, pipe, tanks, and/or forage planting as needed

$_2$Cost is an average that includes concrete, basin wall, waste settling structure, vegetated treatment area, gutters, and/or water diversions as needed

Table 32. Total Cost Analysis Matrix

Practice	Quantity	Unit	Cost per Unit	Total Estimated Cost	Incentive or 70% Cost-share per Unit	Cost-shared amount (NRCS or County)	Hours per Project	Number of Projects	Total Hours	NRCS Hours	County / Other Time
Conservation Tillage	646.46	ac	$22	$14,324	$16	$10,027	3	13	39	19.5	19.5
Nutrient Management Planning	1,806.51	ac	$26	$46,453	$18	$32,517	5	18	90	45	45
Streambank Stabilization							40	34	1,360	680	680
Banks 4-7’	26,386	ft	$35	$924,565	$25	$647,249					
Banks 7’ or More	26,386	ft	$45	$1,191,516	$32	$834,061					
Obstruction Removal (trees, brush, etc.)	20	ac	$2,452	$49,039	$1,716	$34,327					
Fencing	52,770	ft	$2	$94,458	$1	$65,963	20	34	680	340	340
Grass Buffer 35’							12	110	1,320	660	660
Filter Strip Introduced	1,881.9	ac	$188	$354,093	$132	$247,865					
Filter Strip Native	941	ac	$180	$169,810	$126	$118,867					
Pollinator Mix	941	ac	$1,126	$1,059,243	$788	$741,470					
Cover Crops							8	30	240	120	120
Single Species	250	ac	$91	$22, 785	$64	$15,950					

Practice	Quantity	Unit	Cost per Unit	Total Estimated Cost	Incentive or 70% Cost-share per Unit	Cost-shared amount (NRCS or County)	Hours per Project	Number of Projects	Total Hours	NRCS Hours	County / Other Time
Multiple Species	250	ac	$106	$26,614	$75	$18,630					
Alternative water Supply							24	20	480	240	240
Spring Development	10	ea	$4,329	$43,290	$3,030	$30,303					
Stream Crossing (10 x 2,500ft^2)	25,000	ft^2	$2	$50,000	$1	$35,000					
Grazing Land Management$_1$	2,222	ac	$786	$1,745,857	$550	$1,222,100	50	74	3,700	1,850	1,850
Barnyard System$_2$	5	ea	$50,000	$250,000	$35,000	$175,000	48	5	240	120	120
Totals				***$6,042,049***		***$4,229,329***		***338***	***8,149***		***4,074.5***

$_1$Cost is an average that includes planning, fencing, well, pipe, tanks, and/or forage planting as needed

$_2$Cost is an average that includes concrete, basin wall, waste settling structure, vegetated treatment area, gutters, and/or water diversions as needed

Existing runoff management standards have been established by the State of Wisconsin. Chapter NR 151 provides runoff management standards and prohibitions for agriculture. This plan recommends enforcement, when necessary, of the state agricultural performance standards and prohibitions when implementing the plan. Iowa County's Land Conservation Department, Iowa County Agricultural Extension, Michael Fields Agricultural Institute, Iowa County's Uplands Producer-Led Watershed group, and local NRCS staff will work with landowners to implement this plan's conservation practices. Landowners will be educated on programs and funding available to them as well as current state and local agricultural regulations.

Section 5.2: Federal and State Programs

Federal Programs:

NRCS Working Lands Programs (CSP and EQIP)

Conservation Stewardship Program (CSP)

CSP offers funding for participants for existing conservation practices and additional steps to improve resource condition. It provides two types of funding through 5-year contracts - annual payments for installing new practices and maintaining existing practices as well as supplemental payments for adopting a resource conserving crop rotation.

Environmental Quality Incentives Program (EQIP)

EQIP provides financial and technical assistance to implement conservation practices that address resource concerns such as erosion in fields or along streams, waste management, grazing practices, and many others. Farmers receive flat rate payments for installing and implementing management practices.

Conservation Reserve Program (CRP)

A land conservation program administered by the Farm Service Agency. Farmers enrolled in the program receive a yearly rental payment for environmentally sensitive land that they agree to remove from production. Contracts are 10-15 years in length. Eligible practices include conservation cover (including prairie and pollinator planting), upland wildlife habitat, buffers and filter strips, and grassed waterways.

Conservation Reserve Enhancement Program (CREP)

This program provides funding for conservation along rivers and streams. It funds installation, rental payments, and an installation incentive. A 15-year contract or perpetual contract conservation easement can be entered into. Eligible practices include filter strips, riparian buffers, wetland restoration, and grassed waterways.

Wisconsin Programs:

Soil and Water Resource Management (SWRM) Grants

The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) awards annual Soil and Water Resource Management grants to county land and water conservation departments to help pay for county staff and finance cost-sharing for landowners who install conservation practices with county assistance. They also provide cost-sharing for Nutrient Management Planning. Iowa County Land Conservation Department manages these funds and projects.

Targeted Runoff Management Grant Program (TRM)

TRM offers competitive grants for local governments for controlling non-point source pollution. Grants reimburse costs for agriculture or urban runoff management practices in critical areas with surface or groundwater quality concerns. The cost-share rate for TRM projects is up to 70% of eligible costs.

Producer-Led Watershed Protection Grants

This grant program is administered by DATCP, funding projects that focus on farmers and landowners within watersheds working together to prevent and reduce runoff from farm fields. The program can fund "incentive payments" for farmers to undertake conservation practices and supports costs of field days, farm tours, and other public education events.

Land Trusts

Landowners also have the option of working with a private land trust to preserve land. Land trusts preserve private land through conservation easements, purchase land from owners, and accept donated land.

Section 6

Element 5: Information and Education Plan

Section 6.1: Information and Education Outreach Strategies

Iowa County's Land Conservation Department, Iowa County Agricultural Extension, Michael Fields Agricultural Institute, Iowa County's Uplands Producer-Led Watershed group, local NRCS staff, and other partners will follow several strategies to educate farmers, non-farming landowners, public officials, and other members of the public about nutrient contamination issues in these two sub-watersheds.

A primary goal will be to help them understand the nutrient loading problems in these sub-watersheds and encourage their engagement in choosing and implementing the NPS management measures to reduce or eliminate the problems.

Audiences

Because most land within these two sub-watersheds is in agricultural use, the first and largest audience for our outreach is the area's farming community. For this plan, this includes farmers, their input dealers, agricultural lenders, and crop advisors who serve them, farm groups to which they belong, and land owners from whom they rent land. A second audience in these two sub-watersheds is non-farming residents. The third is local town officials in the townships of Arena, Brigham, Dodgeville, and Ridgeway. Fourth and finally, we will target communications to the general public who work or play in the watershed and care about its water quality.

Information and Messaging

Messages will vary across the different audiences, but for all audiences we will provide accurate information about several topics. These topics will include information and updates such as the status of nutrient management and water quality impairment in the watershed, its known causes, potential remedies, the availability of funding to support changes in practices, the general timeline for action, and different ways that people can engage in the watershed plan's implementation. We will use the Uplands Watershed Group's connections with Gulf of Mexico Fishermen and Trout Unlimited to illustrate reasons to protect water quality.

Strategies and relevant information for these targeted messages are as follows:

Farmers, Farmland Owners, Input Dealers, Crop Advisers, Lenders, Farm Groups

- Specific information about water quality along the length of the stream.
- Benefits of Nutrient Management Planning and availability of NMP training workshops (e.g., farmers frequently report saving money through reduced fertilizer applications).
- BMPs recommended for implementation by the plan.
- Potential benefits to farmers of implementation of various BMPs (e.g., greater retention of nutrients, less fuel required in planting, better infiltration of water, etc.).
- Approximate cost of BMP implementation and available funding for cost-share
- Timeline for implementation.

Non-agricultural Residents

- Specific information about water quality along the length of the stream.
- Potential loss of nutrients through septic fields and need for careful engineering and management of septic systems.
- Importance of following BMPs in applying lawn fertilizers.

Local Town Officials

- Specific information about water quality along the length of the stream.
- Importance of water infiltration both in reducing nutrient loss into streams and also reducing damage to roads, bridges, culverts in watershed, and thus avoiding unnecessary costs to taxpayers.

General Public

- Participating in citizen water quality monitoring is an opportunity for any resident in the community to engage in protecting water quality in the area.
- Supporting conservation is important for today's farmers and fishermen and for future generations of farmers and fishermen.
- Good conservation practices not only support strong agriculture into the future, but can reduce the destructive impact of severe storms on roads, bridges, and culverts and the costs of repairing them.

Messengers and Strategies for Delivery

Different target audiences lend themselves to different strategies for delivering the message, and sometimes to different messengers. In all cases, the general messages identified above will be communicated through the media and websites such as Iowa County's Conservation Department, UW Extension, and other partners, as well as displays for use in public venues. In

addition, we will hold one listening session on a later-determined date in each sub-watershed about our watershed plan to address any concerns, and promote engagement and community support. To promote our farmer-friendly message, these will be sponsored by the Uplands Watershed group as well as Iowa County's Conservation and Extension offices and the Michael Fields Agricultural Institute.

Messengers and strategies for specific audiences are as follows:

<u>Farmers, Farmland Owners, Input Dealers, Crop Advisers, Lenders, Farm Groups</u>

- *Direct-Mail Survey to Farm Operators and Farmland Owners*
  Iowa County Conservation has mailing addresses for all farmland owners, to whom a survey will be sent within the first year of the plan with questions for both farmers and farmland owners, investigating respondents' awareness of nutrient contamination problems in the watershed and of basic conservation practices to correct the problem. The results of this survey will help us assess our targets for BMPs, education and outreach. The mailing will also provide recipients with a basic project description, timeline for proposed implementation, and explanations of what to expect and where to get further information.
- *Periodic Direct Mail Updates to Farm Operators and Farmland Owners*
  After the project has launched, we will send direct mailings every 1-2 years for this plan's ten-year schedule, or five mailings total over the project period.
- *Individual Meetings with Farm Operators and Farmland-Owners*
  Iowa County's Conservation staff and the UW-Extension-Iowa County Agriculture Agent, UW-Extension's Nutrient and Pest Management program staff, and local NRCS staff. Other state, local, and nonprofit staff will engage and share information, as circumstances dictate, to ensure that every farm in these two sub-watersheds receives a visit. During the visit, the following actions will be taken: BMPs will be discussed and recommended for each farm, cost-share opportunities identified, and assistance in applications for funding offered, if necessary. Many farmers in the Uplands Watershed Group can be reached simultaneously as needed at the group's meetings, with optional individual follow-ups. The Uplands group agrees to meet at least 4-6 times per year. Meetings with non-farming landowners will also occur, via coordination among all agencies.
- *Upland Watershed Group Farm Tours, Field Days and Associated Local Media*
  The Upland Watershed Group has hosted well over half a dozen events, farm tours, trainings, and field days that have been well-attended, including farmers

with heavy representation within the Meudt Creek sub-watershed. However, to the best of our knowledge, fewer farmers from the Knight Hollow sub-watershed have attended. The best messengers for conservation efforts often are other farmers, and we will continue to offer and help build the group's membership and complete outreach efforts. All farmers and farmland owners in the two sub-watersheds will be invited to all Uplands events, which likely will occur at least twice a year. In Year 9 or 10 of the project, one Uplands public event will focus heavily on this project.

- *Farm Community Leadership Meetings*
  We will work with local farm implement dealerships, farmer cooperatives, farm groups, commodity groups, and technical service providers to educate them about this plan and seek their support for and input into the project. The Uplands Watershed Group has sought and sometimes received the co-sponsorship of events by Iowa County's Farm Bureau, but neither they nor any other farm group has had an active presence. We will meet with leaders of these groups, individually or together, to build their engagement.
- *Small Group Farmer Meetings*
  Over the first few years of the project, we will identify meeting places in the area where we might meet local farmer opinion leaders and a few other farmers whom they suggest for small gatherings, mostly off-season, to discuss the project, challenges, questions and strategies, and hopefully enlist their help.

Non-Farming Residents

Although this is not our plan's principal target audience, we will largely depend on our social media and local media efforts and county website information to reach this audience. However, we will provide two workshops over the first 3 years of the project on lawn care, septic system management, and other residential opportunities for nutrient management.

Local Township Officials

We will set up meetings with local officials (and local town boards if possible) to discuss the purposes of the project and potential road and infrastructure repair savings that could benefit local government and taxpayers. For all audiences, we will refine messaging, based on the needs of the project and communications experiences as the project proceeds. And in all cases, we will provide follow-up outreach as the project nears its end to share the status of the work and any recommendations for further action.

Section 6.2: Information and Education Outreach Plan Schedule

The table below illustrates our plan on information and education outreach with different community stakeholders within Meudt Creek and Knight Hollow. Schedule, outcomes, cost, and partner implementation descriptions are also included.

Table 33. Information and Education Plan Implementation Matrix

Information and Education Action	Target Audience	Strategy and Recommendations	Schedule	Outcomes	Cost	Implementation
Inform public about watershed project, causes of nutrients in streams, potential remedies, timeline, and expected outcomes	-General public	-Local and social media, webpages on partners' websites, and displays for viewing in public venues -One listening session per watershed in years 0-2	Year 0-7	Public understands watershed project and recognizes value of conservation	$8,000	-Iowa County Conservation -UW-Extension -MFAI (Michael Fields Agricultural Institute)

Information and Education Action	Target Audience	Strategy and Recommendations	Schedule	Outcomes	Cost	Implementation
Survey farmers and farmland owners about knowledge of nutrient management; include basic information about project	-Farmers -Farmland owners	Direct mailing with survey of knowledge of nutrient management concerns, basic information about project timeline, technical assistance, funding available, and what to expect for follow-up	Year 0-1	Farmers and farmland owners understand water quality problems in watershed, what they can do, commit to implementing BMPs	$3,000	-Iowa County Conservation -UW Extension -MFAI
Educate about plan, BMPS for managing nutrients in residential yards and septic systems, and ways to access help	-Non-farming residents	-Social media, local media, agency websites. -2 workshops over 3 years	Years 0-3	Residents learn how to manage lawn fertilizers and septic systems to reduce nutrient losses	$1,500	-Iowa County Conservation -UW Extension -MFAI

Information and Education Action	Target Audience	Strategy and Recommendations	Schedule	Outcomes	Cost	Implementation
Explain project purposes and potential road and infrastructure repair savings from greater water infiltration	-Town officials in Arena, Brigham, Dodgeville, and Ridgeway townships	Individual meetings including each township	Years 0-3	Town officials learn that their support for conservation can result in greater infiltration and less flooding, road, culvert, and bridge damage	$500	-Iowa County Conservation -UW Extension -MFAI
Educate farm leaders on watershed project and enlist support	-Input dealers, lenders, and crop advisers	2 or more farm community leadership meetings	Years 0-3	Farm leaders understand their role in supporting farmers' conservation practices	$500	-Iowa County Conservation -UW Extension -MFAI
Educate Uplands and other farmer groups on watershed project and enlist support	-Uplands and other farm groups	2 or more individual meetings with farm group leaders	Years 0-5	Farm leaders understand their role in supporting farmers' conservation practices	$500	-Iowa County Conservation -UW Extension -MFAI

Information and Education Action	Target Audience	Strategy and Recommendations	Schedule	Outcomes	Cost	Implementation
Educate farmers and farmland owners about plan, tailor BMPs for each farm, discuss cost-share opportunities and any assistance needed	-Farmers -Farmland owners	Individual meetings with all farm operators and farmland owners in watershed	Years 0-5	Farmers understand nutrient flow dynamics specific to their farms, recommended BMPS and ways to implement the plan and help fund their implementation	$24,000	-Iowa County Conservation -UW Extension -Nutrient & Pest Management Program -Local NRCS -SW Badger RC&D
Educate farmers about watershed plan, answer questions, promote engagement	-Farmers	1 or 2 small group farmer meetings (mostly winter) per year	Years 0-10	Group discussion of on-farm conservation practices and results helps address problems and creates culture of support for project	$4,000	-Iowa County Conservation -UW Extension -MFAI
Educate farm community about watershed plan and progress, encourage engagement	-Farmers -Farmland owners -Input dealers, lenders, and crop advisers	At least 1 Uplands Farmer Led Watershed Group farm tours, field days, with increasing number of watershed farmers joining group	Years 0-10	Farming community hears Uplands farmers' experiences, discusses obstacles and economic implications, asks questions, builds community support for conservation	$5,000	-Uplands Watershed Group, -MFAI

Information and Education Action	Target Audience	Strategy and Recommendations	Schedule	Outcomes	Cost	Implementation
Educate landowners on watershed plan, its recommended BMPs and other actions, and technical assistance and funding available	-Farmers -Farmland owners	Direct mailing with project updates, recommendations, and what to expect for follow-up, at least once per year	Years 1-7	Farmers and farmland owners learn what others are doing and increase support for this project's conservation practices	$6,000	-Iowa County Conservation -UW Extension -MFAI
Survey about nutrient management strategies	-Farmers -Non-farming farmland owners	Direct mail survey of attitudes about nutrient management in watershed and knowledge of / participation in conservation strategies	Years 7-8	Farmers demonstrate increased knowledge of nutrient management and commitment to conservation practices over survey at project's outset	$3,000	-Iowa County Conservation -UW Extension -MFAI
Educate about outcomes of project and any further recommended actions	-Farmers -Non-farming farmland owners	Direct mailing with information about survey results, project's water quality outcomes, and any further recommend action	Years 9-10	Farmers recognize role they have played and can continue to play in improving water quality and infiltration and reducing soil erosion	$3,000	-Iowa County Conservation -UW Extension -MFAI

Information and Education Action	Target Audience	Strategy and Recommendations	Schedule	Outcomes	Cost	Implementation
Educate about outcomes of project and any further recommended action	-Farmers -Non-farming residents -Town officials -General public	Local and social media, public displays, and special project focus at Uplands Farmer Led Watershed Group tour/public event	Years 9-10	Project participants and the public understand roles that watershed actors play in improving water quality and infiltration and reducing soil erosion, thus saving taxpayer costs and protecting water for downstream users and land for future farmers	$1,500	-Iowa County Conservation -UW Extension -MFAI
					Total: $60,500	

Section 7

Elements 6-8: Project Schedule (10 Year Plan)

Section 7.1: Project Schedule – Element 6

Outlined below is this plan's ten-year schedule, with implementation goals and corresponding milestones to track plan implementation (shown in sections 7.2 and 7.3).

Table 34. Project Schedule and Implementation Goals

Year	Implementation Goal
By Year 3	• Completed initial outreach efforts to community stakeholders. • Projects scheduled per BMP adoption plan in Section 7.3, Progress Indicators. • Meet short-term goals in Section 7.2, Project Milestones.
By Year 7 or 8	• Continue outreach and education efforts and increase number of producers and stakeholders involved in the plan. • Meet the *mid-term* goals in Section 7.2, Project Milestones. • Begin water quality monitoring efforts through the Wisconsin DNR. • Review how many progress indicators are met in Section 7.3, Progress Indicators.
By Year 9	• Wisconsin DNR water quality report on both sub-watersheds. • Begin second re-analyzation effort to determine the plan's effectiveness. • Meet or make significant progress towards the *long-term* goals in Section 7.2, Project Milestones. • Meet Section 7.3, Progress Indicators.

Section 7.2: Project Milestones – Element 7

Education and Outreach

The following list are our short, mid, and long-term milestone goals for outreach and implementation of our plan. The initial 3 years of our plan will rely heavily on outreach and educational efforts. The mid-life of the plan will be more focused on implementing practices and keeping producers and community stakeholders engaged, while the last few years of the plan will do the same in addition to evaluating and analyzing our work.

If less than 70% of the outreach and education implementation milestones are being met for each milestone period, the plan will need to be evaluated and revised to either change the milestone(s) or to implement projects or actions to achieve the milestone(s) that are not being met.

Short Term (0-3 Years)

- Direct-mail survey sent to 240 farmers and farmland owners
- At least 60 individual meetings with farmers and farmland owners
- At least 2 Farm Community Leadership meetings conducted
- At least 2 meetings with farm groups conducted
- At least 3 Uplands Watershed Group public events
- At least 4 Small Group (mostly off-season) farmer meetings conducted
- At least 2 workshops conducted targeting non-farming residents
- At least 1 meeting with local officials
- At least 5 stories in local media
- Creation of at least 1 social media sites for communication, with at least 20 postings
- Installation of at least 1 project webpage on County websites
- Creation of display for use in library and other public places
- At least 2 meetings with town officials
- At least 10 more farmers engaging in Uplands Watershed group

Mid-Term (3-7 Years)

- At least 60 individual meetings with farmers and farmland owners
- At least 8 stories in local media and 20 more postings on social media
- Updating of webpage at least 20 times
- At least 1 Uplands Watershed public event held per year
- At least 10 additional farmers engaging in Uplands Watershed group (20 over the life of the project)

Long Term (7-10 Years)

- Follow-up survey sent to 240 farmers and farmland owners
- Mailing sent to 240 farmers and farmland owners with information about survey results, project's water quality outcomes, and any further recommended actions
- At least 1 Uplands public event held with special focus on project results
- At least 1 meeting with local town officials to discuss implications of project

Section 7.3: Progress Indicators – Element 8

Progress indicators identify the amount and rate of projects we will need to take on in order to stay on track for our plan. Adoption of practices will roughly start during year 3 after extensive outreach on this plan has been completed within the watershed. The table below outlines the practice, total number of projects, and project implementation schedule per practice to track plan implementation over time. Each project is expected to include one or more of the cropland or pastureland BMP combinations/acreage described in section 4.3 of this plan.

Table 35. Progress Indicators – 10-year Schedule

Practice	Total Amount of Projects	Project Schedule
Conservation Tillage	13	1 – 2 annually
Nutrient Management Planning	18	2 – 3 annually
Streambank Stabilization	34	4 – 5 annually
Fencing	34	4 – 5 annually
Grass Buffers – 35'	110	13 – 14 annually
Cover Crops	30	3 – 4 annually
Alternative Water Supply	20	2 – 3 annually
Grazing Land Management	74	9 – 10 annually
Barnyard Run-off System	5	1 annually or biennially

If less than 25% of total practice/project milestones in Table 35 are not met by year 5 of this plan, the plan will need to be evaluated and revised to either change these milestone(s) or to implement projects or actions to achieve the milestone(s) that are not being met.

Another progress indicator not listed in the table 35 will be the monitoring data for each sub-watershed we plan to receive from WAV volunteers and WDNR biologists. WAV is a volunteer program for Wisconsin citizens across the state who are interested in learning and improving the quality of streams and rivers in their watersheds. The program is coordinated through the Wisconsin DNR and the University of Wisconsin Cooperative Extension, and includes individual citizens, environmental groups, students, and other groups of people undertaking three levels of monitoring training.

We anticipate WAV volunteers and WDNR will help to establish baseline pollutant concentration values for each sub-watershed by the end of 2019. This plan will then continue to rely upon WAV monitoring efforts over the plan's ten-year schedule to help understand if we are or are not making progress towards this plan's load reduction goals. More detailed water quality monitoring efforts related to this plan are described in section 8 below.

Section 7.4: Additional Progress Indicators – Element 8

Progress Evaluation

Due to the uncertainty of models and the efficiency of best management practices, an adaptive management approach will be taken with this plan (see figure 20 below). Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals over given time periods. Plan milestones are based on the implementation schedule with short term (0-3 years), medium term (3-7 years), and long term (7-10 years) milestones. Plan progress and success should be evaluated at each milestone period, based on the implementation schedule, milestones, and indicators described in previous sections. Any lack of progress should be analyzed to determine causes and barriers to implementation. Adjustments should be made to the plan based on progress, any problems encountered, and any new data and/or watershed tools.

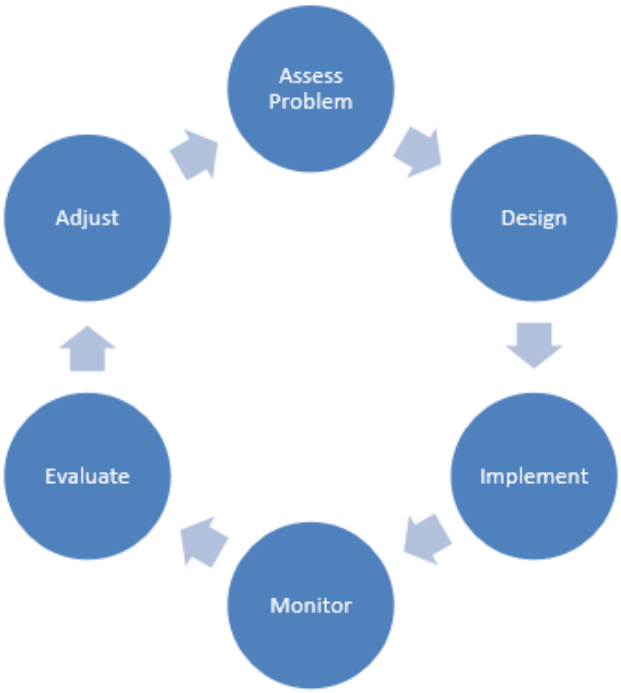


Figure 20. Adaptive Management Approach

Tracking of Progress and Success of Plan

Progress and success of this plan will be tracked by the following components:

1. Information and education activities and participation
2. Pollution reduction evaluation and BMPs installed
3. Water quality monitoring
4. Administrative review

Iowa County Land and Water Conservation Department will be responsible for tracking progress of the plan, in cooperation with partners such as UW-Extension, NRCS, and MFAI.

1. **Information and education tracking will include:**
   a) Number of landowners/operators contacted.
   b) Survey response rates and results.
   c) Number and type of information and education activities held, including number contacted and participated, and any measurable results.
   d) Number of on- on-one meetings with farmers and landowners in the watershed.
   e) Number of group meetings.
   f) Number of local media, social media, and website pieces.
   g) Comments or suggestions for future activities.

2. **Installed best management practices will be mapped using GIS, and pollution reductions from completed projects will be evaluated using models and spreadsheet tools such as STEPL and SnapPlus.**
   The methods outlined in the US EPA technical memo, "Adjusting for Depreciation of Land Treatment When Planning Watershed Projects" will be used when evaluating BMP effectiveness and identifying factors that may affect BMP performance levels and implementation. For additional information on BMP deprecation see Appendix X.

   Pollutant reduction and BMP tracking will include:
   a) Planned and completed BMPs, including cost-share funding sources.
   b) Pollutant load reductions and percent of goal achieved.
   c) Number of follow-up field visits to assess the operation and maintenance of BMPS.
   d) Changes in land use or land management in watershed that may impact BMP effectiveness.
   e) Variations in weather that may have influenced implementation or effectiveness of BMPs.

3. **Water Quality Monitoring Reporting Parameters: TBD after 2019 WDNR report is complete.**

4. **Administrative Review tracking and reporting will include:**
   a) Status of grants relating to project.
   b) Number and funding amount of cost-share agreements.
   c) Total cost of BMP projects.
   d) Staff salary, fringe benefits, and travel expenditures.
   e) Information and education expenses.
   f) Equipment, materials, and supply expenses.

See Appendix B for EPA Technical Memorandum #1, Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

Section 8

Element 9: Monitoring Component

Section 8.1: Current Monitoring Efforts Status

To the best of our knowledge, there have been very few recent monitoring efforts reported on the Meudt Creek and Knight Hollow sub-watersheds in the last ten years. However, Jean Unmuth, the Wisconsin DNR's Water Resource Specialist, and her team started water quality monitoring efforts in the Mill Creek watershed during the spring 2018. The following tables reflect the waterbodies they have begun collecting data from, from June to July 2018. This group plans to continue and complete their work by the fall of 2018 and will release their full report by the early summer to late fall of 2019. The report will have information on water chemistry, aquatic insects and fish populations, and various other habitat and water quality information that can be used to establish a baseline data set to compare to over this plan's ten-year schedule. The report will also include a compilation of all other data the Wisconsin DNR has collected over the past 10 years in the watershed. Accordingly, another milestone for this plan will be to obtain, review and incorporate the report's data and findings into this plan within one year of the report's completion. In addition, the report may also lead to refining other aspects of this plan that may include, but not be limited to: (1) identification of critical areas (i.e., data collection may show areas within each sub-watershed with consistently higher pollutant concentrations than others) and (2) focusing education and outreach efforts with specific landowners/ag producers in the watershed.

In addition to the report, Jean has already helped lead training sessions through the Water Action Volunteers (WAV) program within both sub-watersheds, increasing community interest and education around water quality monitoring. Ongoing WAV monitoring can help to better inform implementation efforts within Meudt Creek and Knight Hollow sub-watersheds.

Table 36. Meudt Creek Current Monitoring Locations

Waterbody	WBIC	Swim Station	Swim Name
Mill Cr.	1242200	10016649	US CTH-Y
UnTrib.of Mill Cr.	1244700	253181	US Rosy Ln
UnTrib.of Mill Cr.	1244900	10051106	US CTH Y
Meudt Cr.	1244600	10051107	US Sawle Rd
Strutt Cr.	1244500	10010774	Strutt Cr CTH H
UnTrib.of Mill Cr.	1244300	10051111	US CTH H
Hubbard Cr.	1244200	10051112	US CTH H
Mill Cr.	1242200	10044785	US Mill Rd

Table 37. Knight Hollow Current Monitoring Locations

Waterbody	**WBIC**	**Swim Station**	**Swim Name**
UnTrib.of Mill Cr.	5035533	10051093	US CTH H
UnTrib.of Mill Cr.	1242900	10051101	DS CTH H
White Hollow Cr.	1242600	253073	US CTH HH
Ryan Cr.	1242500	10051104	US CTH HH
Ryan Cr.	1242500	10051105	US CTH H
Mill Cr.	1242200	10048502	US Amacher H Rd

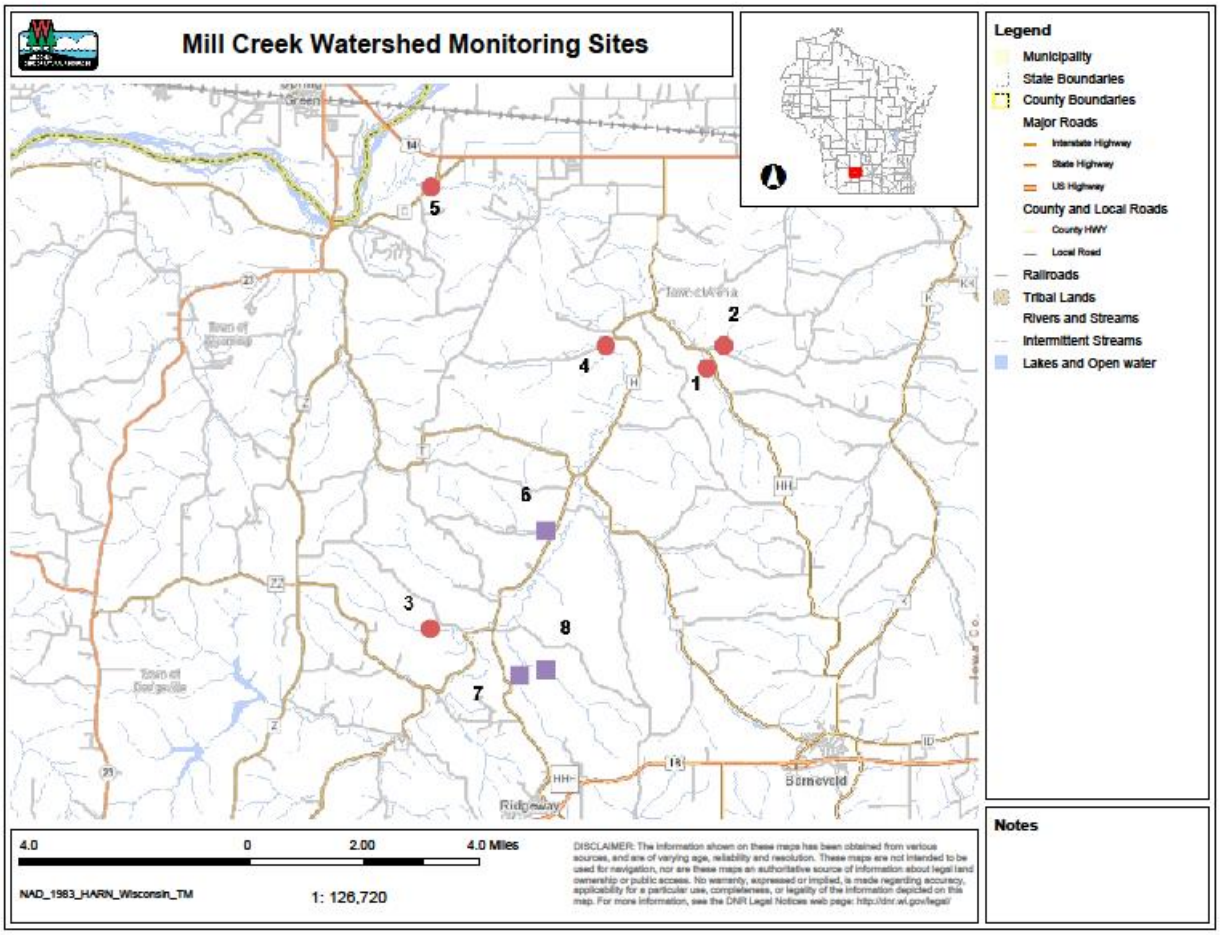


Figure 21. Mill Creek Watershed Monitoring Sites

Section 8.2: 10 Year Monitoring Strategy

The following list outlines the steps this plan will need to complete to successfully monitor the quality of streams and creeks running through Meudt Creek and Knight Hollow. Monitoring will largely be overseen by Jean Unmuth, staff/interns at the Wisconsin DNR, and WAV volunteers composed of community residents and producers. While baseline water monitoring results will not be available until late in 2019, official monitoring efforts completed by WDNR staff will not occur again for approximately 5 years.

To measure changes in water quality and habitat conditions, stream systems will need time to recover and respond to the new BMPs identified in this plan. Per this plan's milestones, we

don't expect many practices to be adopted immediately after the plan begins implementation. It will take time to establish relationships within each sub-watershed to adopt practices making the majority of monitoring efforts one of the last steps in our 9 Key Element Plan.

- Staff
    - To successfully monitor Meudt Creek and Knight Hollow, the Wisconsin DNR will need at least three staff members conducting fieldwork and reports. The work can also be done with one staff and two interns, or another ratio of staff and interns.
- Volunteers
    - WAV volunteers can monitor at any time of the year, at any point of our plan.
    - Although WAV volunteer reports are not official, they are useful in getting a snapshot of the condition of the watershed during the intermediate years between DNR monitoring. Information collected from WAV volunteers can help inform leaders in the area on water quality issues and allow the community to respond to available data immediately.
    - The more volunteers we can train, the more educated and capable the watershed becomes in responding to these and other issues. Although we don't need a set number of volunteers to accomplish the plan's monitoring component, their presence is incredibly helpful to retrieve intermediate data and build a strong culture around conservation and community within the watershed.
- Monitoring Timeline
    - In order to allow the watershed aquatic environment to respond to the implementation of new BMPs, it is recommended that monitoring begin 3-5 years after the practices have been implemented.
    - Most water quality monitoring will likely be completed towards the final year or two of this plan.
- Funding
    - The cost of time, materials, testing, etc. can become substantial burdens to groups, volunteers, and others interested in monitoring. The following are funding resources available to groups interested within the watershed.
    - Surface Water Grant Program
        - This grant is run through the Wisconsin DNR and includes funding available to various groups for river/stream monitoring efforts.

- WAV Level 3 Volunteer Funding
    - For those WAV volunteers who have reached level 3 of their monitoring training, the Wisconsin DNR opens funds for them to help select a watershed they'd like to monitor, providing them with the tools, equipment, and support necessary.
    - This could be a goal for volunteers we find in the watershed to reach for.

Water Quality Indicators

Plan progress will be measured, in part, by water quality data. Median summer phosphorus concentrations and macroinvertebrate index of biotic integrity are some parameters that will be used to determine improvement in water quality for this plan. Water quality monitoring indicators for success are shown in Table 38 below. This table will be fully completed after the 2019 WDNR water quality monitoring report is complete. Estimated load reduction from implemented best management practices will also be used to determine if interim water quality goals are being met.

Table 38. Water Quality Monitoring Indicators for Success

Sub-Watershed	Swim Station ID / Map Number**	Location Description	Indicators	Current Values (Avg.)	Current Values (Median)	Short Term (3 years)	Medium Term (7 years)	Long Term / Target Value (10 years)	Implementation	Funding
Knight Hollow – Mill Creek	253073 / 1	White Hollow Cr. US of CTH HH	Summer Median Total P (mg/l); Fish and Macroinvertebrate IBI	0.064*	0.068	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Knight Hollow – Mill Creek	10051104 / 2	Ryan Creek US CTH HH	Summer Median Total P (mg/l); Fish and Macroinvertebrate IBI	0.068*	0.072	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Meudt Creek – Mill Creek	10051107 / 3	Meudt Creek US Sawle Rd.	Summer Median Total P (mg/l); Fish and Macroinvertebrate IBI	0.085*	0.089	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Knight Hollow – Mill Creek	10048502 / 4	Mill Creek at Amacher Hollow Road	Summer Median Total P (mg/l); Fish and Macroinvertebrate IBI	0.11*	0.12	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Coon Rock – Mill Creek	10030075 / 5	Mill Creek at CTH C	Summer Median Total P (mg/l); Fish and Macroinvertebrate IBI	0.12	0.123	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Meudt Creek – Mill Creek	10051112 / 6	Hubbard Creek at CTH H	Fish and Macroinvertebrate IBI	N/A	N/A	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Meudt Creek – Mill Creek	10033874 / 7	Strutt Creek upstream of Love Creek	Fish and Macroinvertebrate IBI	N/A	N/A	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD
Meudt Creek – Mill Creek	10048634 / 8	Love Creek upstream of Strutt Creek	Fish and Macroinvertebrate IBI	N/A	N/A	TBD	TBD	0.075	DNR, Iowa Cty. LCD, MFAI	DNR/EPA grants, & TBD

*Not enough samples taken for implementation evaluation. Will collect more Summer Median Total P Concentration (mg/l) data to set short-to-long term concentration goals.

**Refer to Figure 21 for map locations

Water Quality Monitoring Progress Evaluation

This implementation plan recognizes that estimated pollutant load reductions and expected improvement in water quality or aquatic habitat may not occur immediately following implementation of practices due to several factors (described below) that will need to be taken into consideration when evaluating water quality data. These factors can affect or mask progress that plan implementation has made elsewhere. Consultation with the DNR and Water Quality biologists will be critical when evaluating water quality or aquatic habitat monitoring results. If the target values/goals for water quality improvement for the milestone period are not being achieved, the water quality targets or timetable for pollutant reduction will need to evaluate and adjusted as necessary.

The following criteria will be evaluated when water quality and aquatic habitat monitoring is completed after implementation of practices:

- Changes in land use or crop rotations within the same watershed where practices are implemented. (Increase in cattle numbers, corn silage acres, and/or urban areas can negatively impact stream quality and water quality efforts)
- Location in watershed where land use changes or crop rotations occur. (Where are these changes occurring in relation to implemented practices?)
- Watershed size, location where practices are implemented and location of monitoring sites.
- Climate, precipitation and soil conditions that occurred before and during monitoring periods. (Climate and weather patterns can significantly affect growing season, soil conditions, and water quality)
- Frequency and timing of monitoring
- Percent of watershed area (acres) or facilities (number) meeting NR 151 performance standards and prohibitions.
- Percent of watershed area (acres) or facilities (number) that maintain implemented practices over time.
- Extent of gully erosion on crop fields within watershed over time. How many are maintained in perennial vegetation vs. plowed under each year?
- Stability of bank sediments and how much this sediment may be contributing P and TSS to the stream.
- How “Legacy’ sediments already within the stream and watershed may be contributing P and sediment loads to stream

Section 9

Literature/Resources Cited

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Appendix A

Adjusted Total BMP Acres

With our reduction goals in mind, tables A1 and A2 below reflect the new totals of acres per individual practice, per sub-watershed. These numbers include existing practices, building upon those acres through the addition of different singular and Combination BMPs. Due to similarities in size, environment, and character of both sub-watersheds, we generally kept with the same reduction strategy for both Meudt Creek and Knight Hollow.

Table A1. Cropland Adjusted Total BMP Acres

BMPs	Meudt Creek Cropland Acres	Knight Hollow Cropland Acres
BMP1	709.4	756.21
BMP2	102.53	62.54
BMP3	36.49	31.18
BMP5	21.2	21.2
BMP6	125	125
Contour Farming	254.11	162.61
Nutrient Management Plan 2	158.27	111.57
Grass Buffer 35'	489.8	409.55
Cover Crops 2	125	125

Table A2. Pasture Adjusted Total BMP Acres

BMPs	Meudt Creek Pasture Acres	Knight Hollow Pasture Acres
BMPc	300	300
BMPd	915	1,307

Appendix B

United States
Environmental Protection
Agency

Technical Memorandum #1

Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

This Technical Memorandum is one of a series of publications designed to assist watershed projects, particularly those addressing nonpoint sources of pollution. Many of the lessons learned from the Clean Water Act Section 319 National Nonpoint Source Monitoring Program are incorporated in these publications.

October 2015

Donald W. Meals and Steven A. Dressing. 2015. Technical Memorandum #1: Adjusting for Depreciation of Land Treatment When Planning Watershed Projects, October 2015. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA, 16 p.
Available online at *www.epa.gov/xxx/tech_memos.htm*.

Introduction

Fields near Seneca Lake, New York.

Watershed-based planning helps address water quality problems in a holistic manner by fully assessing the potential contributing causes and sources of pollution, then prioritizing restoration and protection strategies to address the problems (USEPA 2013). The U.S. Environmental Protection Agency (EPA) requires that watershed projects funded directly under section 319 of the Clean Water Act implement a watershed-based plan (WBP) addressing the nine key elements identified in EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters (USEPA 2008)*. EPA further recommends that all other watershed plans intended to address water quality impairments also include the nine elements. The first element calls for the identification of causes and sources of impairment that must be controlled to achieve needed
load reductions. Related elements include a description of the nonpoint source (NPS) management measures—or best management practices (BMPs)—needed to achieve required pollutant load reductions, a description of the critical areas in which the BMPs should be implemented, and an estimate of the load reductions expected from the BMPs.

Once the causes and sources of water resource impairment are assessed, identifying the appropriate BMPs to address the identified problems, the best locations for additional BMPs, and the pollutant load reductions likely to be achieved with the BMPs depends on accurate information on the performance levels of both BMPs already in place and BMPs to be implemented as part of the watershed project. All too often, watershed managers and Agency staff have assumed that, once certified as installed or adopted according to specifications, a BMP continues to perform its pollutant reduction function at the same efficiency (percent pollutant reduction) throughout its design or contract life, sometimes longer. An important corollary to this assumption is that BMPs in place during project planning are performing as originally intended. Experience in NPS watershed projects across the nation, however, shows that, without diligent operation and maintenance, BMPs and their effects probably will depreciate over time, resulting in less efficient pollution reduction. Recognition of this fact is important at the project planning phase, for both existing and planned BMPs.

Knowledge of land treatment depreciation is important to ensure project success through the adaptive management process (USEPA 2008). BMPs credited during the planning phase of a watershed project will be expected to achieve specific load reductions or other water quality benefits as part of the overall plan to protect or restore a water body. Verification that BMPs are still performing their functions at anticipated levels is essential to keeping a project on track to achieve its overall goals. Through adaptive management, verification results can be used to inform decisions about needs for additional BMPs or maintenance or repair of existing BMPs. In a watershed project that includes short-term (3–5 years) monitoring, subtle changes in BMP performance level might not be detectable or critical, but planners must account for catastrophic failures, BMP removal or discontinuation, and major maintenance shortcomings. Over the longer term, however, gradual changes in BMP performance level can be significant in terms of BMP-specific pollutant control or the role of single BMPs within a BMP system or train. The weakest link in a BMP train can be the driving force in overall BMP performance.

Application of and methods for BMP tracking in NPS watershed projects are described in detail in *Tech Notes 11* (Meals et al. 2014).

This technical memorandum addresses the major causes of land treatment depreciation, ways to assess the extent of depreciation, and options for adjusting for depreciation. While depreciation occurs throughout the life of a watershed project, the emphasis is on the planning phase and the short term (i.e., 3–5 years).

Causes of Depreciation

Depreciation of land treatment function occurs as a result of many factors and processes. Three of the primary causes are natural variability, lack of proper maintenance, and unforeseen consequences.

Natural Variability

Climate and soil variations across the nation influence how BMPs perform. Tiessen et al. (2010), for example, reported that management practices designed to improve water quality by reducing sediment and sediment-bound nutrient export from agricultural fields can be less effective in cold, dry regions where nutrient export is primarily snowmelt driven and in the dissolved form, compared to similar practices in warm, humid regions. Performance levels of vegetation-based BMPs in both agricultural and urban settings can vary significantly through the year due to seasonal dormancy. In a single locale, year-to-year variation in precipitation affects both agricultural management and BMP performance levels. Drought, for example, can suppress crop yields, reduce nutrient uptake, and result in nutrient surpluses left in the soil after harvest where they are vulnerable to runoff or leaching loss despite careful nutrient management. Increasing incidence of extreme weather and intense storms can overwhelm otherwise well-designed stormwater management facilities in urban areas.

Lack of Proper Maintenance

Most BMPs—both structural and management—must be operated and maintained properly to continue to function as designed. Otherwise, treatment effectiveness can depreciate over time. For example, in a properly functioning detention pond, sediment typically accumulates in the forebay. Without proper maintenance to remove accumulated sediment, the capacity of the BMP to contain and treat stormwater is diminished. Similarly, a nutrient management plan is only as effective as its implementation. Failure to adhere to phosphorus (P) application limits, for example, can result in soil P buildup and increased surface and subsurface losses of P rather than the loss reductions anticipated.

Jackson-Smith et al. (2010) reported that over 20 percent of implemented BMPs in a Utah watershed project appeared to be no longer maintained or in use when evaluated just 5 years after project completion. BMPs related to crop production enter prises and irrigation systems had the lowest rate of continued use and maintenance (~75 percent of implemented BMPs were still in use), followed by pasture and grazing planting and man agement BMPs (81 percent of implemented BMPs were still in use). Management practices (e.g., nutrient management) were found to be par ticularly susceptible to failure.

Practices are sometimes simply abandoned as a result of changes in landowner circumstances or attitudes. In a Kansas watershed project, farmers abandoned a nutrient management program because of perceived restrictive reporting requirements (Osmond et al. 2012).

Abandoned waste storage structure.

In the urban arena, a study of more than 250 stormwater facilities in Maryland found that nearly one-third of stormwater BMPs were not functioning as designed and that most needed maintenance (Lindsey et al. 1992). Sedimentation was a major problem and had occurred at nearly half of the facilities; those problems could have been prevented with timely maintenance.

Hunt and Lord (2006) describe basic maintenance requirements for bioretention practices and the consequences of failing to perform those tasks. For example, they indicate that mulch should be removed every 1–2 years to both maintain available water storage volume and increase the surface infiltration rate of fill soil. In addition, biological films might need to be removed every 2–3 years because they can cause the bioretention cell to clog.

In plot studies, Dillaha et al. (1986) observed that vegetative filter strip-effectiveness for sediment removal appeared to decrease with time as sediment accumulated within the filter strips. One set of the filters was almost totally inundated with sediment during the cropland experiments and filter effectiveness dropped 30–60 percent between the first and second experiments. Dosskey et al. (2002) reported that up to 99 percent of sediment was removed from cropland runoff when uniformly distributed over a buffer area, but as concentrated flow paths developed over time (due to lack of maintenance), sediment removal dropped to 15–45 percent. In the end, most structural

BMPs have a design life (i.e., the length of time the item is expected to work within its specified parameters). This period is measured from when the BMP is placed into service until the end of its full pollutant reduction function.

Unforeseen Consequences

The effects of a BMP can change directly or indirectly due to unexpected interactions with site conditions or other activities. Incorporating manure into cropland soils to reduce nutrient runoff, for example, can increase erosion and soil loss due to soil disturbance, especially in comparison to reduced tillage. On the other hand, conservation tillage can result in accumulation of fertilizer nutrients at the soil surface, increasing their availability for loss in runoff (Rhoton et al. 1993). Longterm reduction in tillage also can promote the formation of soil macropores, enhancing leaching of soluble nutrients and agrichemicals into ground water (Shipitalo et al. 2000). Stutter et al. (2009) reported that establishment of vegetated buffers between cropland and a watercourse led to enhanced rates of soil P cycling within the buffer, increasing soil P solubility and the potential for leaching to watercourses.

Despite widespread adoption of conservation tillage and observed reductions in particulate P loads, a marked increase in loads of dissolved bioavailable P in agricultural tributaries to Lake Erie has been documented since the mid-1990s. This shift has been attributed to changes in application rates, methods, and timing of P fertilizers on cropland in conservation tillage not subject to annual tillage (Baker 2010; Joosse and Baker 2011). Further complicating matters, recent research on fields in the St. Joseph River watershed in northeast Indiana has demonstrated that about half of both soluble P and total P losses from research fields occurred via tile discharge, indicating a need to address both surface and subsurface loads to reach the goal of 41 percent reduction in P loading for the Lake Erie Basin (Smith et al. 2015).

Several important project planning lessons were learned from the White Clay Lake, Wisconsin, demonstration projects in the 1970s, including the need to accurately assess pollutant inputs and the performance levels of BMPs (NRC 1999). Regarding unforeseen consequences, the project learned through monitoring that a manure storage pit built according to prevailing specifications actually caused ground water contamination that threatened a farmer's well water. This illustrates the importance of monitoring implemented practices over time to ensure that they function properly and provide the intended benefits.

Control of urban stormwater runoff (e.g., through detention) has been widely implemented to reduce peak flows from large storms in order to prevent stream channel erosion. Research has shown, however, that although large peak flows might be controlled effectively by detention storage, stormflow conditions are extended over a longer period of time. Duration of erosive and bankfull flows are increased, constituting channel-forming events. Urbonas and Wulliman (2007) reported that, when captured runoff from a number of individual detention basins in a stream system is released over time, the flows accumulate as they travel downstream, actually increasing peak flows

along the receiving waters. This situation can diminish the collective effectiveness of detention basins as a watershed management strategy.

Assessment of Depreciation

The first—and possibly most important—step in adjusting for depreciation of implemented BMPs is to determine its extent and magnitude through BMP verification.

BMP Verification

At its core, BMP verification confirms that a BMP is in place and functioning properly as expected based on contract, permit, or other implementation evidence. A BMP verification process that documents the presence and function of BMPs over time should be included in all NPS watershed projects.

At the project planning phase, verification is important both to ensure accurate assessment of existing BMP performance levels and to determine additional BMP and maintenance needs. Verification over time is necessary to determine if BMPs are maintained and operated during the period of interest.

Documenting the presence of a BMP is generally simpler than determining how well it functions, but both elements of verification must be considered to determine if land treatment goals are being met and whether BMP performance is depreciating. Although land treatment goals might not be highly specific in many watershed projects, it is important to document what treatment is implemented. Verification is described in detail in *Tech Notes 11* (Meals et al. 2014). This technical memorandum focuses on specific approaches to assessing depreciation within the context of an overall verification process.

Methods for Assessing BMP Presence and Performance Level

Whether a complete enumeration or a statistical sampling approach is used, methods for tracking BMPs generally include direct measurements (e.g., soil tests, onsite inspections, remote sensing) and indirect methods (e.g., landowner self-reporting or third-party surveys). Several of these methods are discussed in *Tech Notes 11* (Meals et al. 2014). Two general factors must be considered when verifying a BMP: the presence of the BMP and its pollutant removal efficiency. Different types of BMPs require different verification methods, and no single approach is likely to provide all the information needed in planning a watershed project.

Certification

The first step in the process is to determine whether BMPs have been designed and installed/ adopted according to appropriate standards and specifications. Certification can either be the final step in a contract between a landowner and a funding agency or be a component of a permit requirement.

Certification provides assurance that a BMP is fully functional for its setting at a particular time. For example, a stormwater detention pond or water and sediment control basin must be properly sized for its contributing area and designed for a specific retention-and-release performance level. A nutrient management plan must account for all sources of nutrients, consider current soil nutrient levels, and support a reasonable yield goal. A cover crop must be planted in a particular time window to provide erosion control and/or nutrient uptake during a critical time of year. Some jurisdictions might apply different nutrient reduction efficiency credits for cover crops based on planting date. Some structural BMPs like parallel tile outlet terraces require up to 2 years to fully settle and achieve full efficiency; in those cases, certification is delayed until full stability is reached. Knowledge that a BMP has been applied according to a specific standard supports an assumption that the BMP will perform at a certain level of pollutant reduction efficiency, providing a baseline against which future depreciation can be compared. Practices voluntarily implemented by landowners without any technical or financial assistance could require special efforts to determine compliance with applicable specifications (or functional equivalence). Pollution reduction by practices not meeting specifications might need to be discounted or not counted at all even when first installed.

Depreciation assessment indicators

Ideally, assessment of BMP depreciation would be based on actual measurement of each BMP's performance level (e.g., monitoring of input and output pollutant loads for each practice). Except in very rare circumstances, this type of monitoring is impractical. Rather, a watershed project generally must depend on the use of indicators to assess BMP performance level.

The most useful indicators for assessing depreciation are determined primarily by the type of BMP and pollutants controlled, but indicators might be limited by the general verification approach used. For example, inflow and outflow measurements of pollutant load can be used to determine the effectiveness of constructed wetlands, but a verification effort that uses only visual observations will not provide that data or other information about wetland functionality. A central challenge, therefore, is to identify meaningful indicators of BMP performance level that can be tracked under different verification schemes. This technical memorandum provides examples of how to accomplish that end.

Nonvegetative structural practices

Performance levels of nonvegetative structural practices—such as animal waste lagoons, digesters, terraces, irrigation tailwater management, stormwater detention ponds, and pervious pavement—can be assessed using the following types of indicators:

- Measured on-site performance data (e.g., infiltration capacity of pervious pavement),
- Structural integrity (e.g., condition of berms or other containment structures), and
- Water volume capacity (e.g., existing pond volume vs. design) and mass or volume of captured material removed (e.g., sediment removed from stormwater pond forebay at cleanout).

In some cases, useful indicators can be identified directly from practice standards. For example, the Natural Resources Conservation Service lists operation and maintenance elements for a water and sediment control basin (WASCoB) (*USDA-NRCS 2008*) that include:

- Maintenance of basin ridge height and outlet elevations,
- Removal of sediment that has accumulated in the basin to maintain capacity and grade,
- Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the basin, and
- Regular mowing and control of trees and brush.

These elements suggest that ridge and outlet elevations, sediment accumulation, inlet integrity, and vegetation control would be important indicators of WASCoB performance level.

Required maintenance checklists contained in stormwater permits also can suggest useful indicators. For example, the *Virginia Stormwater Management Handbook* (VA DCR 1999) provides an extensive checklist for annual operation and maintenance inspection of wet ponds. The list includes many elements that could serve as BMP performance level indicators:

- Excessive sediment, debris, or trash accumulated at inlet,
- Clogging of outlet structures,
- Cracking, erosion, or animal burrows in berms, and
- More than 1 foot of sediment accumulated in permanent pool.

Assessment of these and other indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

Vegetative structural practices

Performance levels of vegetative structural practices—such as constructed wetlands, swales, rain gardens, riparian buffers, and filter strips—can be assessed using the following types of indicators:

- Extent and health of vegetation (e.g., measurements of soil cover or plant density),
- Quality of overland flow filtering (e.g., evidence of short-circuiting by concentrated flow or gullies through buffers or filter strips),
- On-site capacity testing of rain gardens using infiltrometers or similar devices, and
- Visual observations (e.g., presence of water in swales and rain gardens).

Parking lot rain garden.

As for non-vegetative structural practices, assessment of these indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

Nonstructural vegetative practices

Performance levels of nonstructural vegetative practices—such as cover crops, reforestation of logged tracts, and construction site seeding—can be assessed using the following types of indicators:

- Density of cover crop planting (e.g., plant count),
- Percent of area covered by cover crop, and
- Extent and vitality of tree seedlings.

These indicators could be assessed by on-site inspection or, in some cases, by remote sensing, either from satellite imagery or aerial photography.

Management practices

Performance levels of management practices—such as nutrient management, conservation tillage, pesticide management, and street sweeping—can be assessed using the following types of indicators:

- Records of street sweeping frequency and mass of material collected,
- Area or percent of cropland under conservation tillage,
- Extent of crop residue coverage on conservation tillage cropland, and
- Fertilizer and/or manure application rates and schedules, crop yields, soil test data, plant tissue test results, and fall residual nitrate tests.

Illustration of line-transect method for residue.

Assessment of these indicators would generally require reporting by private landowners or municipalities, reporting that is required under some regulatory programs. Visual observation of indicators such as residue cover, however, can also be made by on-site inspection or windshield survey.

Data analysis

Data on indicators can be expressed and analyzed in several ways, depending on the nature of the indicators used. Indicators reporting continuous numerical data—such as acres of cover crop or conservation tillage, manure application rates, miles of street sweeping, mass of material removed from catch basins or detention ponds, or acres of logging roads/landings revegetated—can be expressed either in the raw form (e.g., acres with 30 percent or more residue cover) or as a percentage of the

design or target quantity (e.g., percent of contracted acres achieving 30 percent or more of residue cover). These metrics can be tracked year to year as a measure of BMP depreciation (or achievement). During the planning phase of a watershed project, it might be appropriate to collect indicator data for multiple years prior to project startup to enable calculation of averages or ranges to better estimate BMP performance levels over crop rotation cycles or variable weather conditions.

Indicators reporting categorical data—such as maintenance of detention basin ridge height and outlet elevations, condition of berms or terraces, or observations of water accumulation and flow— are more difficult to express quantitatively. It might be necessary to establish an ordinal scale (e.g., condition rated on a scale of 1–10) or a binary yes/no condition, then use best professional judgment to assess influence on BMP performance.

In some cases, it might be possible to use modeling or other quantitative analysis to estimate individual or watershed-level BMP performance levels based on verification data. In an analysis of stormwater BMP performance levels, Tetra Tech (2010) presented a series of BMP performance curves based on monitoring and modeling data that relate pollutant removal efficiency to depth of runoff treated (Figure 1). Where depreciation indicators track changes in depth of runoff treated as the capacity of a BMP decreases (e.g., from sedimentation), resulting changes in pollutant removal could be determined from a performance curve. This type of information can be particularly useful during the planning phase of a watershed project to estimate realistic performance levels for existing BMPs that have been in place for a substantial portion of their expected lifespans.

The performance levels of structural agricultural BMPs in varying condition can be estimated by altering input parameters in the *Soil and Water Assessment Tool* (SWAT) model (Texas A&M University 2015a); other models such as the *Agricultural Policy/Environmental eXtender* (APEX) model (Texas A&M University 2015b) also can be used in this way (including application to some urban BMPs).

For urban stormwater, engineering models like *HydroCAD* (HydroCAD Software Solutions 2011) can be used to simulate hydrologic response to stormwater BMPs with different physical characteristics (e.g., to compare performance levels under actual vs. design conditions). Even simple spreadsheet models such as the Spreadsheet Tool for Estimating Pollutant Load (*STEPL*) (USEPA 2015) can be used to quantify the effects of BMP depreciation by varying the effectiveness coefficients in the model.

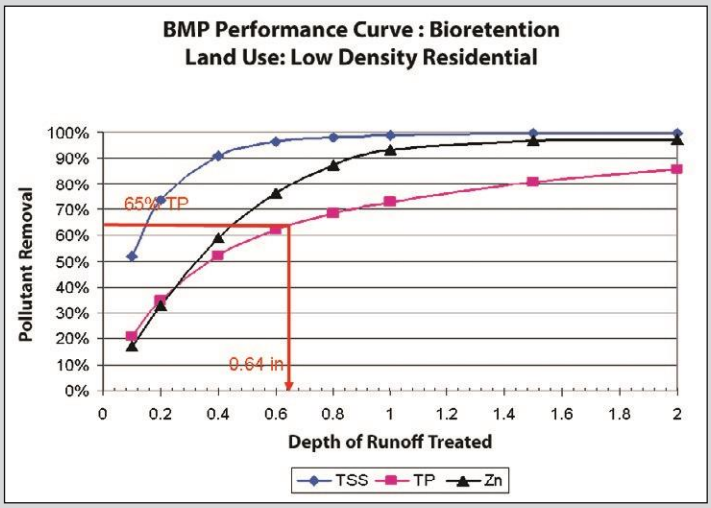

Figure 1. BMP Performance Curve for Bioretention BMP (Tetra Tech 2010).

Data from verification efforts and analysis of the effects of depreciation on BMP performance levels must be qualified based on data confidence. "Confidence" refers mainly to a quantitative assessment of the accuracy of a verification result. For example, the number of acres of cover crops or the

continuity of streamside buffers on logging sites determined from aerial photography could be determined by ground-truthing to be within +10 percent of the true value at the 95 percent confidence level. Confidence also can refer to the level of trust that BMPs previously implemented continue to function (e.g., the proportion of BMPs still in place and meeting performance standards). For example, reporting that 75 percent of planned BMPs have been verified is a measure of confidence that the desired level of treatment has been applied.

While specific methods to evaluate data confidence are beyond the scope of this memo, it is essential to be able to express some degree of confidence in verification results—both during the planning phase and over time as the project is implemented. For example, an assessment of relative uncertainty of BMP performance during the planning phase can be used as direct follow-up to verification efforts to those practices for which greater quantification of performance level is needed. In addition, plans to implement new BMPs also can be developed with full consideration of the reliability of BMPs already in place.

Adjusting for Depreciation

Information on BMP depreciation can be used to improve both project management and project evaluation.

Project Planning and Management

Establishing baseline conditions

Baseline conditions of pollutant loading include not only pollutant source activity but also the influence of BMPs already in place at the start of the project. Adjustments based on knowledge of BMP depreciation can provide a more realistic estimate of baseline pollutant loads than assuming that existing land treatment has reduced NPS pollutant loads by some standard efficiency value.

> Establishing an accurate starting point will make load reduction targets—and, therefore, land treatment design—more accurate. Selecting appropriate BMPs, identifying critical source areas, and prioritizing land treatment sites will all benefit from an accurate assessment of baseline conditions. Knowledge of depreciation of existing BMPs can be factored into models used for project planning (e.g., by adjusting pollutant removal efficiencies), resulting in improved understanding of overall baseline NPS loads and their sources.
>
> While not a depreciation issue per se, when a BMP is first installed—especially a vegetative BMP like a buffer or filter strip—it usually takes a certain amount of time before its pollutant reduction capacity is fully realized. For example, Dosskey et al. (2007) reported that the nutrient reduction performance of newly established vegetated filter strips increased over the first 3 years as dense stands of vegetation grew in and soil infiltration improved; thereafter, performance level was stable over a decade. When planning a watershed project, vegetative practices should be examined to determine the proper level of effectiveness to assume based on growth stage. Also, because of weather or management conditions, some practices (e.g., trees) might take longer to reach their full

effectiveness or might never reach it. The Stroud Preserve, Pennsylvania, section 319 National Nonpoint Source Monitoring Program (NNPSMP) project (1992–2007) found that slow tree growth in a newly established riparian forest buffer delayed significant NO_3–N (nitrate) removal from ground water until about 10 years after the trees were planted (Newbold et al. 2008).

The performance of practices can change in multiple ways over time. For example, excessive deposition in a detention pond that is not properly maintained could reduce overall percent removal of sediment because of reduced capacity as illustrated in Figure 1. The relative and absolute removal efficiencies for various particle size fractions (and associated pollutants) also can change due to reduced hydraulic retention time. Fine particles generally require longer settling times than larger particles, so removal efficiency of fine particles (e.g., silt, clay) can be disproportionally reduced as a detention pond or similar BMP fills with sediment and retention time deteriorates. Expert assessment of the condition and likely current performance level of existing BMPs, particularly those for which a significant amount of pollutant removal is assumed, is essential to establishing an accurate baseline for project planning.

Adaptive watershed management

Watershed planning and management is an iterative process; project goals might not all be fully met during the first project cycle and management efforts usually need to be adjusted in light of ongoing changes. In many cases, several cycles—including mid-course corrections—might be needed for a project to achieve its goals. Consequently, EPA recommends that watershed projects pursue a dynamic and adaptive approach so that implementation of a watershed plan can proceed and be modified as new information becomes available (USEPA 2008). Measures of BMP implementation commonly used as part of progress assessment should be augmented with indicators of BMP depreciation. Combining this information with other relevant project data can provide reliable progress assessments that will indicate gaps and weaknesses that need to be addressed to achieve project goals.

BMP design and delivery system

Patterns in BMP depreciation might yield information on systematic failures in BMP design or management that can be addressed through changes to standards and specifications, contract terms, or permit requirements. This information could be particularly helpful during the project planning phase when both the BMPs and their implementation mechanisms are being considered. For example, a cost-sharing schedule that has traditionally provided all or most funding upon initial installation of a BMP could be adjusted to distribute a portion of the funds over time if operation and maintenance are determined to be a significant issue based on pre-project information. Some BMP components, on the other hand, might need to be dropped or changed to make them more appealing to or easier to manage by landowners. Within the context of a permit program, for example, corrective actions reports might indicate specific changes that should be made to BMPs to ensure their proper performance.

Project Evaluation

Monitoring

Although short-term (3–5 year) NPS watershed projects will not usually have a sufficiently long data record to evaluate incremental project effects, data on BMP depreciation might still improve interpretation of collected water quality data. Even in the short term, water quality monitoring data might reflect cases in which BMPs have suffered catastrophic failures (e.g., an animal waste lagoon breach), been abandoned, or been maintained poorly. Meals (2001), for example, was able to interpret unexpected spikes in stream P and suspended sediment concentrations by walking the watershed and discovering that a landowner had over-applied manure and plowed soil directly into the stream.

Longer-term efforts (e.g., total maximum daily loads[1]) might engage in sustained monitoring beyond individual watershed project lifetime(s). The extended monitoring period will generally allow detection of more subtle water quality impacts for which interpretation could be enhanced with information on BMP depreciation. While not designed as BMP depreciation studies, the following two examples illustrate how changes in BMP performance can be related to water quality.

In a New York dairy watershed treated with multiple BMPs, Lewis and Makarewicz (2009) reported that the suspension of a ban on winter manure application 3 years into the monitoring study led to dramatic increases in stream nitrogen and phosphorus concentrations. First and foremost, knowledge of that suspension provided a reasonable explanation for the observed increase in nutrient levels. Secondly, the study was able to use data from the documented depreciation of land treatment to determine that the winter spreading ban had yielded 60–75 percent reductions in average stream nutrient concentrations.

[1] "Total maximum daily loads" as defined in §303(d) of the Clean Water Act.

The Walnut Creek, Iowa, Section 319 NNPSMP project promoted conversion of row crop land to native prairie to reduce stream NO_3-N levels and used simple linear regression to show association of two monitored variables: tracked conversion of row crop land to restored prairie vegetation and stream NO_3-N concentrations (Schilling and Spooner 2006). Because some of the restored prairie was plowed back into cropland during the project period—and because that change was documented—the project was able to show not only that converting crop land to prairie reduced stream NO_3-N concentrations but also that increasing row crop land led to increased NO_3-N levels (Figure 2).

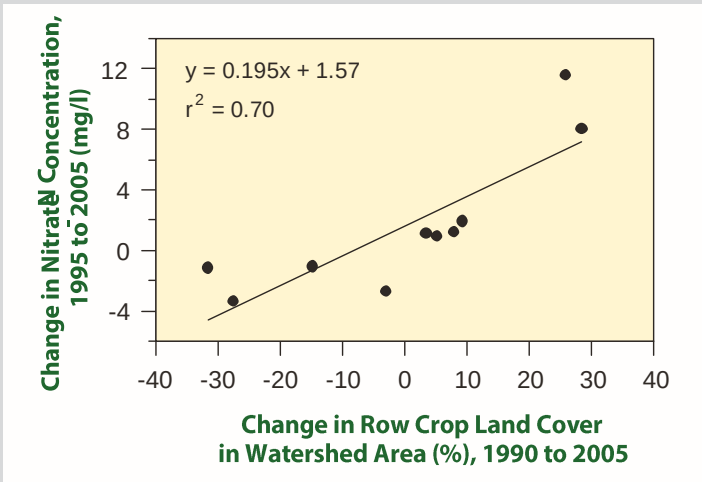

Figure 2. Relating Changes in Stream Nitrate Concentrations to Changes in Row Crop Land Cover in Walnut Creek, Iowa (Schilling and Spooner 2006).

Modeling

When watershed management projects are guided or supported by modeling, knowledge of BMP depreciation should be part of model inputs and parameterization.

The magnitude of implementation (e.g., acres of treatment) and the spatial distribution of both annual and structural BMPs should be part of model input and should not be static parameters. Where BMPs are represented by pollutant reduction efficiencies, those percentages can be adjusted based on verification of land treatment performance levels in the watershed. Incorporating BMP depreciation factors into models might require setting up a tiered approach for BMP efficiencies (e.g., different efficiency values for BMPs determined to be in fair, good, or excellent condition) rather than the currently common practice of setting a single efficiency value for a practice assumed to exist. This approach could be particularly important for management practices such as agricultural nutrient management or street sweeping, in which degree of treatment is highly variable. For structural practices, a depreciation schedule could be incorporated into the project, similar to depreciating business assets. In the planning phase of a watershed project, multiple scenarios could be modeled to reflect the potential range of performance levels for BMPs already in place.

Recommendations

The importance of having accurate information on BMP depreciation varies across projects and during the timeline of a single project. During the project planning phase, when plans for the achievement of pollutant reduction targets rely heavily on existing BMPs, it is essential to obtain good information on the level of performance of the BMPs to ensure that plan development is properly informed. If existing BMPs are a trivial part of the overall watershed plan, knowledge of BMP depreciation might not be critical during planning. As projects move forward, however, the types of BMPs implemented, their relative costs and contributions to achievement of project pollutant

reduction goals, and the likelihood that BMP depreciation will occur during the period of interest will largely determine the type and extent of BMP verification required over time. The following recommendations should be considered within this context:

- For improved characterization of overall baseline NPS loads, better identification of critical source areas, and more effective prioritization of new land treatment during project planning, collect accurate and complete information about:
  - Land use,
  - Land management, and
  - The implementation and operation of existing BMPs. This information should include:
    - Original BMP installation dates,
    - Design specifications of individual BMPs,
    - Data on BMP performance levels if available, and
    - The spatial distribution of BMPs across the watershed.
- Track the factors that influence BMP depreciation in the watershed, including:
  - Variations in weather that influence BMP performance levels,
  - Changes in land use, land ownership, and land management,
  - Inspection and enforcement activities on permitted practices, and
  - Operation, maintenance, and management of implemented practices.
- Develop and use observable indicators of BMP status/performance that:
  - Are tailored to the set of BMPs implemented in the watershed and practical within the scope of the watershed project's resources,
  - Can be quantified or scaled to document the extent and magnitude of treatment depreciation, and
  - Are able to be paired with water quality monitoring data.
- After the implementation phase of the NPS project, conduct verification activities to document the continued existence and function of implemented practices to assess the magnitude of depreciation and provide a basis for corrective action. The verification program should:
  - Identify and locate all BMPs of interest, including cost-shared, non-cost-shared, required, and voluntary practices;
  - Capture information on structural, annual, and management BMPs;
  - Obtain data on BMP operation and maintenance activities; and
  - Include assessment of data accuracy and confidence.
- To adjust for depreciation of land treatment, apply verification data to watershed project management and evaluation by:
  - Applying results directly to permit compliance programs,
  - Relating documented changes in land treatment performance levels to observed water quality,

- Incorporating measures of depreciated BMP effectiveness into modeling efforts, and
- Using knowledge of treatment depreciation to correct problems and target additional practices as necessary to meet project goals in an adaptive watershed management approach.

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