

Agricultural Priority Area Inventory and Best Management Practices
Recommendations for Selected Areas in the Macatawa Watershed

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Introduction

Lake Macatawa is an 1800 acre (2.75 mi²) drowned river mouth that empties into Lake Michigan. The Macatawa Watershed, which includes Lake Macatawa and its tributaries, covers approximately 175 square miles of land including all or part of Laketown, Fillmore, Overisel, Holland, Park, Zeeland, Port Sheldon, Olive and Blendon Townships and the cities of Holland and Zeeland.

The Macatawa Watershed encompasses northwest Allegan County and southwest Ottawa County. This area has traditionally supported intensive livestock production, especially hogs and poultry. Data from the 2007 Census of Agriculture by the National Agricultural Statistics Service for Allegan and Ottawa Counties confirms the extent of this production (Appendix A). Allegan is the top agricultural county by value of sales in Michigan; Ottawa is second. Allegan ranks in the top 5 counties in the state for most categories of livestock sales, including poultry, beef cattle, dairy cattle, and hogs, while Ottawa ranks in the top 10 counties in these same categories. Allegan and Ottawa rank fifth and ninth in the state, respectively, for dairy production. Allegan ranks second in the state for corn silage production, while Ottawa ranks fifth in this crop. Given the higher ranking in corn silage production compared to dairy production, it is reasonable to conclude that area dairies are running high corn silage, low hay/haylage rations. Corn silage can be a highly erosive crop as nearly all crop residue is removed during the late fall harvest, while hay retains significant cover almost year round. Corn silage harvest is typically followed by dairy manure application to draw down storage facilities for the winter. Both counties increased their total acreage farmed from 2002 to 2007: Ottawa by 5,055 acres (3%) and Allegan by a whopping 31,850 (13%). While exact characteristics of the land entering production is not known, it is reasonable to assume this was not the highest quality land available, which would have generally stayed in production in such highly competitive agricultural areas. Conservation Reserve Program (CRP) enrollments give a clue where some of this land came from. Ottawa County had a net loss of 658 acres from 2002 to 2010, while Allegan lost 879 acres between 2002 and 2010 (www.fsa.usda.gov, Conservation Program Statistics).

Animal agriculture demands land not only for feed production, but also to utilize manure. This complicates conservation planning as each acre withdrawn from crops for buffers or waterways is one less acre for manure spreading. This has been less of an issue for poultry operations that have been selling and shipping significant amounts of their manure out of the counties. Poultry litter is dry and very high in nutrients, making export economically sensible. Swine and dairy operations typically store and handle liquid manure and are unlikely to undertake distant transport. Generally Acceptable Agricultural Management Practices (GAAMPs¹) restrict the amount of phosphorus allowed to accumulate in the soil, which can limit “spreadable acres” for a given farm. Many modern farms have extensive buildings and structures to pay for with thin profit margins that are battered by volatile markets. Downsizing their animal numbers to fit the land base may not fit with the need to pay for existing buildings and equipment. The unprecedented rise in the costs of fuel, fertilizer and feed in 2008 was paired with low prices for milk, meat and eggs in 2008 and 2009. As the 2010 agricultural season begins, a moderated but still uncertain market environment will challenge those promoting conservation practices. Demand for land will add to this challenge and will not be changing in the Macatawa region for the foreseeable future.

¹ Adherence to GAAMPs provides farmers the basis of their Right to Farm law protection. See www.michigan.gov/mdard, Farming, Environment, GAAMPs

In the spring of 2010, the Macatawa Area Coordinating Council partnered with the Allegan Conservation District to survey selected areas in the Macatawa Watershed. District employees Mark Ludwig and Kelly Goward walked the Kleinheksel Drain, East Fillmore Drain, and an unnamed tributary to Peter’s Creek to get a field view of agricultural practices and develop recommendations for best management practices (BMPs) in order to target specific and more effective outreach to producers. Secondary private drains and other watercourses were examined in these areas as was practical, and a general assessment was made of agricultural practices observed. These sub-watersheds were selected for examination in preparation for promotion of comprehensive BMP installation to create a “model sub-watershed.” This project is intended to demonstrate that water quality improvements are possible when proper BMPs are adopted and maintained in a concentrated area. The surveyed areas are all heavily farmed and have historically contributed substantial nutrients and sediment to the Macatawa watershed. The measured phosphorus load for the Macatawa Watershed in 1997 was 138,500 lb/year with an estimated 90% from non-point sources (TMDL for Phosphorus in Lake Macatawa, 1999).

Study Area

The three subbasins chosen for this survey were the Kleinhekel Drain (subbasin 14), the East Fillmore Drain (subbasin 18) and an unnamed tributary to Peter’s Creek (subbasin 12). All three subbasins are located in headwater regions in the Macatawa Watershed (Figure 1). The Kleinheksel Drain is located in the southeast corner of Fillmore Township. The East Fillmore Drain is just northeast of the Kleinheksel, in the east central portion of Fillmore Township with boundaries extending into Overisel Township. The unnamed tributary to Peter’s is located in the northeast corner of Overisel Township with a small portion extending into Zeeland Township in Ottawa County. All three subwatersheds are dominated by agricultural land uses with small urban areas and little natural areas or wetlands (Table 1).

Table 1: Land uses in selected subwatersheds of the Macatawa Watershed

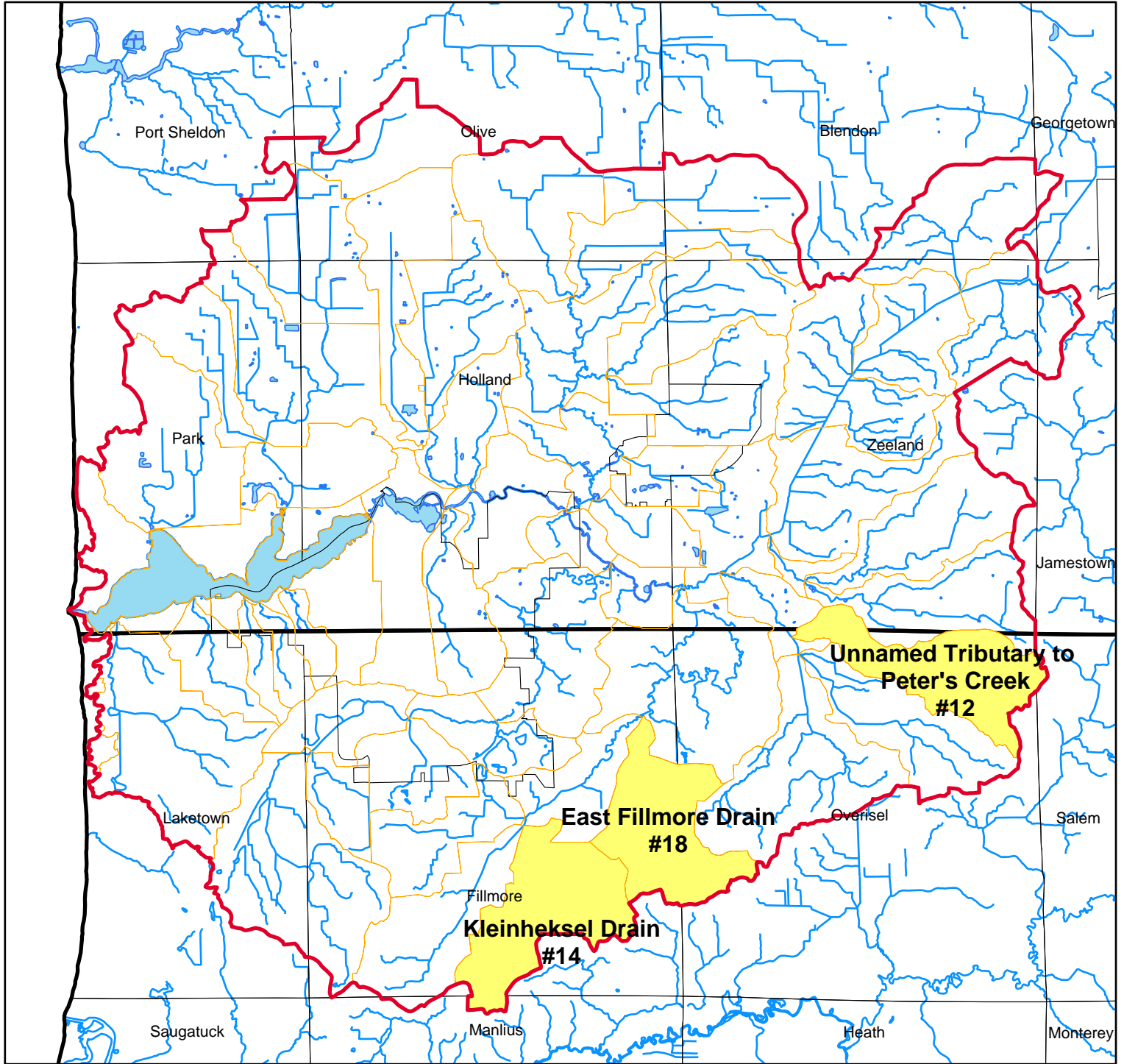
Subwatershed	% Agriculture	% Urban	% Natural	% Water/Wetlands
Kleinheksel (14)	95.4	2.2	2.2	0.2
East Fillmore (18)	85.1	6.4	8	0.5
Peter’s (12)	85.1	6.4	8	0.5








Methods

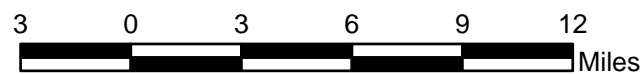
Permission was obtained to walk the public drain right-of-way in order to observe stream channel conditions and existing agricultural best management practices. Practices observed and areas where practices were recommended were indicated on field maps and later digitized into a GIS map. Particularly damaged areas or unfortunate situations were GPS located, summarized on data sheets (Appendix B) and photographed. All data was entered into a spreadsheet and mapped in ArcGIS. County parcel shapefiles were used to determine land ownership of the parcels where best management practices were recommended. Land owner contact information was recorded in the same spreadsheet as the observed and recommended practices. Cost estimates were determined for proposed practices where applicable, as were load reductions for erosion, phosphorus and nitrogen. Cost estimates were based on Natural Resources Conservation Service (NRCS) statewide typical costs for 2011. Erosion reduction estimates were calculated using RUSLE2 where applicable and the MDEQ *Michigan Pollutants Controlled Spreadsheet* for other practices. Nutrient reductions were calculated according to the *Michigan Pollutants Controlled Manual* (Figure 5, Page 26).

Figure 1

Macatawa Watershed 2010 Survey Subbasins



-  Macatawa Watershed
-  Subbasins
-  Study Area
-  County Boundary
-  Township Boundaries
-  Lakes
-  Streams



Erosion Risk Map Development

Existing GIS datasets were used to identify and prioritize critical agricultural areas for protection with best management practices that reduce soil erosion and protect water quality. All data was obtained from the NRCS GIS database and the coordinate system for all shapefiles was NAD 1983, UTM Zone 16N. The erosion risk maps were developed for only the three subbasins that were included in the 2010 field survey.

ESRI ArcMap and ArcCatalog geoprocessing tools were used to isolate selected data layers within each subbasin and calculate risk values based on the selected parameters. All GIS data layers used in the analysis were available on the NRCS computer network. Risk criteria include proximity to water courses, slope, landuse, and soil erodibility factor (K factor). Each set of criteria was divided into categories of low, medium-low, medium-high, and high risk according to specific attributes. A cell size of 25 meters was used for all raster analyses.

The following figures and tables illustrate the characteristics and classifications used to assign erosion risk categories for each parameter.

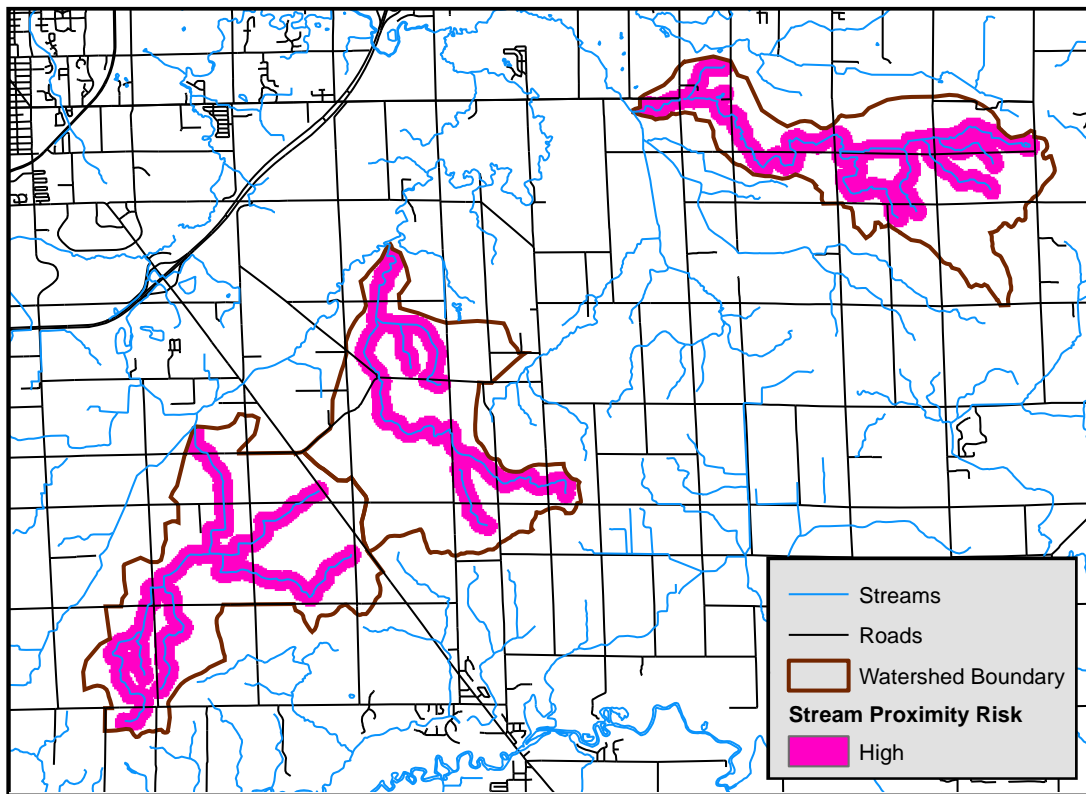


Figure 2: Proximity to Water Courses

Data source: NRCS GIS database (hydro_a_mi005.shp and hydro_a_mi139.shp)

Process:

Land within 500' of any mapped watercourse was considered high risk for contributing sediment to the watercourse. A 500' buffer was created for the stream layer, dissolved, and then clipped to the extent of the subbasin boundary using Geoprocessing Tools. The resulting shapefile was converted to a raster using the Spatial Analyst toolbar. The raster was reclassified so that all cells

within the buffer were given a value of 4, indicating high risk. About 38% of the land in the Kleinheksel, 32% of the land in the East Fillmore and 44% of the land in the Peter's Subbasins are within 500 feet of streams.

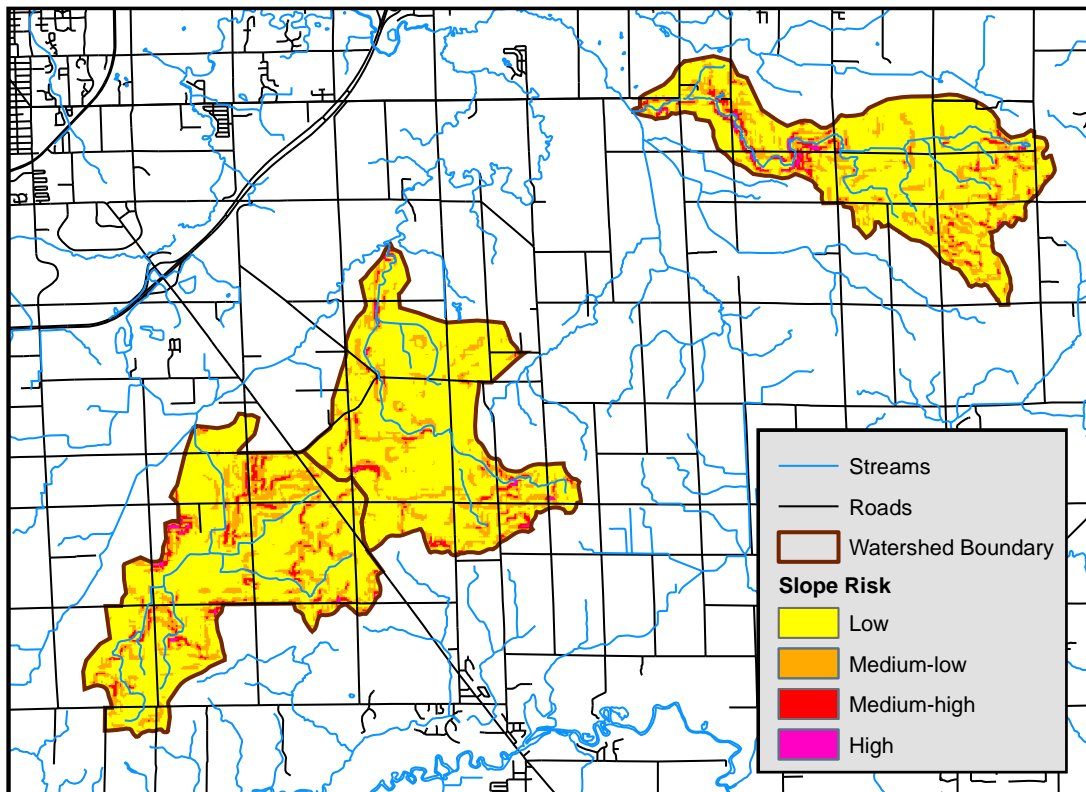


Figure 3: Slope Risk Map

Data source: National Elevation Dataset (NED) (ned_mi005, ned_mi139)

Process:

The Spatial Analyst Toolbar was used to create slope maps from the Ottawa and Allegan County NED datasets. A mask of the study subbasins was used. The slopes values were reclassified using the Spatial Analyst Toolbar into low, medium low, medium high, and high risk according to Table 2.

Table 2: Slope risk categories and results

Slope (%)	Risk Category	% in category (Peters)	% in category (Kleinheksel)	% in category (Fillmore)
0-6	Low (1)	73	74	80
6.0000001-12	Medium low (2)	21	22	17
12.0000001-18	Medium high (3)	5	4	3
>18	High (4)	1	0	0

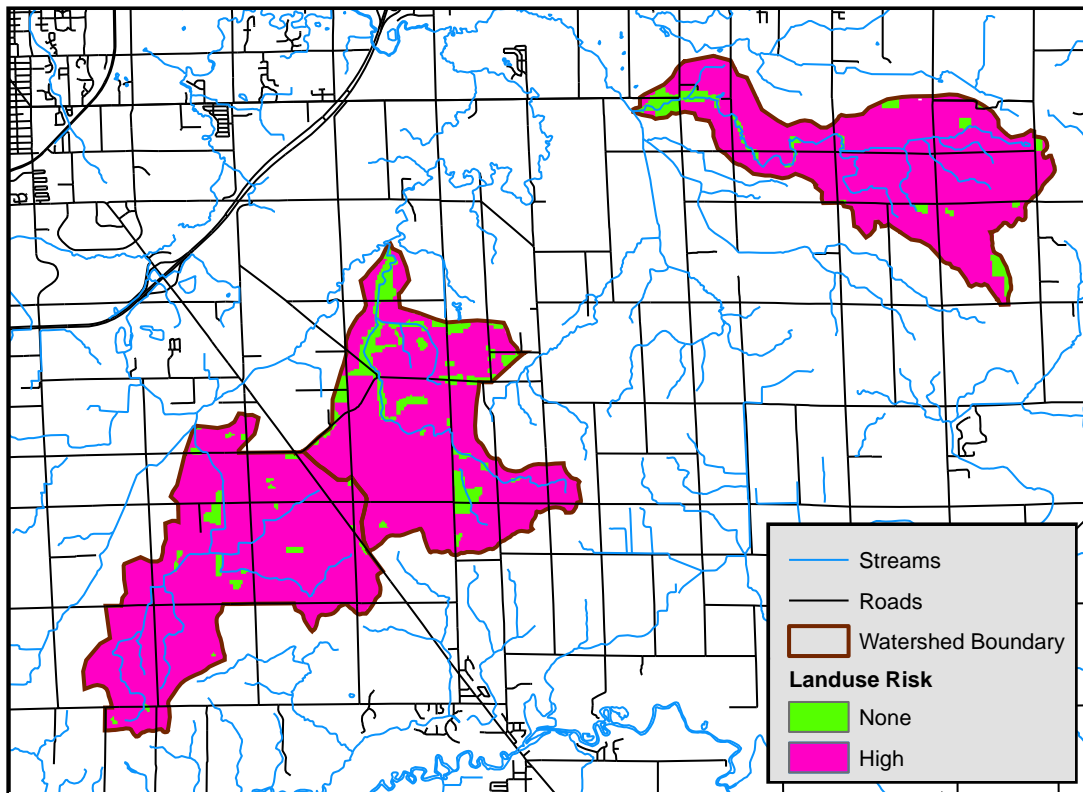


Figure 4: Landuse risk map

Data source: NRCS GIS database (lulc78_a_mi005.shp, lulc78_a_mi139.shp), 1978

Process:

Landuse shapefiles for Ottawa and Allegan County were clipped to the extent of the subbasins using Geoprocessing Tools. The clipped shapefile was converted to a raster using the Spatial Analyst Toolbar. The raster of landuse was reclassified so that the landuse of agriculture was assigned a value of 4 (high risk) and all other landuses were assigned a value of 0 (no risk) (Table 3). These values were used since the only landuse of concern in this evaluation was agriculture.

Table 3: Landuse risk categories and results

Landuse	Risk Category	% in category (Peters)	% in category (Kleinheksel)	% in category (Fillmore)
Other	None (0)	7	3	14
Agriculture	High (4)	93	97	86

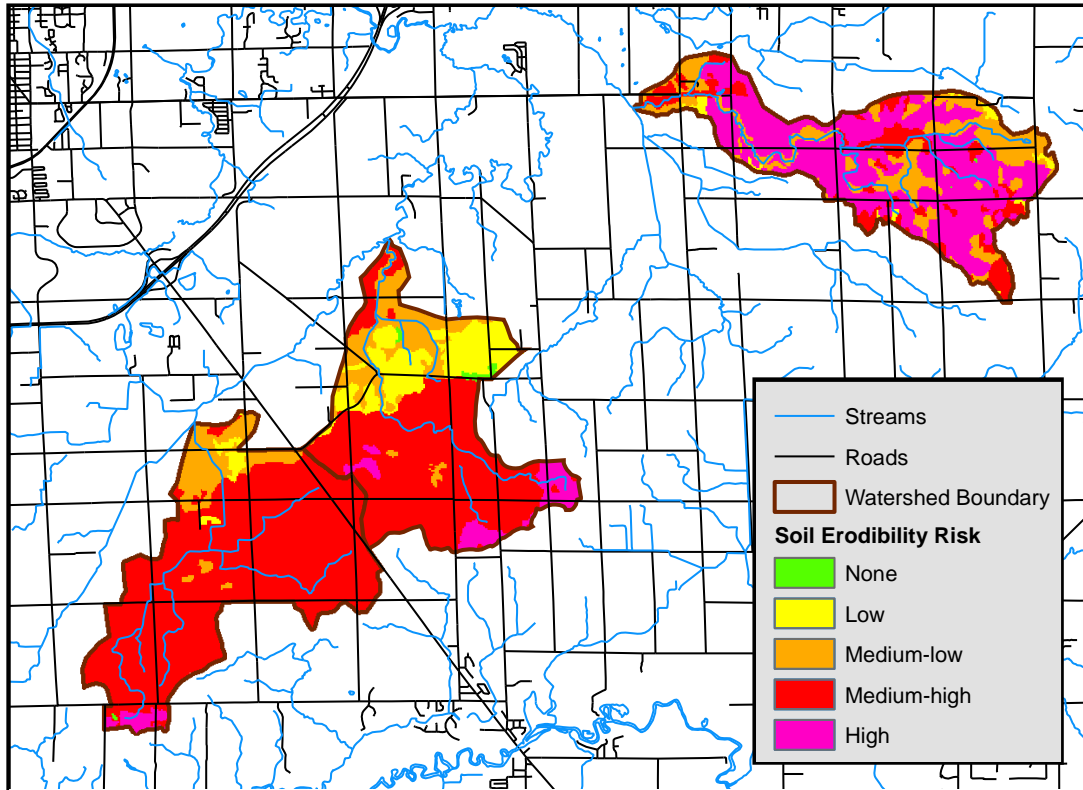


Figure 5: Soil Erodibility Factor Risk Map

Data source: NRCS GIS database (soilmu_a_mi005.shp, soilmu_a_mi139.shp)

Process:

A soil K factor is the soil erodibility factor that represents the soil's susceptibility to erosion and the rate of runoff. The Allegan and Ottawa county soil datasets were clipped to the extent of the subbasins using Geoprocessing Tools. The resulting shapefile was converted to a raster using the spatial analyst Toolbar. Since the dataset was relatively small, K factors were individually looked up in the soil survey and recorded manually. The soil raster was reclassified according to Table 4.

Table 4: Soil Erodibility Risk Categories and Results

K factor	Risk Category	% in category (Peters)	% in category (Kleinheksel)	% in category (Fillmore)
0*	None (0)	0	0	1
0.05-0.15	Low (1)	2	2	18
0.16-0.25	Medium low (2)	26	10	16
0.26-0.4	Medium high (3)	15	86	58
>0.4	High (4)	57	2	7

*A K factor of zero is assigned to non-soil map units, such as water.

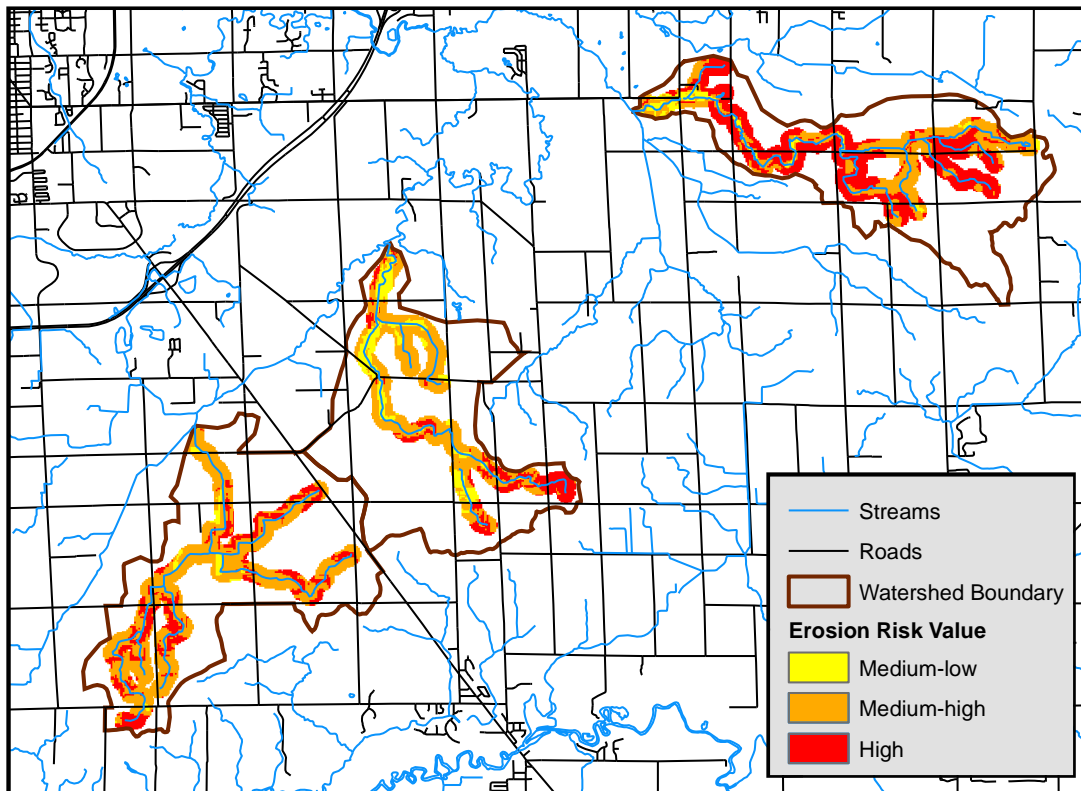


Figure 6: Erosion Risk Map

Process:

The previously described risk factor rasters of proximity to watercourses, slope, landuse, and soil erodibility factor were added using the Raster Calculator in the Spatial Analyst Toolbar. Based on the previous classifications, the possible resulting values were 4 through 16, 4 being the lowest value since a value of 4 (high risk) was automatically assigned to any land within 500 feet of the stream. A value of 4 would indicate that the only risk factor present was proximity to the stream, and there was not any land within any of the three subbasins that received a value of 4. A value of 16 indicates that the land is in the high risk category for all parameters. The Unnamed Tributary to Peter's Creek was only subbasin to have land that received a value of 16, but only about 1%. The resulting raster calculation was reclassified into the four risk categories as presented in Table 5.

Table 5: Final Risk Map Categories and Results

Results of calculation	Risk Category	% in category (Peters)	% in category (Kleinheksel)	% in category (Fillmore)
4	Low (1)	0	0	0
5-8	Medium low (2)	7	3	21
9-12	Medium high (3)	39	73	60
13-16	High (4)	54	24	19

Results

The Macatawa Watershed experienced several extreme weather events in 2009. June saw a seven inch plus, 24 hour rain event over much of the watershed. Cool temperatures were the rule all season which led to a late harvest. Fall was rainy and fields were wet at harvest time. There was a lot of tire rutting from harvest equipment and what appeared to be surface drains plowed into some fields, probably with mold board plows, to provide emergency drainage. It is very possible that some farms may have normally done some fall tillage but could not get into the fields, so what is designated as "no till" in this survey may not reflect normal practices.

The vast majority of the agricultural fields surveyed were used for corn and soybean production, with little hay production observed. The dominant livestock in this area are swine and poultry, which have little need for hay in most systems. Only one area with winter annual small grain (rye or wheat) was observed; no areas showed signs of freeze-killed fall cover crops.

Much of the crop land surveyed had some conservation practices installed. Solid grassed waterways, high residue cropping practices and buffers were observed. Unfortunately other sites showed little effort toward soil erosion prevention. A few blatant GAAMPs violations and catastrophic erosion areas were GPS located, documented and photographed. These situations have been summarized for this report to facilitate follow-up (Appendix C).

Summary tables with field inventory data for each subbasin along with supporting documents for cost and load reduction calculations are in Appendix D. Maps of proposed best management practices for each subbasin are in Appendix E.

Kleinheksel Drain

In the Kleinheksel Drain subbasin, best management practices were recommended for 34 unique farm tracts. Of the 34 tracts visited, 13 also had existing BMPs. Existing and proposed BMPs are summarized in Table 6. The BMP most notably lacking in the Kleinheksel Drain is filter strips. Less than 2% of the agricultural riparian areas surveyed were planted to permanent vegetation. Residue management or cover crops were recommended on about 70% of the acres surveyed. There are also many fields that would greatly benefit from grassed waterways to reduce erosion associated with concentrated flow. If all of the proposed BMPs are installed, erosion would be reduced by 4,300 tons/year, phosphorus by 5,000 pounds/year and nitrogen by 12,000 pounds/year.

Table 6: Existing and Proposed Best Management Practices in the Kleinheksel Drain Subbasin

Best Management Practice	Units Existing	Units Proposed
Residue Management ¹	399.6 ac	876.3 ac
Pasture/Hay	84.1 ac	0
Wetland Restoration	0	35.8 ac
Filter Strip ²	918 ft	51,684 ft
Grassed Waterway	4,799 ft	27,636 ft
Grade Stabilization Structure	0	17
Drop Structure	0	1
Heavy Use Area Protection	0	1

¹ including no-till; can also substitute cover crops as a proposed BMP

² both sides of the drain

East Fillmore Drain

In the East Fillmore Drain subbasin, best management practices were recommended for 18 unique farm tracts. Of the 18 tracts visited, 7 also had existing BMPs. Five additional tracts had existing BMPs where no new BMPs were proposed. Existing and proposed BMPs are summarized in Table 7. Compared to the Kleinheksel Drain, the BMP most notably lacking in the East Fillmore Drain is residue management. Only about 20% of the acres surveyed are practicing some type of residue management. On a positive note, over 40% of the agricultural riparian areas surveyed were planted to permanent vegetation. There are also many fields that would greatly benefit from grassed waterways to reduce erosion associated with concentrated flow, although to a lesser extent than in the Kleinheksel. If all of the proposed BMPs are installed, erosion would be reduced by 3,000 tons/year, phosphorus by 3,700 pounds/year and nitrogen by 9,000 pounds/year.

Table 7: Existing and Proposed Best Management Practices in the East Fillmore Drain Subbasin

Best Management Practice	Units Existing	Units Proposed
Residue Management ¹	206.3 ac	848.5 ac
Pasture/Hay	36.7 ac	0
Filter Strip ²	14,525 ft	18,855 ft
Grassed Waterway	2,284 ft	9,101 ft
Grade Stabilization Structure	0	9
Drop Structure	0	2

¹ including no-till; can also substitute cover crops as a proposed BMP

² both sides of the drain

Unnamed Tributary to Peter's Creek

In the Peter's Creek subbasin, best management practices were recommended for 24 unique farm tracts. Of the 24 tracts visited, 18 also had existing BMPs. Twelve additional tracts had existing BMPs where no new BMPs were proposed. Existing and proposed BMPs are summarized in Table 8. Like in the Kleinheksel Drain, the BMP most notably lacking in Peter's Creek is filter strips. Less than 4% of the agricultural riparian areas surveyed were planted to permanent vegetation. On a positive note, over 80% of the acres surveyed are practicing some type of residue management. There are also many fields that would greatly benefit from grassed waterways to reduce erosion associated with concentrated flow, although to a lesser extent than

in the Kleinheksel. There were more occurrences of gullies (grade stabilization structures) in Peter's than in Kleinheksel or East Fillmore. If all of the proposed BMPs are installed, erosion would be reduced by 1,200 tons/year, phosphorus by 1,300 pounds/year and nitrogen by 2,700 pounds/year.

Table 8: Existing and Proposed Best Management Practices in the Peter's Creek Subbasin

Best Management Practice	Units Existing	Units Proposed
Residue Management ¹	699.3 ac	135.5 ac
Pasture/Hay	238.9 ac	0
Filter Strip ²	1,080 ft	30,826 ft
Grassed Waterway	1,387 ft	9,756 ft
Grade Stabilization Structure	0	24
Livestock Access	0	1

¹ including no-till; can also substitute cover crops as a proposed BMP

² both sides of the drain

Best Management Practice Recommendations

Fall cover crops in these areas would be appropriate and fit into a diversity of agricultural systems. Winter annual cover crops such as cereal rye, annual ryegrass or winter wheat have been shown to be extremely effective at reducing nutrient runoff from fall manure applications. Cover cropping may fit this region better than BMPs such as buffers or grassed waterways that are partially promoted as providing hay for livestock for which there is little demand. Focusing on the ability of cover crops to conserve nitrogen, break up compaction and increase soil health may help with marketing the practice, as well as cost-benefit analyses. Aerial application of cover crop seed has an advantage over traditional seeding methods in that seed may be applied to a standing crop. The cover crop establishes well ahead of the harvest of soil protecting cash crops and is ready to hold nutrients from fall manure applications. There are several aerial applicators in the State of Michigan that have the capability to seed cover crops (Appendix F). Another approach to establishing cover crops is the use of slurry seeding. Cover crop seed is applied with manure slurry, enabling the plants to grow very rapidly in the enriched soil.

Other practices to consider are newer high residue cropping practices such as vertical tillage or zone tillage that preserve residue coverage better than the common traditional tillage practices. Pure “no till” may not be acceptable to some producers who have tried it and were unsatisfied with the early tools and techniques that in some cases, underperformed on heavy soils.

Other Observations

It was evident that drains exiting poorly protected agriculture fields then transitioning into forested land are subject to significant stream channel erosion. Maps with aerial photographs showing forested areas are in Appendix G. The lack of healthy grass cover to stabilize the shaded channel leads to dynamic stream channel migration and leaves these areas quite damaged at times. Areas of heavy deposition of soil and agricultural residues were observed in some lowland forested areas, indicating heavy flooding well outside of the normal stream channels. Some of this is to be expected, especially in light of the extreme 2009 rain events, but the degree of apparent flooding was at times quite striking.

The invasive garlic mustard (*Alliaria petiolata*) plant is strongly established through many of the forested areas, possibly crowding out shade tolerant grasses and clearly impacting spring wildflowers. Internet sources indicate that garlic mustard is an effective erosion prevention plant; however there is a significant loss of biodiversity as this weed spreads. Though biodiversity was not formally surveyed, nice stands of spring ephemerals were observed including trout lily (*Erythronium americanum*), spring beauty (*Claytonia virginica*), common trillium (*Trillium grandiflorum*), and bloodroot (*Sanguinaria canadensis*). Also observed were ramps, a.k.a. wild leeks (*Allium tricoccum*), Virginia wild rye (*Elymus virginicus*), snapping turtles, garter snakes, and one very surprised coyote.

Summary

Overall, the intensive agriculture practiced in Allegan and Ottawa counties is having an impact on the Macatawa Watershed. While much could be improved to reduce these impacts, economic and agronomic realities and perceptions may favor BMPs that maximize available crop production acreage. Survey information should be used to target outreach beyond the usual consumers with a clear eye on the realities producers face to achieve new levels of effectiveness.

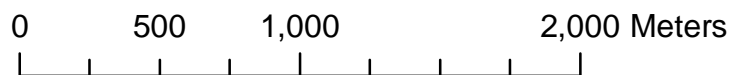
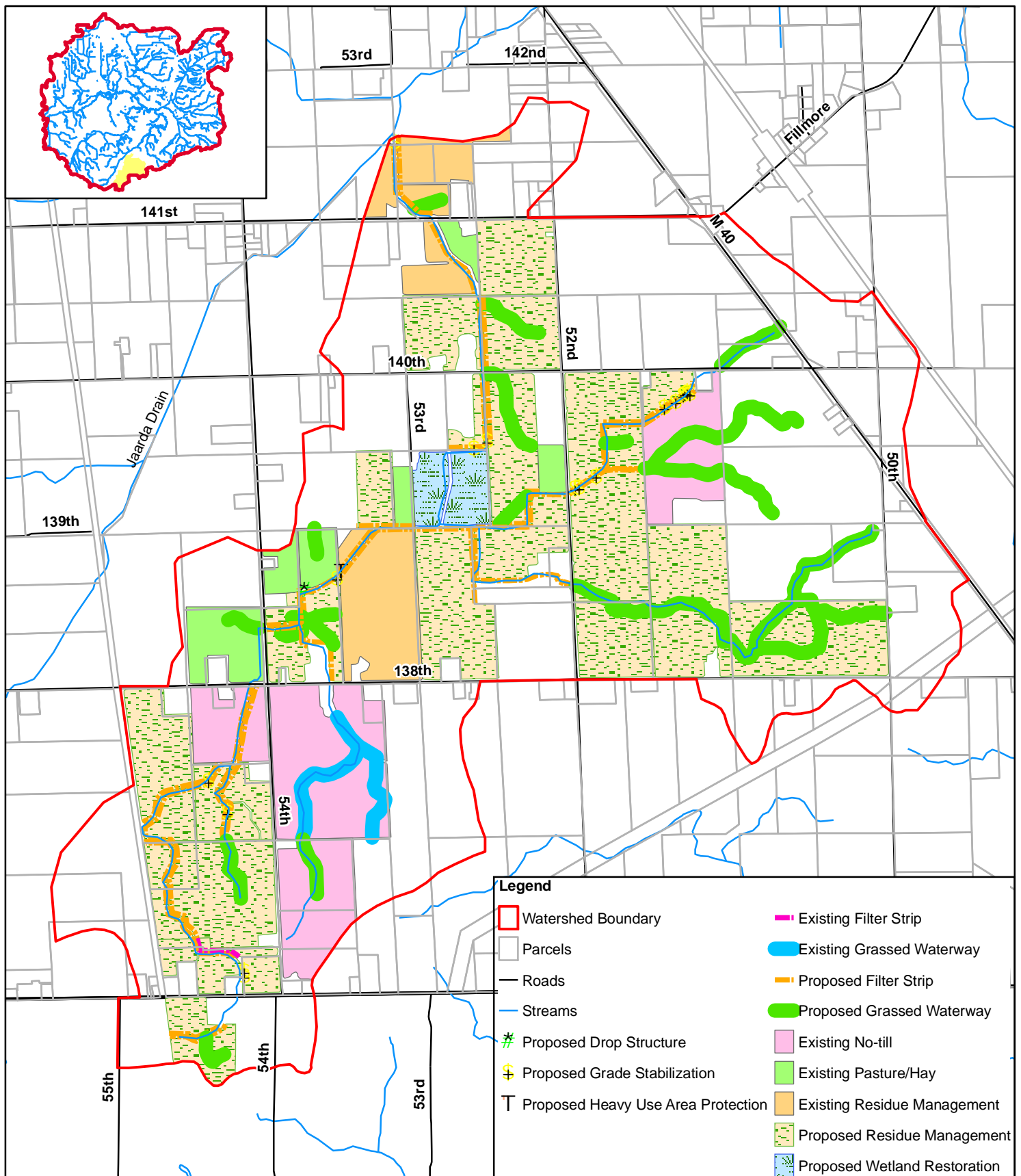
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Appendices Available Upon Request

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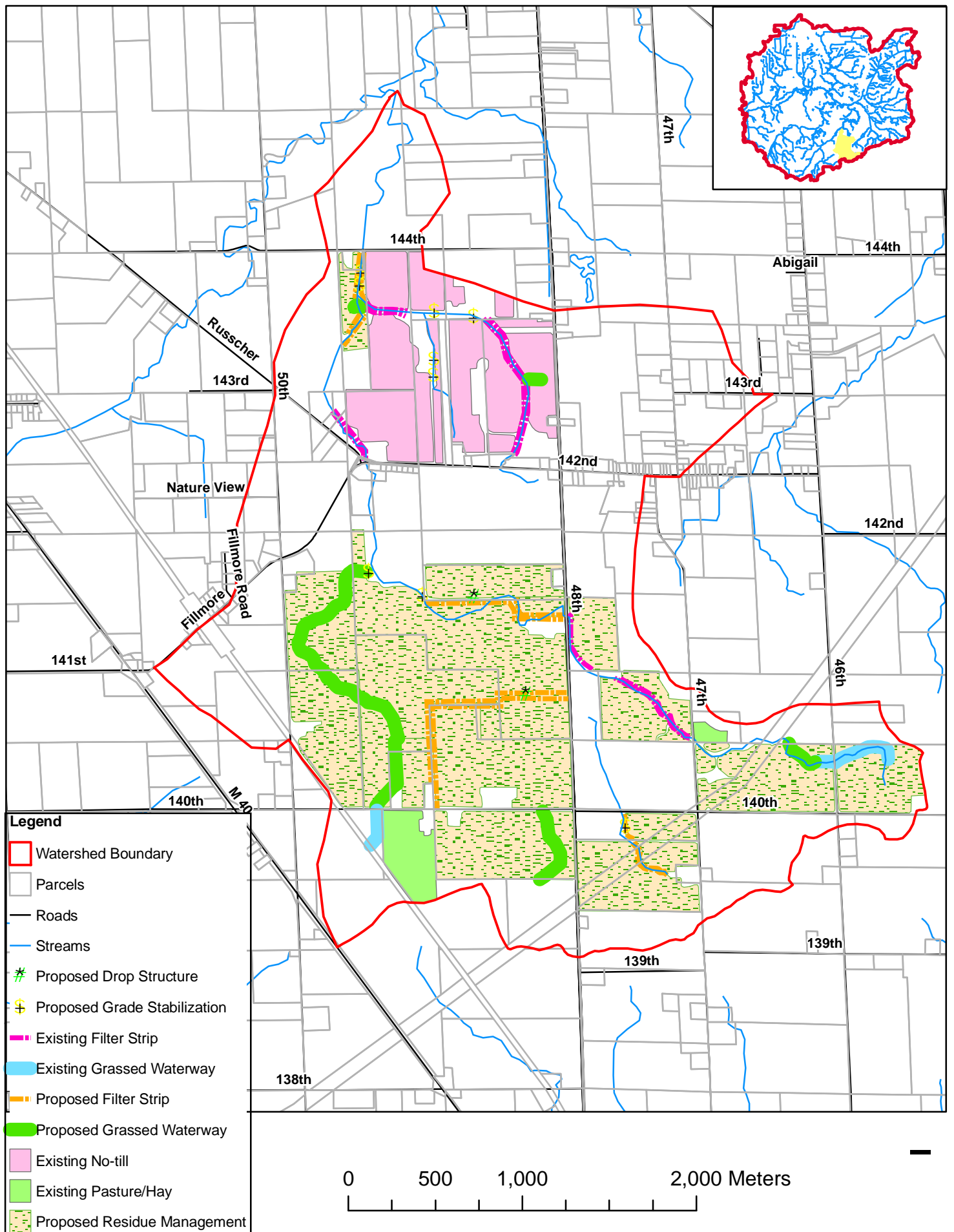
APPENDIX E

PROPOSED BEST MANAGEMENT PRACTICE MAPS

2010 Best Management Practice Inventory Kleinheksel Drain



2010 Best Management Practice Inventory East Fillmore Drain

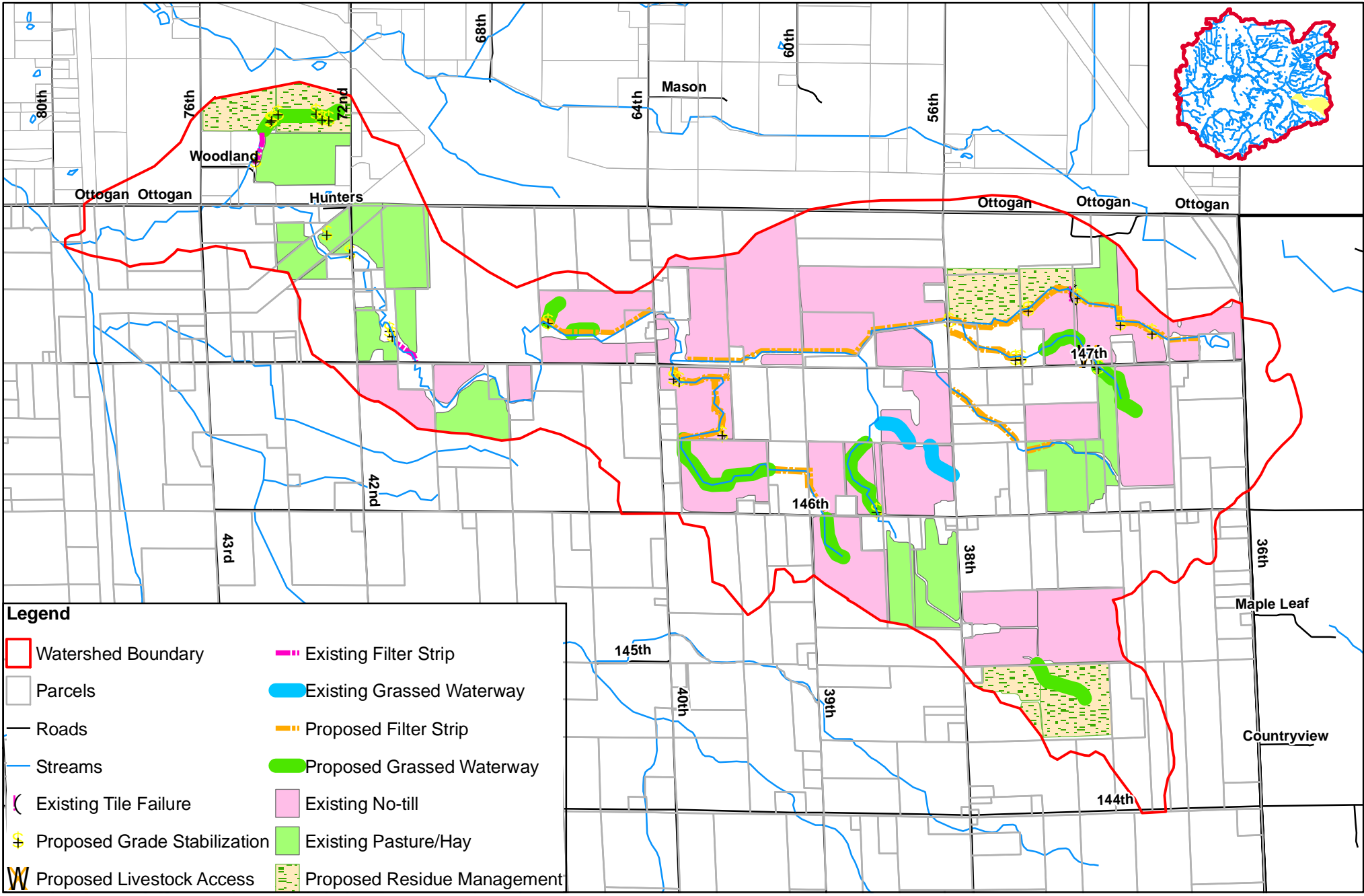


Legend

- Watershed Boundary
- Parcels
- Roads
- Streams
- ✱ Proposed Drop Structure
- ✚ Proposed Grade Stabilization
- Existing Filter Strip
- Existing Grassed Waterway
- Proposed Filter Strip
- Proposed Grassed Waterway
- Existing No-till
- Existing Pasture/Hay
- Proposed Residue Management

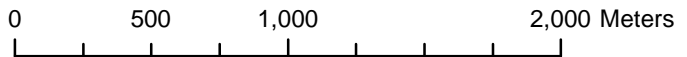
0 500 1,000 2,000 Meters

2010 Best Management Practice Inventory Unnamed Tributary to Peter's Drain



Legend

Watershed Boundary	Existing Filter Strip
Parcels	Existing Grassed Waterway
Roads	Proposed Filter Strip
Streams	Proposed Grassed Waterway
Existing Tile Failure	Existing No-till
Proposed Grade Stabilization	Existing Pasture/Hay
Proposed Livestock Access	Proposed Residue Management





Macatawa Watershed Project

Agricultural Priority Area Inventory and Best Management Phase II

Practice Recommendations for the Macatawa Watershed

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March 2003

Introduction

Lake Macatawa is a 1,800 acre drowned river mouth located in Park and Holland Townships of Ottawa County. The Lake is part of the 110,000 acre Macatawa Watershed located in southwestern Ottawa County and northwestern Allegan County. The Macatawa Watershed covers 12 townships, which includes Port Sheldon, Olive, Blendon, Georgetown, Park, Holland and Zeeland Townships in Ottawa County and Laketown, Fillmore, Overisel, Salem, and Manlius Townships in Allegan County. According to 1997 data, the watershed is approximately 68% agriculture, 9% residential, 5% commercial/industrial, 3% roads and 15% forest and surface water. The predominate land-use in the watershed is agricultural, although residential/commercial is the primary land-use in Park, Holland, Georgetown Townships and following the M-21 corridor through the west quarter of Zeeland Township. Agricultural land-use in the watershed is concentrated in Laketown, Fillmore, Manlius and Overisel Townships of Allegan County and Northern Holland, Olive, Blendon and the eastern three quarters of Zeeland Townships in Ottawa County. The agricultural land-use area in Blendon Township is rapidly decreasing due to growth and development pressures.

In March of 2000 the Macatawa Area Coordinating Council (MACC) subcontracted with the Allegan Conservation District to inventory the priority agricultural subwatersheds/subareas, provide technical assistance for conservation planning and agricultural best management practice implementation. In 1996 through 1997, the approximate nonpoint source phosphorus load to Lake Macatawa was 126,000 pounds. The goal of the Macatawa Watershed Project is to reduce phosphorus in Lake Macatawa Watershed by nearly seventy percent during the years 1999 – 2009. To assist in reaching this goal, the MACC and the Allegan Conservation District (ACD) formed a Conservation Partnership to address stakeholder concerns associated with phosphorus loading from agricultural crop fields within the watershed. The Allegan Conservation District performed a physical inventory of the priority agricultural sub-watersheds within the Macatawa Watershed. The purpose was to identify fields where conservation practices will have the greatest positive impact on surface water by reducing phosphorus loading.

Priority Agricultural Area Delineation

Through an agreement with the MACC, the MDEQ sampled 44 sites twice a month throughout the watershed from November of 1996 to November 1997. The sampling helped determine three priority agricultural sub-watersheds, which were inventoried in 2000. These priority areas equal approximately 36,032 acres and were selected according to non-point source phosphorus loads at certain sampling sites. Through continued sampling, a determination was made in 2002 to inventory additional priority sub-watersheds within the Macatawa Watershed. These sub-watersheds include sections 3,5,6,7,8 in Zeeland Township, 43 in SE Blendon Township, SW Georgetown Township, 44 in NE Zeeland Township, and NW Jamestown Township. The sub-watershed priority agricultural areas equal approximately 18,464 acres and were selected for inventory based on the TMDL data indicating higher phosphorus concentrations from these subwatersheds. The potential impact is related to topography and soil properties that affect runoff and detachment of soil particles, which carry phosphorus to surface water.

The inventoried priority agricultural area in Ottawa County consists of mainly sandy/sandy loam, loam and muck soils. Blendon Township topography is (0 to 6%) gently sloping sandy/sandy loam, low runoff and well drained in sections 25,26,34 and (2 to 6%) gently sloping, loamy texture, high runoff and poorly drained in sections 35 and 36 as the topography drops to muck bottomland. Jamestown Township topography, in sections 6 and 7, is mainly (0 to 12%) gently sloping loamy soil, well-drained to somewhat poorly drained with areas of severe erosion along clay-loam ravines with (12 to 25%) slopes. Zeeland Township topography is mainly (0 to 6%) gently sloping loamy soil, high runoff, well drained to somewhat poorly drained. Within Zeeland Township, Sections 9,10,11,12,16,17 and 20 contain areas of severe erosion along clay-loam ravines with (12 to 25%) slopes. Also, the topography is mainly flat, poorly drained, muck/bottom-land soil, along the M-21 corridor and Macatawa River through sections 1,2,3,9,10 and along the Macatawa River through sections 16,20,21,29 and 31 of Zeeland Township.

Throughout the inventory area, crops consist of mostly row crops, primarily corn and beans with some wheat as well as alfalfa. The crops cultivated in the bottomland area of section

1,2,3 and 10 are predominately vegetables with some corn. Animal feeding operations are primarily swine, poultry and dairy.

Physical Inventory

The inventory documented land-use, vegetative cover, crop/tillage patterns and proposed Best Management Practices (BMPs) sites on aerial photos obtained from the Farm Services Agency in Ottawa County. Each photo shows a specific section within the priority area and is matched with a section map in the Ottawa County plat book, which shows roads, rivers and county drains. Specific BMPs are proposed to address non-point source pollution on agricultural fields identified as priority fields based on proximity to surface water and the potential for soil runoff. The Macatawa Watershed Technician conducted this inventory by walking many of the county drains, tributaries and the Macatawa River. Some areas were difficult to inventory because there were no designated county drains to access the field and the view from the roadway was obstructed.

Also, pictures of some proposed BMP locations were taken for future reference in determining which locations would have the highest positive impact on water quality.

Results

As a result of the physical inventory the following systems of BMPs are recommended (as shown in Table 1.): Crop Residue Management, Cover Crops, Pasture & Hayland Planting, Critical Area Planting, Filter Strips, Grassed Waterways, Grade Stabilization Structures, Exclusion Fencing and Stream Crossing/Livestock Access. These BMPs will have a positive impact on reducing erosion, runoff, sediment and phosphorus delivery into surface water.

Best Management Practices

BMPs are applied collectively to reduce or prevent the detachment, transport and delivery of sediment, nutrients and other pollutants from the watershed into water resources. In addition to improving water quality, BMPs are designed to sustain producer profitability, while maximizing conservation practices on the farm. A BMP is described as any structural, vegetative or managerial practice used to treat, prevent or reduce water pollution.

- ❖ **Grassed Waterway** – A natural or constructed channel that is shaped or graded to Natural Resources Conservation Service (NRCS) required specifications, which include the establishment of suitable vegetation for the stable conveyance of runoff. It is designed to accommodate concentrated flows without erosion, and deliver runoff to a stable outlet. A stable outlet is one that can sustain volume and velocity of runoff without allowing head cutting or gully erosion at the waterway outlet.
- ❖ **Filter Strips** – Vegetated areas of perennial, cool season or (native) warm season grasses adjoining a stream, drainage ditch, lake or wetland. They remove sediment, organic matter, nutrients and other pollutants from sheet-flow runoff water.
- ❖ **Crop Residue Management** – This system uses crop residue to protect cropland soil during critical periods of erosion. The plant residue can be either the dead mulch left from the previous crop or a live cover crop that has been suppressed. Residue cover intercepts raindrops and dissipates its energy as it strikes the soil particles, as well as providing protection from wind erosion. Residue cover aids moisture retention and keeps the soil temperature cooler. In addition, this practice results in an economic benefit to the landowner by reducing the amount of tillage trips across the field across the field with machinery.
- ❖ **Grade Stabilization Structure** – A structure used to control the grade and control in natural or shaped channels. These structures prevent the formation or head cutting of gullies and enhance environmental quality and reduce pollution hazards.
- ❖ **Exclusion Fencing** – A constructed barrier to livestock, which prevents them from accessing stream banks and surface water.
- ❖ **Stream Crossings/Livestock Access** – A constructed stable area extending either into or across streams, drains or shallow water bodies. This practice is used to minimize sediment and nutrient delivery where livestock need access to surface water used for cattle crossing or watering source.

- ❖ Critical Area Planting – Used to stabilize severely eroding sites that are sources of sediment and nutrient delivery to adjoining surface water. This practice includes the establishment of a vegetative covers for long term stabilization of the site. Establishment processes may include grading, seedbed preparation, erosion control blankets and geotextile fabric.
- ❖ Pasture & Hayland Planting – This practice may be used to reduce soil erosion and runoff to surface water by establishing a vegetative cover of (native) warm season or cool season grasses for grazing and mechanical harvest. These cultivars are used to improve or maintain livestock nutrition and health in addition to protecting the soil from detachment and transport. This reduces sediment and nutrients, such as phosphorus, from reaching surface water.

Total BMPs, agricultural acres and priority fields are shown in (Table1.) designated by township and section. A priority field has one or more of the following criteria.

1. The field is adjacent to a lake, stream, ditch, wetland, or flood plain.
2. The field is part of a series of fields, which require BMP treatments as a whole system to prevent pollutant runoff from entering the surface water.
3. The soils have a high runoff potential based on texture and hydrology.

The recommended BMPs were selected from the current Macatawa Watershed CMI and 319 grant Proposed System of BMPs. These practices are designed to reduce the amount of sediment and nutrients entering surface waters when installed, as recommended. The total cost of implementing each of these BMPs is established using the following sources: the Natural Resources Conservation Service (NRCS) published cost list of 2002, actual cost of similar practices installed within the Macatawa Watershed in 2002, cost share amounts in the MDEQ Agricultural Best Management Practices Manual for Michigan's Nonpoint Source Pollution Program and the Macatawa Watershed Project cost share rates table.

As documented in (Table 1.), **grassed waterways and filter strips would have the largest affect on reducing sediment and nutrient delivery to surface water.** The acreage for each practice is based on an average width of thirty feet derived from typical NRCS grassed waterway designs, NRCS field office technical guide (FOTG) and filter strip, standards for phosphorus reduction. An average was calculated from these standards based on soil hydrology and slope.

In addition, Crop Residue Management and Cover Crops are suggested on fields containing or adjacent to grassed waterways or filter strips to insure they function properly, and to extend their life expectancy. Crop residue management and cover crops acreage is based on priority field acreage. Because fields had standing crops or were at different stages of tillage during the inventory period, the final acreage figure will depend on each producer's actual tillage practices. Remaining BMPs include the eleven grade stabilization structures, which are located in areas of severe erosion related to deep ravines and soil hydrology. There could be more sites requiring these structures, but access and the view was limited around the forested ravines. In addition, there were six sites associated with livestock production, which require one or all of the following BMPs, Critical Area treatment, Exclusion Fencing, Stream Crossings/Livestock Access and Pasture & Hayland Planting. One site in Section 2 of Zeeland Township is especially degraded due to over grazing and unlimited access by cattle to a perennial drain.

However, producers are not limited to these conservation practices. They can select additional practices cost shared by other agencies, or use their own funds to implement a comprehensive conservation management system.

Conclusion

The information brought forward in this 2002 report represents only the priority area designated for this inventory period. This information has been used to identify critical agricultural fields in townships within the watershed, which have a potential negative affect on surface water based on soil properties, topography, tillage practices and proximity to surface water. Producers can voluntarily install Best Management Practices (BMPs) to prevent sediment and phosphorus loading of surface water flowing into Lake Macatawa. Approximately 25,000 agricultural priority acres remain, mainly in Allegan County, for another inventory phase, which would be beneficial in getting a better representation of all nonpoint source pollution sites in the watershed. The appendix to this report includes documentation of critical, negatively impacted sites, the specific BMPs proposed and their cost. A key area of concern in Zeeland Township is section 2. Other main areas include sections 10, 15, 16, 22, 23, 34 in Zeeland Township and sections 25, 35 in Blendon township.

Table 1: 2002, Recommended Best Management Practices and Cost-Estimates for Agricultural Priority Areas

Township/Section	Recommended Resource Management System & Best Management Practices											
Blendon Township	Total Agriculture (acres)	Priority Fields (acres)	Grassed Waterways (feet / acres)	Filter Strips (acres)	Crop Residue Management (acres)	Grade Stabilization Structure (#)	Critical Area Planting (acres)	Exclusion Fencing (feet)	Stream Crossings (#)	Nutrient Mgmt. / Waste Utilization (acres)	Cover Crops (acres)	Pasture & Hayland Planting (acres)
25	238	187	200 / 0.1	5	102	2	0.0	0	0	163	0	0
26	159	76.4	0	4	37	0	0.0	0	0	67	14.5	0
34	234	67.6	0	4	16	0	0.0	0	0	178	33.4	0
35	250	137	800 / 0.6	0	118	0	0.0	5050	1	287	23.1	0
36	309	143	600 / 0.4	0.8	45.9	0	0.0	0	0	101	16	0
Subtotals	1190	611	1600 / 1.1	13.8	318.9	2	0.0	5050	1	796	87	0

Township/Section	Recommended Resource Management System & Best Management Practices											
Georgetown Township	Total Agriculture (acres)	Priority Fields (acres)	Grassed Waterways (feet/acres)	Filter Strips (acres)	Crop Residue Management (acres)	Grade Stabilization Structure (#)	Critical Area Planting (acres)	Exclusion Fencing (feet)	Stream Crossings (#)	Nutrient Mgmt./ Waste Utilization (acres)	Cover Crops (acres)	Pasture & Hayland Planting (acres)
30	39.9	0	0	0	0	0	0.0	0	0	0	0	0
Subtotals	39.9	0	0	0	0	0	0.0	0	0	0	0	0

Township/Section	Recommended Resource Management System & Best Management Practices											
Jamestown Township	Total Agricultural (acres)	Priority Fields (acres)	Grassed Waterways (feet/acres)	Filter Strips (acres)	Crop Residue Management (acres)	Grade Stabilization Structure (#)	Critical Area Planting (acres)	Exclusion Fencing (feet)	Stream Crossings (#)	Nutrient Mgmt./ Waste Utilization (acres)	Cover Crops (acres)	Pasture & Hayland Planting (acres)
6	106	35	0	1.2	18	0	0.0	0	0	44	14.3	0
7	185	119	450 / 0.3	0	112	1	0.0	0	0	133	0	0
Subtotals	291	154	450 / 0.3	1.2	130	1	0.0	0	0	177	14.3	0

Table 1: 2002, Recommended Best Management Practices and Cost-Estimates for Agricultural Priority Areas

Township/Section	Recommended Resource Management System & Best Management Practices											
	Total Agricultural (acres)	Priority Fields (acres)	Grassed Waterways (feet/acres)	Filter Strips (acres)	Crop Residue Management (acres)	Grade Stabilization Structure (#)	Critical Area Planting (acres)	Exclusion Fencing (feet)	Stream Crossings/Livestock Access (#)	Nutrient Mgmt./Waste Utilization (acres)	Cover Crops (acres)	Pasture & Hayland Planting (acres)
1	366	192	0	6	46	1	0.0	0.0	0	282	112	0
2	446	429	4020 / 2.8	9.6	177.8	3	7.0	450.0	1	393	156.4	9
3	417	321	2630 / 1.8	2.3	135.8	0	0.0	0.0	0	231	22.6	0
4	200.5	160.5	870 / 0.6	6	144	0	0.0	0.0	0	211	0	0
5	179.5	144.7	3360 / 2.3	0	92	0	0.0	0.0	0	127	0	0
7	373.7	149	0	2	131.8	0	0.0	0.0	0	366.7	0	0
8	283.1	150	680 / 0.5	3.4	122.4	0	0.0	0.0	0	247.6	17	0
9	301	177.2	1150 / 0.8	3.9	51.2	0	0.0	0.0	0	133.5	45.5	0
10	329.4	288.3	0	10.7	195.3	0	0.0	0.0	0	219.6	26.8	0
11	367.7	319.2	600 / 0.4	0	210.8	2	0.0	0.0	0	254.4	35.9	0
12	144.7	78.4	0	0	24	2	0.0	0.0	0	80.7	0	0
14	241.9	172.6	250 / 0.2	2	104.3	0	0.0	0.0	0	217.3	0	0
15	418.2	274.8	0	3.3	136.5	0	0.0	5010.0	2	337.2	0	60.8
16	351	274	1430 / 1.0	8.7	259	0	0.0	0.0	0	396.3	0	0
17	173.5	79.7	0	2.3	48.1	0	0.0	0.0	0	173.5	0	0
18	56.1	0	0	0	0	0	0.0	0.0	0	56.1	0	0
20	100.3	16.5	0	0	0	0	0.0	0.0	0	86.5	0	0
21	356	321.2	0	1	66.5	0	0.0	0.0	0	214.3	0	0
22	543.5	371.2	4250 / 2.9	4.5	314.3	0	0.0	1320.0	0	411.6	5.5	6.5
23	539.9	458.2	0	6.4	296.8	0	0.0	1000.0	1	445.9	7.3	0
24	206.6	135.8	2640 / 1.8	1.2	108	0	0.0	0.0	0	145.8	0	0
25	294.7	242.9	2720 / 1.9	1.5	129.9	0	0.0	0.0	0	166.9	18	0
26	457.4	440	680 / 0.5	8.9	321	0	0.0	0.0	0	357.7	12.8	0
27	525.3	280.7	0	2.8	167.2	0	0.0	0.0	0	460	0	0
28	447.3	221.4	1370 / 1.0	3.9	136.6	0	0.0	0.0	0	328.3	0	6
29	245.4	171.9	0	3.5	104.6	0	0.0	0.0	0	196.9	0	0
31	91.7	0	0	0	0	0	0.0	0.0	0	77.8	0	0
32	231.5	0	0	0	0	0	0.0	0.0	0	211.9	0	0
33	406.8	210.5	0	0.3	100.6	0	0.0	0.0	0	354.9	31.2	0
34	455.3	417.3	1240 / 0.9	6.3	322.6	0	0.0	0.0	1	361.5	8	0
35	534.2	451.1	630 / 0.4	11	370.2	0	0.0	0.0	0	450	0	0
36	81.6	78	0	2	78	0	0.0	0.0	0	81.6	0	0
Subtotals	10166.8	7027.1	28520 / 19.8	113.5	4395.3	8.0	7.0	7780.0	5.0	8078.5	499.0	82.3 ac
Totals	11,687.7	7,792.1	30570 / 21.2	128.5	4,844.2	11.0	7.0	12830.0	6.0	9051.5	600.3	82.3 ac

Table 1: 2002, Recommended Best Management Practices and Cost-Estimates for Agricultural Priority Areas

Cost	Total Agricultural (acres)	Priority Fields (acres)	Grassed Waterways (feet/acres)	Filter Strips (acres)	Crop Residue Management (acres)	Grade Stabilization Structure (#)	Critical Area Planting (acres)	Exclusion Fencing (feet)	Stream Crossings/ Livestock Access (#)	Nutrient Mgmt./ Waste Utilization (acres)	Cover Crops (acres)	Pasture & Hayland Planting (acres)
Totals	11,687.7	7,792.1	30570 / 21.2	128.5	4,844.2	11.0	7.0	12830.0	6.0	9051.5	600.3	82.3 ac
Estimated Cost	NA	NA	\$2,850/ac. Without tile, \$6,000/ac. With tile	\$400/ac. Establishment, \$100/ac/yr *Rental	\$12/ac. No-Till, \$7.50/ac. Mulch-Till **Incentive pymnt.	\$6,000 ea.	\$3,000/ac	\$1.77/ft.	\$5,000 ea.	\$4.20/ac ***Soil Test	\$5.00/ac.	\$105.00/ac
Total Cost	NA	NA	\$60,420 w/out tile, \$127,200 w/tile	\$51,400 = est. & 3yr/ac = \$38,550 *Rental	\$58,130 No-till or \$36,332 Mulch-Till	\$66,000	\$21,000	\$22,709	\$30,000	\$38,016	\$3,002	\$8,642

* Rental Payment Based on \$100.00/Acre/Year for Three Years, Payed at the Time the Filterstrip Practice is Installed

** Incentive Payment Authorized for One Year Only/Each Acre

*** Not Cost Shared



Macatawa Watershed Project

Appendix

Agricultural Priority Area Inventory, Specific Best Management Practice Recommendations for Sites in the Macatawa Watershed

By: Bruce Van Den Bosch
Macatawa Watershed Technician
March 2003

Site #1

Location: NW1/4NE1/4, Section 2, Zeeland Township, T.5N. R.14W.

BMPs: T – 3392, Critical Area Planting, 7.0 acres, \$3,000.00/acre
T – 3392, Pasture Planting, 9.0 acres, \$105.00/acre
T – 3392, Stream Access, 1 ea, \$5,000.00/ea.
T - 3392, Exclusion Fencing, 450 ft., \$1.77/ft.



Figure 1. T – 3392, Critical Area Planting Site (Gully Erosion), Cattle Access to Drain, Exclusion Fencing

Site #2

Location: E1/2NE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3393, Grassed Waterway, 1307 ft., 0.9 acres, \$6,000.00/acre
T – 3393, Crop Residue Management, No – Till, 57.5 acres, \$12.00/acre
T – 3393, Filter Strip, 3350 ft., 2.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. rent
T – 3393, Grassed Waterway, 870 ft, 0.6 acres, \$6000.00/acre
T – 3393, Grade Stabilization Structure (Vegetated Chute), 1/ea, \$2,000.00/ea.

Site #3

Location: SE1/4NW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3412, Grassed Waterway, 2870 ft., 2.0 acres, \$6000.00/acre
T – 3412, Crop Residue Management, No – Till, 83.7 acres, \$12.00/acre
T – 3412, Filter Strip, 2560 ft., 1.8 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #4

Location: NE1/4SW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3416, Crop Residue Management, NO – Till, 22.6 acres, \$12.00/acre
T – 3416, Filter Strip, 1400 ft., 1.0 acres, \$400.00/ acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #5

Location: NW1/4SW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3415, Cover Crop, 7.0 acres, \$5.00/acre
T – 3415, Filter Strip, 520 ft., 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #6

Location: NW1/4SW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 2787, Cover Crop, 13.7 acres, \$5.00/acre
T – 2787, Filter Strip, 620 ft., 0.4 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #7

Location: NW1/4SW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 6640, Cover Crop, 8.1 acres, \$5.00/acre
T – 6640, Filter Strip, 340 ft., 0.2 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #8

Location: SW1/4SW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 2965, Cover Crop, 10.3 acres, \$5.00/acre
T – 2965, Filter Strip, 950 ft., 0.7 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #9

Location: SE1/4SW1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 2787, Cover Crop, 57.9 acres, \$5.00/acre
T – 2787, Filter Strip, 2500 ft., 1.7 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #10

Location: NW1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3417, Cover Crop, 12.5 acres, \$5.00/acre
T – 3417, Filter Strip, 450 ft., 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #11

Location: NW1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3418, Cover Crop, 11.2 acres, \$5.00/acre
T – 3418, Filter Strip, 450 ft., 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #12

Location: NE1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 2962, Cover Crop, 13.6 acres, \$5.00/acre
T – 2962, Filter Strip, 450 ft., 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #13

Location: NE1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 2789, Cover Crop, 13.6 acres, \$5.00/acre
T – 2789, Filter Strip, 450 ft., 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #14

Location: NE1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 2961, Cover Crop, 13.6 acres, \$5.00/acre
T – 2961, Filter Strip, 450 ft., 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #15

Location: SW1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3390, Grade Stabilization Structure (Drop Structure), \$6,000.00/ea.

Site #16

Location: SW1/4SE1/4, Section 2, Zeeland Township, T5N. R14W.

BMPs: T – 3398, Grade Stabilization Structure (Drop Structure), \$6,000.00/ea.
T – 3398, Crop Residue Management, No – Till, 14.0 acres, \$12.00/acre



Figure 2. T – 3398, Grade Stabilization Structure (Drop Structure)

Site #17

Location: SW1/2SW1/4, Section 25, Blendon Township, T6N. R14W.

BMPs: T – 6495, Filter Strip, 3380 ft, 2.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent
T – 6495, Crop Residue Management, No – Till, 38.5 acres, \$12.00/acre
T – 6495, Grade Stabilization Structure (Vegetated Chute), 2/ea, \$2000.00/ea
T – 6495, Grassed Waterway, 200 ft, 0.1 acre, \$6000.00/acre



Figure 3. T – 6495, Filter Strip

Site #18

Location: SW1/4NW1/4, Section 35, Blendon Township, T6N. R14W.

BMPs: T – 3360, Exclusion Fencing, 3200 ft., \$1.77/ft.
T – 3360, Stream Crossing, 1/ea, \$5,000.00/ea.



Figure 4. T – 3360, Exclusion Fencing, Stream Crossing

Site #19

Location: NE1/4SW1/4, Section 26, Blendon Township, T6N. R14W.

BMPs: T – 3336, Filter Strip, 1300 ft, 0.9 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent
T – 3336, Cover Crop, 21.4 acres, \$5.00/acre



Figure 5. T – 3336, Filter Strip, Cover Crop

Site #20

Location: NW1/4SE1/4, Section 26, Blendon Township, T6N. R14W.

BMPs: T – 3344, Filter Strip, 4440 ft, 3.0 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent
T – 3344, Crop Residue Management, No – Till, 40.6 acres, \$12.00/acre

Site #21

Location: E1/2NE1/4, Section 35, Blendon Township, T6N. R14W.

BMPs: T – 3359, Exclusion Fencing, 2300 ft., \$1.77/ft.
T – 3359, Crop Residue, No – Till, 41 acres, \$12.00/acre
T – 3359, Grassed Waterway, 800 ft, 0.6 acres, \$6000.00/acre



Figure 6. T – 3359, Grassed Waterway, Requires Stilling Basin (in pool) and Tile

Site #22

Location: NW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3411, Cover Crop, 10.0 acres, \$5.00/acre

Site #23

Location: NW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3410, Cover Crop, 10.0 acres, \$5.00/acre
T – 3410, Filter Strip, 300 ft, 0.2 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #24

Location: NW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3383, Cover Crop, 18.6 acres, \$5.00/acre
T – 3383, Filter Strip, 500 ft, 0.3 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent
T – 3383, Grade Stabilization Structure (Vegetated Chute), 1/ea, \$2000.00/ea.

Site #25

Location: NW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3378, Cover Crop, 9.6 acres, \$5.00/acre
T – 3378, Filter Strip, 230 ft, 0.16 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #26

Location: NW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3409, Cover Crop, 8.0 acres, \$5.00/acre
T – 3409, Filter Strip, 250 ft, 0.17 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent

Site #27

Location: NW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3408, Cover Crop, 21.0 acres, \$5.00/acre
T – 3408, Filter Strip, 1250 ft, 0.9 acres, \$400.00/acre establishment, \$100.00/ac./yr./3 yr. Rent
T – 3408, Crop Residue Management, No – Till, 8.4 acres, \$12.00/acre

Site #28

Location: SW1/4NW1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3395 & 3396, Cover Crop, 34.0 acres, \$5.00/acre
T – 3395 & 3396, FilterStrip, 2700 ft, 1.9 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3395 & 3396, Crop Residue Management, No – Till, 16.5 acres, \$12.00/acre

Site #29

Location: SE1/4NW1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3403, Filter Strip, 2180 ft, 1.5 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3403, Crop Residue Management, No – Till, 2.9 acres, \$12.00/acre

Site #30

Location: SW1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3406, Filter Strip, 2620 ft, 1.8 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3406, Crop Residue Management, No – Till, 8.6 acres, \$12.00/acre

Site #31

Location: SE1/4NE1/4, Section 1, Zeeland Township, T5N. R14W.

BMPs: T – 3407, Filter Strip, 770 ft, 0.5 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3407, Crop Residue Management, No – Till, 12.3 acres, \$12.00/acre

Site #32

Location: W1/2SE1/4, Section 3, Zeeland Township, T5N. R14W.

BMPs: T – 2943, Filter Strip, 500 ft, 0.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2943, Crop Residue Management, No – Till, 37.3 acres, \$12.00/acre

Site #33

Location: SE1/4SE1/4, Section 3, Zeeland Township, T5N. R14W.

BMPs: T – 2944, Filter Strip, 1400 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2944, Cover Crop, 22.6 acres, \$5.00/acre

Site #34

Location: SE1/4SE1/4, Section 3, Zeeland Township, T5N. R14W.

BMPs: T – 3180, Filter Strip, 1300 ft, 0.9 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3180, Crop Residue Management, No – Till, 7.9 acres, \$12.00/acre

Site #35

Location: E1/2SE1/4, Section 4, Zeeland Township, T5N. R14W.

BMPs: T – 2109, Filter Strip, 1300 ft, 0.9 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2109, Crop Residue Management, No – Till, 76.0 acres, \$12.00/acre
T – 2190, Grassed Waterway, 870 ft, 0.6 acres, \$6000.00/acre

Site #36

Location: E1/2SE1/4, Section 4, Zeeland Township, T5N. R14W.

BMPs: T – 2930, Filter Strip, 4750 ft, 3.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2930, Crop Residue Management, No – Till, 68.0 acres, \$12.00/acre

Site #37

Location: SE1/4SE1/4, Section 9, Zeeland Township, T5N. R14W.

BMPs: T – 2931, Filter Strip, 5200 ft, 3.6 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2931, Crop Residue Management, No – Till, 43.2 acres, \$12.00/acre

Site #38

Location: SE1/4SW1/4SE1/4, Section 9, Zeeland Township, T5N. R14W.

BMPs: T – 5298, Cover Crop, 8.0 acres, \$5.00/acre

Site #39

Location: S1/2SW1/4, Section 10, Zeeland Township, T5N. R14W.

BMPs: T – 2959, Filter Strip, 1050 ft, 0.7 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2959, Crop Residue Management, No – Till, 56.0 acres, \$12.00/acre

Site #40

Location: N1/2SW1/4, Section 10, Zeeland Township, T5N. R14W.

BMPs: T – 2958, Filter Strip, 5010 ft, 3.5 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2958, Crop Residue Management, No – Till, 57.9 acres, \$12.00/acre

Site #41

Location: NE1/4NW1/4, Section 10, Zeeland Township, T5N. R14W.

BMPs: T – 2957, Filter Strip, 300 ft, 0.2 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2957, Crop Residue Management, No – Till, 15.0 acres, \$12.00/acre

Site #42

Location: NW1/4NE1/4, Section 10, Zeeland Township, T5N. R14W.

BMPs: T – 2963, Filter Strip, 920 ft, 0.6 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2963, Cover Crop, 9.0 acres, \$5.00/acre

Site #43

Location: NE1/4NE1/4, Section 10, Zeeland Township, T5N. R14W.

BMPs: T – 2964, Filter Strip, 19300 ft, 1.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2964, Cover Crop, 10.0 acres, \$5.00/acre
T – 2964, Crop Residue Management, NO – Till, 5.6 acres, \$12.00/acre

Site #44

Location: NE1/4NE1/4, Section 10, Zeeland Township, T5N. R14W.

BMPs: T – 2965, Filter Strip, 1480 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2965, Crop Residue Management, No – Till, 19.2 acres, \$12.00/acre

Site #45

Location: S1/2NE1/4, Section 11, Zeeland Township, T5N. R14W.

BMPs: T – 3428, Grassed Waterway, 600 ft, 0.4 acres, \$6000.00/acre
T – 3428, Crop Residue Management, No – Till, 64.5 acres, \$12.00/acre
T – 3428, Grade Stabilization Structure (Drop Structure), 1/ea, \$6000.00/ea.

Site #46

Location: SW1/4, Section 15, Zeeland Township, T5N. R14W.

BMPs: T – 2972, Exclusion Fencing, 3950 ft, \$1.77/ft.
T – 2972, Pasture Planting, 27.6 acres, \$105.00/acre
T – 2972, Stream Crossing, 1/ea, \$5,000.00/ea.



Figure 7. T – 2972, Pasture Planting, Stream Crossing

Site #47

Location: NW1/4SW1/4, Section 15, Zeeland Township, T5N. R14W.

BMPs: T – 2988, Pasture Planting, 4.0 acres, \$105.00/acre

Site #48

Location: E1/2SW1/4, Section 15, Zeeland Township, T5N. R14W.

BMPs: T – 2989, Pasture Planting, 49.2 acres, \$105.00/acre
T – 2989, Exclusion Fencing, 2330 ft, \$1.77/ft.
T – 2989, Stream Crossing, 1/ea, \$5000.00/ea.

Site #49

Location: SW1/4SE1/4, Section 15, Zeeland Township, T5N. R14W.

BMPs: T – 2994, Filter Strip, 1840 ft, 1.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2994, Crop Residue Management, No – Till, 37.2 acres, \$12.00/acre

Site #50

Location: SW1/4SE1/4, Section 16, Zeeland Township, T5N. R14W.

BMPs: T – 2971, Filter Strip, 1660 ft, 1.1 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2971, Crop Residue Management, No – Till, 45.6 acres, \$12.00/acre

Site #51

Location: SE1/4NE1/4, Section 16, Zeeland Township, T5N. R14W.

BMPs: T – 2876, Crop Residue Management, No – Till, 20.1 acres, \$12.00/acre

Site #52

Location: NE1/4NE1/4, Section 16, Zeeland Township, T5N. R14W.

BMPs: T – 2970, Filter Strip, 2970 ft, 1.6 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2970, Crop Residue Management, No – Till, 36.5 acres, \$12.00/acre

Site #53

Location: NW1/4NE1/4, Section 16, Zeeland Township, T5N. R14W.

BMPs: T – 434, Filter Strip, 2050 ft, 1.4 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 434, Crop Residue Management, No – Till, 35.5 acres, \$12.00/acre

Site #54

Location: SW1/4NE1/4, Section 16, Zeeland Township, T5N. R14W.

BMPs: T – 2980, Filter Strip, 1500 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2980, Crop Residue Management, No – Till, 28.8 acres, \$12.00/acre

Site #55

Location: SW1/4NE1/4, Section 16, Zeeland Township, T5N. R14W.

BMPs: T – 2475, Filter Strip, 1750 ft, 1.2 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 2475, Crop Residue Management, No – Till, 30.4 acres, \$12.00/acre

Site #56

Location: SW1/4,NW1/4 Section 22, Zeeland Township, T5N. R14W.

BMPs: T – 3008, Pasture Planting, 6.5 acres, \$105.00/acre
T – 3008, Exclusion Fencing, 1320 ft, \$1.77/ft
T – 3008, Crop Residue Management, No – Till, 36.9 acres, \$12.00/acre



Figure 8. T – 3008, Pasture Planting, Exclusion Fencing

Site #57

Location: SE1/4NW1/4, Section 22, Zeeland Township, T5N. R14W.

BMPs: T – 3015, Filter Strip, 1250 ft, 0.9 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3015, Crop Residue Management, No – Till, 35.0 acres, \$12.00/acre
T – 3015, Cover Crop, 1.7 acres, \$5.00/acre

Site #58

Location: SE1/4NW1/4,N1/2SW1/4, Section 22, Zeeland Township, T5N. R14W.

BMPs: T – 3021, Filter Strip, 1990 ft, 1.49 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3021, Crop Residue Management, No – Till, 162.8 acres, \$12.00/acre
T – 3021, Cover Crop, 3.8 acres, \$5.00/acre
T – 3021, Grassed Waterway, 1430 ft, 1.0 acres, \$6000.00/acre

Site #59

Location: SW1/4NE1/4, Section 22, Zeeland Township, T5N. R14W.

BMPs: T – 3022, Filter Strip, 650 ft, 0.4 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3022, Crop Residue Management, No – Till, 8.2 acres, \$12.00/acre

Site #60

Location: SE1/4NE1/4, Section 22, Zeeland Township, T5N. R14W.

BMPs: T – 6983, Filter Strip, 2650 ft, 1.8 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 6983, Crop Residue Management, No – Till, 53.2 acres, \$12.00/acre

Site #61

Location: SW1/4,NW1/4 Section 23, Zeeland Township, T5N. R14W.

BMPs: T – Allegan 1978, Stream Crossing, 1 ea., \$5000.00/ea
T – Allegan 1978, Exclusion Fencing, 850 ft, \$1.77/ft

Site #62

Location: S1/2NW1/4, Section 23, Zeeland Township, T5N. R14W.

BMPs: T – 3459, Filter Strip, 2180 ft, 1.5 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3459, Crop Residue Management, No – Till, 54.6 acres, \$12.00/acre

Site #63

Location: NW1/4NW1/4, Section 23, Zeeland Township, T5N. R14W.

BMPs: T – 3455, Filter Strip, 1910 ft, 1.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3455, Crop Residue Management, No – Till, 24.4 acres, \$12.00/acre
T – 3455, Cover Crop, 7.3 acres, \$5.00/acre

Site #64

Location: NE1/4NW1/4, Section 23, Zeeland Township, T5N. R14W.

BMPs: T – 396, Filter Strip, 1000 ft, 0.7 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 396, Crop Residue Management, No – Till, 16.8 acres, \$12.00/acre

Site #65

Location: NW1/4NW1/4, Section 25, Zeeland Township, T5N. R14W.

BMPs: T – 3488, Filter Strip, 3100 ft, 4.4 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3488, Crop Residue Management, No – Till, 14.0 acres, \$12.00/acre
T – 3488, Cover Crop, 12.0 acres, \$5.00/acre
T – 3488, Grassed Waterway, 920 ft, 0.6 acres, \$6000.00/acre



Figure 9. T – 3488, Filter Strip

Site #66

Location: NW1/4NE1/4, Section 25, Zeeland Township, T5N. R14W.

BMPs: T – 7120, Crop Residue Management, No – Till, 76.5 acres, \$12.00/acre
T – 7120, Grassed Waterway, 1830 ft, 1.3 acres, \$6000.00/acre



Figure 10. T – 7120, Grassed Waterway

Site #67

Location: NW1/4NE1/4, Section 26, Zeeland Township, T5N. R14W.

BMPs: T – 3007, Filter Strip, 3940 ft, 2.7 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3007, Crop Residue Management, No – Till, 32.7 acres, \$12.00/acre
T – 3007, Cover Crop, 12.8 acres, \$5.00/acre

Site #68

Location: E1/2SW1/4, Section 26, Zeeland Township, T5N. R14W.

BMPs: T – 6477, Filter Strip, 5000 ft, 3.4 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 6477, Crop Residue Management, No – Till, 102.6 acres, \$12.00/acre

Site #69

Location: NE1/4E1/2SW1/4, Section 26, Zeeland Township, T5N. R14W.

BMPs: T – 3480, Filter Strip, 1210 ft, 0.8 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3480, Crop Residue Management, No – Till, 18.1 acres, \$12.00/acre

Site #70

Location: NE1/4, Section 34, Zeeland Township, T5N. R14W.

BMPs: T – 3053, Filter Strip, 2250 ft, 1.5 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3053, Crop Residue Management, No – Till, 89.4 acres, \$12.00/acre

Site #71

Location: NW1/4NE1/4, Section 34, Zeeland Township, T5N. R14W.

BMPs: T – 3052, Filter Strip, 690 ft, 0.5 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3052, Crop Residue Management, No – Till, 25.9 acres, \$12.00/acre
T – 3052, Stream Crossing, 1/ea, \$5000.00/ea.



Figure 11. T- 3052, Stream Crossing (Drain Flows Over Farm Access Road)

Site #72

Location: E1/2NW1/4, Section 34, Zeeland Township, T5N. R14W.

BMPs: T – 3050, Filter Strip, 1450 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3050, Crop Residue Management, No – Till, 78.4 acres, \$12.00/acre

Site #73

Location: SW1/4NW1/4,E1/2SW1/4 Section 34, Zeeland Township, T5N. R14W.

BMPs: T – 3051, Filter Strip, 2090 ft, 1.4 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3051, Crop Residue Management, No – Till, 21.0 acres, \$12.00/acre
T – 3051, Cover Crop, 8.0 acres, \$5.00/acre
T – 3051, Grassed Waterway, 1240 ft, 0.9 acres, \$6000.00/acre

Site #74

Location: NW1/4SW1/4, Section 34, Zeeland Township, T5N. R14W.

BMPs: T – 487, Filter Strip, 420 ft, 0.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 487, Crop Residue Management, No – Till, 22.9 acres, \$12.00/acre

Site #75

Location: SE1/4SE1/4, Section 34, Zeeland Township, T5N. R14W.

BMPs: T – 223, Filter Strip, 1870 ft, 1.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 223, Crop Residue Management, No – Till, 60.8 acres, \$12.00/acre

Site #76

Location: S1/2SW1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – OT - Allegan, Filter Strip, 3320 ft, 2.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – OT - Allegan, Crop Residue Management, No – Till, 84.9 acres, \$12.00/acre

Site #77

Location: NW1/4SW1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – 3495, Filter Strip, 450 ft, 0.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3495, Crop Residue Management, No – Till, 26.5 acres, \$12.00/acre
T – 3495, Grassed Waterway, 630 ft, 0.4 acres, \$6000.00/acre

Site #78

Location: NW1/4SE1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – 3498, Filter Strip, 1900 ft, 1.3 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3498, Crop Residue Management, No – Till, 52.5 acres, \$12.00/acre

Site #79

Location: SE1/4SE1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – 3499, Filter Strip, 2740 ft, 1.9 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3499, Crop Residue Management, No – Till, 67.1 acres, \$12.00/acre

Site #80

Location: NW1/4NE1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – 3480, Filter Strip, 2260 ft, 1.6 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3480, Crop Residue Management, No – Till, 39.5 acres, \$12.00/acre

Site #81

Location: E1/2E1/2NW1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – 3497, Filter Strip, 1420 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3497, Crop Residue Management, No – Till, 34.3 acres, \$12.00/acre

Site #82

Location: W1/2E1/2NW1/4, Section 35, Zeeland Township, T5N. R14W.

BMPs: T – 3496, Filter Strip, 1470 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3496, Crop Residue Management, No – Till, 33.9 acres, \$12.00/acre

Site #83

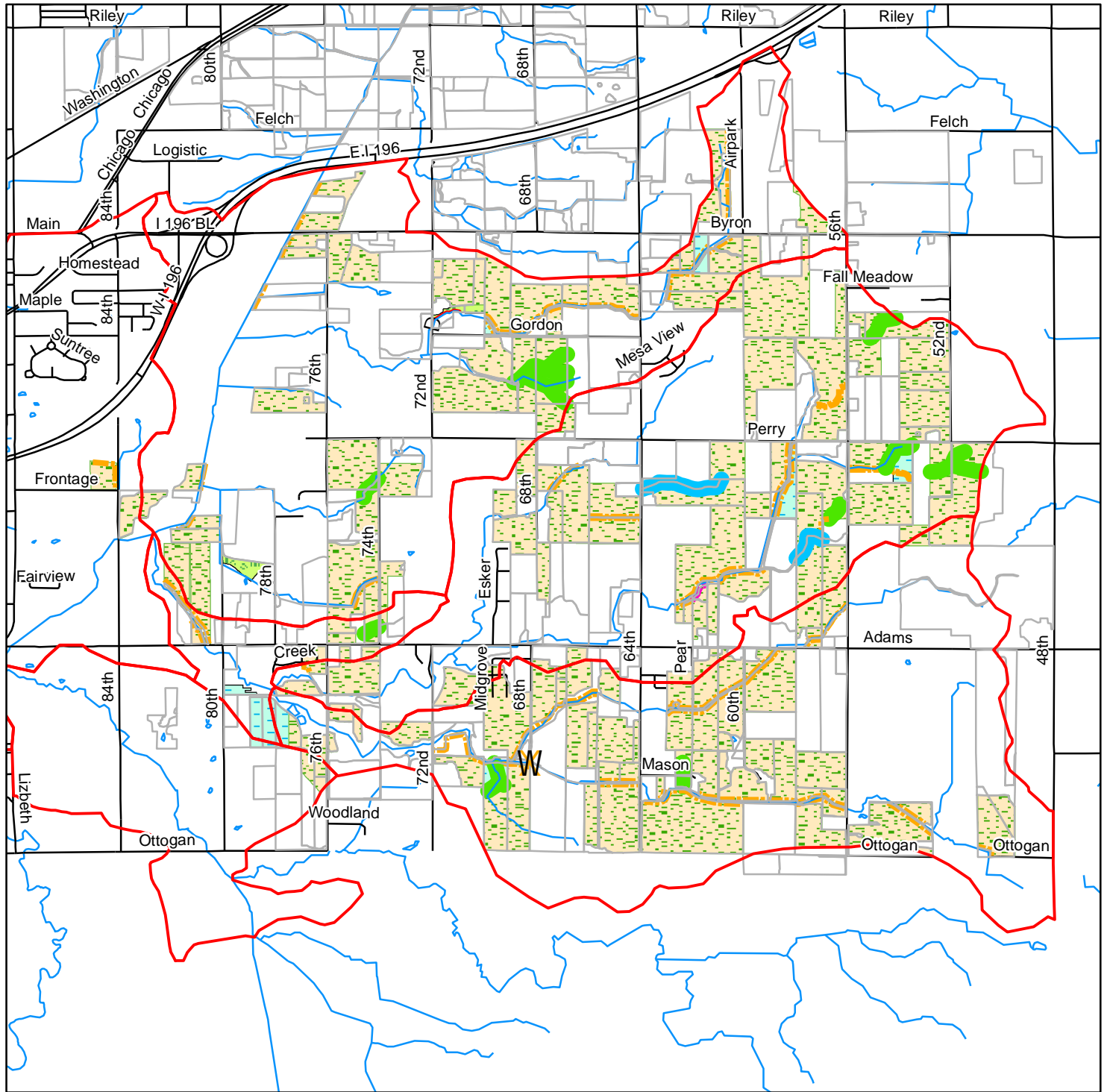
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BMPs: T – 3042, Filter Strip, 1430 ft, 1.0 ac, \$400.00/ac establishment, \$100.00/ac./yr./3 yr. Rent
T – 3042, Crop Residue Management, No – Till, 28.6 acres, \$12.00/acre














2002 Agricultural Inventory Addendum

(maps developed in 2011 by the Allegan Conservation District)

2002 Best Management Practice Inventory Subbasins 5-9 & 13 (Upper Macatawa River and Peters Creek)

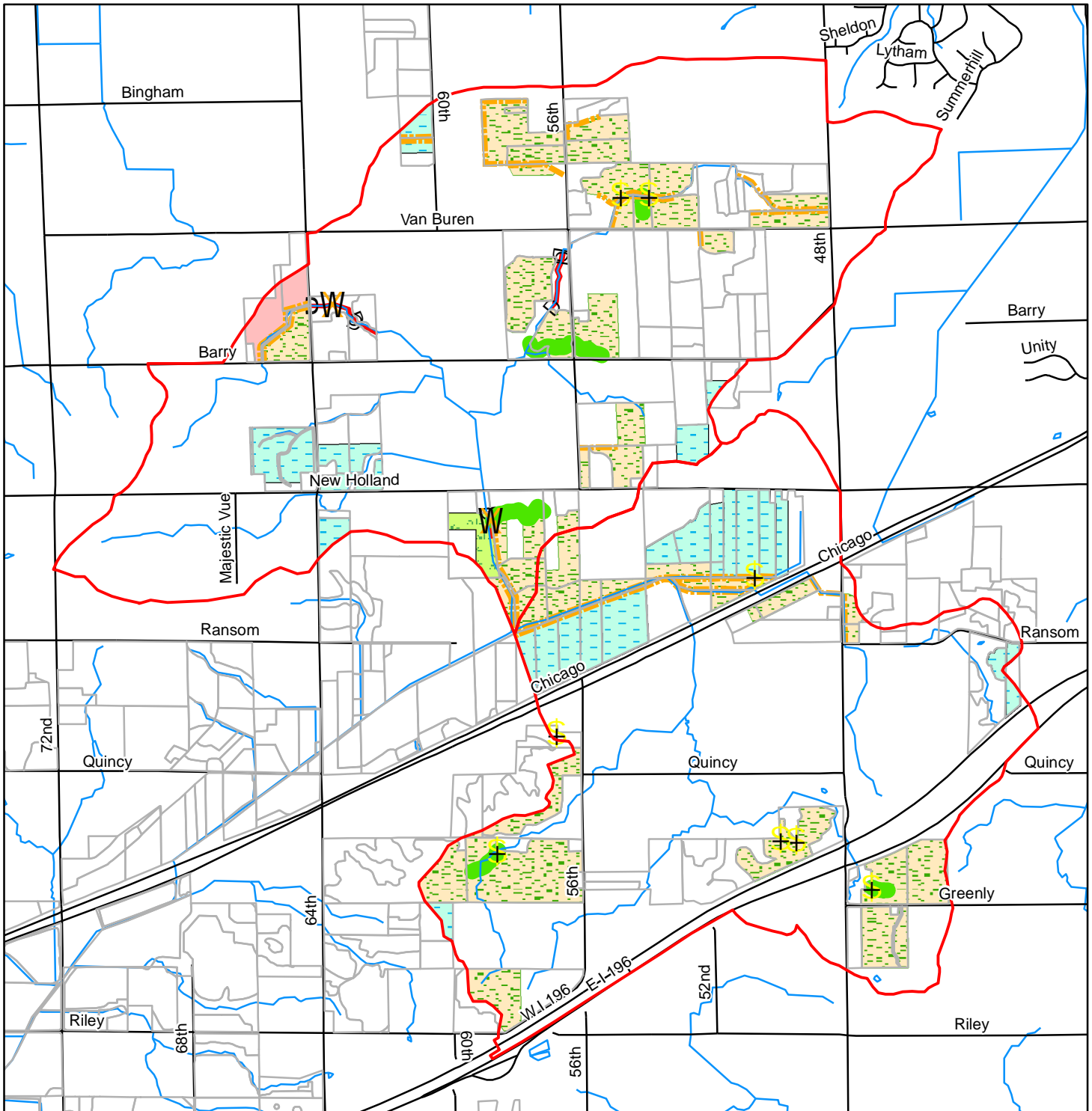


Legend

- | | |
|---|---|
|  Watershed Boundary |  Exclusion Fencing |
|  Parcels |  Existing Filter Strip |
|  Roads |  Existing Grassed Waterway |
|  Streams |  Filter Strip |
|  Livestock Access |  Grassed Waterway |
| |  Cover Crop |
| |  Critical Area/Pasture |
| |  Residue Management |



2002 Best Management Practice Inventory Subbasins 1 & 2 (Upper Macatawa River)



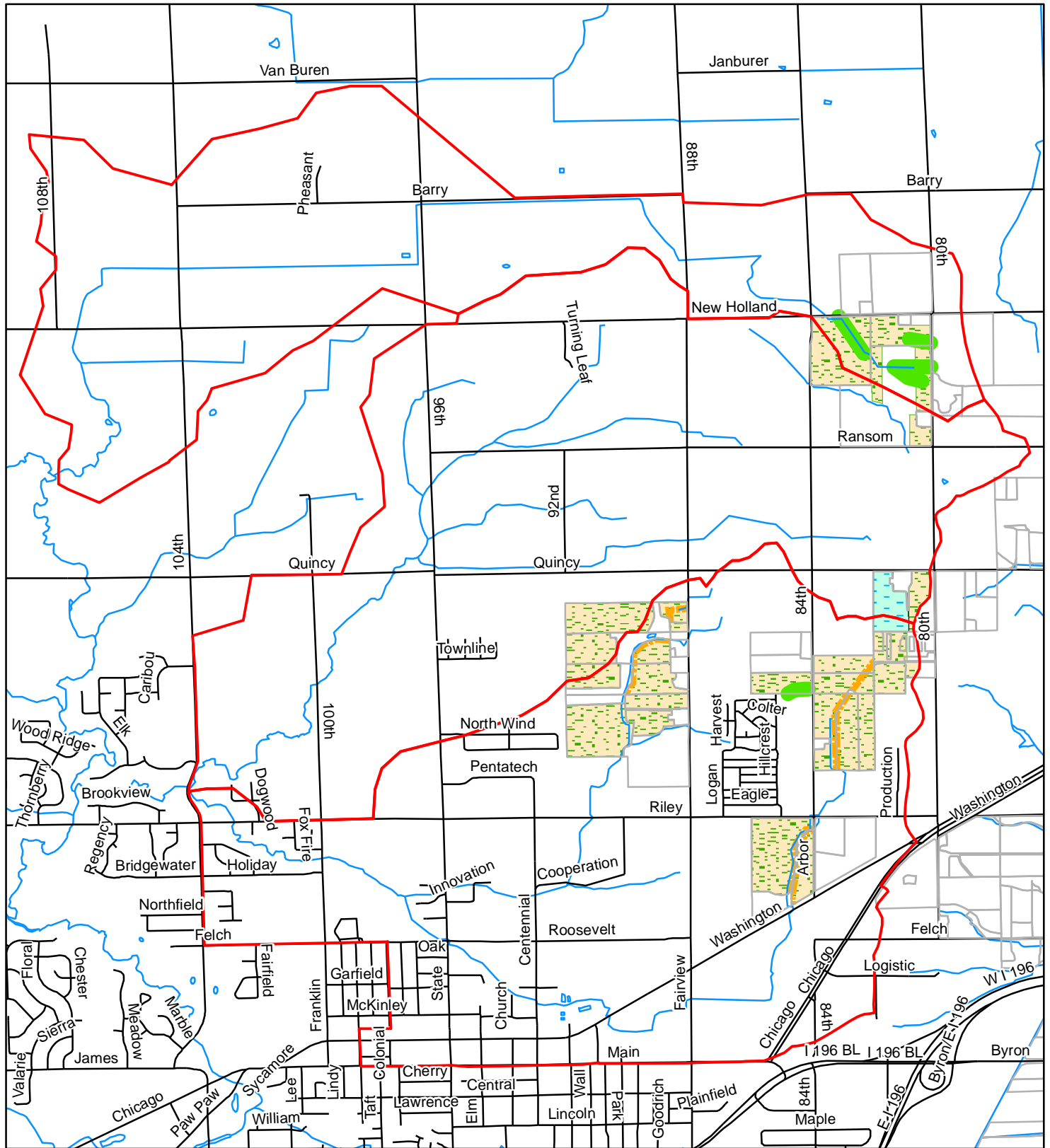
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- | | |
|-------------------------------|-----------------------|
| Watershed Boundary | Exclusion Fencing |
| Parcels | Filter Strip |
| Roads | Grassed Waterway |
| Streams | Cover Crop |
| Grade Stabilization Structure | Critical Area/Pasture |
| Livestock Access | Existing No-Till |
| | Residue Management |



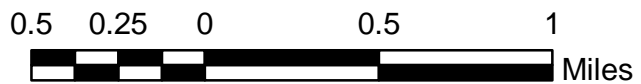
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2002 Best Management Practice Inventory Subbasins 28-30 (Noordeloos Creek)

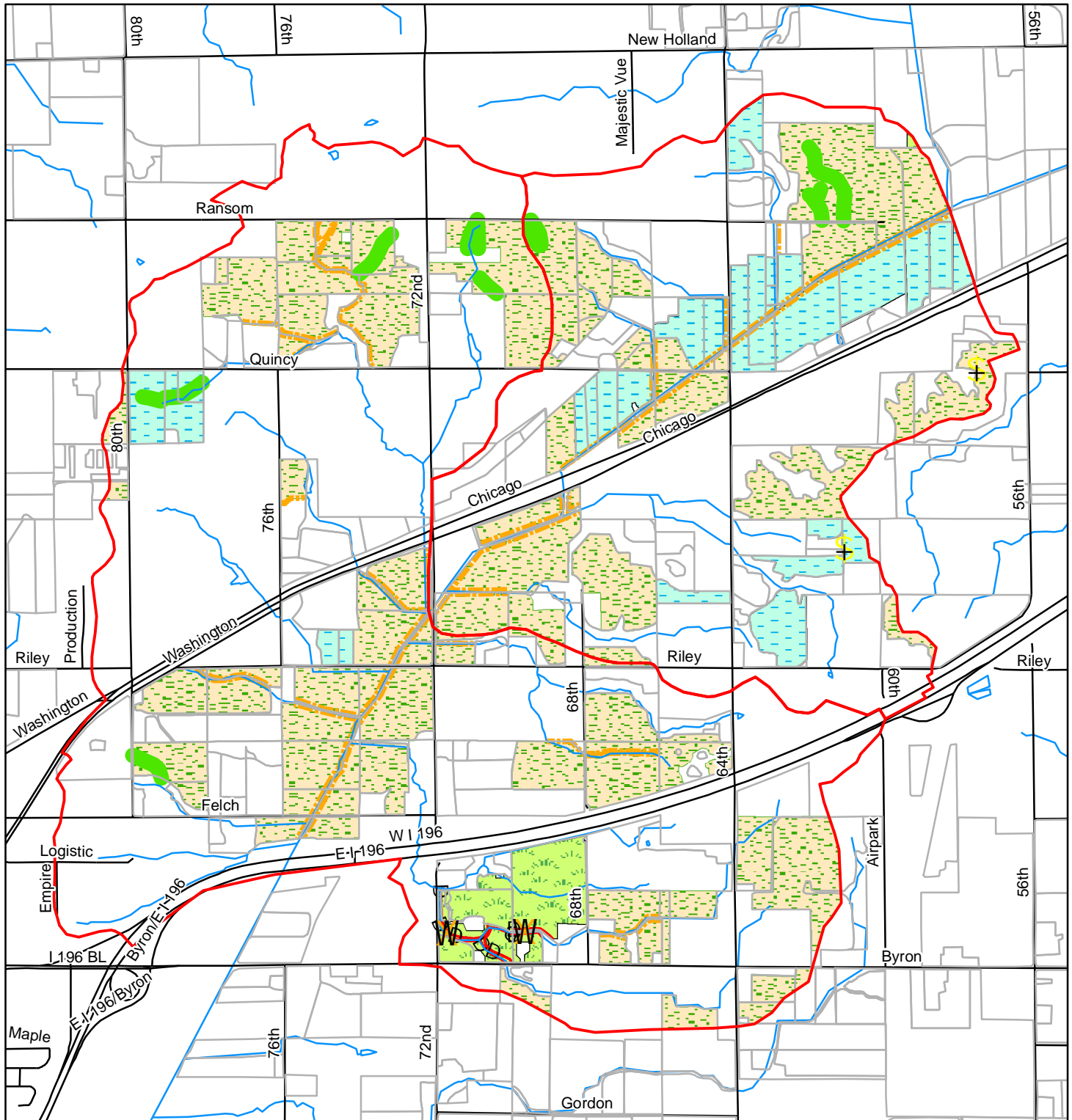


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



- Watershed Boundary
- Parcels
- Roads
- Streams
- Filter Strip
- Grassed Waterway
- Cover Crop
- Residue Management



2002 Best Management Practice Inventory Subbasins 3 & 4 (Upper Macatawa River)



Legend

- | | | | |
|--|-------------------------------|---|-----------------------|
|  | Watershed Boundary |  | Exclusion Fencing |
|  | Grade Stabilization Structure |  | Filter Strip |
|  | Livestock Access |  | Grassed Waterway |
|  | Parcels |  | Cover Crop |
|  | Roads |  | Critical Area/Pasture |
|  | Streams |  | Residue Management |

