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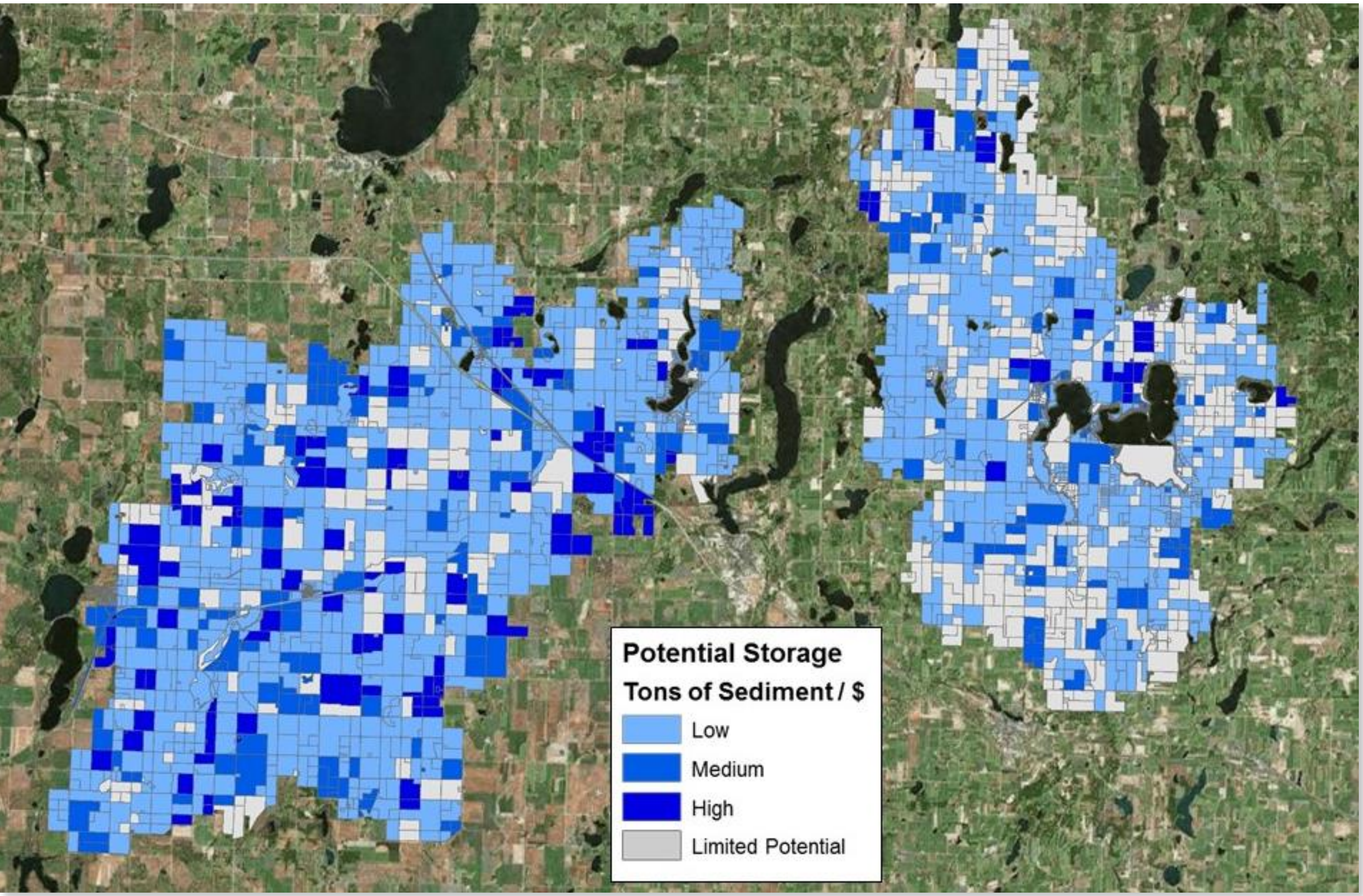

DESKTOP ANALYSIS TO TARGET AND MEASURE CONSERVATION PRACTICES

Sauk River Watershed District

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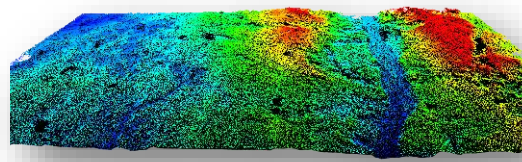
APPENDICES

1 SCOPE AND PURPOSE

1.1 INTRODUCTION

The Ashley Creek and Adley Creek desktop analysis project is being performed with the goal of identifying locations suitable for Best Management Practices (BMP) and Conservation Practices (CP) and measuring the water quality benefits of potential BMPs and CPs to pro-actively protect water quality. This was achieved using the Prioritize, Target, and Measure Application (PTMApp) Desktop.



PTMApp can be used in rural settings to: 1) identify the sources and amount of sediment, nitrogen and phosphorus which leave the landscape and enter a downstream lake or river; 2) target specific fields on the landscape (based upon NRCS design standards, landscape characteristics, land productivity and/or landowner preference) for the implementation of nonpoint source best management practices (BMPs) and conservation practices (CPs); and 3) estimate the benefits of single or multiple BMPs and CPs within a watershed where the benefits are expressed as the downstream load reduction reaching a lake or river and the estimated cost / load reduction. For single practices, an optimization curve showing the relationship between the estimated implementation cost and the reduction in annual load for a watershed can be obtained. These tools allow anyone to target solutions to the identified priorities and develop tailor-made solutions rather than one size fits all approaches.

The application has desktop (PTMApp Desktop) and Web (PTMApp Web) components. PTMApp Desktop consists of a toolbar for use within ESRI's ArcGIS technology. Once created, data can be shared using the PTMApp Web component. The intended audiences for PTMApp are Soil and Water Conservation Districts and water resource practitioners.

The targeted BMPs and CPs from this study are intended to provide measurable progress towards water quality goals defined in local water management plans and the Watershed Restoration and Protection Strategy (WRAPS) process for two priority subwatersheds within the Sauk River Watershed District (SRWD), Ashley Creek and Adley Creek. The targeted BMPs and CPs are also consistent with the Minnesota Board of Water and Soil Resources (BWSR) Nonpoint Priority Funding Plan and statewide nutrient reduction strategies. The data and information from this report will be used by the SRWD and local partners to implement accountable projects and practices that improve water quality within the Sauk River Watershed (SRW).

1.2 STUDY AREA

The Ashley Creek subwatershed consists of five 12-digit Hydrologic Unit Code (HUC) watersheds that encompass 125 square miles (**Figure 1)**, Silver Creek (070102020204), Upper Ashley Creek (070102020201), County Ditch No. 3 (07012020202), Middle Ashley Creek (070102020203), and Lower Ashley Creek (9070102020205). The Adley Creek subwatershed consists of 4 12-digit HUC watersheds the encompass 93 square miles, Adley Creek (070102020404), Trout Creek (07012020401), Big Birch Lake (07012020402), Little Birch Lake (07012020403). Within the Adley Creek subwatershed, the Adley Creek 12-digit HUC was the primary focus of this study based upon local prioritization efforts.

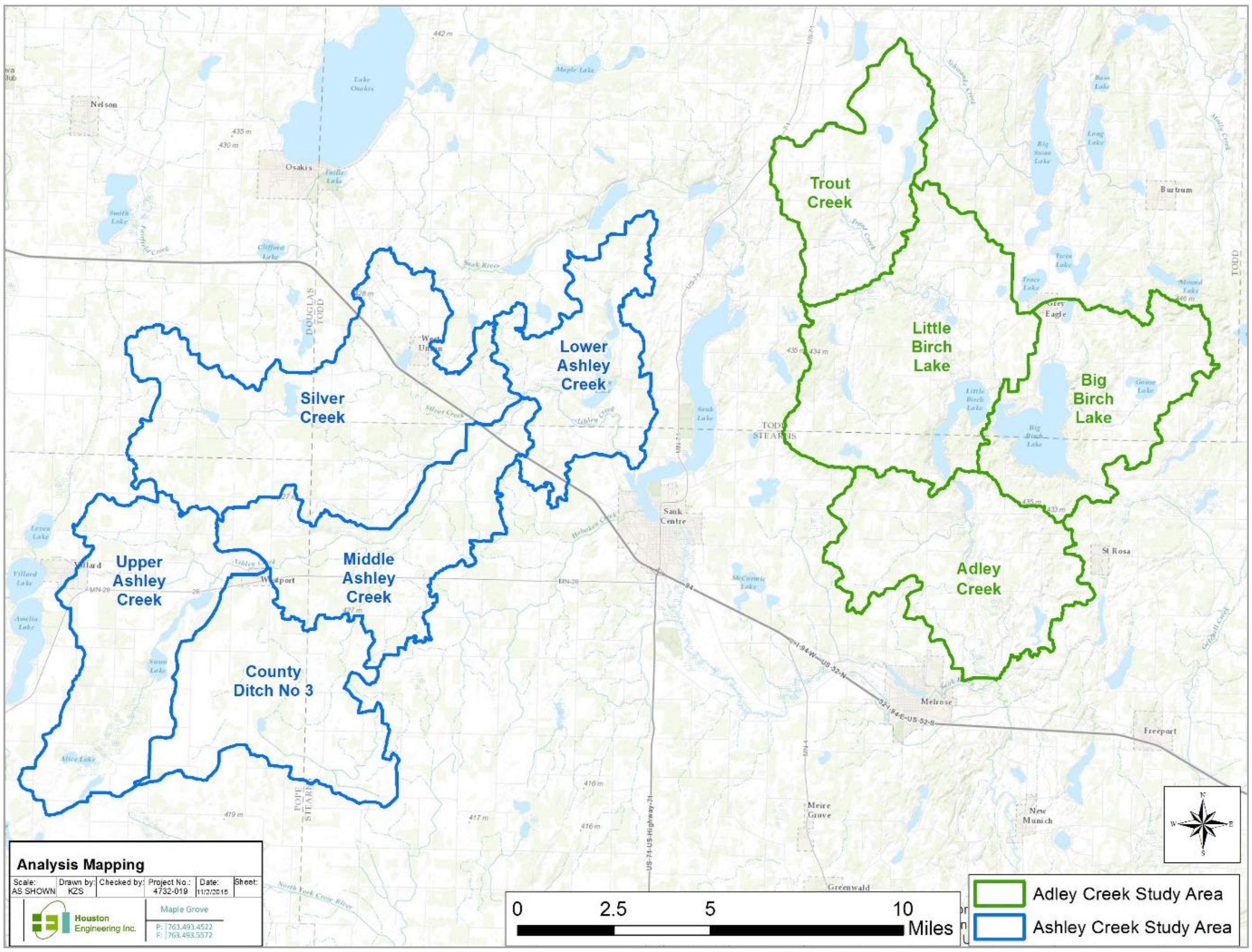
2 DATA SOURCES

Several data sources were used during this desktop analysis are required to run PTMApp Desktop. In summary, these are the data sources that serve as, or enable development of the required inputs for PTMApp Desktop which are documented in the PTMApp Desktop User Guide (available online: http://www.rrbdin.org/prioritize-target-and-measure-application-ptmapp-desktop). Descriptions of the primary data sources used and a summary of their origin and content follows.

2.1 TOPOGRAPHIC DATA

This study utilizes the State of Minnesota's Elevation Mapping Project's[1] Light Detection and Ranging (LiDAR) elevation data collected to a vertical root mean square error (RMSE) of plus or minus six inches. For purposes of this work, the bare earth LiDAR points were interpolated into a digital elevation model (DEM) at a 3 meter by 3 meter resolution.

Figure 1. Ashley and Adley Creek priority study areas



[1] http://www.mngeo.state.mn.us/committee/elevation/mn_elev_mapping.html

2.2 RAINFALL FREQUENCY/DURATION DATA

The National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (NOAA, 2013) precipitation data were used for the rainfall depths for the 10-year, 24-hour event and 2-year, 24-hour event to generate runoff volume and peak discharge estimates.

2.3 LAND USE/LAND COVER

The 2011 National Land Cover Dataset[2] (NLCD) was used to develop runoff Curve Numbers, and to generate estimates of Total Nitrogen (TN) and Total Phosphorus (TP) loading. The National Agricultural Statistics Service[3] (NASS) 2014 Cropland Data Layer (CDL) was used for assigning cover management values for various land cover types in the revised universal soil lose equation (RUSLE).

2.4 SOILS

Hydrologic Soil Group designations from the Natural Resources Conservation Service's (NRCS) SSURGO[4] database were also used in the developing Curve Numbers for hydrologic conditioning of the DEM. Soil Erodibility Factors (K_w) from these data were used as inputs for RUSLE. SSURGO hydric rating, crop productivity index, and minimum depth to groundwater data was also used for identifying potential BMP and CP locations.

2.5 RAINFALL-RUNOFF (R-FACTOR) VALUES

Information on R-factors used in RUSLE is available from the NRCS MN Field Guide. The R-factor accounts for the impact of meteorological characteristics on erosion rates.

2.6 HSPF MODEL FOR SAUK RIVER WATERSHED

An HSPF model was developed in a previous study (RESPEC, 2014). This model was used to scale the results of PTMApp Desktop so that they were consistent with the results of the HSPF output data.

2.7 STUDY BOUNDARY AND PRIORITY RESOURCE POINTS

The study area boundaries and priority resource points where developed for this study by SRWD. The priority resource points are the locations at which TN, TP, and sediment source loads are routed too. They are also the locations where source load reductions can be summarized for potential BMPs and CPs.

3 METHODS

3.1 HYDROLOGIC CONDITIONING

Hydrologic conditioning is the process of modifying the topographic data represented as the raw or "bare earth" DEM through a series of GIS processing steps to more accurately represent the movement of water on the landscape. Upon completion of the hydrologic conditioning process the DEM becomes modified to reflect the movement of water not only based on topography, but the presence of other factors affecting water movement like the locations of culverts, drains, or other structures. The hydrologic conditioning process used for this analysis was to enforce waterways from

[2] 2011 National Land Cover Database (NLCD), Website: http://www.mrlc.gov/nlcd2011.php
[3] National Agricultural Statistics Service (NASS), 2012 Cropland Data Layer (CDL), Website: http://www.nass.usda.gov/
[4] Natural Resource Conservation Service (NRCS), Soil Survey Geographic Database (SSURGO). Website: http://soildatamart.nrcs.usda.gov/

the high resolution National Hydrography Dataset (NHD) and watershed boundaries from the Watershed Boundary Dataset (WBD).

The level of detail in the conditioning process can vary significantly depending on the purpose and need of the conditioned DEM's uses. **Figure 2** displays the range of conditioning scale and some basic explanation of their differences. The DEM conditioning for this study was performed to the C standard to provide a large range of functionality in the output data products.

Figure 2. Hydrologic DEM conditioning and data product scale

Minimum Criteria		DEM Reconditioning and Data Product Scale				
		Fine			*Coarse*	
		A	B	C	D	E
1	Elevation Source Data	High Resolution Topographic Data (e.g., using LiDAR)				USGS National Elevation Dataset
2	Mininum drainage area threshold used for Quality Control	< 1 sq. mile	1 - 5 sq. miles	5 - 10 sq. miles	> 10 sq. miles	All Ranges
3	Maximum Digital Elevation Model and Raster Data Product Resolution	5 meter	5 meter	10 meter	30 meter	Any
4	Hydrologic Boundary and Vector Data Product Resolution	160 acres maximum *(Ideally 40 acres)*	1 square mile maximum	5-10 sq. mile maximum	> 10 square mile maximum	12-digit HUC
5	Source of Reconditioning Data	User intrepretation using source elevation data, supplemented with field-verified data where required	User intrepretation using source elevation data, supplemented with field-verified data where required	User intrepretation	User intrepretation	Existing GIS dataset (NHD, MnDNR 24k Streams, etc...)
6	Intensity of Recondition	High *Several iterations by experienced hydrologist to meet Criteria 2*	Moderately High *Several iterations by experienced hydrologist to meet Criteria 2*	Moderate *Minimal iterations by experienced hydrologist to meet Criteria 2*	Low *Minimal iterations by experienced hydrologist to meet Criteria 2*	None
7	Data Products and Functionality	BMP Design Water Quality Overland Flow On-the-fly Watershed Delineation Hydrographics Gridded Parameter Modeling "Lumped" Parameter Modeling	On-the-fly Watershed Delineation Hydrographics "Lumped" Parameter Modeling	Hydrographics "Lumped" Parameter Modeling	Hydrographics "Lumped" Parameter Modeling	NHD Plus

**"User interpretation" implies photographic interpretation combined with the source elevation data to make assumptions on drainage characteristics.*

3.2 TIME OF TRAVEL

A travel time raster was used to estimate the quantity of sediment and nutrients delivered to downstream water resources of concern. The travel time raster was developed using an ArcGIS script available from the Minnesota DNR. Flow direction, flow accumulation and slope derived from the conditioned DEM were used along with land cover to compute hydrologic velocities between each cell. The velocities for each cell were converted to a travel time based on the length between cells and then accumulated in the downstream direction, creating a raster of travel time to the watershed outlet.

3.3 PROCESSING DATA IN PTMAPP DESKTOP

The science and theory used to process data in PTMApp Desktop are well documented through a series of peer-reviewed Technical Memorandum (HEI, 2014a, b, and c; HEI, 2015). This documentation is available at http://www.rrbdin.org/prioritize-target-and-measure-application-ptmapp-theory. These documents describe all of the technical aspects of the processing performed to generate the output products for this study. In addition, these methods have been described in a free webinar that can be viewed at http://www.rrbdin.org/prioritize-target-and-measure-application-ptmapp-webinars. Rather than describe, in detail, all of these methods here, the Technical Memorandum have been provided as an additional deliverable of this project.

Briefly, PTMApp Desktop generates source load yields (TP, TN, and sediment) based upon empirical methods (HEI, 2014a). These source yields are then routed to downstream locations, concentrated flow paths and priority resource points, using a sediment delivery ratio for sediment and first order decay equations for TP and TN. Potential locations for BMPs and CPs are identified based upon NRCS design standards (HEI, 2014b) and are aggregated into treatment groups (bio-filtration, filtration, infiltration, protection, source reduction, and storage). The BMP and CP locations are then integrated with the source load data and surface hydrology calculations to estimate the BMP and CP efficiency and source load reductions (HEI, 2014c). Finally, the cost of potential BMPs and CPs are estimated based upon 2014 Minnesota Environmental Quality Incentives Programs (EQIP) payment schedules. It is important to note that this is a desktop analysis to help target and measure locations for on-the-ground BMP and CP implementation. The full output data catalog has been provided as an additional deliverable of this study.

Local knowledge is still critical for ensuring that the data generated from this desktop analysis identify locations that are practical and feasible for implementing projects and practices. For example, land owner willingness and existing practices are two factors that cannot be accounted for in this project. Local knowledge can be used to incorporate and adjust for these factors.

3.4 TARGETED IMPLEMENTATION SCENARIOS

In order to estimate the benefits of multiple practices implemented together on the landscape, a treatment train analysis must be run in PTMApp Desktop (HEI, 2015). The original outputs from PTMApp Desktop only estimate the benefits of individual BMPs (i.e. no consideration of upstream benefits of other practices). The treatment train analysis in PTMApp Desktop estimates the benefits (TP, TN, and sediment load reductions) of multiple practices on the landscape. Following scenario design guidance from SRWD, two targeted implementation scenarios were defined for each of the study subwatersheds. BMPs and CPs were selected for the treatment train analysis if they matched the criteria below.

3.4.1 SCENARIO 1: PRACTICES WITH THE LARGEST LOAD REDUCTIONS

For Scenario 1, criteria were used to select those practices with the greatest load reductions to the outlets of Adley and Ashley Creek. For Adley Creek, practices were further restricted to only include those within Adley Creek (070102020404) 12-digit HUC subwatershed, based upon local prioritization. The criteria below were selected, as they appeared to capture those BMPs and CPs with the largest potential individual load reductions.

3.4.1.1 SCENARIO 1: ADLEY CREEK

The following criteria were used for selecting practices with the largest load reductions in Adley creek:

- > 5 lbs./year reduction in TP at the outlet of Adley Creek for storage practices based upon median efficiency
- > 1 lbs./year reduction in TP at the outlet of Adley Creek for all other treatment groups based upon median efficiency

For Adley Creek, TP was selected as a proxy for sediment and TN. Those practice locations estimated to provide the greatest reduction in TP, also provided the largest reductions in TN and sediment within Adley Creek (070102020404) 12-digit HUC subwatershed.

3.4.1.2 SCENARIO 1: ASHLEYCREEK

The following criteria were used for selecting practices with the largest load reductions in Ashley creek:

- > 0.5 tons/year reduction in sediment at the outlet of Ashley Creek for filtration practices based upon median efficiency
- > 3 lbs./year reduction in TP or > 1 ton/year reduction in sediment at the outlet of Ashley Creek for all storage practices based upon median efficiency
- > 3 lbs./year reduction in TP or > 1 ton/year reduction in sediment at the outlet of Ashley Creek for all source reduction practices based upon median efficiency

For Ashley Creek, a greater number of potential practices required additional criteria to ensure that the BMPs and CPs with the greatest potential for load reductions were selected.

3.4.2 SCENARIO 2: COST-EFFECTIVE PRACTICES

For Scenario 2, criteria were used to select those practices with the most cost-effective load reductions among practices that provide at least 0.1 tons/year of sediment reduction or 0.1 lbs./year of TP reduction to the outlets of Adley and Ashley Creek based upon median efficiency. For Adley Creek, practices were further restricted to only include those within Adley Creek (070102020404) 12-digit HUC subwatershed, based upon local prioritization.

3.4.2.1 SCENARIO 2: ADLEY CREEK

The following criteria were used for selecting practices with the most cost-effective load reductions in Adley creek:

- < $7,000 ton/year of sediment reduction or < $7,000/lbs./year of TP reduction at the outlet of Adley Creek for all treatment groups based upon median efficiency
- > 0.1 tons/year of sediment reduction or > 0.1 lbs./year of TP reduction at the outlet of Adley Creek for all treatment groups based upon median efficiency

3.4.2.2 SCENARIO 2: ASHLEY CREEK

The following criteria were used for selecting practices with the most cost-effective load reductions in Ashley creek:

- < $7,000 ton/year of sediment reduction or < $7,000/lbs./year of TP reduction at the outlet of Ashley Creek for all treatment groups based upon median efficiency
- > 0.1 tons/year of sediment reduction or > 0.1 lbs./year of TP reduction at the outlet of Ashley Creek for all treatment groups based upon median efficiency

4 PRODUCTS AND RESULTS

4.1 GEODATABASE PRODUCTS

The number of GIS products resulting from the conditioning process is large, and the wealth of data complex. Therefore, developing maps for each product is prohibitive and only example products are included in the body of the report. To facilitate subsequent use and ensure protection of the fiscal investment in creating the products, a complete data catalog was developed as part of PTMApp Desktop (**Appendix A**). Products resulting from completing the terrain analysis process are grouped into four types and provided in four separate GIS file geodatabases. The product types are:

- "Base" Data geodatabase – this file geodatabase contains all of the publicly available statewide data that is available as part of the PTMApp Desktop download package. It has, however, been clipped to the extent of the study area watersheds;
- Planning geodatabase – this file geodatabase contains planning level inputs that were included during PTMApp Desktop processing. It includes the study area boundaries and HSPF model scaling data.
- Processing geodatabase – this file geodatabase contains all data outputs and data used for processing functions within PTMApp Desktop. The majority of the PTMApp Desktop data is housed within this file geodatabase.
- Targeted_Plan geodatabase – The treatment group layers used in scenario 1 and 2 for the treatment train analyses are housed within this file geodatabase.
- ScaledLoads_Model geodatabase – this file geodatabase contains the HSPF model outputs in a format that is compatible for use in PTMApp Desktop for the entire SRW. HSPF scaling data found in the individual study area file geodatabase have been clipped to the study areas. This scaling database can be used for any area within the extent of the original HSPF model.

Results, example products and a brief description of their use follow within the remainder of this section.

4.2 RESULTS AND EXAMPLE PRODUCTS

The output products from PTMApp Desktop can be used in a number of business workflows (**Figure 3**), each of which were evaluated by a panel of Local Governmental Units (LGUs) during the development of PTMApp. SRWD and their partners had already completed a 12-digit HUC prioritization process (through Complete Source Assessment) prior to the start of this study. The business workflows are tasks that SWCD and WD staff might undertake as part of daily work to prioritize, target the locations of projects and practices that provide measurable water quality benefits. These workflows, or subset of the workflows, might be completed as part of implementation strategy development for an annual work plan, development of Watershed Restoration and Protection Strategies (WRAPS), accelerated implementation grants (AIG) through BWSR, or federal 319 grants to name a few. This desktop analysis picked up at Complete Source Assessment and worked through:

- Evaluate Practice Feasibility
- Estimate Individual Practice Water Quality Benefits
- Target Preferred Practice Locations
- Develop Targeted Implementation Plan
- Estimate Benefits of Targeted Implementation Plan

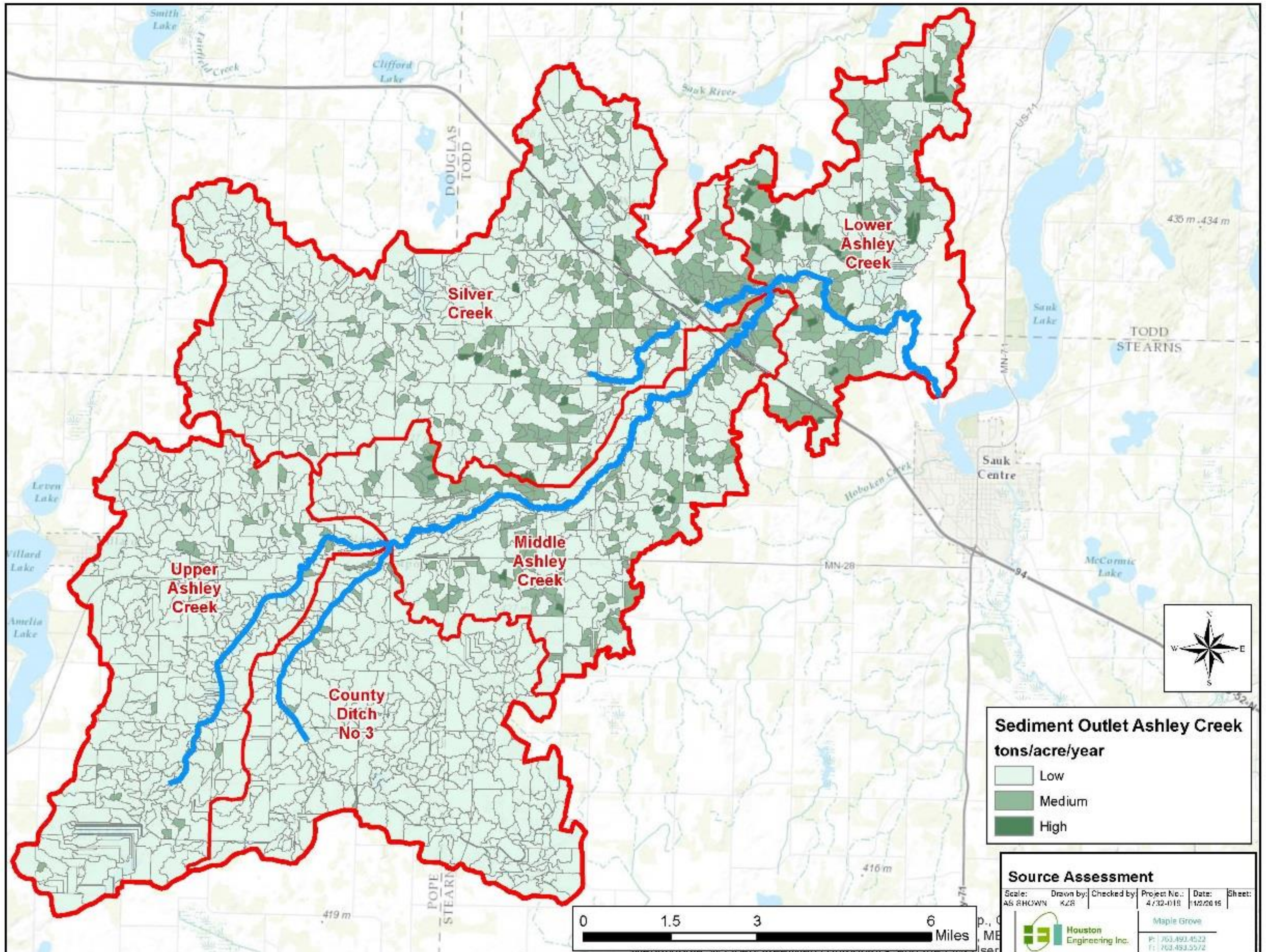
This results section will walk through examples of these business workflows for the development and results of Scenarios 2 for Ashley Creek from Section 3.4.2.2 above. The data developed through this study can continue to be used to develop numerous BMP and CP implementation scenarios. As such, the purpose of showing results from Scenario 2 for Ashley Creek is to illustrate how the business workflows in **Figure 3** can be implemented, so that they can be repeated to address additional resource management priorities. After walking through the examples for Scenario 2 for Ashley Creek, the estimated water quality benefits of all four scenarios are shown in **Tables 1-4** or Section 4.3.

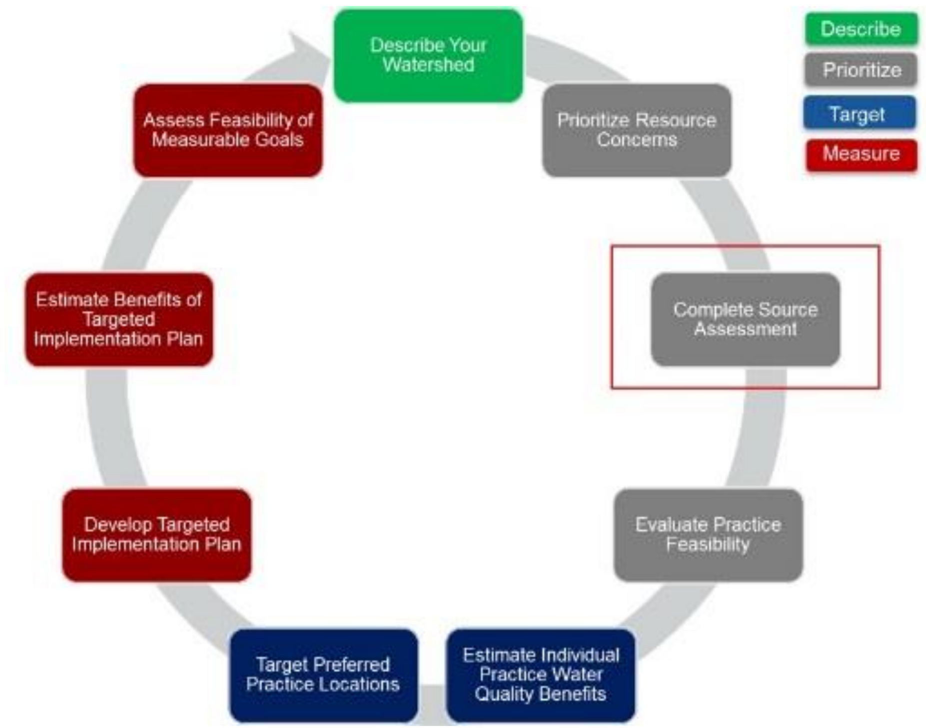
Figure 3. Business workflows addressed by PTMApp Desktop.

4.2.1 COMPLETE SOURCE ASSESSMENT

The sediment yield (tons/acre/year) delivered to the outlet of Ashley Creek that have been scaled relative to a HSPF model for SRW (RESPEC, 2014), within the Ashley Creek study area are shown in **Figure 4**. Similar products can be developed for TN and TP for any priority resource point input during processing. The results indicate that the highest areas of sediment loading to the outlet of Ashley Creek are within Lower Ashley Creek (9070102020205), with additional areas in Silver Creek (070102020204) and Middle Ashley Creek (070102020203). For strategies aimed at reducing sediment delivered to the outlet of Ashley Creek, the “High” sediment yield areas would provide ideal locations to target practices. However, we first must evaluate the feasibility of implementing BMPs and CPs in those areas. In other words, the highest loading (sediment, TN, or TP) areas on the landscape, might have limited opportunities for implementing a practice to address the issue.

Figure 4. Ashley Creek source assessment for sediment yield delivered to the outlet of Ashley Creek. Total Nitrogen and Total Phosphorus were also assessed (not shown in map).

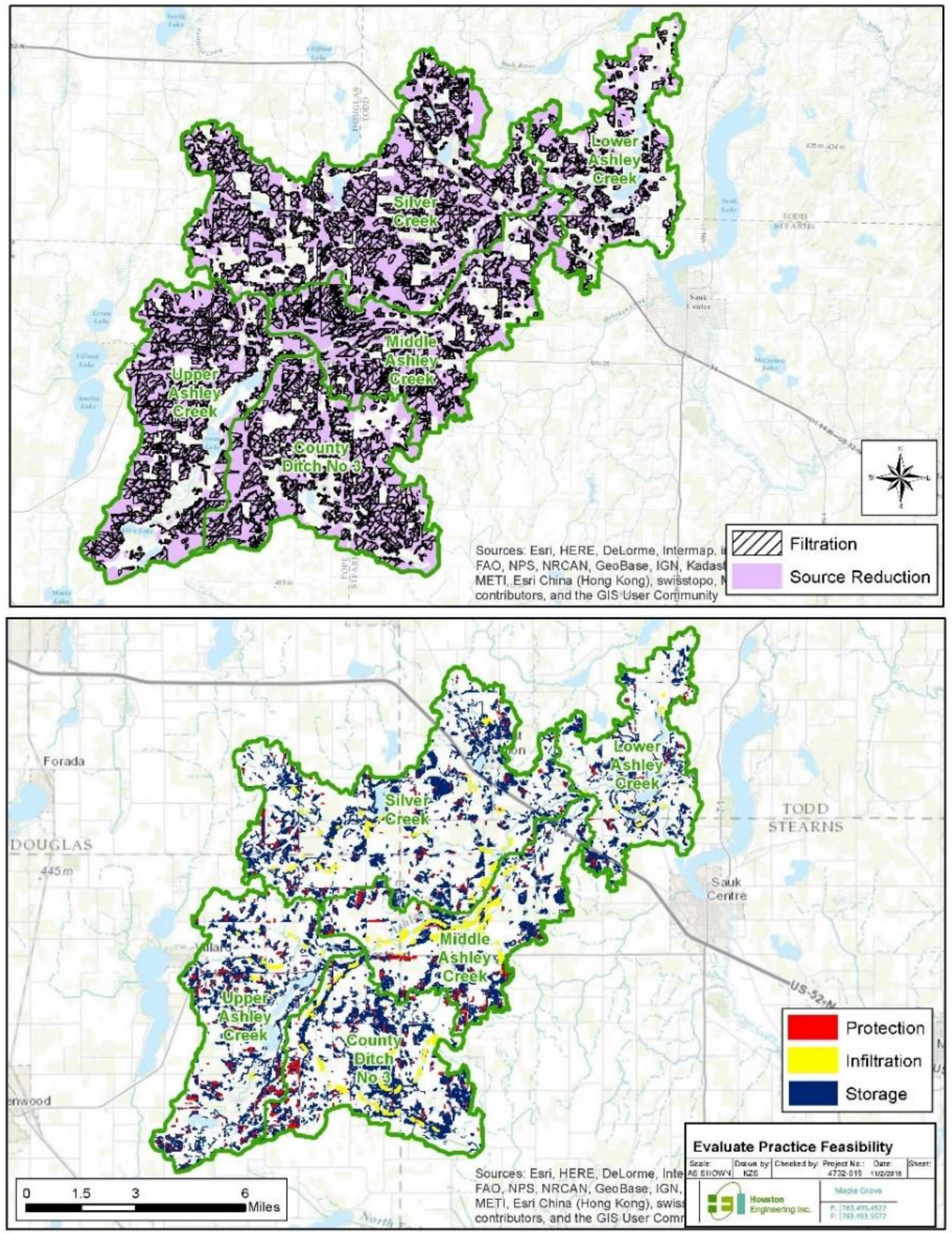


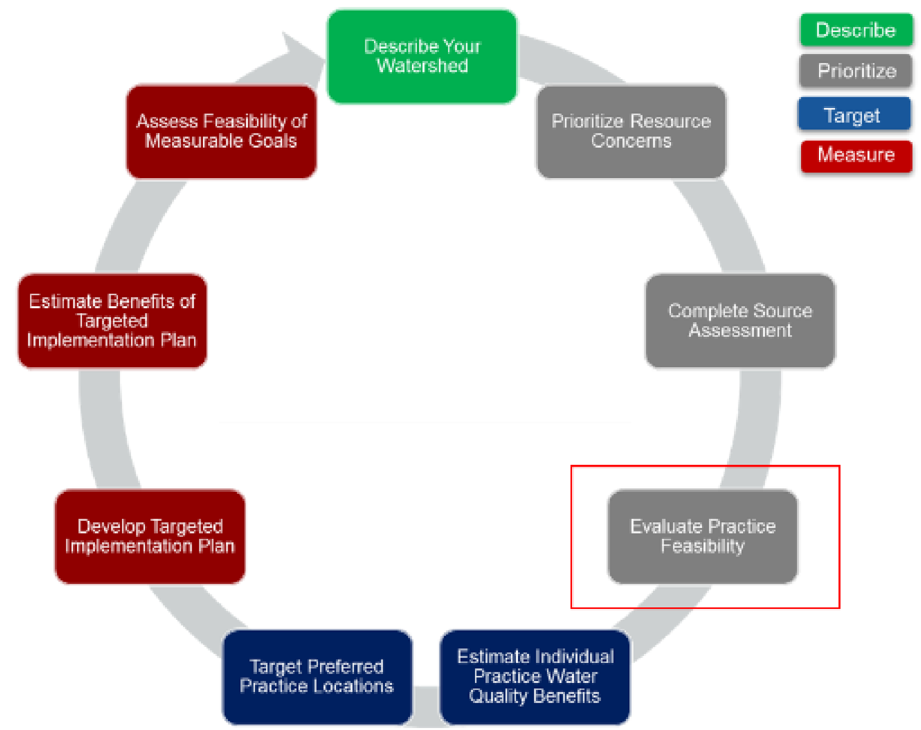


4.2.2 EVALUATE PRACTICE FEASIBILITY

The potential opportunities for BMPs and CPs within the Ashley Creek study area are shown in **Figure 5**. The opportunities are displayed based upon PTMApp treatment groups (HEI, 2014b). It's important to note that that these are only potential locations at this point in the business workflow. Local knowledge is still needed to refine the list to a realistic set of targeted practices (see section 4.2.5). These BMP and CP opportunities can be combined with the source assessment data in PTMApp to estimate the "measurable" water quality benefits for implementing the practices.

Figure 5. Potential opportunities for BMPs and CP within the Ashley Creek Study Area.

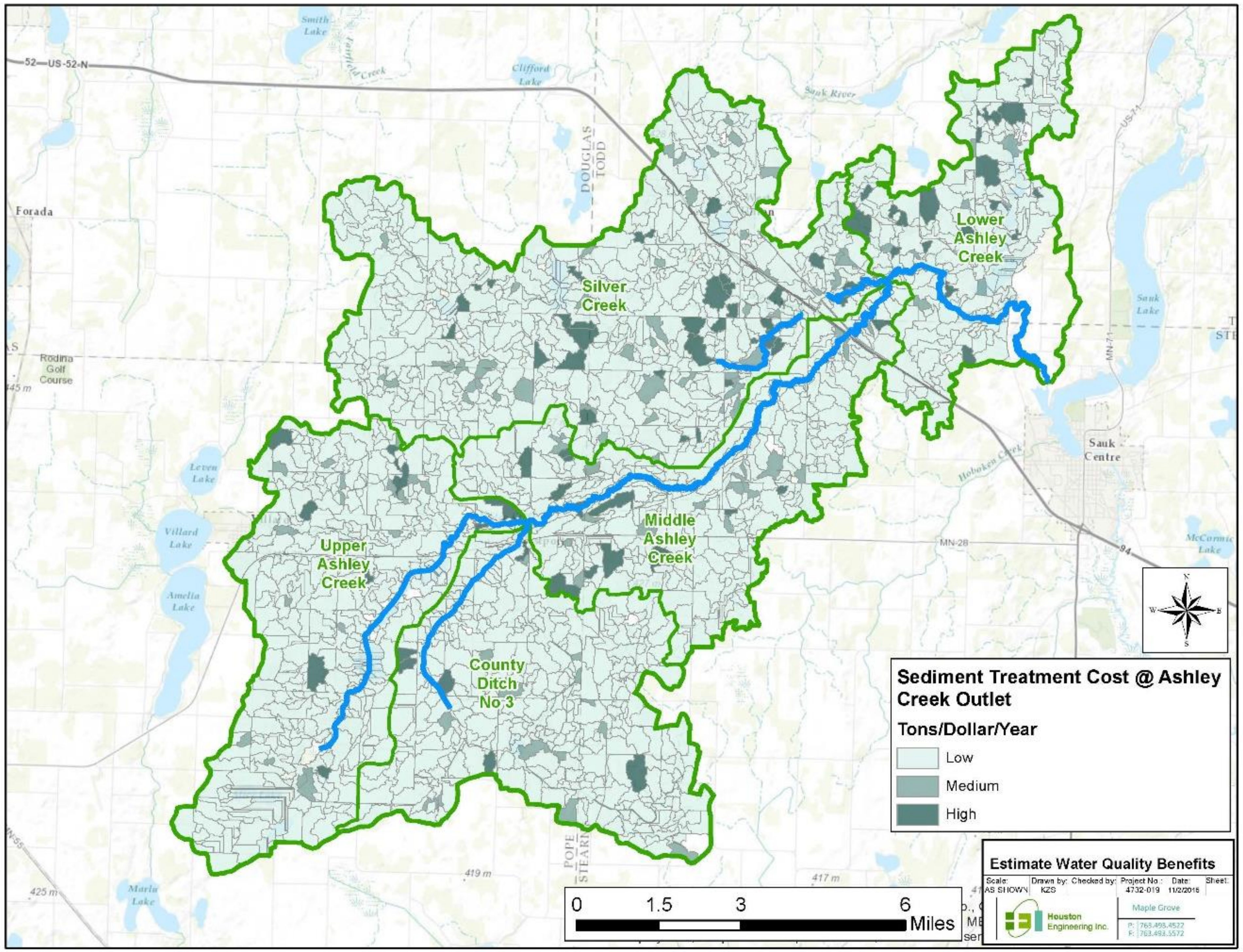


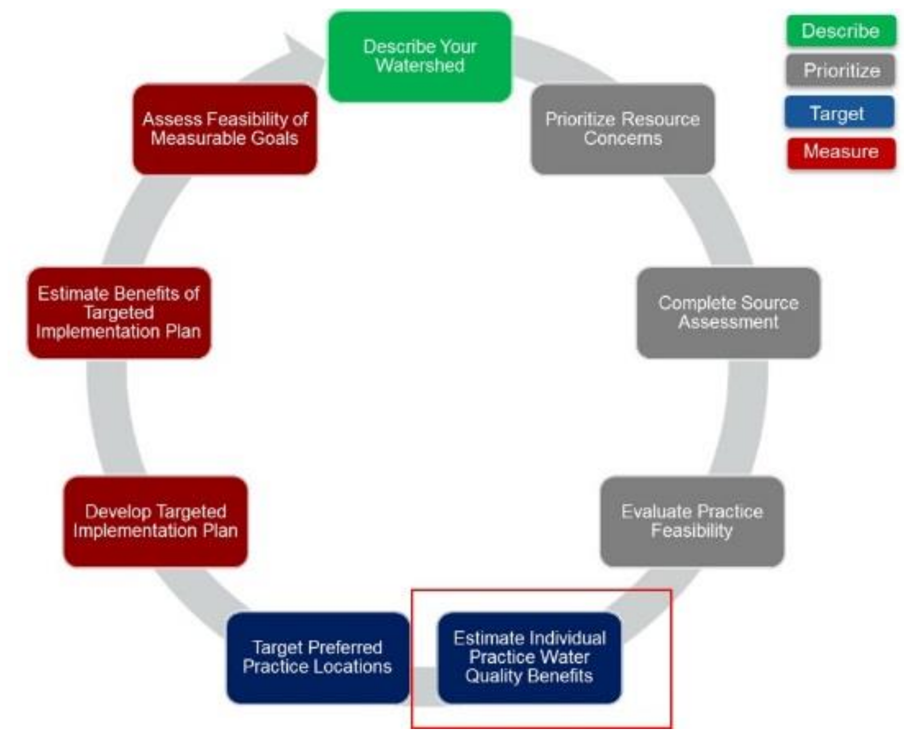


4.2.3 ESTIMATE WATER QUALITY BENEFITS

The treatment cost, tons/year/dollar spent, of reducing sediment to the outlet of Ashley Creek are shown in **Figure 6**. The areas providing the largest “bang for your buck” are in the High category. It’s worth noting that the most cost-effective areas for sediment reductions do not correspond exactly to the highest source load areas (see **Figure 4**). These results can be used to target practice locations to implement BMPs and CPs that provide the most cost-effective avenue to make progress towards local, state, and regional water quality management goals.

Figure 6. The treatment cost (tons/year/dollar spent) of reducing sediment delivered to the outlet of the Ashley Creek study area. Similar products can be developed for total nitrogen and total phosphorus.

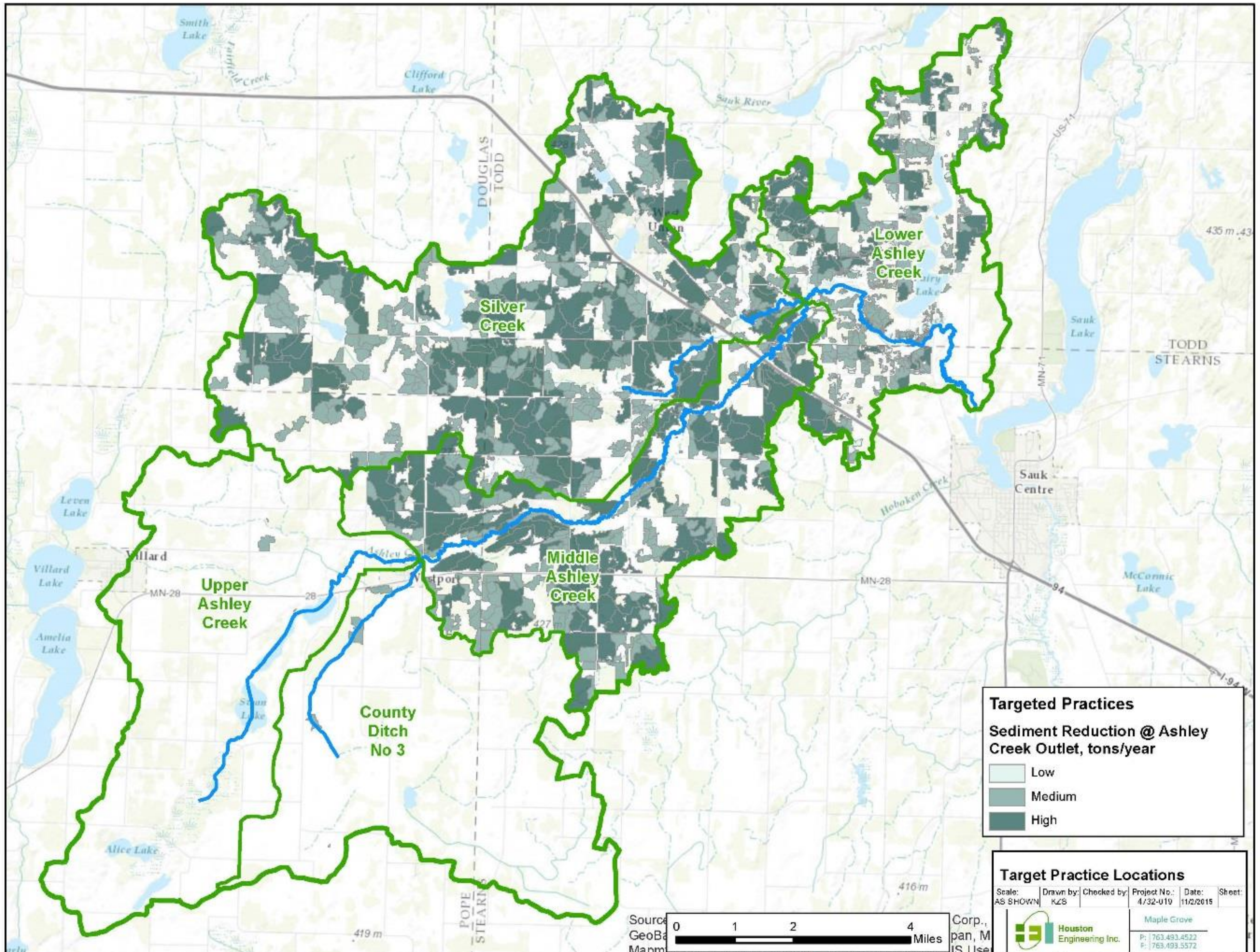


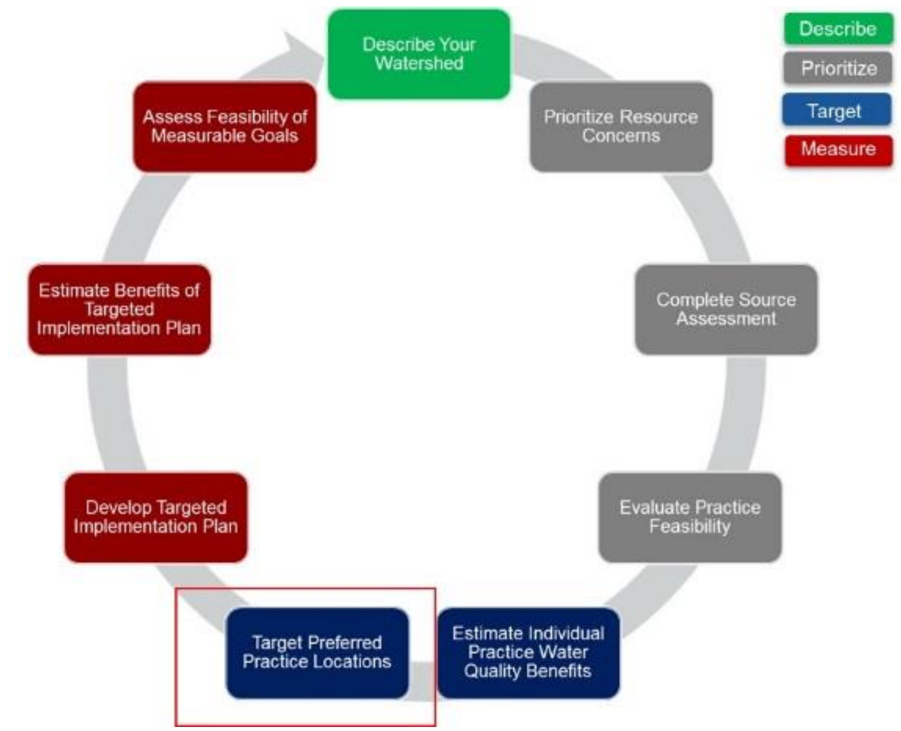


4.2.4 TARGET PREFERRED PRACTICE LOCATIONS

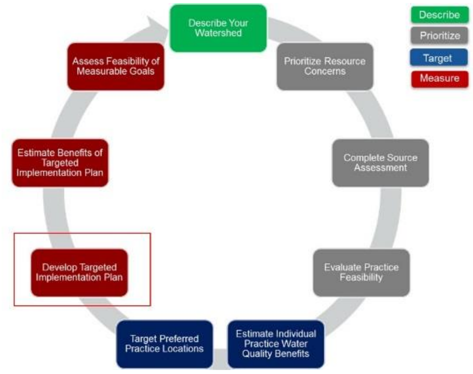
The BMPs and CPs targeted for Scenario 2 within the Ashley Creek study area shown in **Figure 7**. Scenario 2 focused on targeting practices that provided the most cost-effective reductions in sediment at TP to the outlet of Ashley Creek (see section 3.4.2.2). This step in the business workflow is based upon queries of the data generated by PTMApp. It is intended to provide feasible locations for implementing practices that will provide measurable water quality improvements for local priority resources. However, there are a number of factors that might influence the practices which end up being implemented such as, existing practices already in place or willingness of the landowner to participate. The inclusion of such factors is discussed in the next business workflow section, Develop Targeted Implementation Plan (section 4.2.5).

Figure 7. Practices targeted for implementation during the development of Scenario 2 for the Ashley Creek Study Area.





4.2.5 DEVELOP TARGETED IMPLMENTATION PLAN



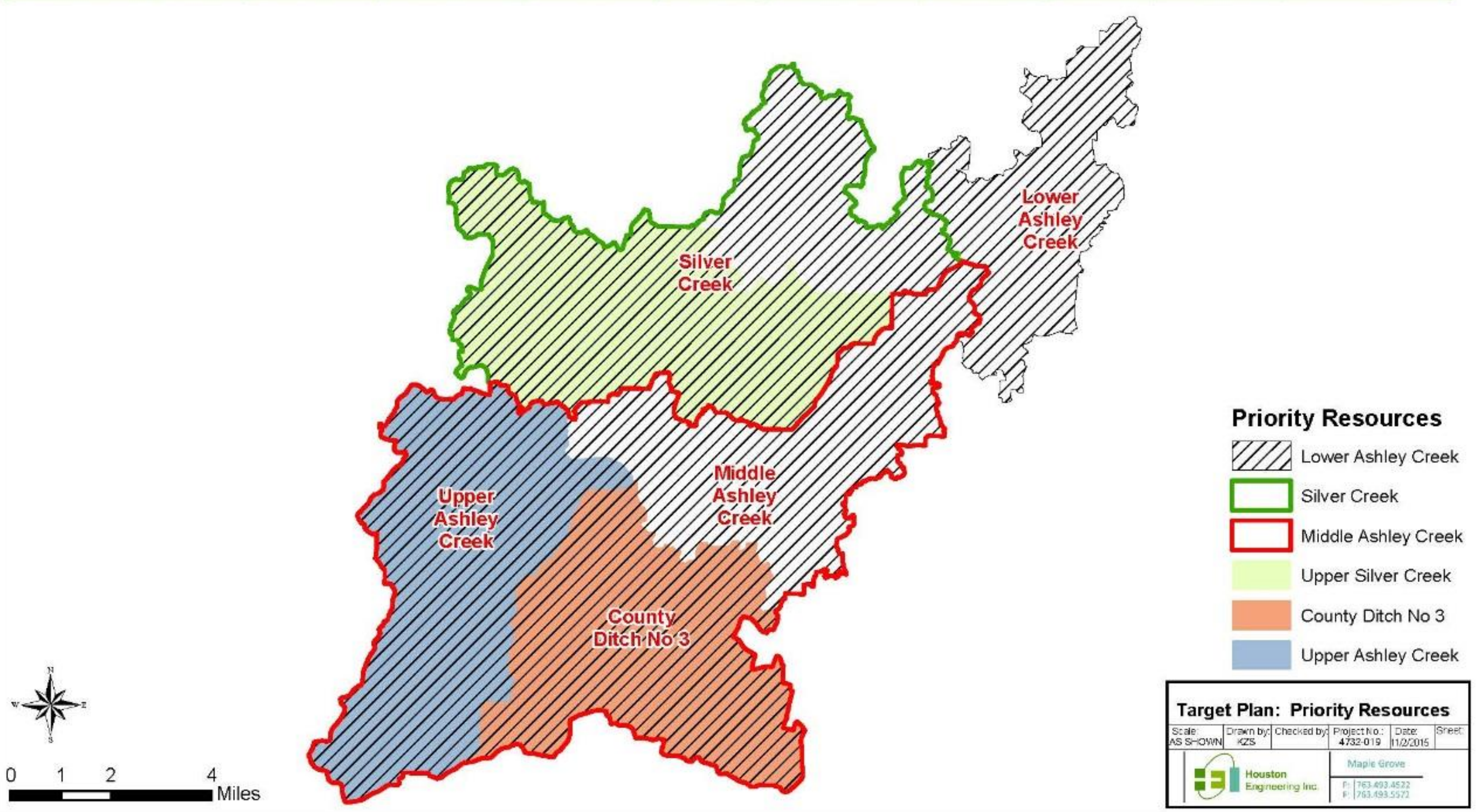
Additional information can be incorporated to refine that practices targeted based upon PTMApp data (see example in section 4.2.4). It's likely that many areas in watersheds might already have numerous BMPs and CPs implemented, lack landowners who are willing to participate in additional BMPs and CPs, or have benefits outside of water quality (water quantity, wildlife habitat, aquatic habitat, etc...) that adjust the targeted locations for BMPs and CPs. For example, local knowledge was used for the Adley Creek study area scenarios to restrict targeting to the Adley Creek (070102020404) 12-digit HUC subwatershed, as this area was identified by SRWD as a priority subwatershed for practice implementation.

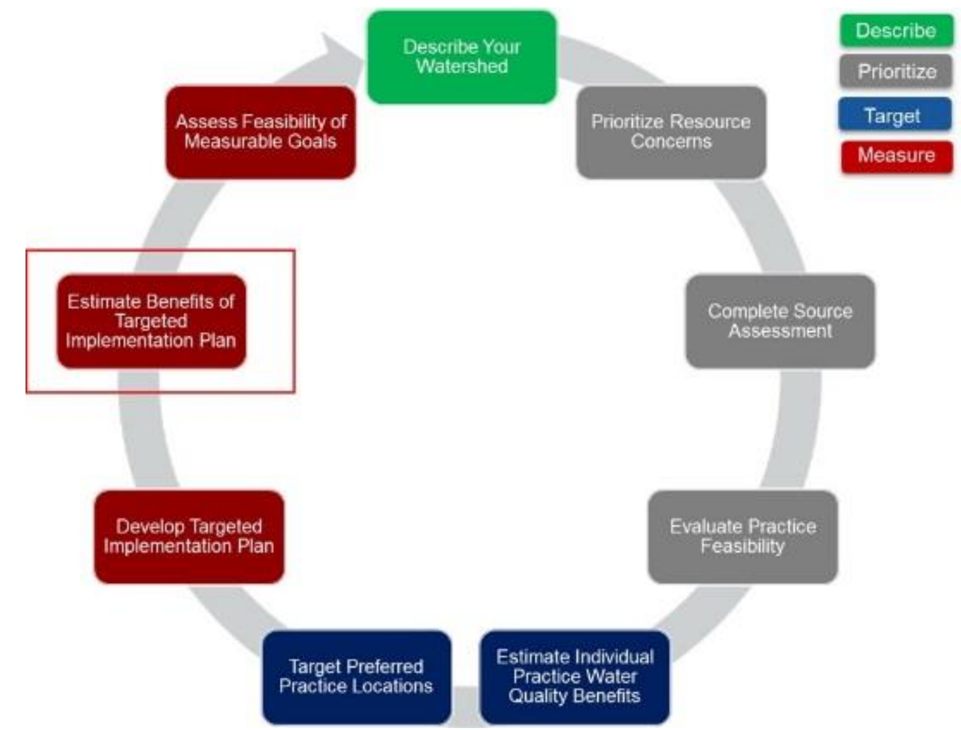
4.2.6 BENEFITS OF TARGETED IMPLMENTAITON PLAN

The annual load reduction estimates for TN, TP, sediment based upon Scenario 2 for the Ashley Creek study area are shown in **Figure 8.** The load reductions are calculated at each priority resource point within the Ashley Creek study area and can be used to assess progress towards and feasibility of a measurable water quality goal. This information can be used directly within a targeted implementation plan.

Figure 8. Sediment, TP, and TN reductions based upon Scenario 2 for Ashely Creek.

Priority Resource	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction
	Sediment, tons/year			TP, lbs/year			TN, lbs/year		
Lower Ashley Creek	559	267	**292**	331	130	**201**	6,148	2,945	**3,203**
Silver Creek	340	146	**194**	213	113	**100**	4,087	3,133	**955**
Middle Ashley Creek	308	186	**122**	274	115	**158**	4,277	2,756	**1,521**
Upper Silver Creek	259	117	**142**	200	98	**102**	4,100	3,141	**959**
County Ditch No. 3	164	158	**6**	182	175	**6**	3,514	3,470	**44**
Upper Ashley Creek	208	201	**7**	245	225	**20**	4,944	4,538	**405**

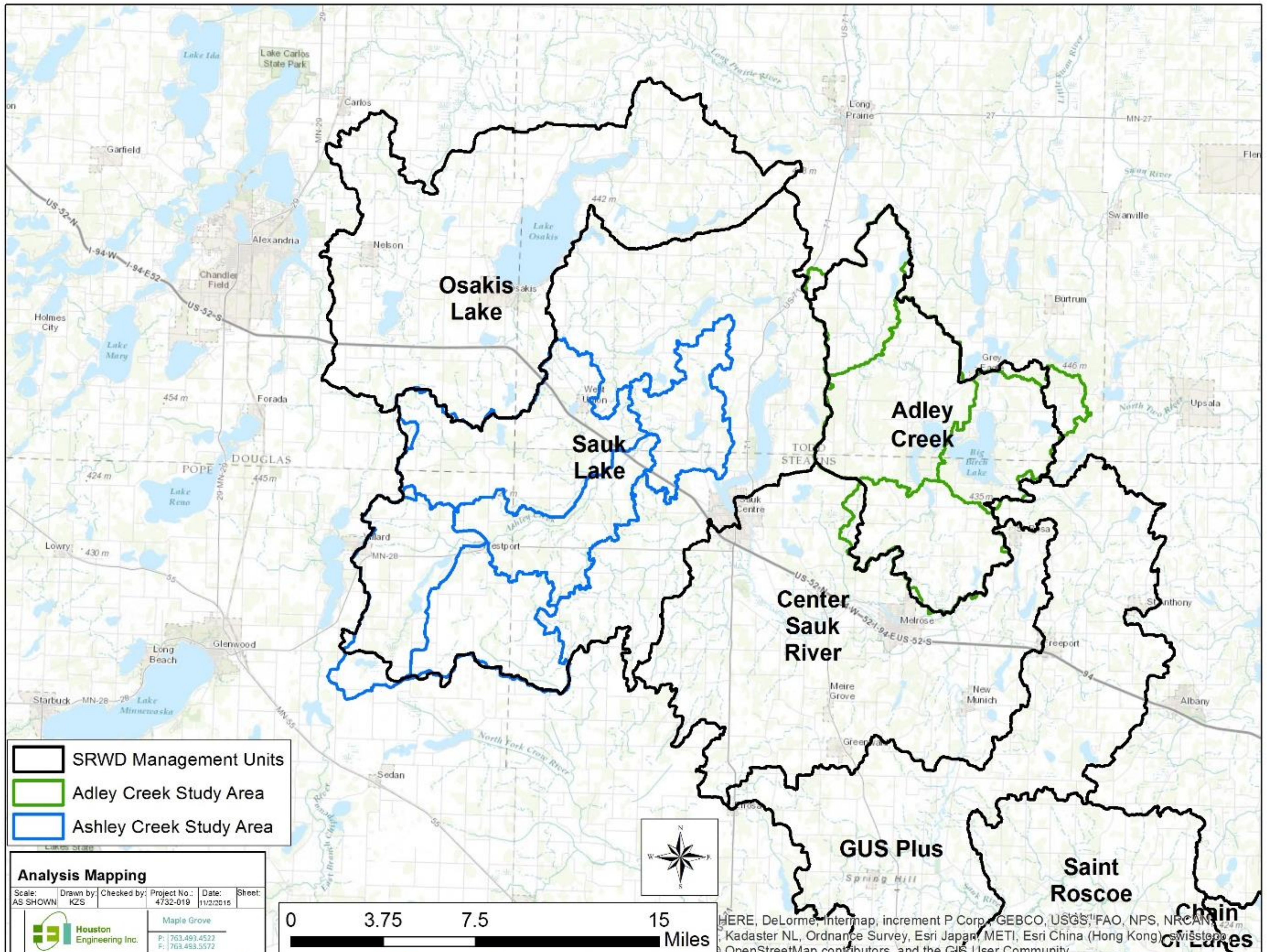


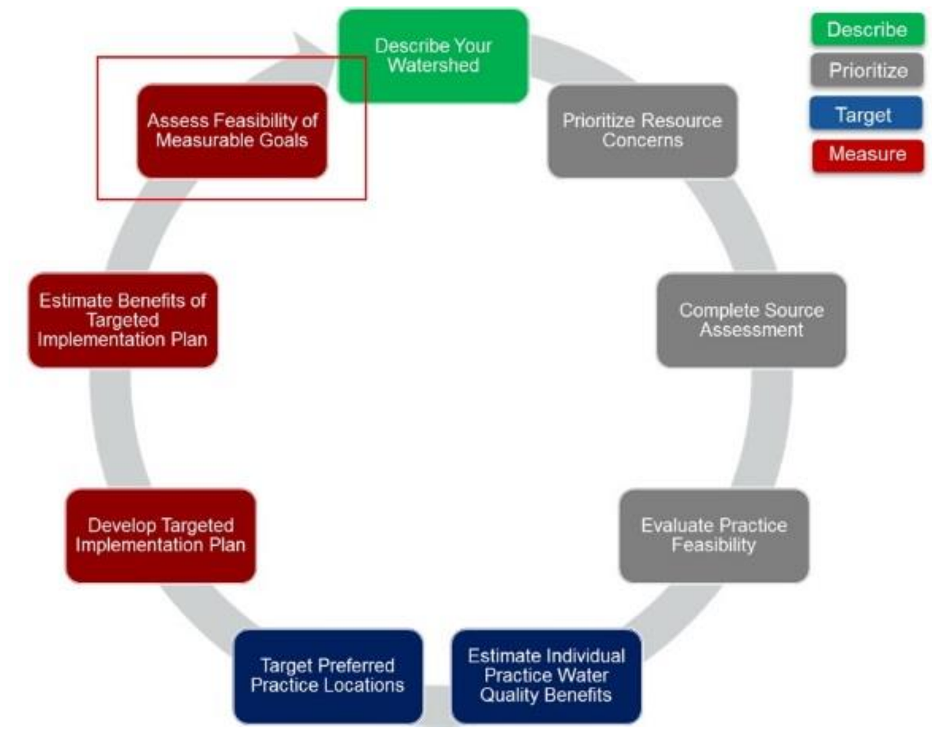


4.2.7 ASSESS FEASIBILITY OF MEASURABLE GOALS

The estimated benefits of the targeted implementation plan (see section 4.4.6) can be compared to water quality goals from watershed, state, or regional strategies, such as those found in the States Nutrient Reduction Strategy or the Sauk River Watershed WRAPS. For example, a study completed during the Sauk River Watershed WRAPS development (RESPEC, 2014) identified an achievable total suspended solids (TSS) reduction for SRWD Sauk Lake Management Unit (Error! Reference source not found.) of 1,486 tons/year using BMPs and CPs in agricultural areas. The Ashley Creek study area only makes up a portion of the Sauk lake Management Unit (Error! Reference source not found.). The results of this project suggest that implementing Scenario 2 would provide 18% of the reductions needed for this goal assuming that TSS is a surrogate for suspended sediment.

Figure 9. Sauk River Watershed District Management Units relative to the study areas used in this project.





4.3 TARGETED IMPLEMENTATION SCENARIOS

4.3.1 SCENARIO 1: ADLEY CREEK

The results of the treatment train analysis for Scenario 1 in the Adley Creek Study Area are shown in **Table 1.** A total of 169 practices were analyzed in the scenario. The largest estimated load reductions were all in Adley Creek Outlet and were 21 tons/year of sediment and 57 and 569 lbs./year of TP and TN, respectively.

4.3.2 SCENARIO 1: ASHLEYCREEK

The results of the treatment train analysis for Scenario 1 in the Ashley Creek Study Area are shown in **Table 2**. A total of 61 practices were analyzed in the scenario. The largest estimated load reductions were all in Lower Ashley Creek and were 68 tons/year of sediment and 81 and 1,421 lbs/year of TP and TN, respectively.

4.3.3 SCENARIO 2: ADLEY CREEK

The results of the treatment train analysis for Scenario 2 in the Adley Creek Study Area are shown in **Table 3**. A total of 1,379 practices were analyzed in the scenario. The largest estimated load reductions were all in Adley Creek Outlet and were 48 tons/year of sediment and 144 and 2,202 lbs/year of TP and TN, respectively.

4.3.4 SCENARIO 2: ASHLEY CREEK

The results of the treatment train analysis for Scenario 2 in the Ashley Creek Study Area are shown in **Table 4**. A total of 1,517 practices were analyzed in the scenario. The largest estimated load reductions were all in Lower Ashley Creek and were 292 tons/year of sediment and 201 and 3,203 lbs/year of TP and TN, respectively.

5 CONCLUSIONS

This study evaluated two targeted implementation scenarios each for Ashley Creek and Adley Creek study areas. The results indicate that practices targeted through Scenario 2 can provide measurable reductions in TP, TN, and sediment at the outlets of Ashley and Adley Creek. In addition, the data developed through this study can continue to be used in conjunction with PTMApp Desktop and local knowledge to develop targeted implementation plans that are consistent with local management priorities, state strategies, and the goals of BWSR's Nonpoint Priority Funding Plan (BWSR, 2014).

The load reductions identified through the scenarios evaluated in this study were generally lower than HSPF modeling results (RESPEC, 2014). These differences may be attributed to:

- HSPF applies uniform reductions for BMPs and CPs across subwatersheds and lacks the ability to target specific locations on the landscape for BMPs and CPs
- PTMApp does not account for in channel sources of sediment, TP, or TN. PTMApp only transports upland constituents to downstream resources.
- Within HSPF, load reductions for buffers and in field practices are applied to all types of flow (surface, groundwater, and interflow)

Table 1. Estimated load reductions from the Scenario 1 treatment train analysis fo rthe Adley Creek study area.

Priority Resource	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction
	Sediment, tons/year			TP, lbs/year			TN, lbs/year		
North Branch Adley Creek	27	19	8	73	52	22	1,191	960	231
Middle Branch Adley Creek	5	5	1	50	44	5	748	722	26
Adley Creek Outlet	434	413	21	263	206	57	4,440	3,872	569

Table 2. Estimated load reductions from the Scenario 1 treatment train analysis for the Ashley Creek study area.

Priority Resource	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction
	Sediment, tons/year			TP, lbs/year			TN, lbs/year		
Lower Ashley Creek	559	491	68	331	250	81	6,148	4,727	1,421
Silver Creek	340	310	30	213	193	21	4,087	3,804	283
Middle Ashley Creek	308	288	20	274	204	69	4,277	3,228	1,049
Upper Silver Creek	259	236	23	200	160	40	4,100	3,566	535
County Ditch No. 3	164	164	0	182	182	0	3,514	3,514	0
Upper Ashley Creek	208	208	0	245	245	0	4,944	4,944	0

Table 3. Estimated load reductions from the Scenario 2 treatment train analysis for the Adley Creek study area.

Priority Resource	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction
	Sediment, tons/year			TP, lbs/year			TN, lbs/year		
North Branch Adley Creek	27	14	13	73	34	40	1,191	688	502
Middle Branch Adley Creek	5	3	3	50	24	25	748	404	344
Adley Creek Outlet	434	387	48	263	119	144	4,440	2,238	2,202

Table 4. Estimated load reductions from the Scenario 2 treatment train analysis for the Ashley Creek study area.

Priority Resource	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction	Original Load	Remaining Load	Load Reduction
	Sediment, tons/year			TP, lbs/year			TN, lbs/year		
Lower Ashley Creek	559	267	292	331	130	201	6,148	2,945	3,203
Silver Creek	340	146	194	213	113	100	4,087	3,133	955
Middle Ashley Creek	308	186	122	274	115	158	4,277	2,756	1,521
Upper Silver Creek	259	117	142	200	98	102	4,100	3,141	959
County Ditch No. 3	164	158	6	182	175	6	3,514	3,470	44
Upper Ashley Creek	208	201	7	245	225	20	4,944	4,538	405

6 REFERENCES

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Appendix A: GIS Data Catalog

Data Name	Description	Data Type	Source
asslake	MPCA Assessed Lakes (2012)	Shapefile - Polygon	MPCA
assstrm	MPCA Assessed Streams (2012)	Shapefile - Line	MPCA
asswet	MPCA Assesed Wetlands (2012)	Shapefile - Polygon	MPCA
bdrkgeo	Bedrock Geology	Shapefile - Polygon	MGC
bound_cnty	County Boundaries	Shapefile - Polygon	MGC
bound_huc10	HUC10 Watershed Boundary	Shapefile - Polygon	USDA
bound_huc12	HUC12 Watershed Boundary	Shapefile - Polygon	USDA
bound_ms4	MS4 boundaries	Shapefile - Polygon	MPCA
bound_muni	Municipality Boundaries	Shapefile - Polygon	MGC
bound_state	Minnesota State Boundary	Shapefile - Polygon	MGC
bound_tnshp	Township Boundaries	Shapefile - Polygon	MGC
bound_wtrdist	Watershed District Boundaries	Shapefile - Polygon	MGC
ecoldtyp	Ecological Land Types	Shapefile - Polygon	MGC
ecoreg	Ecoregions	Shapefile - Polygon	MGC
feedlots	Feedlots in Minnesota	Shapefile - Point	MPCA
flow_dnr	Flow monitoring gages (MnDNR)	Shapefile - Point	MGC
flow_mpca	Flow monitoring gages (MPCA)	Shapefile - Point	MPCA
flow_usgs	Flow monitoring gages within HUC10 (USGS)	Shapefile - Point	USGS
gwsus	Groundwater Susceptibility	Shapefile - Polygon	MGC
implake	MPCA Impaired lakes (2012)	Shapefile - Polygon	MPCA
impstrm	MPCA Impaired streams (2012)	Shapefile - Line	MPCA
impwet	MPCA Impaired wetlands (2012)	Shapefile - Polygon	MPCA
landuse	2011 National Land Cover Database	Raster	MRLC
mn_rainfall_10	Minnesota Statewide Rainfall - 10yr 24-hr Atlas 14	Raster	NOAA
mn_rainfall_2	Minnesota Statewide Rainfall - 2yr 24-hr Atlas 14	Raster	NOAA
nhd_flow	NHD Flowline Data	Shapefile - Line	USGS
nhd_wtrbd	NHD Waterbodies Data	Shapefile - Polygon	USGS
nwi	National Wetland Inventory	Shapefile - Polygon	USFWS
roads	Minnesota Trunk Highway system	Shapefile - Line	MnDOT
rroads	Railroads	Shapefile - Line	MnDOT
samp_bio	MPCA Biological Assessment Sites	Shapefile - Point	MPCA
samp_wq	MPCA Water Quality Sampling Locations (Rivers, Streams, and Lakes)	Shapefile - Point	MPCA
soils	US General Soil Map (STATSGO2)	Shapefile - Polygon	MGC
surfgeo	Surficial Geology	Shapefile - Polygon	MGC
topo	Topography	Raster	MGC
wellprtct	Wellhead Protection Areas	Shapefile - Polygon	MGC
wldrfg	Wildlife Refuge Inventory	Shapefile - Polygon	MGC
wma	Wildlife Management Areas	Shapefile - Polygon	MGC
wpa	Waterfowl Production Areas	Shapefile - Polygon	MGC

* All data was gathered in 2015 and is subject to periodic updates. PTMApp users should check with data source for most current data

HUC - Hydrologic Unit Code

MGC - Minnesota Geospatial Commons

MnDNR - Minnesota Department of Natural Resources

MnDOT - Minnesota Department of Transportation

MPCA - Minnesota Pollution Control Agency

MRLC - Multi-Resolution Land Characteristics Consortium

NOAA - National Oceanic and Atmospheric Administration

USDA - United States Department of Agriculture

USFWS - United States Fish and Wildlife Service

USGS - United States Geological Survey

Data Name	Description	Data Type	Source
	In Adley Creek Output Folder		
Adley_Parcels_Final	Merged County Land Parcel File	layer	PTMApp
Adley_Parcels_p_res_route	table with TP,TN, and sediment routed to downstream resources	table	PTMApp
Adley_Parcels_table_treat_train_catch_S1	Results of scenario 1 for catchment delivery	table	PTMApp
Adley_Parcels_table_treat_train_catch_S2	Results of scenario 2 for catchment delivery	table	PTMApp
Adley_Parcels_table_treat_train_p_res_S1	Results of scenario 1 for delivery to priority resources	table	PTMApp
Adley_Parcels_table_treat_train_p_res_S2	Results of scenario 2 for delivery to priority resources	table	PTMApp
	In Ashley Creek Output Folder		
Ashley_Parcels_Final	Merged County Land Parcel File	layer	PTMApp
Ashley_Parcels_p_res_route	table with TP,TN, and sediment routed to downstream resources	table	PTMApp
Ashley_Parcels_table_treat_train_catch_S1	Results of scenario 1 for catchment delivery	table	PTMApp
Ashley_Parcels_table_treat_train_catch_S2	Results of scenario 2 for catchment delivery	table	PTMApp
Ashley_Parcels_table_treat_train_p_res_S1	Results of scenario 1 for delivery to priority resources	table	PTMApp
Ashley_Parcels_table_treat_train_p_res_S2	Results of scenario 2 for delivery to priority resources	table	PTMApp

Data Name	Description	Data Type	Source
existproj	Existing Project Locations	Shapefile - Point	User
floodext	Known Flooding Extents	Shapefile - Polygon	User
flow_local	Flow Monitoring (Local Enties)	Shapefile - Point	User
futureproj	Future Project Locations	Shapefile - Point	User
keyhabitat	Key Habitat Locations	Shapefile - Polygon	User
npc	Locations of Native Plant Communities	Shapefile - Polygon	User
npdes	NPDES Permit Locations	Shapefile - Point	User
pollutsrce	Potential Pollution Source Locations	Shapefile - Point	User
precipgage	Precipitation Gage Locations	Shapefile - Point	User
primeag	Locations of Prime Agricultural Land	Shapefile - Polygon	User
primefarm	Locations of Prime Farmland	Shapefile - Polygon	User
probareas	Known Problem Areas (Flooding, Erosion, Etc.)	Shapefile - Polygon	User
rals	Regional Assessment Locations	Shapefile - Point	User
rarespc	Rare Species Habitat Locations	Shapefile - Point	User
resconslnd	Locations of Existing Resources and Conservation Lands	Shapefile - Polygon	User
scaleload_point	Location of one known scaling load point, preferably 1W1P boundary pour point	Shapefile - Point	User
sgcn	Species in Greatest Conservation Need Habitat Locations	Shapefile - Point	User
sna	Locations of Scientific and Natural Areas	Shapefile - Polygon	User

* Planning data listed is suggested along with naming convention. User may wish to add additional planning data.

Data Name	Description	Data Type	Source
adj_catchment	Adjoint hydrologic catchment boundaries.	Shapefile - Polygon	PTMApp
biofiltration	Locations suitable for biofiltration practices.	Shapefile - Polygon	PTMApp
bmp_biofilt	Locations suitable for biofiltration practices. Areas not suitable are nulled. Each suitable location has a unique integer value generated from the binary grid using region groups.	Raster	PTMApp
bmp_filtration	Locations suitable for filtration practices. Areas not suitable are nulled. Each suitable location has a unique integer value generated from the binary grid using region groups.	Raster	PTMApp
bmp_implementation	User provided input for treatment train analysis.	Shapefile - Polygon	User
bmp_infiltration	Locations suitable for infiltration practices. Areas not suitable are nulled. Each suitable location has a unique integer value generated from the binary grid using region groups.	Raster	PTMApp
bmp_null	User provided input for screen BMP.	Shapefile - Polygon	User
bmp_prot	Locations suitable for protection practices. Areas not suitable are nulled. Each suitable location has a unique integer value generated from the binary grid using region groups.	Raster	PTMApp
bmp_sred	Locations suitable for source reduction practices. Areas not suitable are nulled. Each suitable location has a unique integer value generated from the binary grid using region groups.	Raster	PTMApp
bmp_storage	Locations suitable for storage practices. Areas not suitable are nulled. Each suitable location has a unique integer value generated from the binary grid using region groups.	Raster	PTMApp
bound_1w1p	Boundary for 1W1P planning area.	Shapefile - Polygon	PTMApp
catchment	Individual hydrologic catchment boundaries.	Shapefile - Polygon	PTMApp
catchmentraster	Grid representing the location of catchments with cell values equal to the catch_id attribute.	Raster	PTMApp
cti	Compound topographic index.	Raster	PTMApp
curve_num	Curve number raster.	Raster	PTMApp
ds_fl	Downstream flow length.	Raster	PTMApp
ds_tt	Accumulated downstream travel time in hours.	Raster	PTMApp
fac_surf	Flow accumulation from surface contributing area only.	Raster	User
fac_total	Flow accumulation from fill all.	Raster	User
fdr_surf	Flow direction raster from surface contributing area only.	Raster	User
fdr_total	Flow direction raster from fill all.	Raster	User
fill_dem	DEM from fill on agree DEM.	Raster	PTMApp
filtration	Locations suitable for filtration practices.	Shapefile - Polygon	PTMApp
hyd_dem	Hydrologically conditioned digital elevation model.	Raster	PTMApp
infiltration	Locations suitable for infiltration practices.	Shapefile - Polygon	PTMApp
landseg_polygon	User provided input for scale loads. Distribution of land segments with yields data attached.	Shapefile - Polygon	User
ls_factor	Length-Slope factor calculated and used in RUSLE.	Raster	PTMApp
overland_sdr	Delivery ratio of sediment to the flow line.	Raster	PTMApp
p_res_catchment	Priority resource hydrologic catchment boundaries and/or plan regions.	Shapefile - Polygon	PTMApp
p_res_pts	Point locations of priority resources and/or plan regions, with water quality goals in attributes.	Shapefile - Point	User
p_res_snap	Watershed outlet point of priority resource and/or plan regions.	Raster	PTMApp
PeakQ_10yr	Peak flow from upstream contributing drainage area for 10-yr 24-hour event.	Raster	PTMApp
PeakQ_2yr	Peak flow from upstream contributing drainage area for 2-yr 24-hour event.	Raster	PTMApp
pp_catchment	Outlet pour points for catchments.	Raster	PTMApp
protection	Locations suitable for protection practices.	Shapefile - Polygon	PTMApp
raw_dem	Non-conditioned digital elevation model.	Raster	PTMApp
RO_vol_10yr	Runoff volume from upstream contributing drainage area for 10-yr 24-hour event.	Raster	PTMApp
RO_vol_2yr	Runoff volume from upstream contributing drainage area for 2-yr 24-hour event.	Raster	PTMApp
runoff_depth_10	Runoff depth associated with the 10-yr 24-hour event.	Raster	PTMApp
runoff_depth_2	Runoff depth associated with the 2-yr 24-hour event.	Raster	PTMApp
rusle_c	RUSLE - Cover management factor.	Raster	User
rusle_kw	RUSLE - Soil erodibility factor.	Raster	User
rusle_m	RUSLE - m-weight factor.	Raster	User
rusle_p	RUSLE - Support practice factor.	Raster	User
rusle_r	RUSLE - rainfall-runoff erosivity factor.	Raster	User
Sed_mass	Sediment mass leaving the landscape adjusted by calibration factor (tons/acre/year).	Raster	PTMApp

Data Name	Description	Data Type	Source
Targeted_Plan_Scenario1	BMPs selected for treatment train analysis for scenario 1	layer	PTMApp
Targeted_Plan_Scenario2	BMPs selected for treatment train analysis for scenario 2	layer	PTMApp