Watershed Analysis for Granite Lake

Wright County, MN

March 2018

Prepared By

Wright SWCD

Executive Summary

The purpose of this watershed assessment is to identify the most effective locations for water quality improvement projects within the Granite Lake watershed. The project area is based on the drainage area to Granite Lake. It is located in northwest Wright County and is encompassed Albion Township (Figure 1). The goal of this assessment is to improve the quality of water entering Granite Lake by reducing total suspended solids and total phosphorous through construction of best management practices (BMPs).

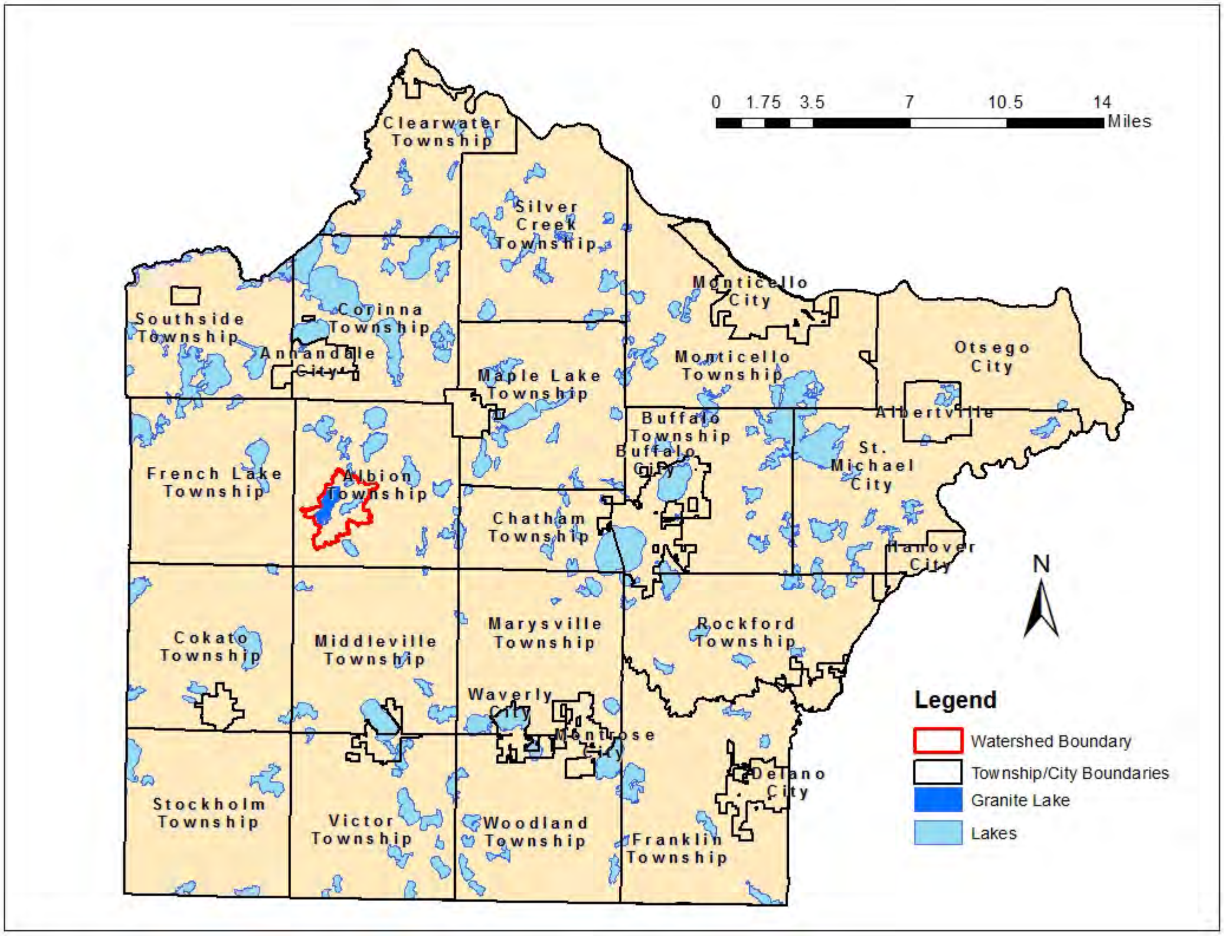

Figure 1. The project area is located in western Wright County in Albion township.

The assessment used a computer model, developed by Houston Engineering Inc., called Prioritize, Target and Map Application (PTMApp) version 2.0.27. It uses geospatial information to identify locations where BMPs will likely be most effective and provide efficient removal of contaminants. Review of suggested locations by experienced staff is still required as the data the program uses to identify locations may have changed since collected and the value of on- site judgment is indispensable

The pollutant reduction estimates may be used to prioritize practices within the Granite Lake Watershed and for grant applications but in no case should this data be used to represent actual pollutant removal until after installation is complete and site-specific monitoring data is available.

PTMApp identified 1907 potential BMPs within the Granite Lake Watershed. Each of these is broken up into one of six treatment groups. There were 115 filtration BMPs, 375 biofiltration BMPs, 45 infiltration BMPs, 1146 protection BMPs, 171 source reduction BMPs and 60 storage BMPs. Based on PTMApp output data and field work by Wright Soil and Water Conservation District (SWCD) staff 20 practices were chosen to further investigate and prioritize for possible installation. Of these 20 practices 5 are filtration, 8 are storage and 7 are source reduction.

In general, we found some common patterns in how the computer generated BMPs would differ from a BMP assessment made by Wright SWCD staff. These differences are noteworthy inasmuch as it would change PTMApp outputs for loads and reductions. Filtration BMPs when reviewed on an aerial photo seemed to be more accurate in a location for grassed waterways as opposed to filter strip/buffer locations. Situations in which a filter strip/buffer would be most appropriate didn't match flow lines and tended to be square in design. Grassed waterway BMPs seemed to be designed smaller than they would actually be installed. Storage BMP sizes were overestimated and shapes seemed impractical for actual installation. Source reduction BMPs were close in some cases but PTMApp divides them up by catchment rather than field or parcel. In such cases the source reduction area may be either overestimated or underestimated. We did not assess such tendencies for infiltration, biofiltration or protection practices since we didn't select any for further analysis.

The selected BMPs were prioritized based on the total sediment and total phosphorus load from its field size catchment, the estimated reduction in total sediment and total phosphorus per year, the potential contaminant reduction to occur in a downstream lake and a slight preference of structural BMPs over management BMPs (Table 1)

Table 1. Priority ranking system for select BMPs in the Granite Lake Watershed

Rank	ID	BMP Type	Size (acres)	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Estimated Project Cost	Cost/ Lb TP /year	Cost/ Lb TSS /year
1	SR6	Source Reduction	21.4	78.0	4.2	$1,498	$529.21	$28.50
2	SR1	Source Reduction	7.1	20.0	1.0	$497	$1,071.55	$111.14
3	SR7	Source Reduction	26.2	12.9	2.1	$1,834	$1,242.43	$172.30
4	S1	Wetland Restoration	1.5	3.7	0.9	$10,000	$1,408.33	$600.73
5	S4	Control Basin	1.4	0.5	1.9	$22,000	$1,410.53	$4,445.40
6	SR2	Source Reduction	7.4	5.1	0.6	$518	$1,826.17	$435.82
7	SR5	Source Reduction	16.8	13.9	1.0	$1,176	$1,852.40	$159.91
8	SR3	Source Reduction	20.9	16.9	1.0	$1,463	$2,182.45	$2.469.67
9	SR4	Source Reduction	21.1	14.9	0.8	$1,477	$2,748.19	$149.14
10	S3	Control Basin	2.4	18.6	0.8	$20,000	$3,062.50	$119.50
11	S5	Wetland Restoration	2.2	0.6	0.2	$19,000	$11,670.00	$3,704.50
12	S7	Control Basin	0.7	2.1	0.2	$21,000	$12,825.00	$1,058.43
13	S2	Wetland Restoration	1.1	0.9	0.1	$14,000	$17,095.00	$2,469.67
14	S6	Control Basin	0.7	1.1	0.1	$21,000	$25,650.00	$2,020.64
15	F4	Grassed Waterway	0.5	3.8	N/A	$1,196	N/A	$584.92
16	F1	Grassed Waterway	1.4	1.8	N/A	$2,258	N/A	$1,234.83
17	F3	Grassed Waterway	0.6	1.4	N/A	$609	N/A	$1,587.64
18	F2	Buffer Strip	0.7	1.2	N/A	$356	N/A	$1,852.25
19	F5	Grassed Waterway	0.2	0.6	N/A	$609	N/A	$3,704.50
20	S8	Control Basin	15.3	N/A	N/A	$11,000	N/A	N/A

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Introduction

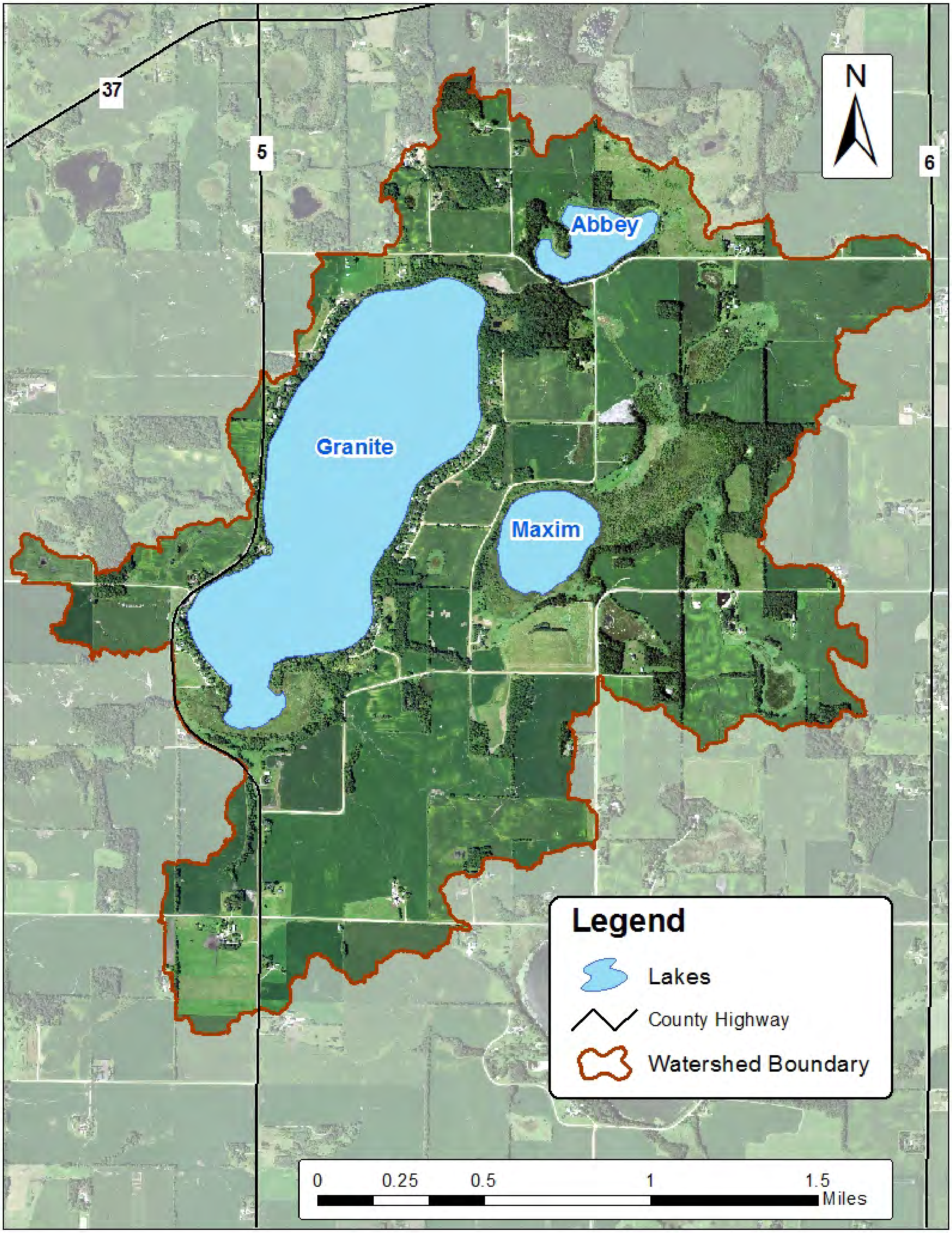
The watershed analysis of Granite Lake was performed to identify suitable locations for best management practices (BMPs) that will most effectively remove contaminants and be the most cost effective. The analysis includes an estimation of the water quality benefits that could result from the potential projects. The analysis was completed using Prioritize, Target and Measure Application (PTMApp) Desktop.

PTMApp was chosen as the model for this analysis because it is designed for rural settings, innovative and preferred by the Board of Water and Soil Resources. The sources of sediment, nitrogen and phosphorus leaving the landscape are identified. Specific fields are targeted as potential locations for BMPs. Finally the benefits of implementing the BMPs are calculated as a reduction in the nutrient or sediment loading reaching the outlet of the watershed.

The BMPs that result from PTMApp are intended to help protect the water quality of Granite Lake and provide measurable progress towards the North Fork Crow Total Maximum Daily Load efforts. The resulting targeted BMPs are appropriate for funding in accordance with the Minnesota Nonpoint Priority Funding Plan and statewide nutrient reduction strategies. The data and information from this report will be used by the Wright SWCD and local partners to implement accountable projects and practices that improve water quality within the Granite Lake watershed.

Study Area

This watershed analysis was based on the land area that contributes water to Granite Lake (Figure 2). The project area is located in northwest Wright County in Albion Township (Figure 1). The Granite Lake Watershed encompasses 2417 acres, including Granite (362 acres), Abbey Lake (25 acres), Maxim Lake (46 acres). The Granite Lake watershed is a headwater portion of the 12-digit Hydrologic Unit Code called North Fork Crow River (070102040602). The outlet to Granite Lake is an unnamed stream that flows to the North Fork of the Crow River. Water enters Granite Lake through surface runoff and/or groundwater.


37
5
6
N
Abbey
Granite
Maxim
Legend
Lakes
County Highway
Watershed Boundary
0
0.25
0.5
1
1.5
Miles

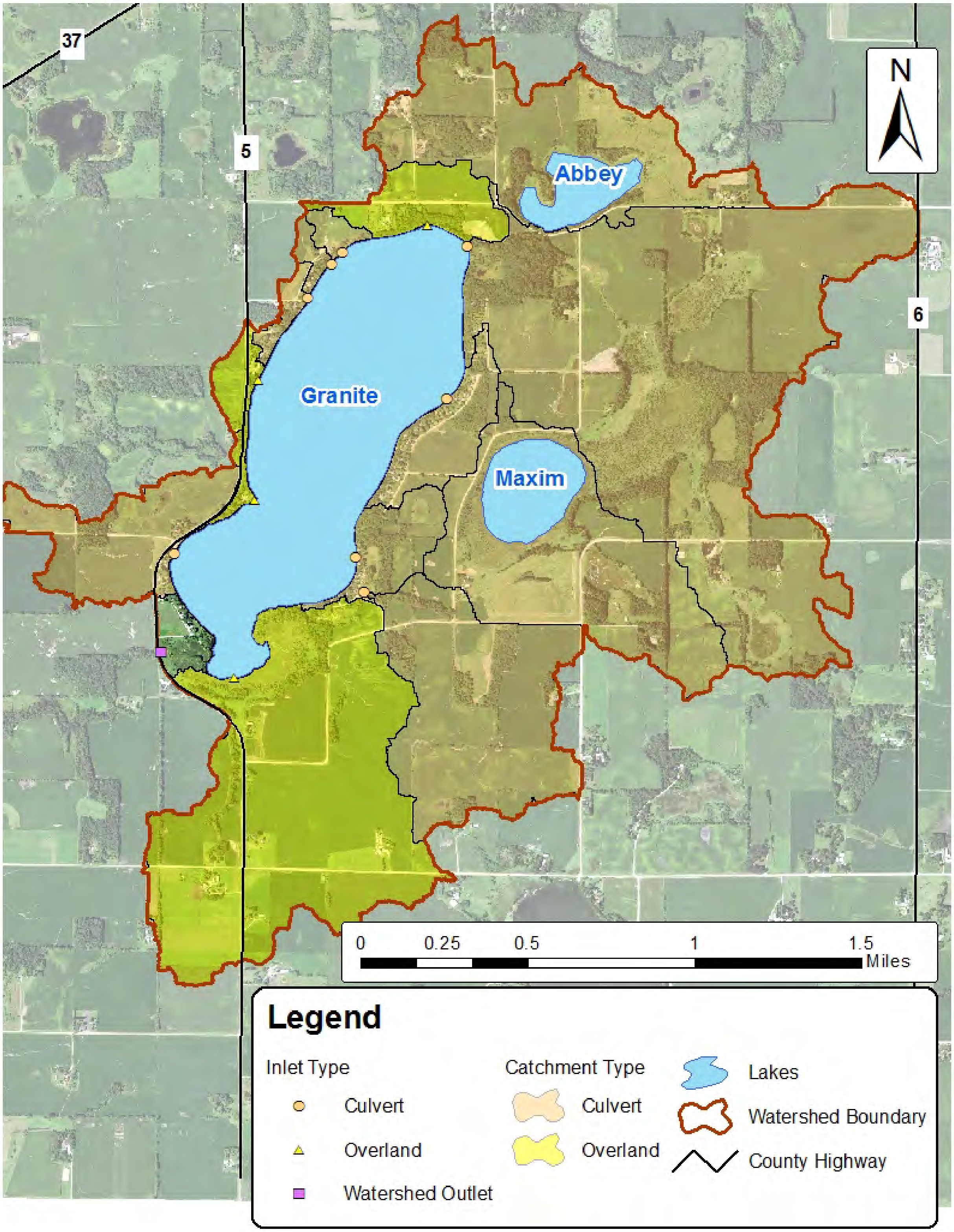


Figure 2. The area that drains to Granite Lake (outlined in red) and the lakes within the watershed.

There are a variety of land uses in the Granite Lake watershed (Table 1). Just under a fifth of the land area is covered by the lakes. According to the National Land Cover Database (Homer et al., 2011) over half of the watershed area is either cultivated crops or hay/pasture. Other covers include forest (9.62%), scrubland (3.08%) and herbaceous cover (2.69%). Only about six percent of the land area is developed

Table 2. Land cover within the Granite Lake Watershed according to the 2011 National Land Cover Dataset

Land Cover	Area (acres)	Percent of Area
Open Water	447.90	18.53%
Developed	140.95	5.83%
Forest	229.30	9.62%
Shrub	74.41	3.08%
Herbaceous	65.04	2.69%
Hay/Pasture	276.89	11.46%
Cultivated Crops	1101.15	45.56%
Wetlands	75.54	3.13%
Total	**2416.72**	**100%**

Granite Lake has fair water quality and was called out as a tipping point lake in the Wright County Water Management Plan. This effort will target BMP's in an effort to ensure the water quality is improved so in this highly used and prized Wright County and regional resource. The Granite Lake Watershed Association (GLWA) has been monitoring the lake since 1999 and has been participating in RMB Labs Lake Monitoring Program since 2002. As part of RMB's monitoring program samples are taken five times a year between May and September. Sampling includes a water clarity reading with a secchi disc (mean 5.9 ft), weather conditions, total phosphorous (mean 51.7 µg/L) and chlorophyll-a (mean 25.4 µg/L) (Figure 3). Based on this data the tropic state index on Granite Lake is 57.1, categorizing it as eutrophic. Granite Lake has one public boat access one the southwest corner. There are two invasive species known to be present in Granite Lake, Eurasian watermilfoil (*Myriophyllum spicatum)* and curly-leaf pondweed (*Potamogeton crispus*) (MNDNR, 2017).

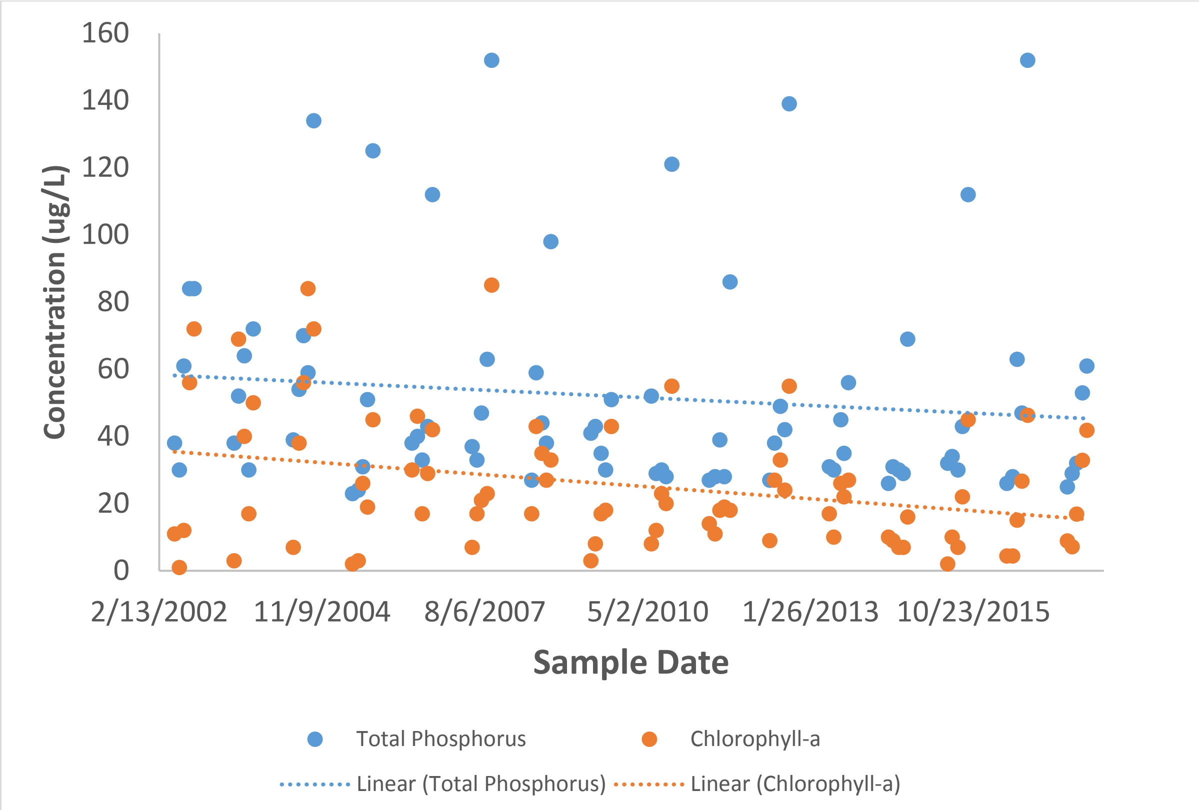


Figure 3. Total Phosphorous (blue) and chlorophyll-a (orange) concentrations in Granite Lake since 2002 from the RMB Lake monitoring database. Both parameters are trending towards improving water quality.

Data Sources

Several data sources are required to prepare and run PTMApp Desktop. These data sources are either the direct inputs for PTMApp or allow for the creation of the required inputs. A full list of the required inputs are available in the PTMApp Desktop User Guide (HEI, 2016). Descriptions and summaries of primary data sources and their origins and content follows.

Elevation

The elevation data used for this project is Light Detection and Ranging (LiDAR) developed in 2008. The data was collected in 2012 for the Minnesota Department of Natural Resources. The vertical accuracy is about 2 in root mean squared error. The horizontal accuracy is +/-3.8 ft at 95% confidence. The data was interpolated into a digital elevation model (DEM) at one meter by one meter resolution (MNDNR, 2014).

Rainfall/Runoff

Meterological data affects how much soil may be removed from the landscape. Rainfall data used were from the National Oceanic and Atmospheric Administration (NOAA). The total rainfall depths used represented a 2-year, 24-hour event and a 10-year 24-hour event from the NOAA Atlas 14 (NOAA, 2013). As a portion of the revised universal soil loss equation (RUSLE) the r-factor accounts for meteorological impact on erosion rates. The r-factor data layer was generated from the National Resource Conservation Service (NRCS) Minnesota Field Guide.

Land use/Land Cover

Land cover affects infiltration of water and erosion of soils. Land cover data used were from the National Land Cover Dataset (NLCD) of 2011 (Homer et al., 2015). The data was used to generate runoff Curve Numbers and to estimate the total nitrogen and total phosphorus loading. Cover management values for various land cover types were used from the National Agricultural Statistics Service 2014 Cropland Data Layer (USDA, 2014) for RUSLE.

Soils

Some soil types are more susceptible to erosion. Soil data was used from the NRCS SSURGO database (NRCS, 2016). Attributes from the soil dataset were used in developing the Curve Numbers and the soil erodibility factor (K_w). Other soil attributes considered in the PTMApp Model and potential BMP locations were hydric rating, crop productivity index, and minimum depth to groundwater.

Study Boundary and Priority Resource Points

The study area boundary and priority resources point data layers were developed by Wright SWCD. The preliminary study area boundary was determined using the D8 method (Tribe, 1992). The final study area boundary was a result of the hydrologic conditioning using protocol from Houston Engineering Inc (HEI, 2017). Priority resource points were developed during a site visit between Wright SWCD and SLA. Culverts were automatically considered to be priority resource points. Additional priority resource points were added during the hydrologic conditioning process to represent overland flow to the lake. All of the priority resource points entering Granite Lake are shown in Figure 4.

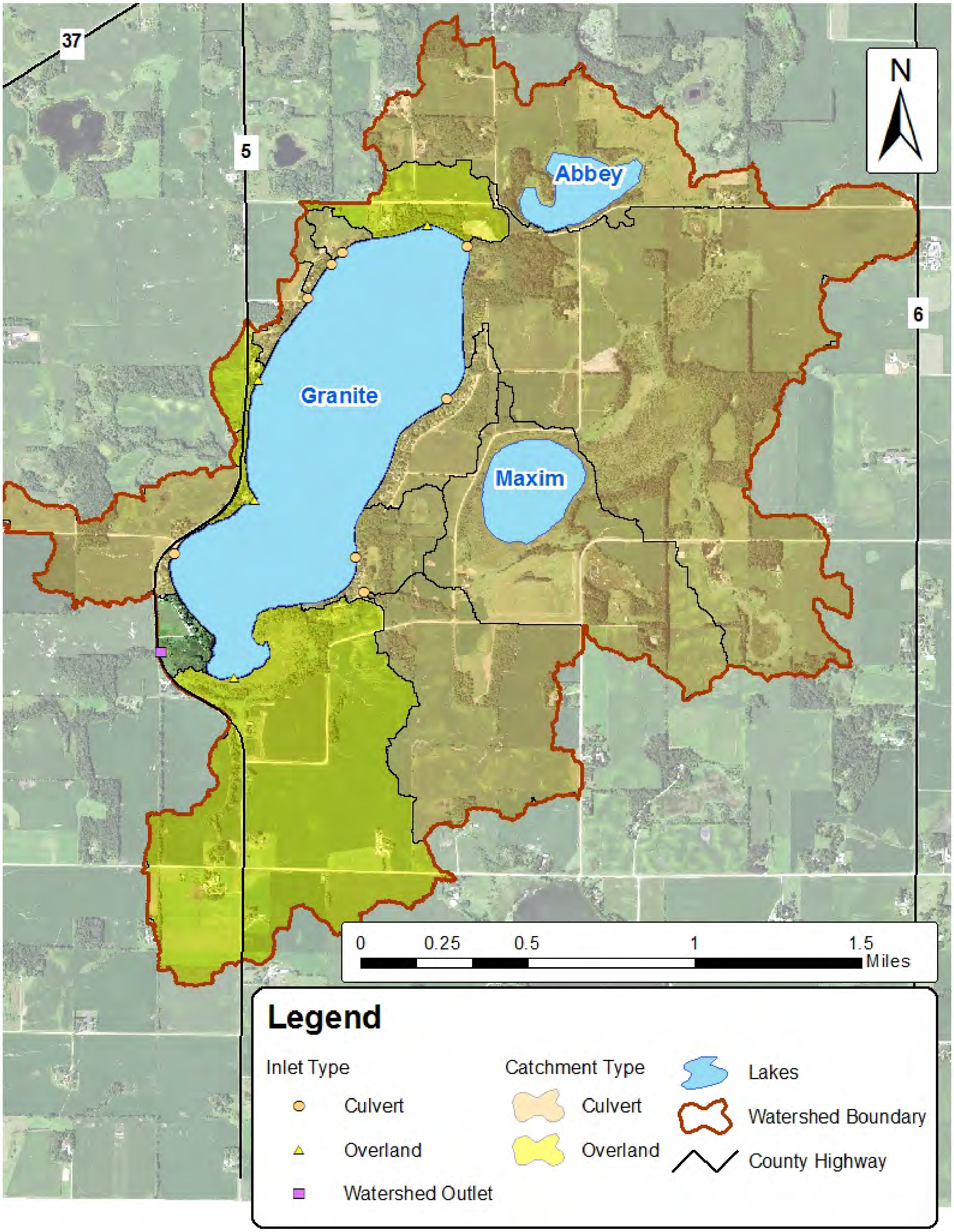


Figure 4. Priority resources points and their drainage areas by type of flow to the lake.

Methods

Hydrologic Conditioning

Creation of an elevation model is based on surficial features. However, subsurface features such as culverts are not captured. In the resulting elevation model a road acts as a barrier preventing the passage of water. Hydrologic conditioning "burns" a hole in the road to allow water to flow (Figure 5). Several data sources were used to determine where subsurface features are present, including: aerial imagery, the original elevation model, transportation features and structure inventories.

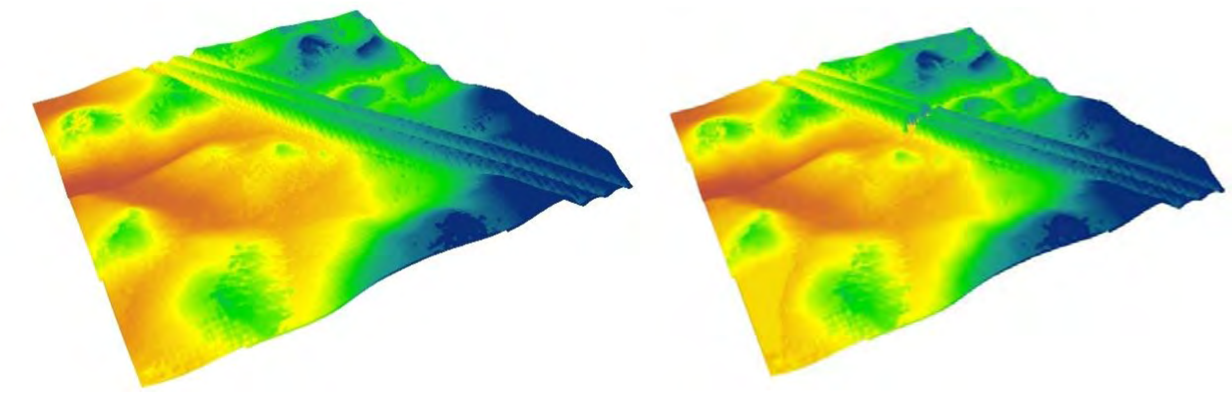


Figure 5. Image on the left shows how a road can act as a barrier since subsurface structures are not captured in a normal elevation model. The image on the right shows the "burn" or correction made to allow water to flow through a culvert. Image credit: Houston Engineering Inc.

The elevation data for the Granite Lake watershed was hydrologically conditioned by Wright SWCD to account for subsurface features (e.g. culverts). The hydrologic conditioning process attempted to capture as many subsurface features as possible.

An effort was made through hydrologic conditioning to capture all of the drainage to the lake. This involved building an imaginary "wall" around the lake so water will drain to priority resource points. This model ensures that the entire load of phosphorous, nitrogen and sediment is represented at the priority resource points. Additional priority resource points were created as necessary to represent areas that are primarily overland flow.

A non-contributing drainage area analysis was completed. This analysis determined the areas where water is unlikely to continue downstream during a 10-year, 24-hour rainfall event. Field inspections were completed in areas where the drainage direction was unclear.

The preliminary hydrologically conditioned elevation model was subject to a quality assurance/quality control process by Houston Engineering Inc. All the other data layers were dependent on the hydrologic conditioning. Some of the data was simply dependent on the boundary of the watershed which changed slightly with the hydrologic conditioning process. Other layers utilized elevation, water flow direction and/or water accumulation as part of their creation.

Time of Travel

The quantity of sediment and nutrients delivered to Granite Lake is dependent on the time it takes runoff to reach the receiving water. A raster dataset was created to simulate water travel time throughout the watershed. An ArcGIS script made available to Wright SWCD from HEI used land cover, flow direction, flow accumulation, slope from the hydrologically conditioned elevation model to compute hydrologic velocities between each cell. The velocities were converted to time based on the length between cells as the water moves downstream.

Processing Data in PTMApp Desktop

The vast amount of processing that takes place in PTMApp is too extensive to fully relay in this report. The Red River Basin Decision Information Network houses the documentation of the science and theory used to process data in PTMApp. Several Technical Memoranda are available on their webpage, they describe the specific processing used to generate the output products for PTMApp (HEI, 2016a).

As a brief overview, PTMApp estimates the annual loads of total phosphorous, total nitrogen and sediment received at the outlet of the watershed. The loads are routed through the watershed based on an upstream to downstream analysis of water pathways. A sediment delivery ratio and first order decay equations (TP, TN) are used to account for changes in load throughout the watershed. The placement of BMPs are based on NRCS design standards and are sorted by treatment group (biofiltration, filtration, infiltration, protection, source reduction, and storage). The placement of the BMPs is then combined with the initial loads calculated to estimate efficiency and load reductions (HEI, 2016b).

Lake Routing

Given that this watershed is based on the outlet to a lake and there are two other lakes within the watershed we wanted to include the lake routing tool in this assessment. Lake routing accounts for settling of sediment and treatment of phosphorus that may occur in the waterbodies.

Targeted Implementation Scenarios

The original output of PTMApp produced 1718 practices, obviously not all of these practices can be implemented. Wright SWCD chose to narrow down the practices by their possible effect on Granite Lake. First we consider the five catchments that export the highest amounts of sediment and the five catchments that export the highest amounts of phosphorus. Then we considered the ten practices from each of HEI's treatment groups that would reduce the greatest amount of phosphorus and sediment to the watershed outlet.

Verification Procedures

After using the PTMApp results to determine the top practices Wright SWCD staff used their professional judgement to determine if the practices were practical. Wright SWCD staff used aerial photography, LiDAR and flow patterns. Observations included validating a good location and noting reasons why certain locations are not optimal. Some reasons noted included that fields appeared to no longer be in production or a structural practice would not fit due to a building or a lawn. Additionally, some practices were ruled out because some sort of conservation practice was already in place such as the land being in the Reinvest in Minnesota program and an infiltration practice already built was included. Ultimately, our office has not worked with biofilitration practices which are often targeted towards reducing nitrogen. Since only one or two biofiltration practices seemed feasible we removed them from our final selection. There were only 12 infiltration practices in the entire watershed and the types of practices suggested by HEI such as two-staged ditches will not apply in this watershed. Finally staff changed the treatment group based on feasibility. In some cases filtration changed to source reduction and the only feasible protection practice was changed to a filtration practice. After the field check 5 filtration practices and 7 source reduction fields were selected, 8 storage practices were created as a result of verification (Figure 6).

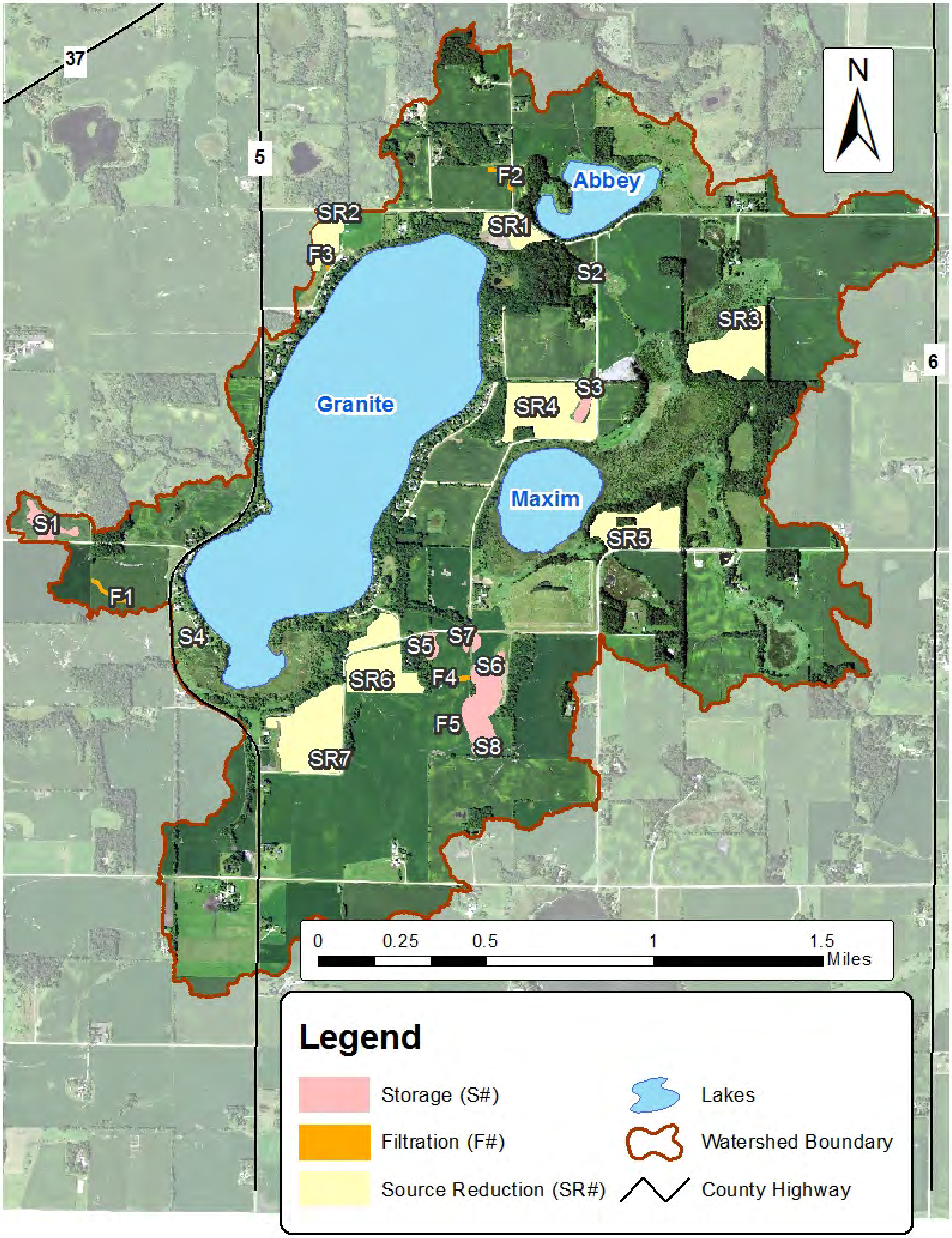


Figure 6. BMPs selected by Wright SWCD staff, including post field work modifications

Post Field Work Modifications

After the field check the selected practices were redrawn by Wright SWCD staff (Figure 7). This was necessary because of the restrictions and inherent error of PTMApp. Filtration and storage practices were often expanded and drawn to better follow flow lines and contours. Source reduction practices were drawn to follow field lines, this may have restricted or expanded the size of the practices. Due to an error in processing portions of two source reduction fields and on storage practice were unable to recalculate load reductions after the modifications. The two source reduction fields were ranked based on the known load reduction. The storage practice was put at the lowest ranking since its reductions are unknown but staff still consider it a potential practice.

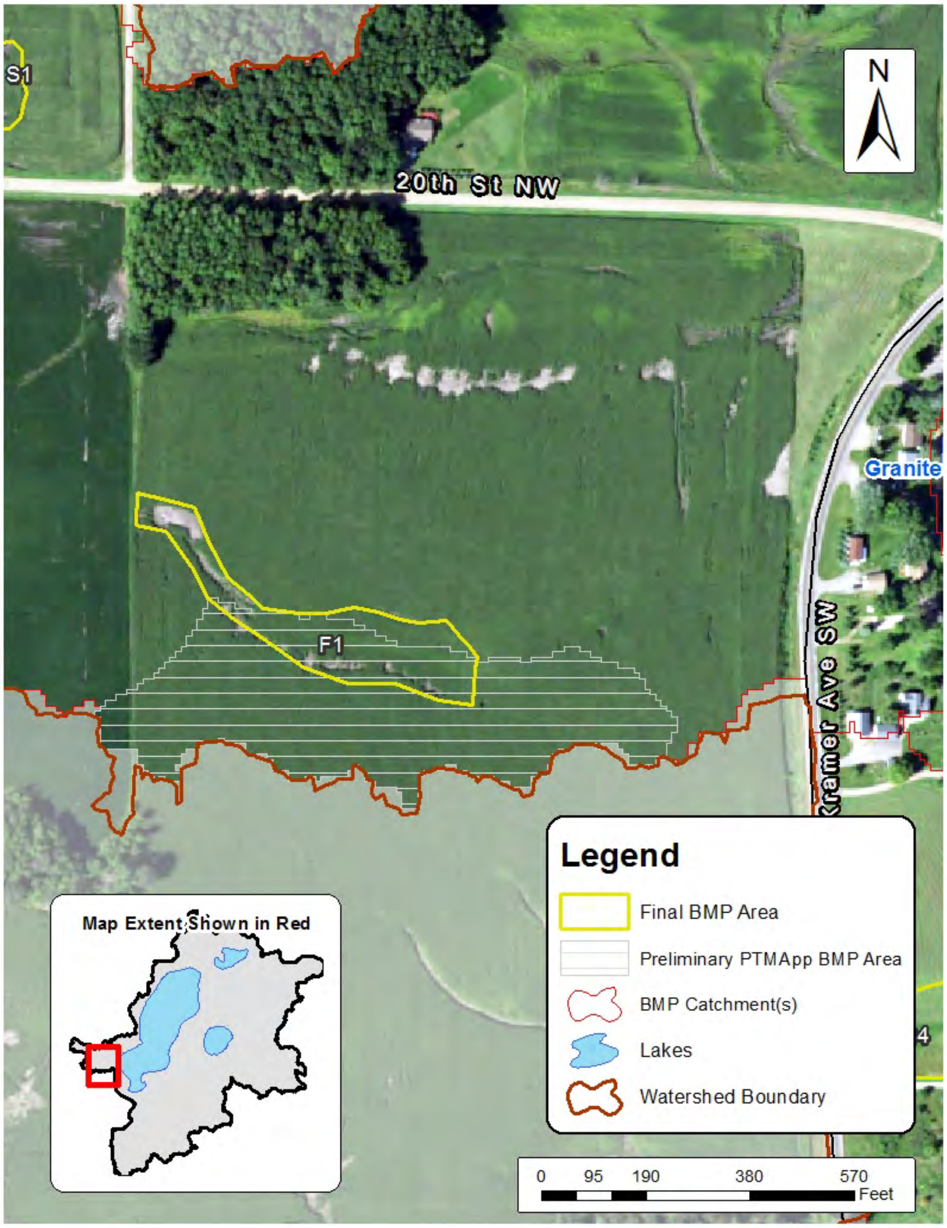


Figure 7. A practice created by PTMApp (white) was redrawn by WSWCD staff.

Ranking

BMPs were ranked by SWCD staff using outputs from PTMApp and cost estimations. The primary concern in the watershed is phosphorus delivery to the lake. Therefore we ranked the practices based on the cost to reduce 1 pound of phosphorus annually. Filtration and storage practices were assumed to have a ten year life span, but the source reduction practices will need to be reestablished each year so they assumed a 1 year life span. The following is an equation used to determine ranking.

$$\frac{\left(\begin{array}{c}(Project\ Install\ Cost * 15\%\ for\ design) + \$500\ for\ outreach\ and\ admin) \\ +(Annual\ Maintenance\ Cost * Life\ spaan\ of\ project)\end{array}\right)}{Life\ span\ of\ project * Annual\ Phosphorus\ Reduction} = BMP\ Rank$$

After staff redesigned the selected practices the results of the filtration practice indicate a negligible total phosphorus reduction. These were given give a low rank but then ranked according to their sediment reduction.

Staff additionally, wanted to consider a ranking process based on the portions of the watershed that contribute the greatest load. An alternative ranking process is listed in Appendix A.

Table 3. Priority ranking system for select BMPs in the Granite Lake Watershed

Rank	ID	BMP Type	Size (acres)	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Estimated Project Cost	Cost/ Lb TP /year	Cost/ Lb TSS /year
1	SR6	Source Reduction	21.4	78.0	4.2	$1,498	$529.21	$28.50
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15	F4	Grassed Waterway	0.5	3.8	N/A	$1,196	N/A	$584.92

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18	F2	Buffer Strip	0.7	1.2	N/A	$356	N/A	$1,852.25
19	F5	Grassed Waterway	0.2	0.6	N/A	$609	N/A	$3,704.50
20	S8	Control Basin	15.3	N/A	N/A	$11,000	N/A	N/A

Watershed Profile

PTMApp creates field scale catchments that average approximately 40 acres in size. The Granite Lake Watershed was divided into 59 catchments. Once the catchments are created PTMApp determines the contaminant load delivered to the outlet of the catchment itself and the outlet of the watershed (Table 4).

Table 4. Contaminant delivery from each field scale catchment to the catchment outlet and to the outlet of Granite Lake Watershed. An entry of N/A indicates the value is less than 0.01.

ID	Size (acres)	Sediment to Catchment Outlet (tons)	TP to Catchment Outlet (lbs)	Sediment to Granite Lake (tons)	Sediment to Granite Lake (tons/acre)	TP to Granit e Lake (lbs)	TP to Granite Lake (lbs/acre)
69	72.03	32.35	7.53	30.01	0.42	6.69	0.09
73	37.55	30.61	3.84	27.15	0.72	3.18	0.08
102	60.45	N/A	N/A	N/A	N/A	N/A	N/A
109	18.92	11.15	2.12	9.95	0.53	1.77	0.09
129	17.63	1.42	1.54	1.20	0.07	1.18	0.07
131	24.43	0.59	0.41	0.52	0.02	0.33	0.01
154	30.43	0.00	0.01	N/A	N/A	0.01	N/A
170	21.41	0.00	0.01	N/A	N/A	0.01	N/A
171	11.27	7.05	1.99	6.90	0.61	1.92	0.17
179	24.59	19.20	5.18	18.63	0.76	4.94	0.20
181	17.13	N/A	N/A	N/A	N/A	N/A	N/A
204	8.73	0.11	2.13	0.11	0.01	2.11	0.24
9901	4.72	N/A	N/A	N/A	N/A	N/A	N/A
9902	26.22	11.12	3.00	10.92	0.42	2.91	0.11
9903	1.33	0.12	0.40	0.11	0.09	0.39	0.29
9904	10.05	0.11	0.96	0.11	0.01	0.93	0.09
9905	53.49	27.04	8.66	26.34	0.49	8.31	0.16
9906	40.25	36.78	5.53	35.70	0.89	5.27	0.13

ID	Size (acres)	Sediment to Catchment Outlet (tons)	TP to Catchment Outlet (lbs)	Sediment to Granite Lake (tons)	Sediment to Granite Lake (tons/acre)	TP to Granite Lake (lbs)	TP to Granite Lake (lbs/acre)
9907	10.19	12.43	1.10	12.08	1.18	1.05	0.10
9908	7.96	6.32	1.63	6.11	0.77	1.55	0.19
9909	11.19	4.79	1.46	4.65	0.42	1.40	0.12
9910	18.26	7.39	3.86	7.22	0.40	3.73	0.20
9911	98.53	50.64	18.67	49.64	0.50	18.09	0.18
9912	15.10	0.99	0.71	0.87	0.06	0.59	0.04
9913	0.10	N/A	N/A	N/A	N/A	N/A	N/A
9914	10.31	0.86	7.55	0.86	0.08	7.55	0.73
9915	53.42	44.69	9.80	43.43	0.81	9.37	0.18
9916	7.42	2.38	1.62	2.33	0.31	1.56	0.21
500030	106.40	62.14	15.94	58.83	0.55	14.62	0.14
500033	117.71	14.51	4.49	13.74	0.12	4.11	0.03
500036	13.50	N/A	0.04	0.00	0.00	0.04	0.00
500048	33.69	2.35	1.71	2.28	0.07	1.63	0.05
500061	19.19	11.15	1.74	9.97	0.52	1.46	0.08
500063	28.98	22.34	4.60	19.39	0.67	3.67	0.13
500067	121.31	112.74	21.18	96.18	0.79	16.48	0.14
500086	65.79	0.01	0.06	0.01	N/A	0.06	N/A
500088	32.26	0.00	0.19	N/A	0.00	0.18	0.01
500092	35.44	N/A	N/A	N/A	N/A	N/A	N/A
500094	68.09	76.85	11.38	68.85	1.01	9.56	0.14
500103	18.15	N/A	N/A	N/A	N/A	N/A	N/A
500115	22.42	2.92	1.40	2.54	0.11	1.13	0.05
500118	44.66	12.61	2.25	10.90	0.24	1.79	0.04
500129	122.25	77.21	19.17	64.32	0.53	14.36	0.12
500135	104.70	8.52	5.59	7.51	0.07	4.58	0.04
500143	22.15	19.82	3.35	19.39	0.88	3.24	0.15
500150	103.03	30.20	7.27	26.63	0.26	5.96	0.06
500152	40.26	0.01	1.18	0.01	N/A	1.14	0.03
500162	23.73	0.00	0.47	0.00	N/A	0.46	0.02
500192	12.38	7.08	2.25	6.87	0.55	2.14	0.17
500197	12.55	N/A	0.11	N/A	N/A	0.11	0.01
500198	13.18	3.59	2.03	3.41	0.26	1.87	0.14
500208	123.98	136.52	17.33	130.28	1.05	16.10	0.13
500209	10.77	9.25	1.77	8.80	0.82	1.63	0.15
500215	20.47	13.88	3.42	13.06	0.64	3.11	0.15
500217	102.37	107.27	16.48	101.09	0.99	15.00	0.15

ID	Size (acres)	Sediment to Catchment Outlet (tons)	TP to Catchment Outlet (lbs)	Sediment to Granite Lake (tons)	Sediment to Granite Lake (tons/acre)	TP to Granit e Lake (lbs)	TP to Granite Lake (lbs/acre)
500229	104.39	52.16	16.57	51.15	0.49	16.06	0.15
500231	123.31	73.98	23.64	71.46	0.58	22.38	0.18
500233	12.41	7.71	2.58	7.48	0.60	2.46	0.20
500234	21.80	11.98	3.46	11.28	0.52	3.14	0.14

The primary sources of total sediment appear to be the catchments to the east of Granite Lake (Figure 8). For the most part the catchments delivering the most sediment to Granite Lake correspond to heaviest agricultural activities. In addition the agricultural fields to the east are very steep which tends toward erosion.The areas with lower sediment delivery are primarily those that first travel through Maxim Lake or Abbey Lake which would naturally allow some settling of phosphorus.

The primary sources of total phosphorus are more to the west of Granite Lake. There is very little area to the west so any runoff would have little opportunity to be treated before entering Granite Lake. Additionally, the more gradual slopes to the west should have lower erosion, but may still export phosphorus.

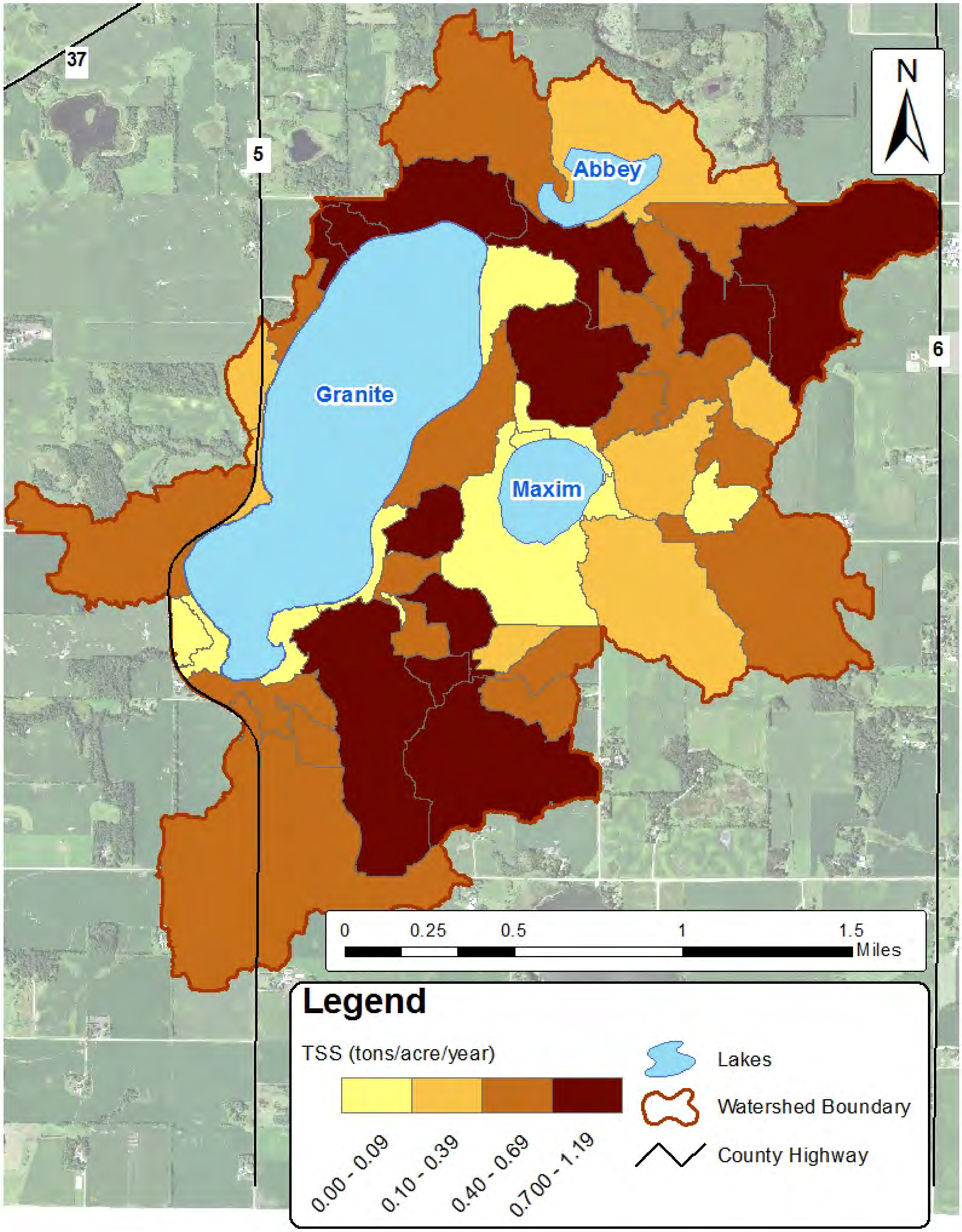

Figure 8. Sources of sediment to Granite Lake. A darker color indicates a higher sediment delivery.

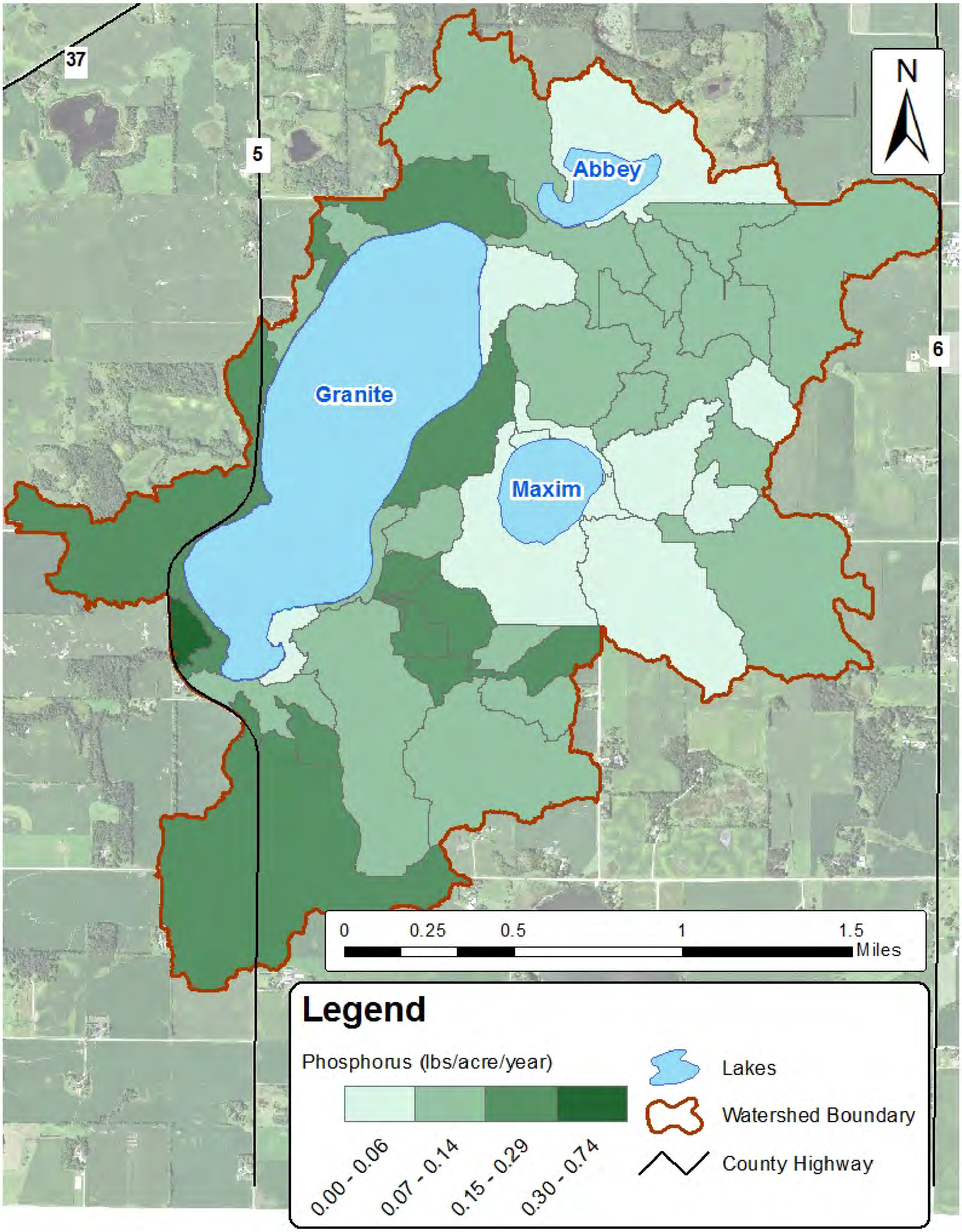

Figure 9. Total phosphorus delivery to Granite Lake. A darker shade indicates higher delivery.

BMP Profiles

Filtration

There are two types of filtration BMPs considered as options when PTMApp identifies a filtration practice. The first is a filtration strip, it is meant to capture overland flow before it reaches a nearby resource of concern such as a wetland. The second practice is a grassed waterway, this practice is meant to take on a portion of concentrated flow and treat the water as it moves through the filter.

Cost estimates for filtration strips are based on Natural Resources Conservation Service (NRCS) program payments. Conservation Reserve Program (CRP) pays up to $84.00/acre which includes site preparation, 1-3 species seed mix, planting and weed control. This is assumed to be half the cost of construction so we assume a total cost of $168.00/acre. The producer will be provided a rental agreement lasting 10-15 years and receive annual payments to offset the loss of income due to taking the land out of production. Environmental Quality Incentives Program (EQIP) program pays a flat rate of $509.33/acre (native grass) or $501.95 (introduced grass), again this is assumed to be 50% of the total cost. Thus for this project we assume total cost of $1,011/acre. EQIP does not offer compensation for taking the land out of production but there is a lost production cost to the landowner.

Grassed waterways are eligible for CRP at the same rate, but EQIP payments are different. EQIP for grassed waterways are based on the size of area draining to the grassed filter and paid based on the length of filter. The majority of the drainage areas in this study will be less than 100 acres which would receive $1.57 per linear foot also assumed to be 50% of the total cost. The grassed waterways in this project are assumed to cost $3.14/linear ft. Since EQIP does not provide compensation for land removed from production there would be an additional cost to the farmer.

F1

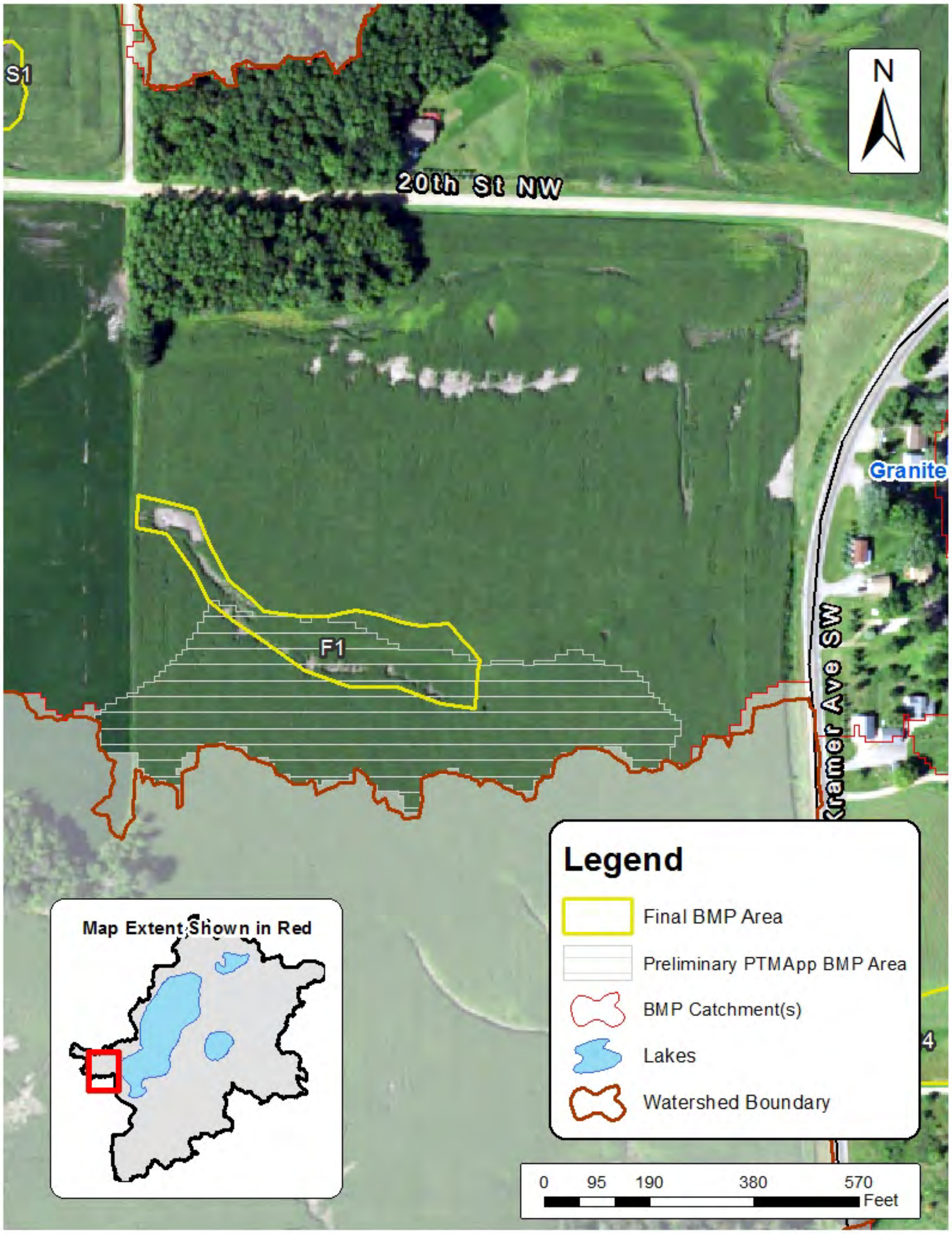

Figure 10. Field scale map of BMP F1, a grassed waterway. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: Filtration BMP located on the southwest side of Granite Lake. The grassed waterway would help repair the gully forming in the field. The surface soil texture at the site is primarily clay loam with 0-2% slopes.

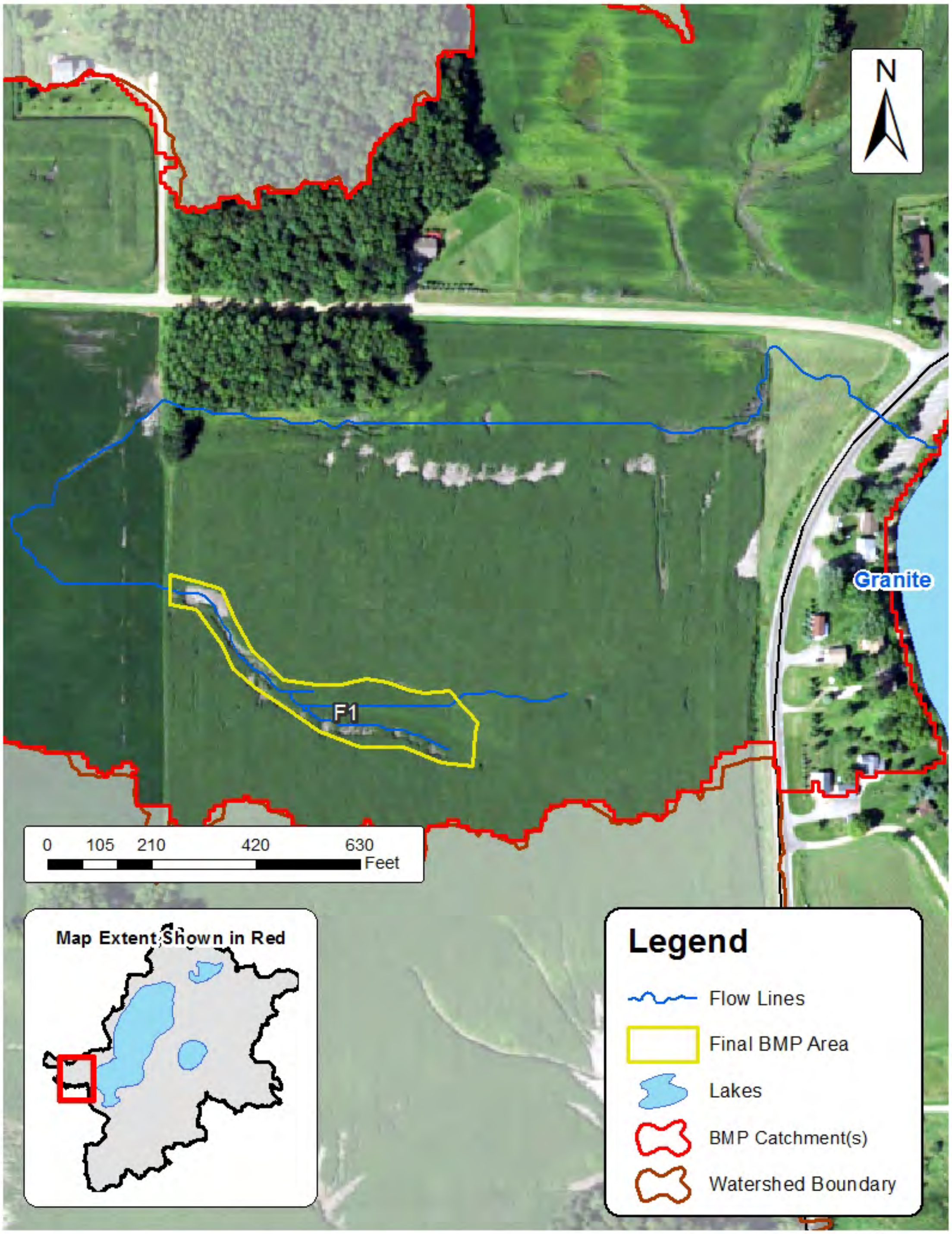

Figure 11. Catchment and flowpath for BMP F1

Catchment Description: F1 is contained in one catchment and is located at the top of the catchment. Water flows west for a short time until it curves around a hill and back east to Granite Lake via a culvert. The primary landuse in 2011 was primarily crops (84.6%), the remaining area is developed (7.9%), and forest (3.4%).

Table 5. Parameters for BMP F1

BMP Name	F1
Rank	18
Project Type	Grassed waterway
Project Size (acres)	1.4
Cost Estimate	$2,258
BMP TSS Load Reduction (tons/year)	1.8
BMP TP Load Reduction (lbs/year)	N/A
Catchment Number(s)	9911
Catchment Size (acres)	98.5
Catchment TSS Load (tons/year/acre)	0.5
Catchment TP Load (lbs/year/acre)	0.2

PTMApp identified an area of the field that is obviously forming a gully. However it included more area than is necessary. Staff designed this BMP to straddle the gully and expand a little towards the top to accommodate another flowline. Results show that even though the practice will be smaller it will reduce more sediment and phosphorus by stabilizing more of the gully.

Table 6. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F1

	PTMApp Design	Staff Design
Size	5.2	1.4
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	1.1	1.8
TSS-Q3 (tons/year)	1.6	2.6
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.1	0.3
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	1.1	1.8
TSS-Q3 (tons/year)	1.6	2.6
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.1	0.3

F2

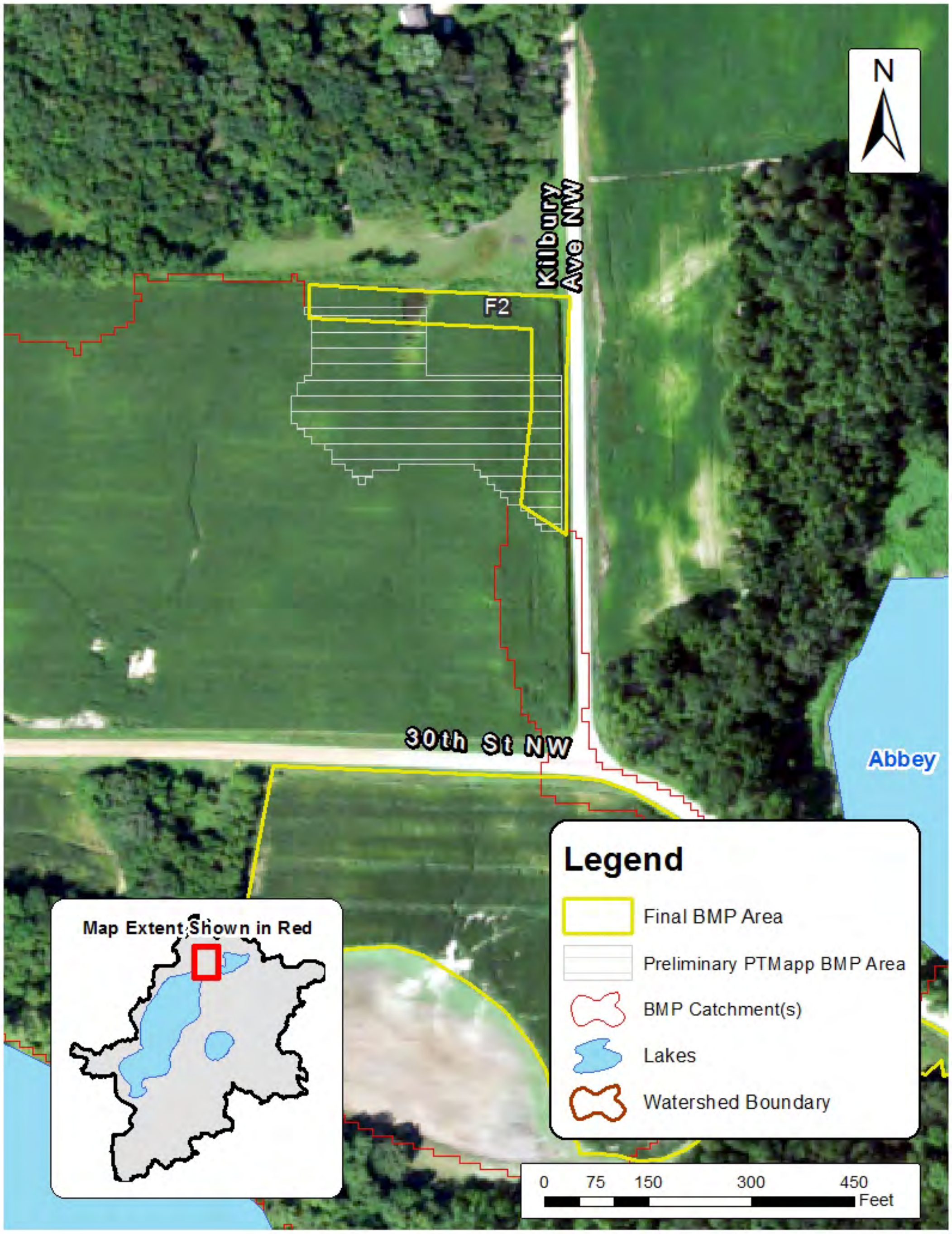

Figure 12. Field scale map of BMP F2, a filter strip. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: Filtration BMP located on the north side of Granite Lake. The area surrounding BMP is farmland. This filter strip will buffer the water entering Lake Abbey before it reaches Granite Lake. The soil is Angus-Cordova complex with 0-5% slope.

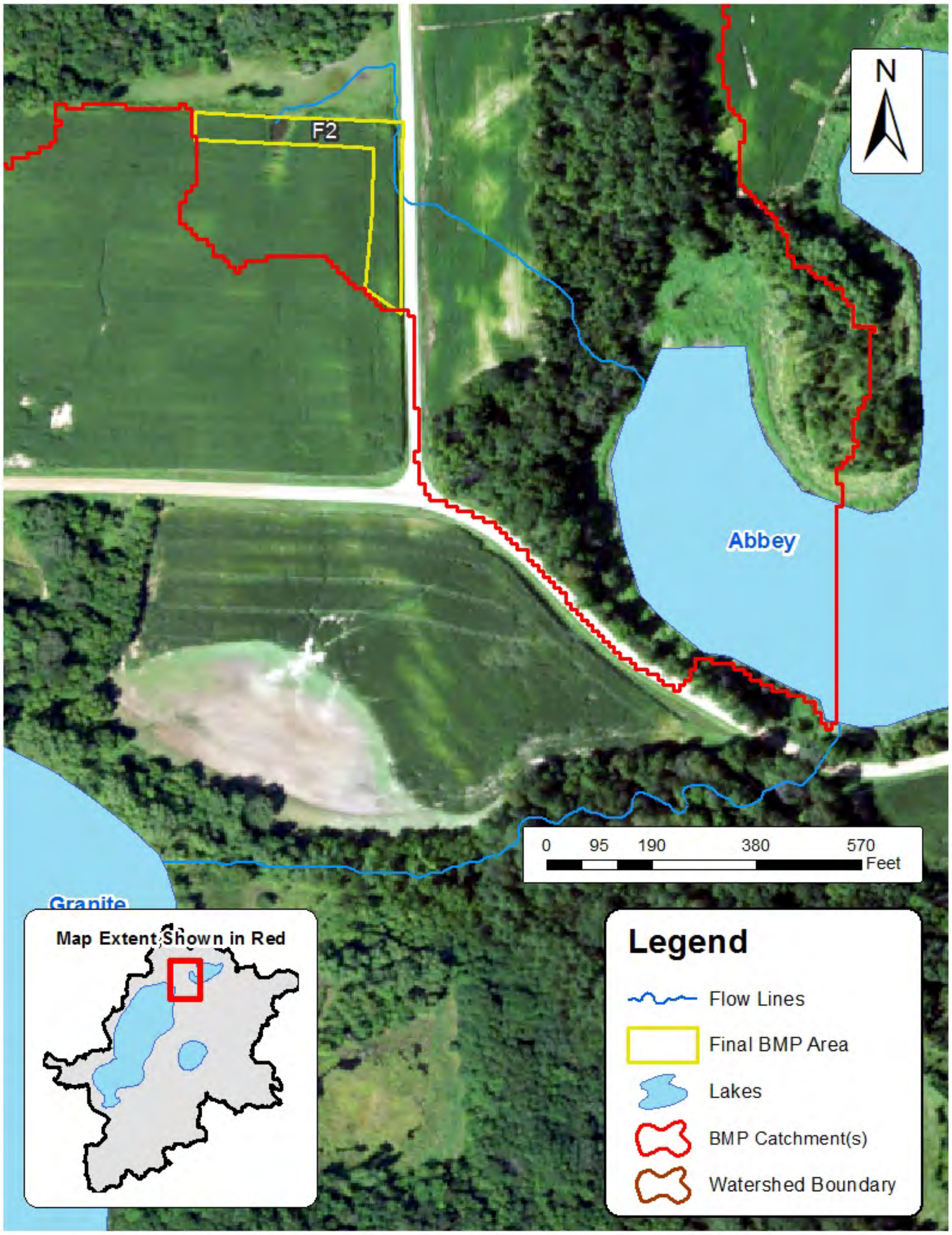

Figure 13. Catchment and flowpath for BMP F1

Catchment Description: F2 is contained in one catchment and is located at the top of the catchment. Water flows east to Lake Abbey before entering Lake Granite via a culvert. The primary landuse in 2011 was cultivated crops (53.7%), forest was also prominent (18.1%), and the rest is developed (8.5%) shrub (5.39%), pasture (4.2%) and wetlands (3.19%).

Table 7. Parameters for BMP F2

BMP Name	**F2**
Rank	19
Project Type	Filtration/Buffer Strip
Project Size (acres)	0.7
Cost Estimate	$356
BMP TSS Load Reduction (tons/year)	1.2
BMP TP Load Reduction (lbs/year)	N/A
Catchment Number(s)	500030
Catchment Size (acres)	106.4
Catchment TSS Load (tons/year/acre)	0.6
Catchment TP Load (lbs/year/acre)	0.1

PTMApp originally placed this BMP at the top of the catchment. Given the lack of obvious gullies and the back and forth flow pattern staff suggest a buffer strip in this area. Re-run of PTMApp shows similar reduction with this practice.

Table 8. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F2

	PTMApp Design	**Staff Design**
Size	1.7	0.8
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	1.1	1.2
TSS-Q3 (tons/year)	1.6	1.7
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.1	0.1
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	1.1	1.2
TSS-Q3 (tons/year)	1.6	1.7
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.1	0.1

F3

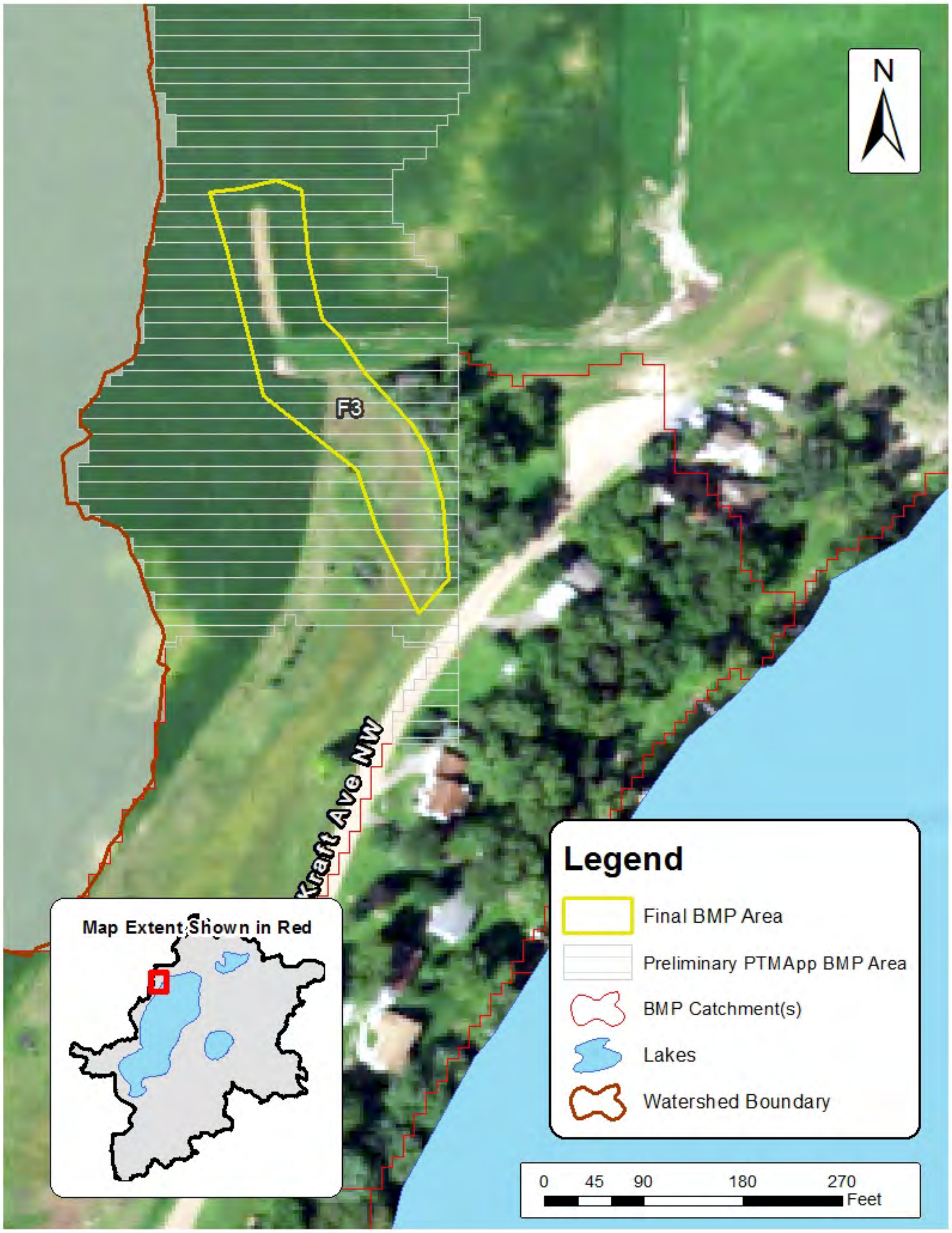

Figure 14. Field scale map of BMP F3, a grassed waterway. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: F3 is a grassed waterway on the northwest side of Granite Lake. The area surrounding the BMP is farmland. Additionally, the farm field is identified as a source reduction area (SR2). Primary soil is Angus-Le Sueur complex with 1-5% slopes.

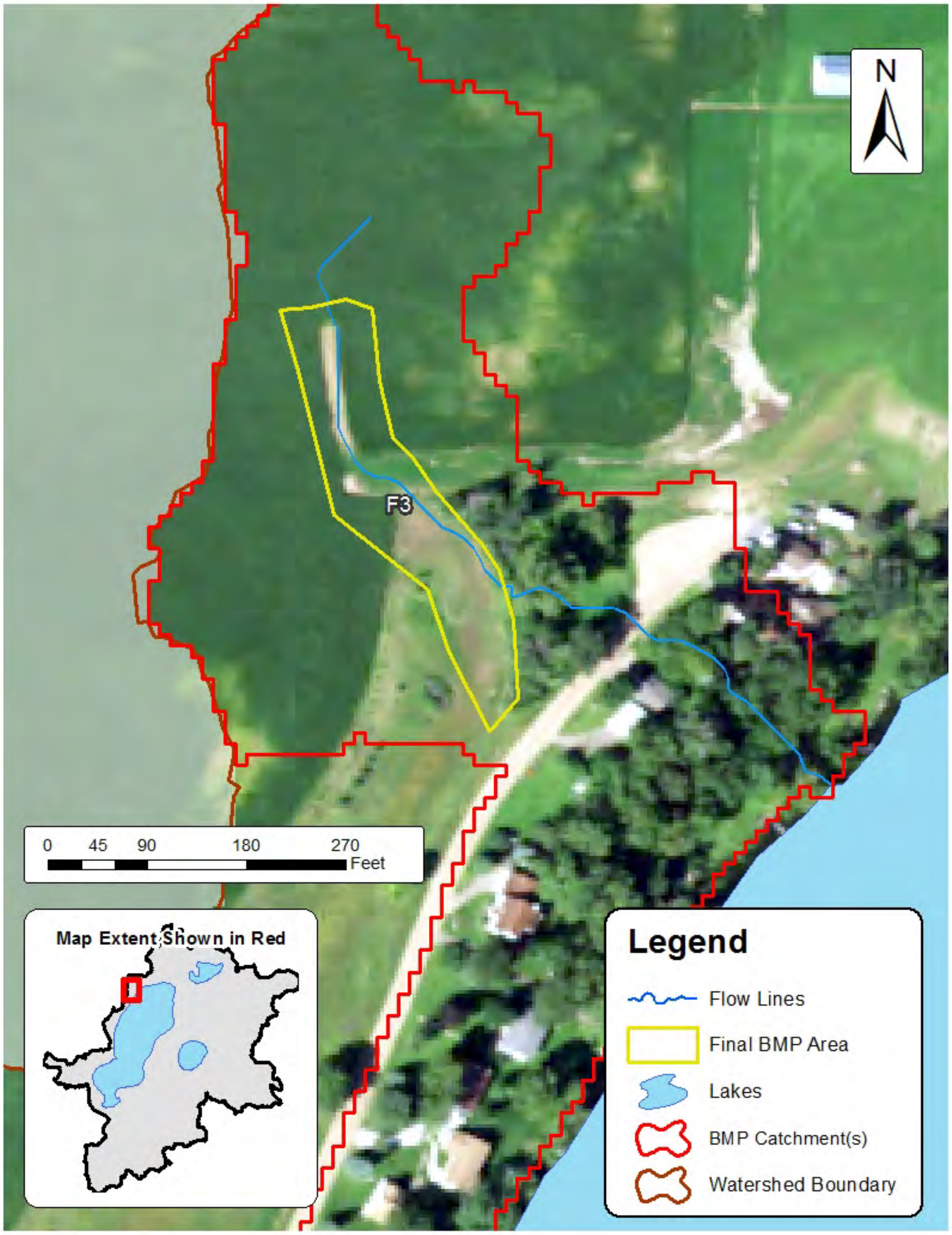

Figure 15. Catchment and flowpath for BMP F1

Catchment Description: F1 is contained in one catchment and is located near the bottom of the catchment. Water flows from an agricultural field through F3, under a road and into Granite Lake through a culvert. The primary landuse in 2011 was cultivated crops (56.87%). Other landuses included developed space (20.43%), forest (17.60%) and hay/pature (5.1%).

Table 9. Parameters for BMP F3

BMP Name	F3
Rank	15
Project Type	Grassed Waterway
Project Size (acres)	0.6
Cost Estimate	$1,262
BMP TSS Load Reduction (tons/year)	1.4
BMP TP Load Reduction (lbs/year)	N/A
Catchment Number(s)	9908
Catchment Size (acres)	7.9
Catchment TSS Load (tons/year/acre)	0.8
Catchment TP Load (lbs/year/acre)	0.2

PTMApp's design for this filtration strip is much larger than what is practical. Staffed reduced the size to straddle a gully so much more land can remain in production. The staff design run shows lower reductions but the size is much smaller.

Table 10. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F3

	PTMApp Design	Staff Design
Size	4.3	0.6
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	1.7	1.4
TSS-Q3 (tons/year)	2.5	2.0
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.1	0.1
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	1.7	1.4
TSS-Q3 (tons/year)	2.5	2.0
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.1	0.1

F4

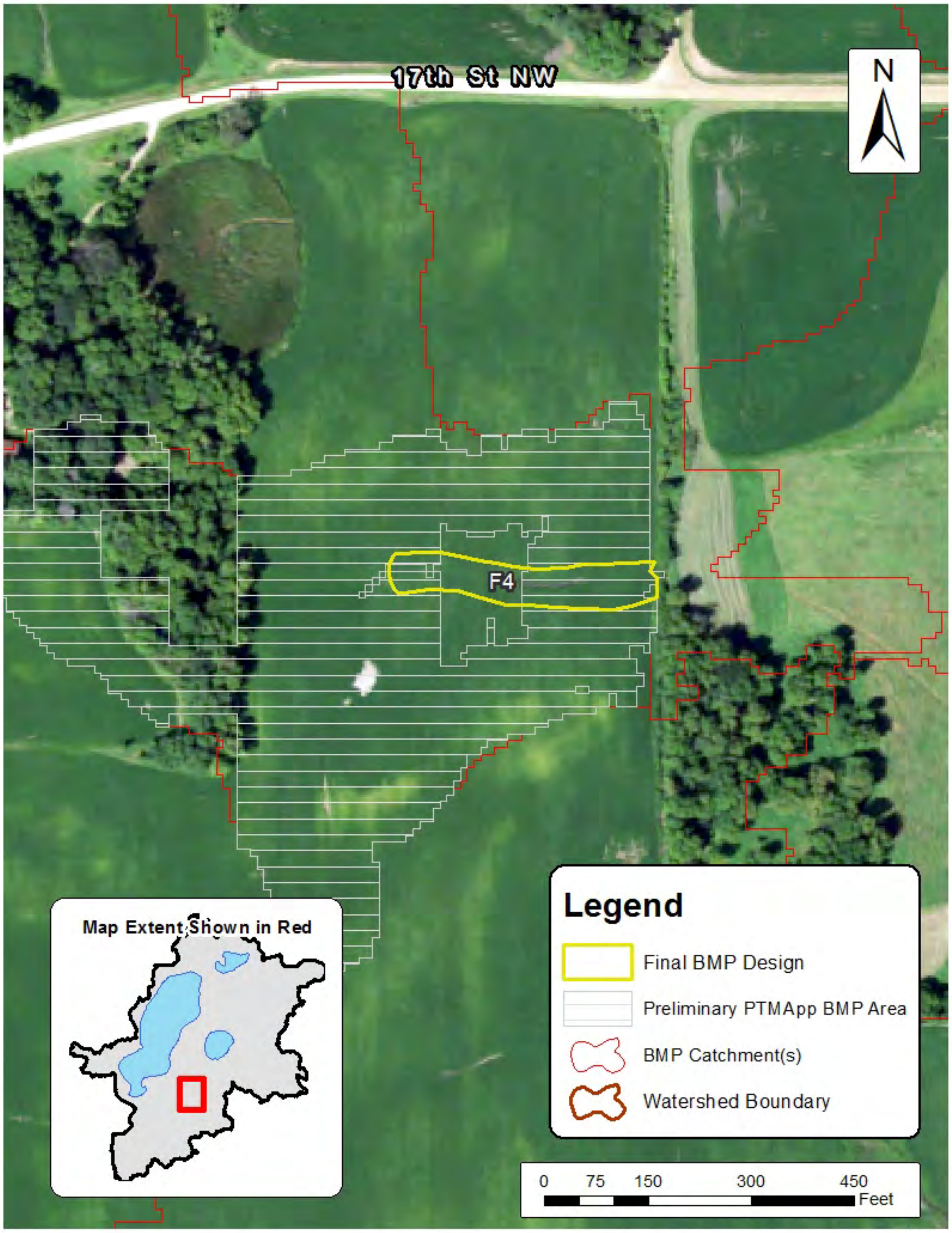

Figure 16. Field scale map of BMP F4, a grassed waterway. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: F4 is a grassed waterway to be located southeast of Granite Lake. Soils are spilt between Angus-Le Sueur complex and Glencoe clay loam.

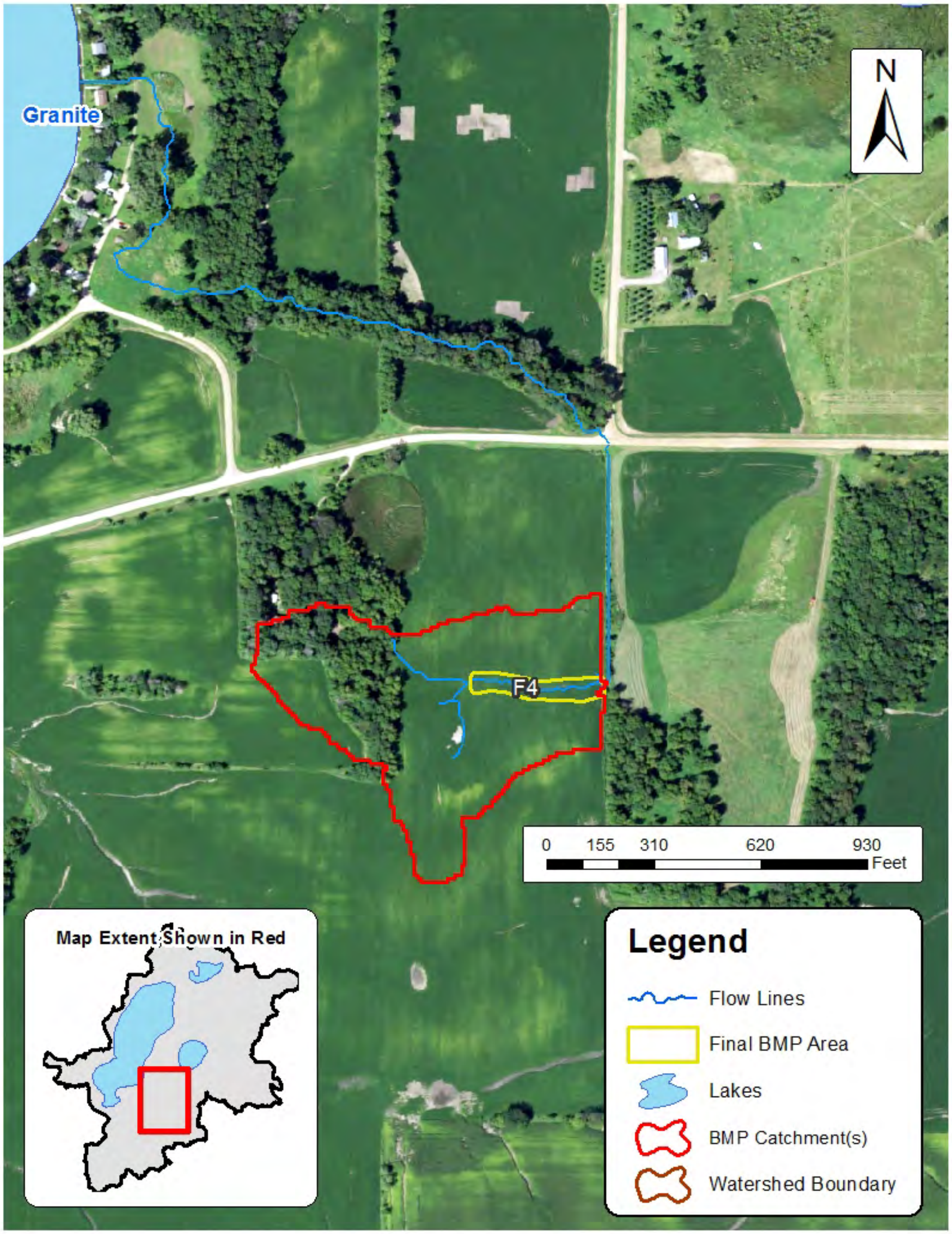

Figure 17. Catchment and flowpath for BMP F4

Catchment Description: F1 is contained in one catchment and is located at the bottom of the catchment. Water travels from a cropland and forested area before it travels through a small creek to Granite Lake. The catchment is dominated by cultivated crops (88.95%), the remaining area is shrubland (7.62%), forest (1.96%) and hay/pasture (1.47%)

Table 11. Ranking parameters for BMP F4

BMP Name	**F4**
Rank	12
Project Type	Grassed Waterway
Project Size (acres)	0.5
Cost Estimate	$1,196
BMP TSS Load Reduction (tons/year)	3.8
BMP TP Load Reduction (lbs/year)	N/A
Catchment Number(s)	500209
Catchment Size (acres)	10.8
Catchment TSS Load (tons/year/acre)	0.8
Catchment TP Load (lbs/year/acre)	0.2

PTMApp's design for this filtration strip is much larger than what is practical. Staffed reduced the size to straddle a gully so much more land can remain in production. The staff design run has comparable reductions even though the size is much smaller.

Table 12. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F4

	PTMApp Design	**Staff Design**
Size	8.9	0.5
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	4.3	3.8
TSS-Q3 (tons/year)	6.2	5.4
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.3	0.3
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.0	0.0
TSS-Q2 (tons/year)	4.3	3.8
TSS-Q3 (tons/year)	6.2	5.4
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.3	0.3

F5

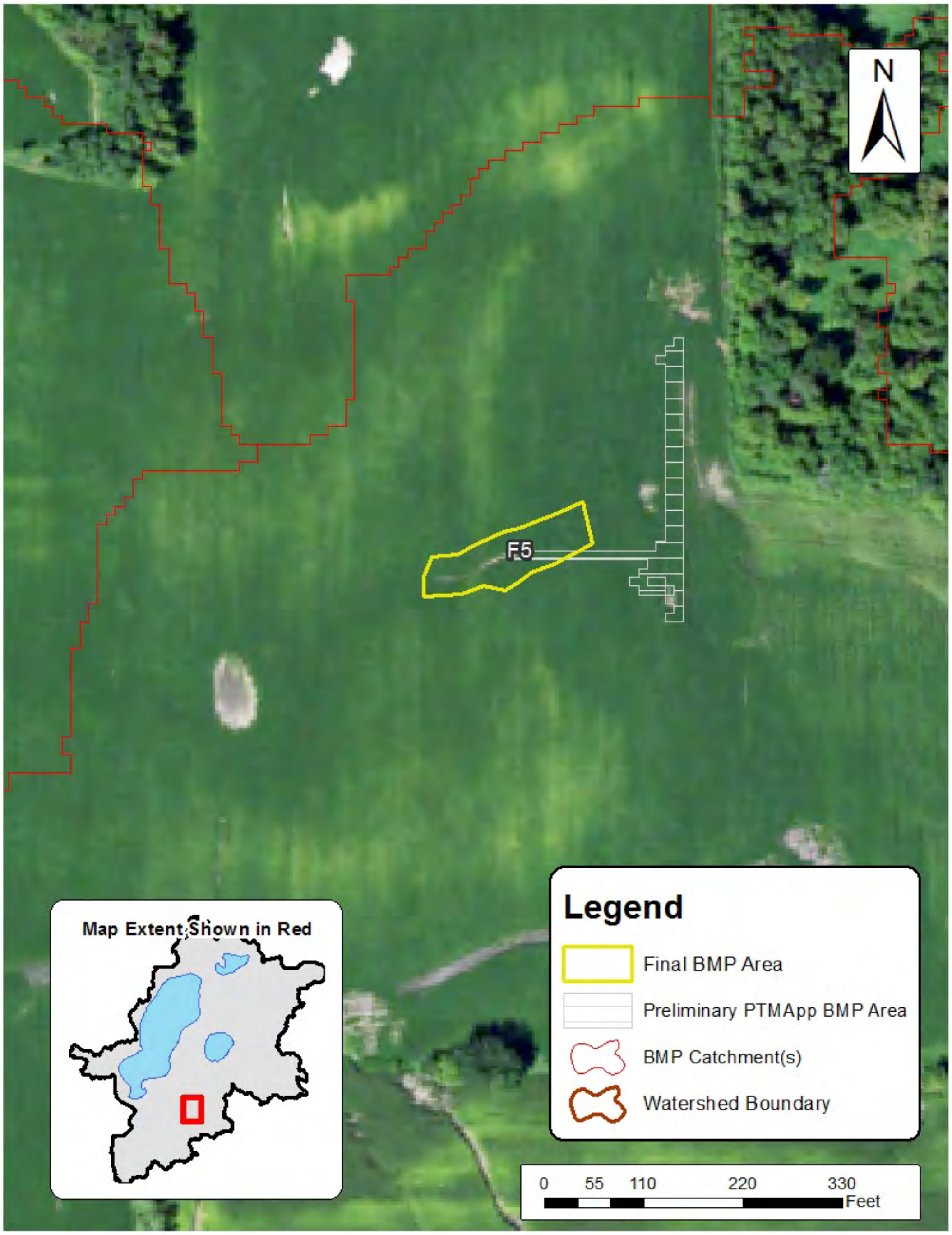

Figure 18. Field scale map of BMP F4, a grassed waterway. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: F4 is a grassed waterway southeast of Granite Lake. Dominate soil type is Lester loam with 12 to 18% slopes, eroded.

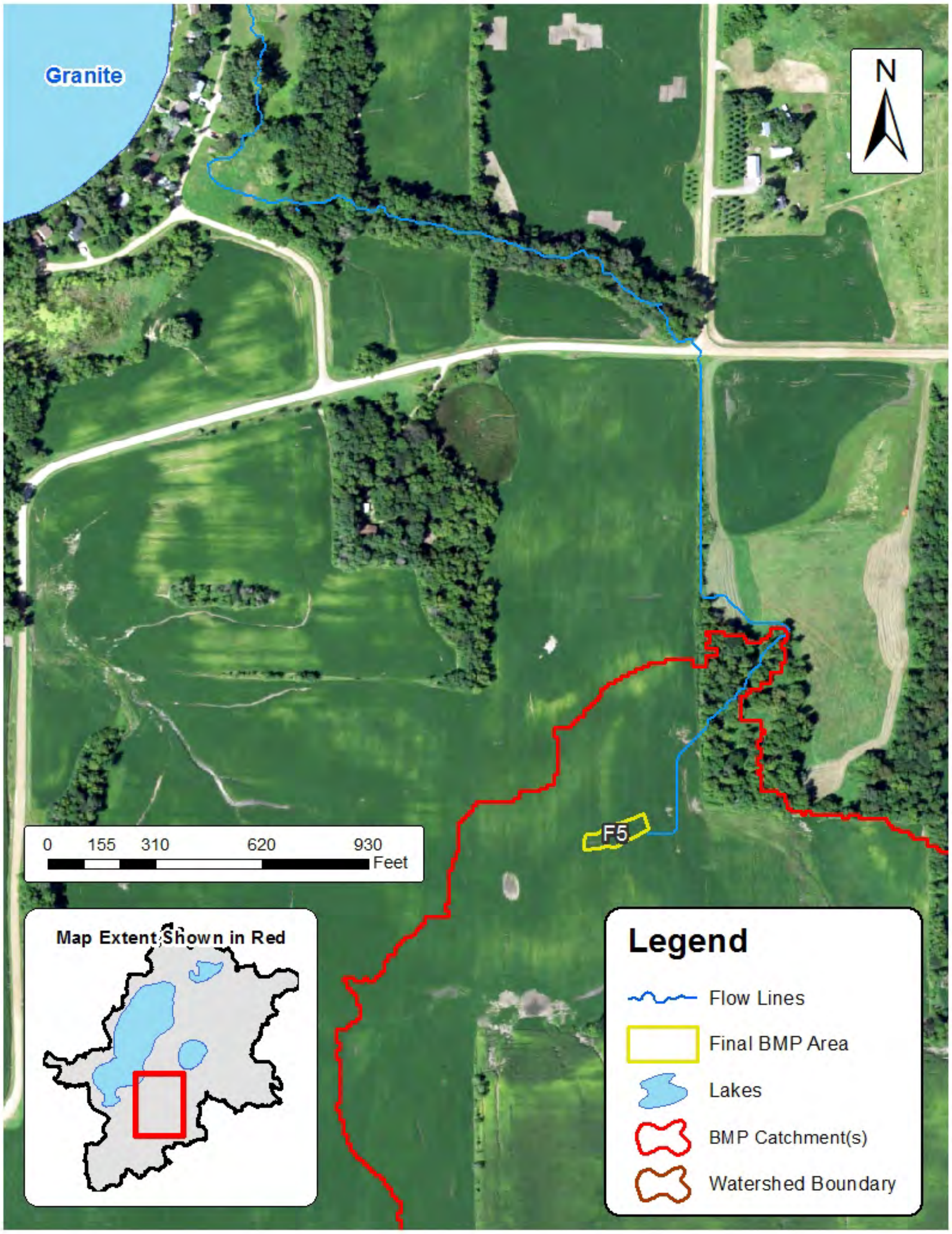

Figure 19. Catchment and flowpath for BMP F5

Catchment Description: F5 is contained within one catchment and it is near the bottom of the catchment. Water flows from cropland to a small creek to the lake. The catchment is dominated by cropland (86.96%), the rest is hay/pasture (8.67%), forest (2.44%) and wetland (2.93%).

Table 13. Ranking parameters for BMP F5

BMP Name	F5
Rank	14
Project Type	Grassed waterway
Project Size (acres)	0.2
Cost Estimate	$609
BMP TSS Load Reduction (tons/year)	0.6
BMP TP Load Reduction (lbs/year)	N/A
Catchment Number(s)	500217
Catchment Size (acres)	102
Catchment TSS Load (tons/year/acre)	1.0
Catchment TP Load (lbs/year/acre)	0.1

PTMApp originally created this practice as a protection practice. Rather than doing a grade stabilization or field scale tillage operation staff suggested a waterway. Reduction predictions appear to be better with the different practice type.

Table 14. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F5

	PTMApp Design	Staff Design
Size	0.2	0.2
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.3	0.2
TSS-Q2 (tons/year)	0.3	0.6
TSS-Q3 (tons/year)	0.3	0.7
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.0	0.1
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.3	0.2
TSS-Q2 (tons/year)	0.3	0.6
TSS-Q3 (tons/year)	0.3	0.7
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.0	0.0
TP-Q3 (lbs /year)	0.0	0.1

Storage

Storage BMPs are intended to slow water travel, this can have several effects. First, slowing the water down reduces the erosion potential preventing sediment from being pick up in the first place. Second, the reduction in velocity and power allows some sediment already in suspension to fall out of suspension.

Cost estimations for the selected storage BMPs were created by Wright SWCD staff. Standard local pricing was used for materials and the basin construction was based on a per linear foot pricing. The pricing for the storage BMPs is likely the most accurate since the greatest number of factors were able to be taken into account.

S1

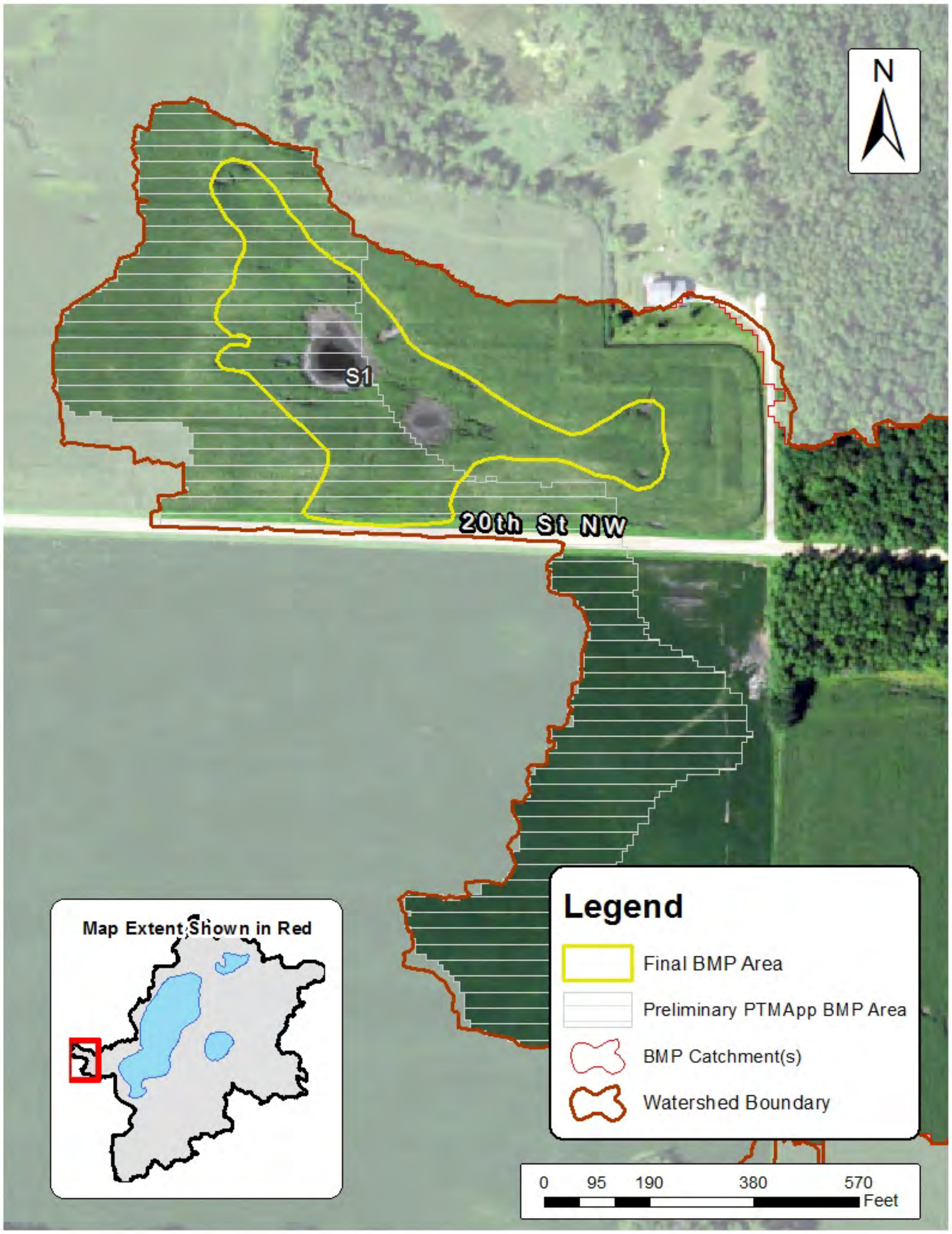

Figure 20. Field scale map of BMP S1, a wetland restoration. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S1 is a wetland restoration west of Granite Lake. Dominant soil type is Cordova clay loam, 0-2% slopes.

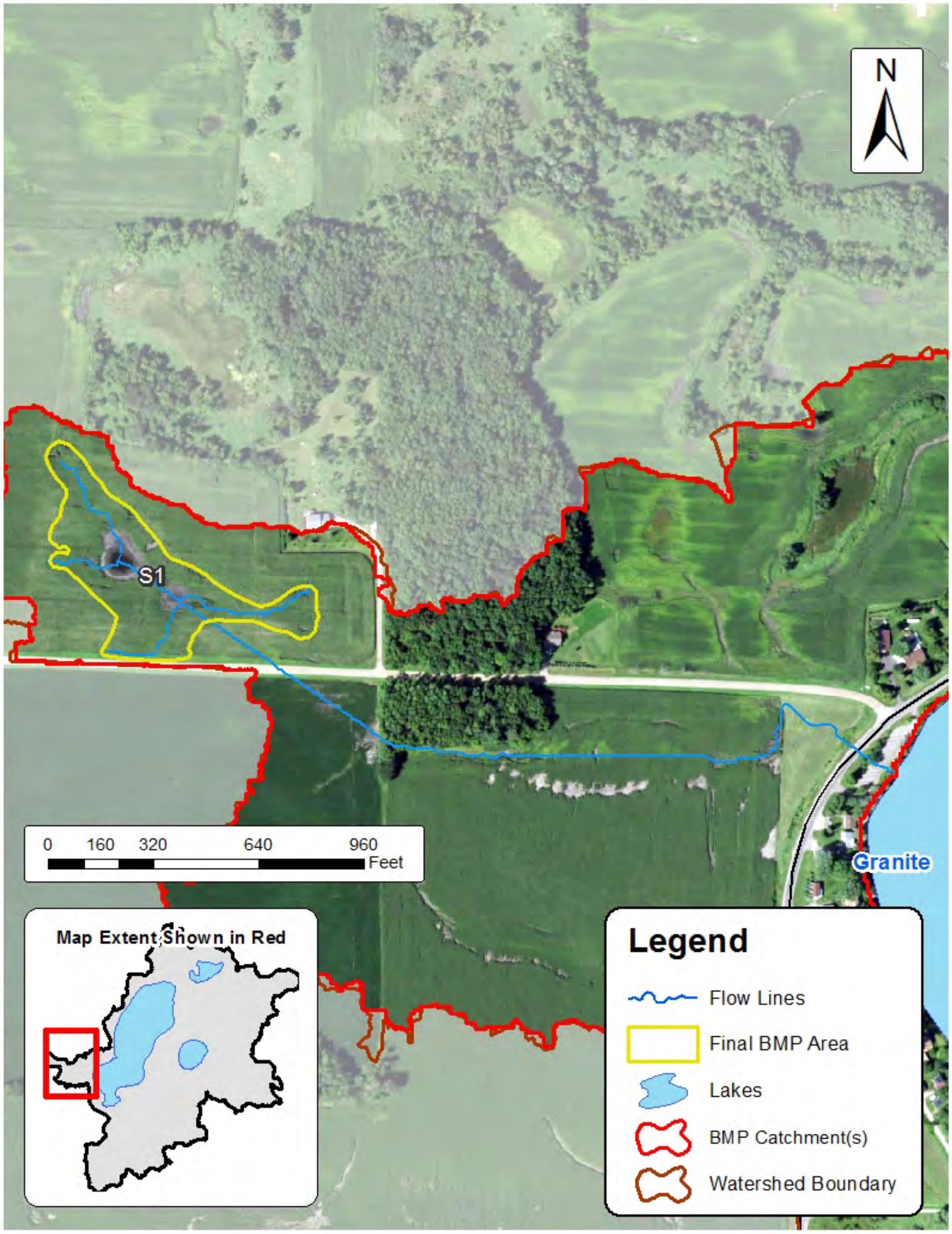

Figure 21. Catchment and flowpath for BMP S1

Catchment Description: S1 is contained within one catchment and is located at the top of the catchment. The catchment is dominated by cropland (84.86%), the rest is developed (7.91%), forest (3.44%), shrubland (1.81%) and wetlands (1.02%)

Table 15. Parameters for BMP S1

BMP Name	S1
Rank	16
Project Type	Wetland Restoration
Project Size (acres)	1.5
Cost Estimate	$10,000
BMP TSS Load Reduction (tons/year)	3.7
BMP TP Load Reduction (lbs/year)	0.9
Catchment Number(s)	9911
Catchment Size (acres)	98.5
Catchment TSS Load (tons/year/acre)	0.5
Catchment TP Load (lbs/year/acre)	0.2

PTMApp placed this practice along the top of the watershed. Staff suggested moving it into a natural depression. The staff design is much smaller than the PTMApp placement.

Table 16. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S1

	PTMApp Design	Staff Design
Size	13.7	4.5
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	3.8	1.3
TSS-Q2 (tons/year)	5.9	3.7
TSS-Q3 (tons/year)	6.2	4.7
TP-Q1 (lbs /year)	0.0	N/A
TP-Q2 (lbs /year)	0.8	0.9
TP-Q3 (lbs /year)	2.0	1.6
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	3.8	1.3
TSS-Q2 (tons/year)	5.9	3.7
TSS-Q3 (tons/year)	6.2	4.7
TP-Q1 (lbs /year)	0.0	N/A
TP-Q2 (lbs /year)	0.8	0.9
TP-Q3 (lbs /year)	2.0	1.6

S2

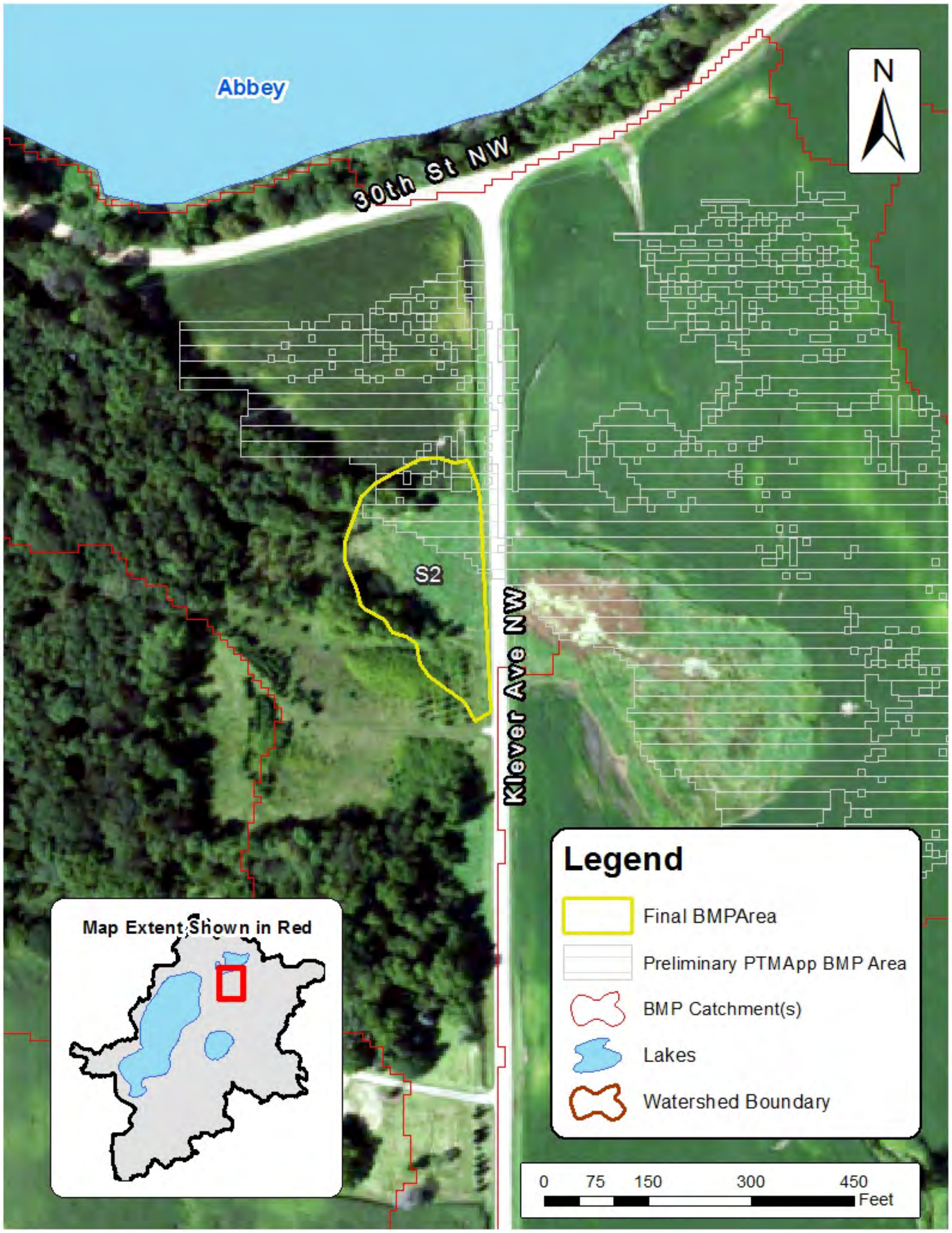

Figure 22. Field scale map of BMP S2, a wetland restoration. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S2 is a wetland restoration northeast of Granite Lake and south of Abbey Lake. Dominant soils are Hamel loam, 1-3% slopes.

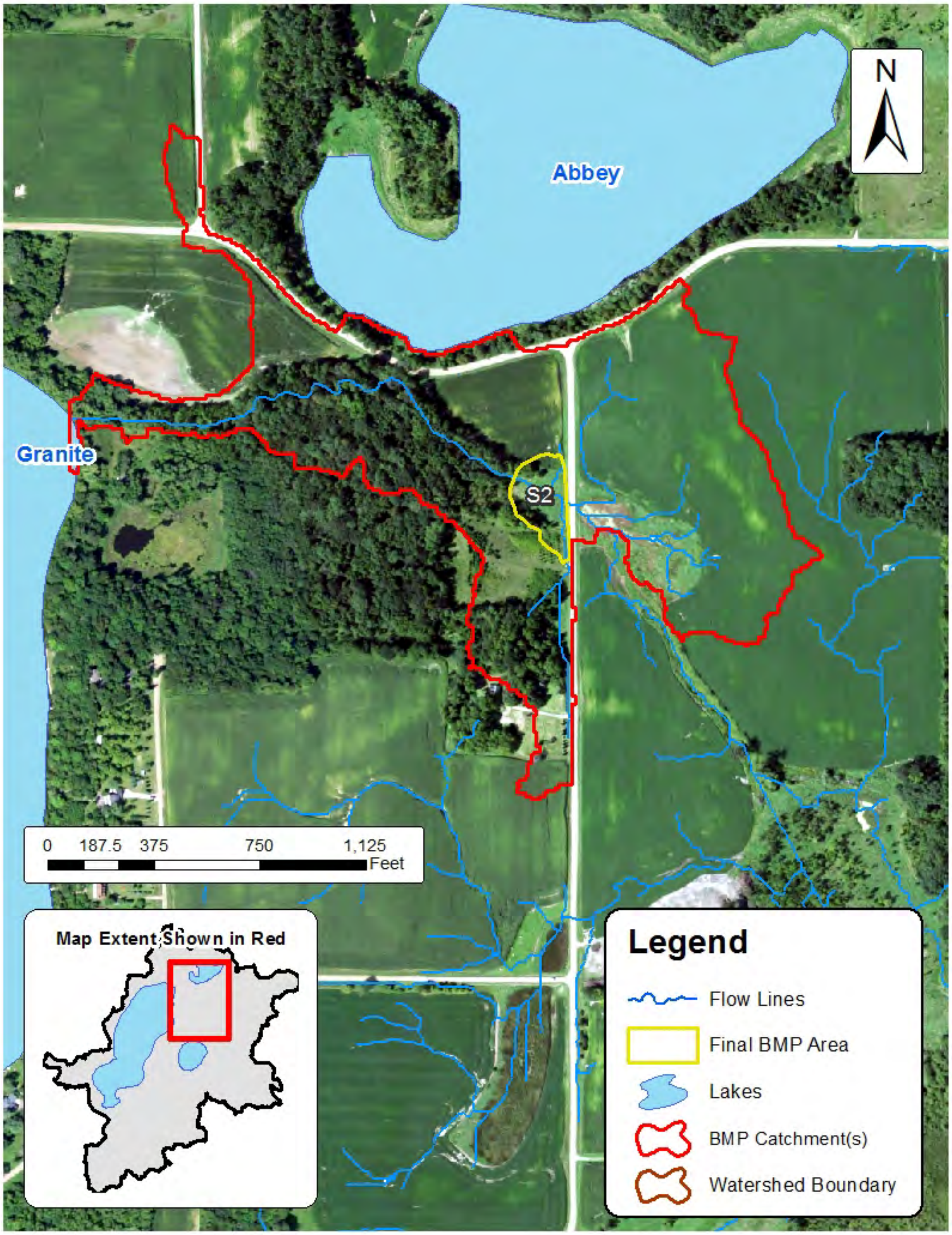

Figure 23. Catchment and flowpath for BMP S1

Catchment Description: S2 is contained within one catchment and is located in the middle of the catchment. Water would flow from cropland to S2 and then out into a small creek through a forest area to Granite Lake. The landuse of the catchment is dominated by hay/pastures (31.6%), crops (26.5%) and forest (18.3%). Other landuse includes: developed (11.4%), shrub (7.1%), open water (2.3%), herbaceous (1.6%) and wetlands (1.0%).

Table 17. Ranking parameters for BMP S2

BMP Name	**S2**
Rank	9
Project Type	Wetland Restoration
Project Size (acres)	1.1
Cost Estimate	$14,000
BMP TSS Load Reduction (tons/year)	11.6
BMP TP Load Reduction (lbs/year)	0.1
Catchment Number(s)	9906
Catchment Size (acres)	40.3
Catchment TSS Load (tons/year/acre)	0.9
Catchment TP Load (lbs/year/acre)	0.1

The PTMApp placement of this BMP was expansive. Due to know landowner relations the staff suggested keeping to the west of the road. Staff kept it to a contour line that forms a natural depression. As a result the staff design is much smaller than the PTMApp placement.

Table 18. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S2

	PTMApp Design	**Staff Design**
Size	12.1	1.1
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	2.7	4.0
TSS-Q2 (tons/year)	7.8	11.6
TSS-Q3 (tons/year)	9.8	14.6
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.4	0.1
TP-Q3 (lbs /year)	0.7	0.1
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	2.7	5.5
TSS-Q2 (tons/year)	7.8	15.9
TSS-Q3 (tons/year)	9.8	20.1
TP-Q1 (lbs /year)	0.0	N/A
TP-Q2 (lbs /year)	0.4	0.1
TP-Q3 (lbs /year)	0.7	0.2

S3

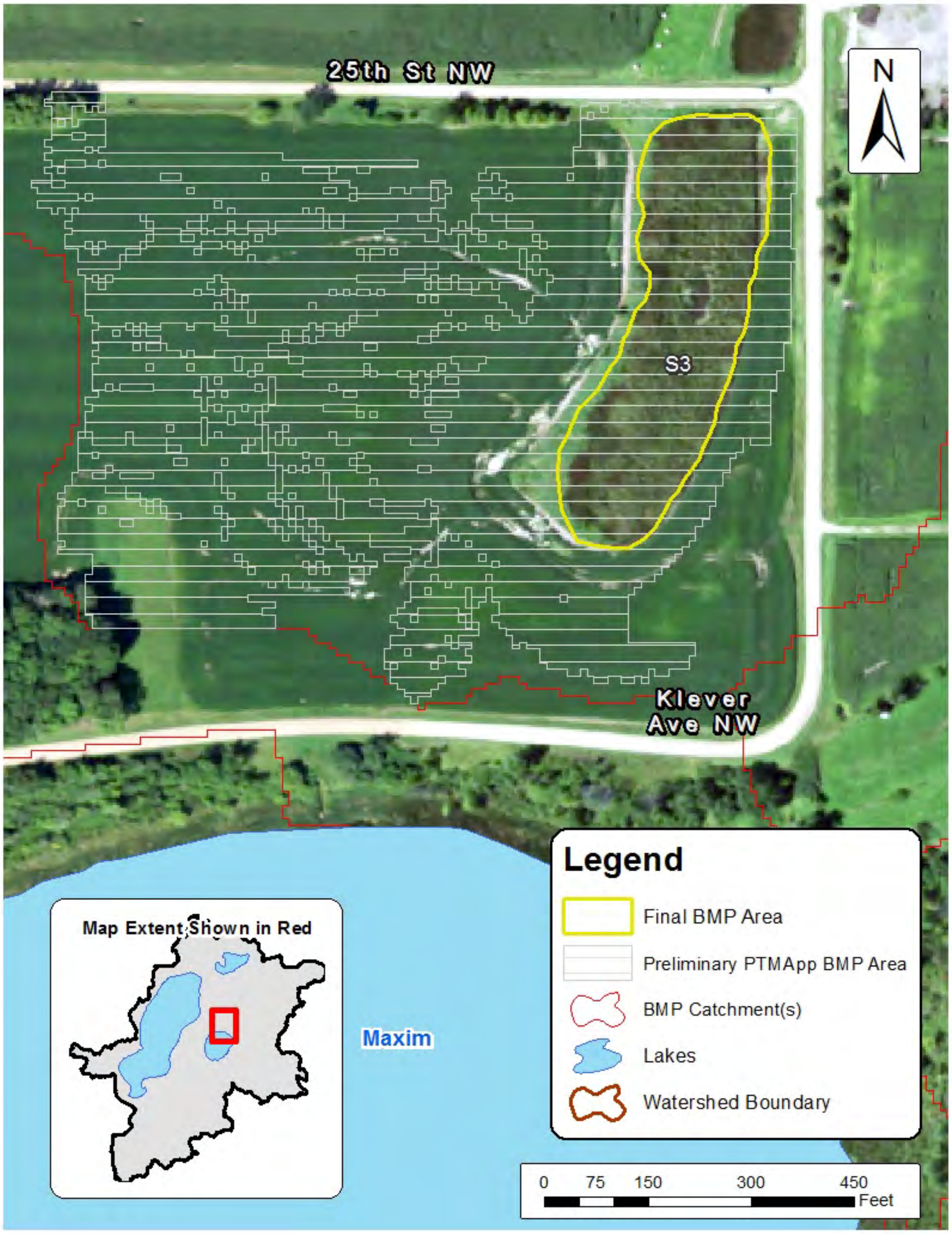

Figure 24. Field scale map of BMP S3, a filter strip. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S3 is a water and sediment control basin east of Granite Lake and north of Maxim Lake. The dominant soil type is Glencoe clay loam, 0-1% slopes.

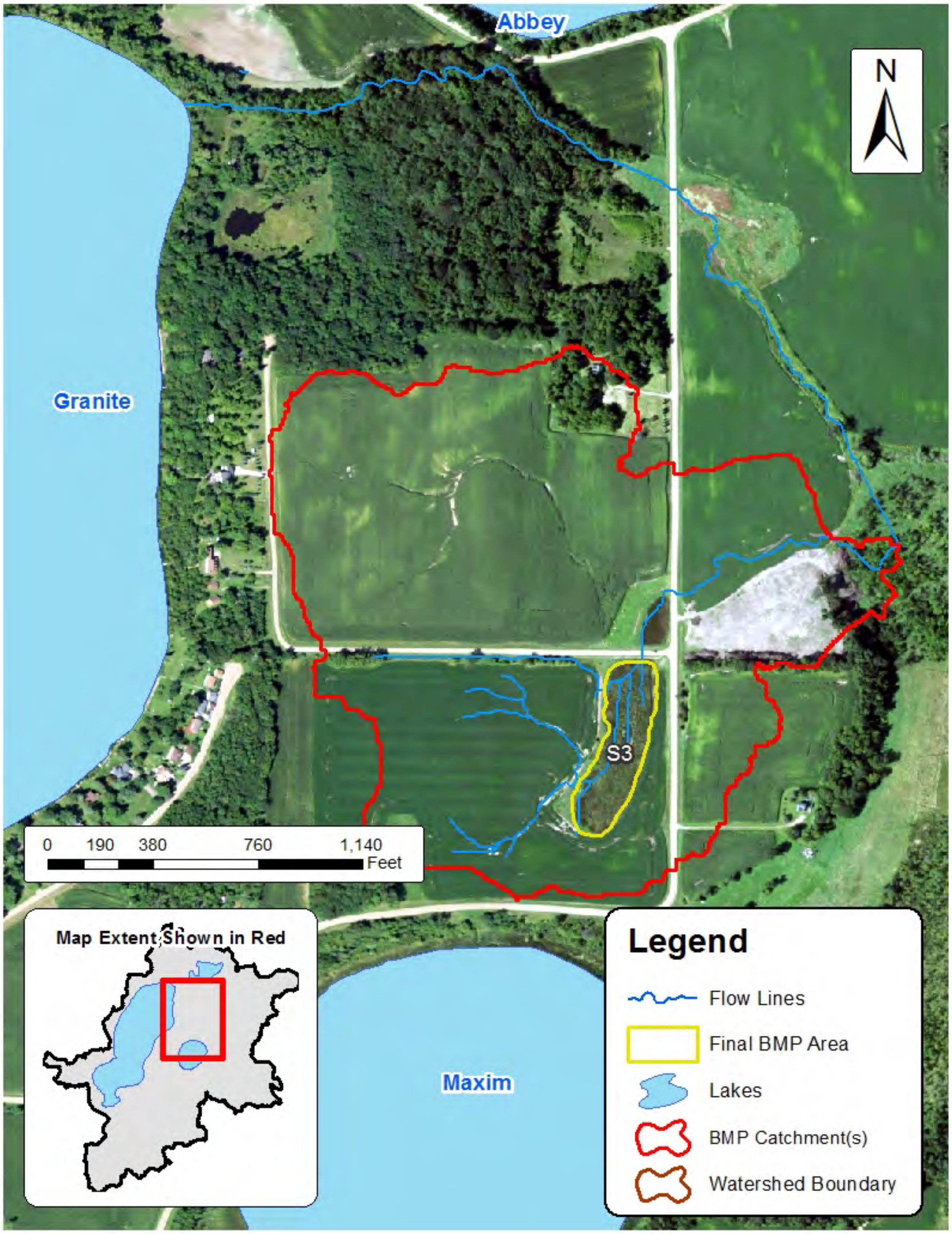

Figure 25. Catchment and flowpath for BMP S3

Catchment Description: S3 is contained in one catchment and is located near the top of the catchment. Water drains from the cropland through S3 and drains to a creek to Granite Lake. The landuse of the catchment is mixed: hay/pasture (31.60%), crops (26.53%), forest (18.32%), developed (11.40%), shrub (7.11%), herbaceous (1.65%) and wetland (1.5%).

Table 19. Ranking parameters for BMP S3

BMP Name	**S3**
Rank	4
Project Type	Control Basin
Project Size (acres)	2.4
Cost Estimate	$20,000
BMP TSS Load Reduction (tons/year)	18.6
BMP TP Load Reduction (lbs/year)	0.8
Catchment Number(s)	500094
Catchment Size (acres)	68.1
Catchment TSS Load (tons/year/acre)	1.0
Catchment TP Load (lbs/year/acre)	0.1

This BMP was very expansive as placed by PTMApp. Staff suggested keeping the storage practice to the mucky area to the east of the field and using source reduction on the remainder of the field.

Table 20. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S3

	PTMApp Design	**Staff Design**
Size	14.7	2.5
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	6.6	6.5
TSS-Q2 (tons/year)	18.9	18.6
TSS-Q3 (tons/year)	23.9	23.5
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.9	0.8
TP-Q3 (lbs /year)	1.6	1.3
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	6.6	6.5
TSS-Q2 (tons/year)	18.9	18.6
TSS-Q3 (tons/year)	23.9	23.5
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.9	0.8
TP-Q3 (lbs /year)	1.6	1.3

S4

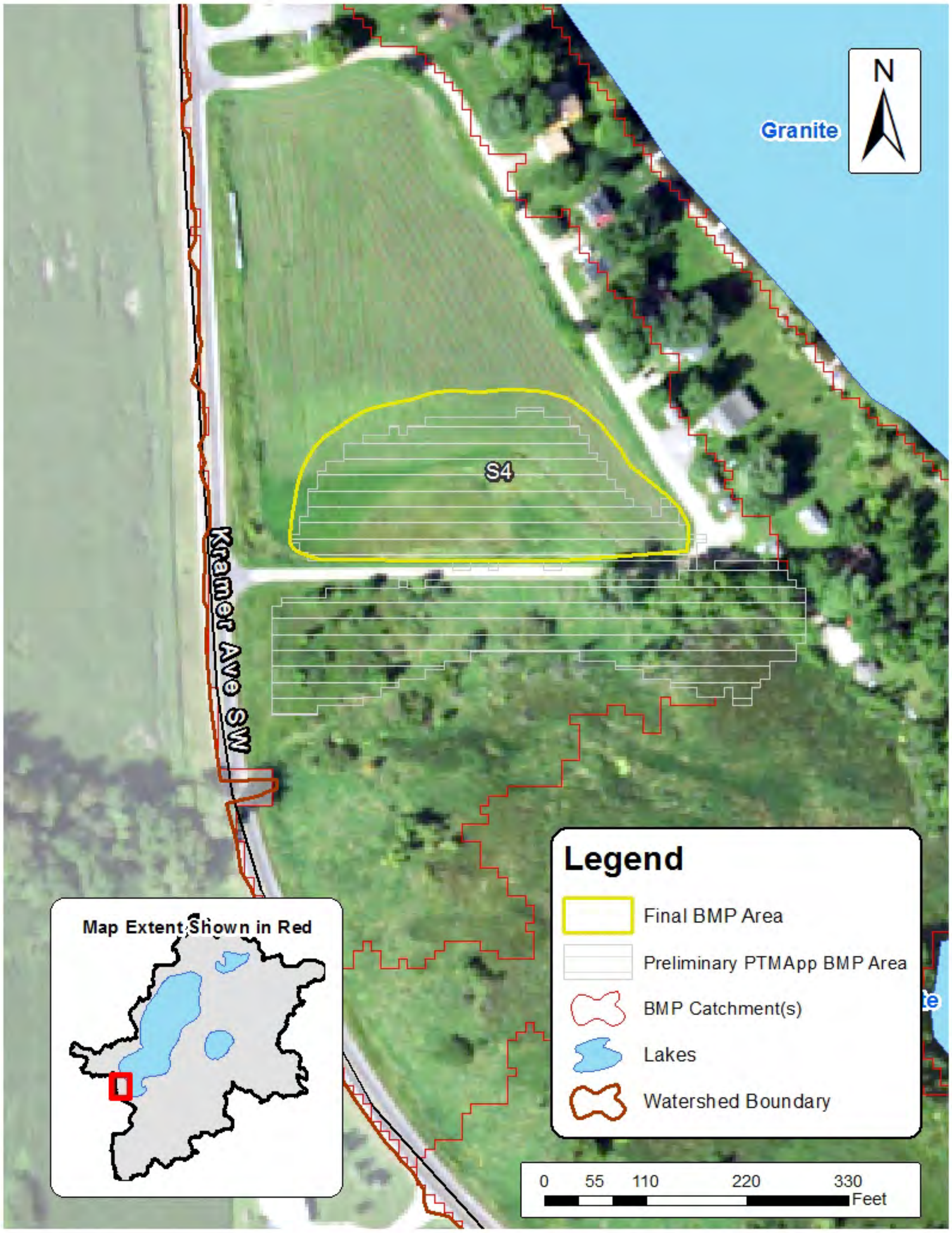

Figure 26. Field scale map of BMP S4, a control basin. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S4 is a water and sediment control basin west of Granite Lake. Dominant soil types are Glencoe clay loam and Cordova clay loam, 0-2% slopes.

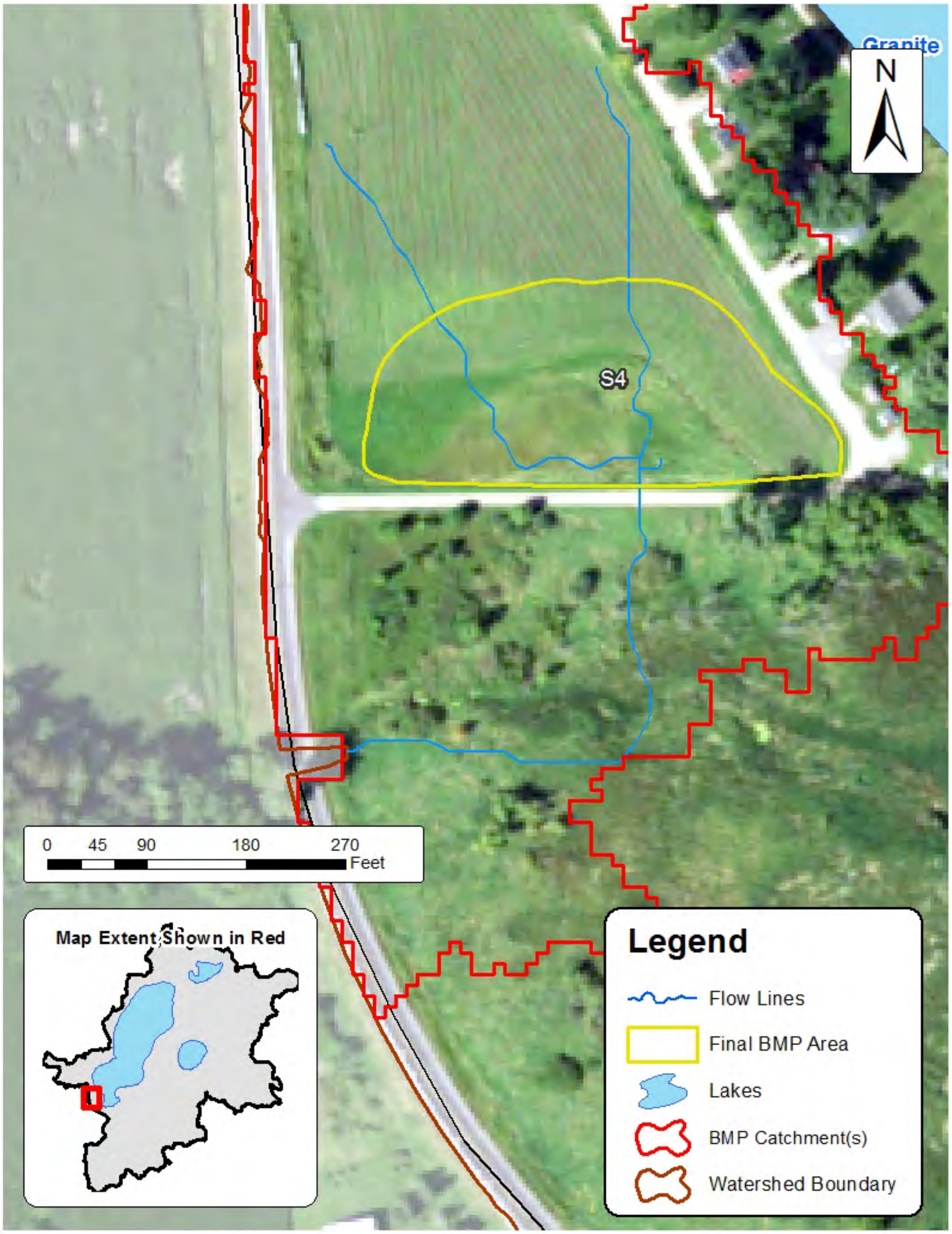

Figure 27. Catchment and flowpath for BMP S4

Catchment Description: S4 is contained within one catchment and is located near the bottom of the catchment. Water that flows through this practice does not travel through Granite Lake but exits the watershed through the same outlet. The catchment is mostly developed lakeshore (73.54%) the rest is crops (23.32%), wetlands (2.06%) and forest (1.08%)

Table 21. Ranking parameters for BMP S4

BMP Name	S4
Rank	3
Project Type	Control Basin
Project Size (acres)	1.4
Cost Estimate	$22,000
BMP TSS Load Reduction (tons/year)	0.5
BMP TP Load Reduction (lbs/year)	1.9
Catchment Number(s)	9914
Catchment Size (acres)	10.3
Catchment TSS Load (tons/year/acre)	0.1
Catchment TP Load (lbs/year/acre)	0.7

The PTMApp placement of this practice was very good. However, staff recommended keeping the practice to the north of the road.

Table 22. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S4

	PTMApp Design	Staff Design
Size	2.6	1.4
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.2	0.2
TSS-Q2 (tons/year)	0.5	0.5
TSS-Q3 (tons/year)	0.7	0.7
TP-Q1 (lbs /year)	0.1	0.0
TP-Q2 (lbs /year)	2.0	1.9
TP-Q3 (lbs /year)	3.5	3.4
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.2	0.2
TSS-Q2 (tons/year)	0.5	0.5
TSS-Q3 (tons/year)	0.7	0.7
TP-Q1 (lbs /year)	0.1	0.0
TP-Q2 (lbs /year)	2.0	1.9
TP-Q3 (lbs /year)	3.5	3.4

S5

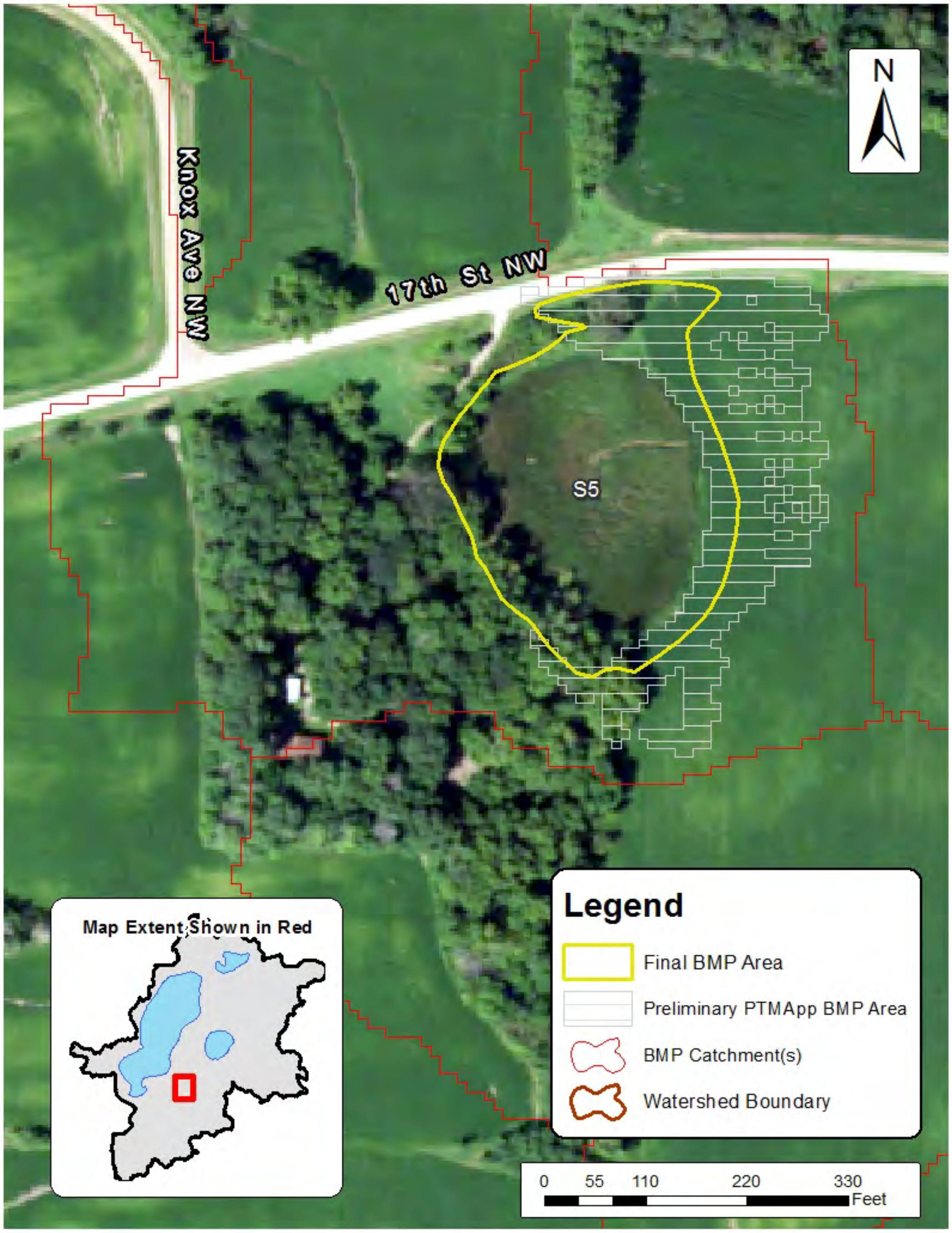

Figure 28. Field scale map of BMP S5, a wetland restoration. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S5 is a wetland restoration south east of Granite Lake. The dominant soil type is Klossner, Okoboji, and Glencoe soils, ponded, 0-1% slopes.

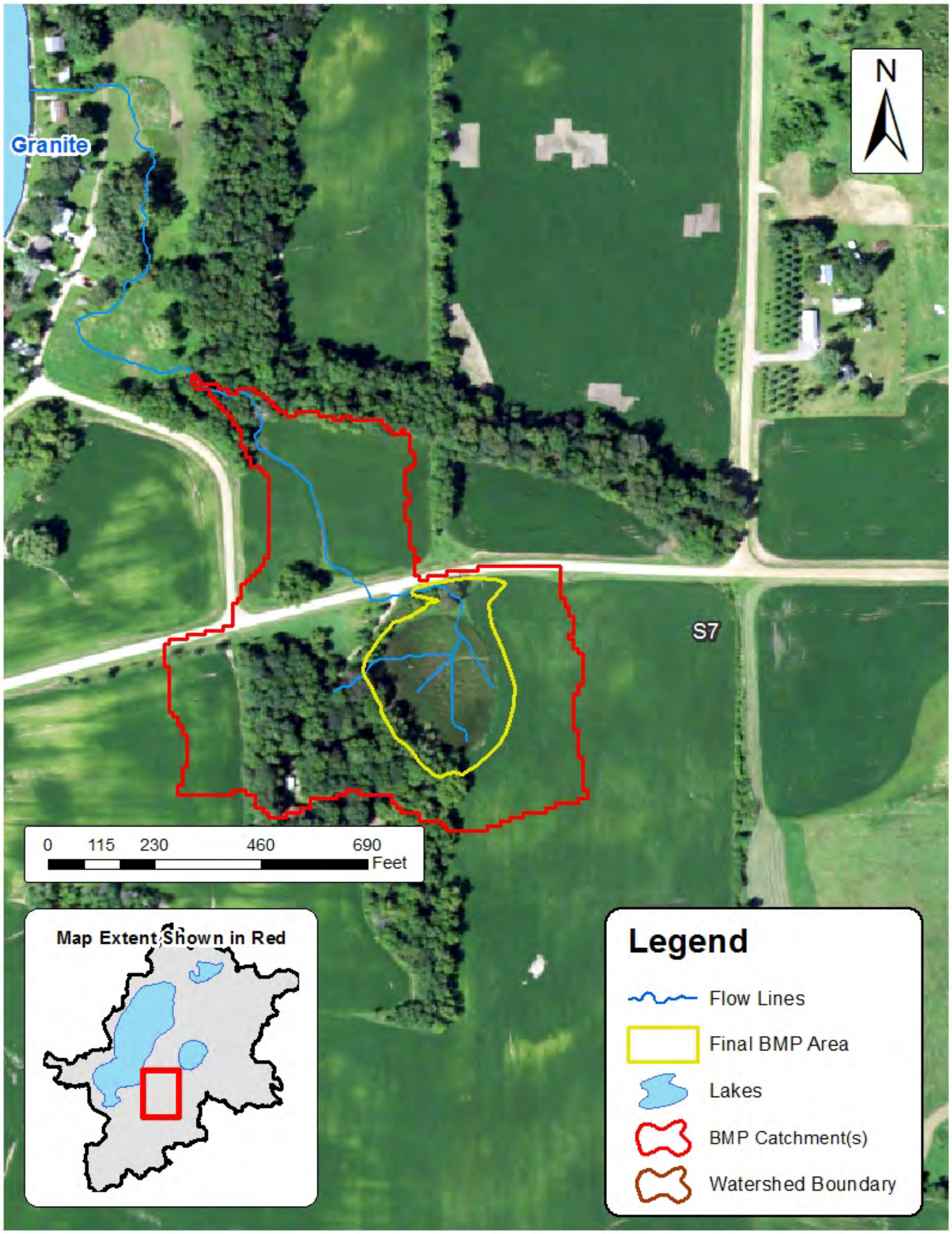

Figure 29. Catchment and flowpath for BMP F1

Catchment Description: S5 is contained within one catchment and is located near the top of the catchment. Water leaving S5 would flow northeast overland to Granite Lake. The landuse of the catchment is dominated by cultivated crops (68.6%). Other landuses include: forest (17.6%), developed (11.5%) and shrub (2.4%).

Table 23. Ranking parameters for BMP S5

BMP Name	S5
Rank	17
Project Type	Wetland Restoration
Project Size (acres)	2.2
Cost Estimate	$19,000
BMP TSS Load Reduction (tons/year)	1.6
BMP TP Load Reduction (lbs/year)	0.4
Catchment Number(s)	500192
Catchment Size (acres)	12.4
Catchment TSS Load (tons/year/acre)	0.6
Catchment TP Load (lbs/year/acre)	0.2

This BMP was sized well but staff suggested moving it into a natural depression. This is one of the few storage practices where the staff design was larger than the PTMApp placement.

Table 24. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S5

	PTMApp Design	Staff Design
Size	1.6	2.2
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.6	0.6
TSS-Q2 (tons/year)	1.6	1.6
TSS-Q3 (tons/year)	2.1	2.1
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.4	0.4
TP-Q3 (lbs /year)	0.7	0.7
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.6	0.6
TSS-Q2 (tons/year)	1.6	1.6
TSS-Q3 (tons/year)	2.1	2.1
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.4	0.4
TP-Q3 (lbs /year)	0.7	0.7

S6

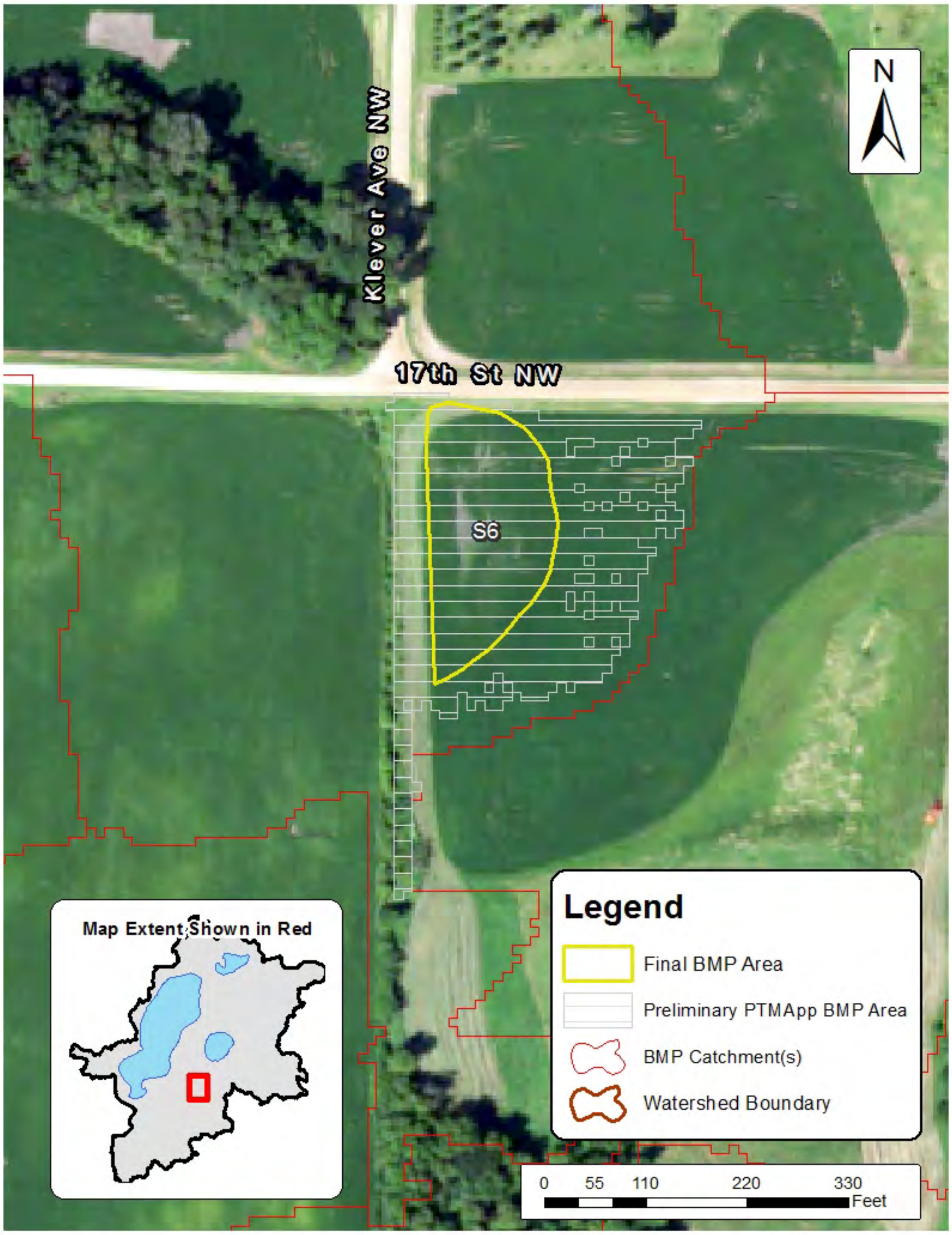

Figure 30. Field scale map of BMP S6, control basin. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S6 is a water and sediment control basin southeast of Granite Lake. The dominant soil type is Cordova clay loam, 0-2% slopes.

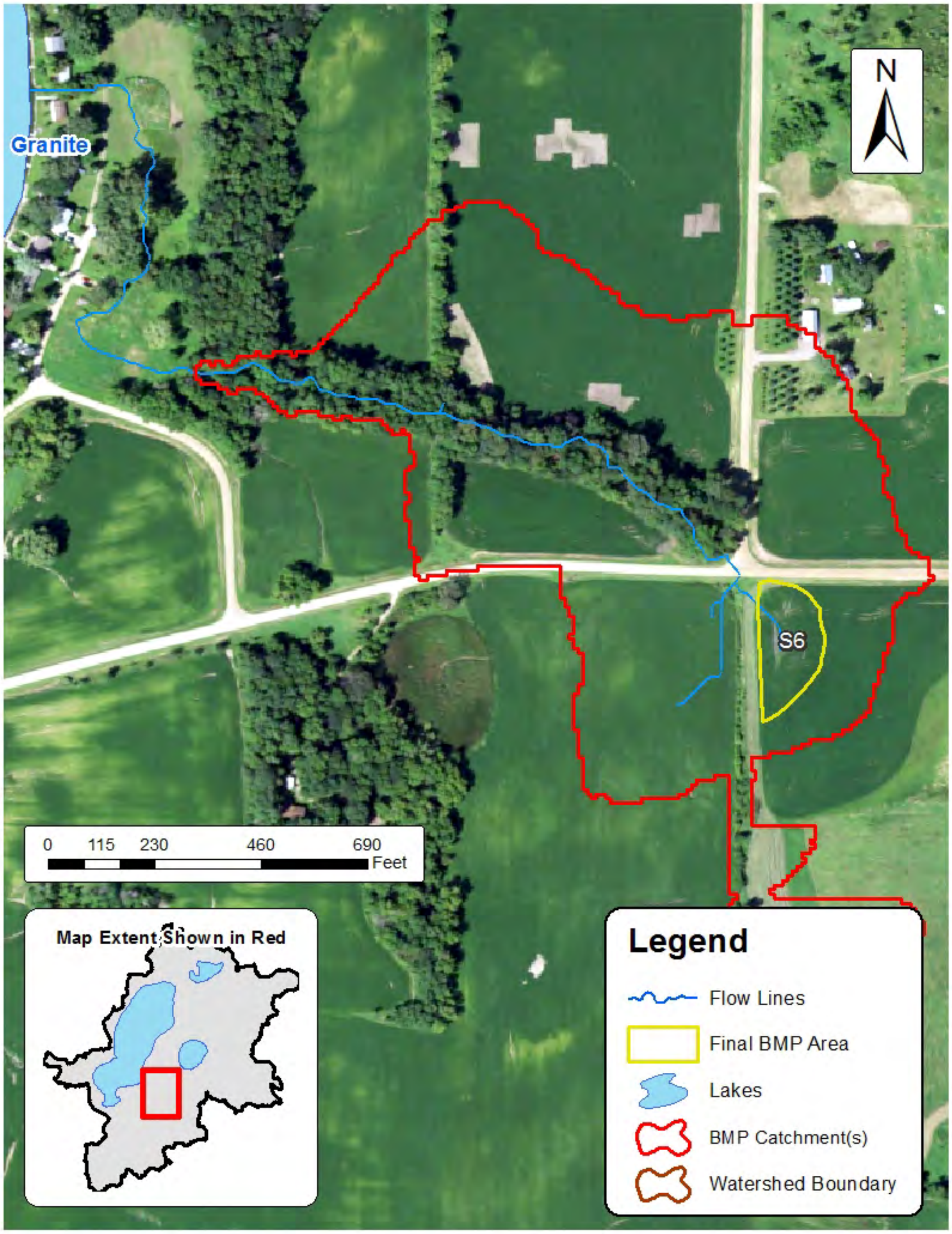

Figure 31. Catchment and flowpath for BMP S6

Catchment Description: S6 is contained within one catchment and is located at the top of the catchment. Water leaving S6 will flow west through a forest area then continue to enter Granite Lake via overland land flow. Landuse in the catchment is dominated by cultivated crops (79.3%) but also includes some developed (13.9%) and forest (6.8%).

Table 25. Ranking parameters for BMP S6

BMP Name	S6
Rank	13
Project Type	Control Basin
Project Size (acres)	0.7
Cost Estimate	$21,000
BMP TSS Load Reduction (tons/year)	1.1
BMP TP Load Reduction (lbs/year)	0.1
Catchment Number(s)	179
Catchment Size (acres)	24.5
Catchment TSS Load (tons/year/acre)	0.76
Catchment TP Load (lbs/year/acre)	0.2

This BMP was sized and shaped well but staff suggested moving it into a natural depression. It is unlikely that S6 would be built without S7.

Table 26. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S6

	PTMApp Design	Staff Design
Size	2.0	0.7
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.8	0.4
TSS-Q2 (tons/year)	2.4	1.1
TSS-Q3 (tons/year)	3.1	1.4
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.3	0.1
TP-Q3 (lbs /year)	0.5	0.2
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.8	0.4
TSS-Q2 (tons/year)	2.4	1.1
TSS-Q3 (tons/year)	3.1	1.4
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.3	0.1
TP-Q3 (lbs /year)	0.5	0.2

S7

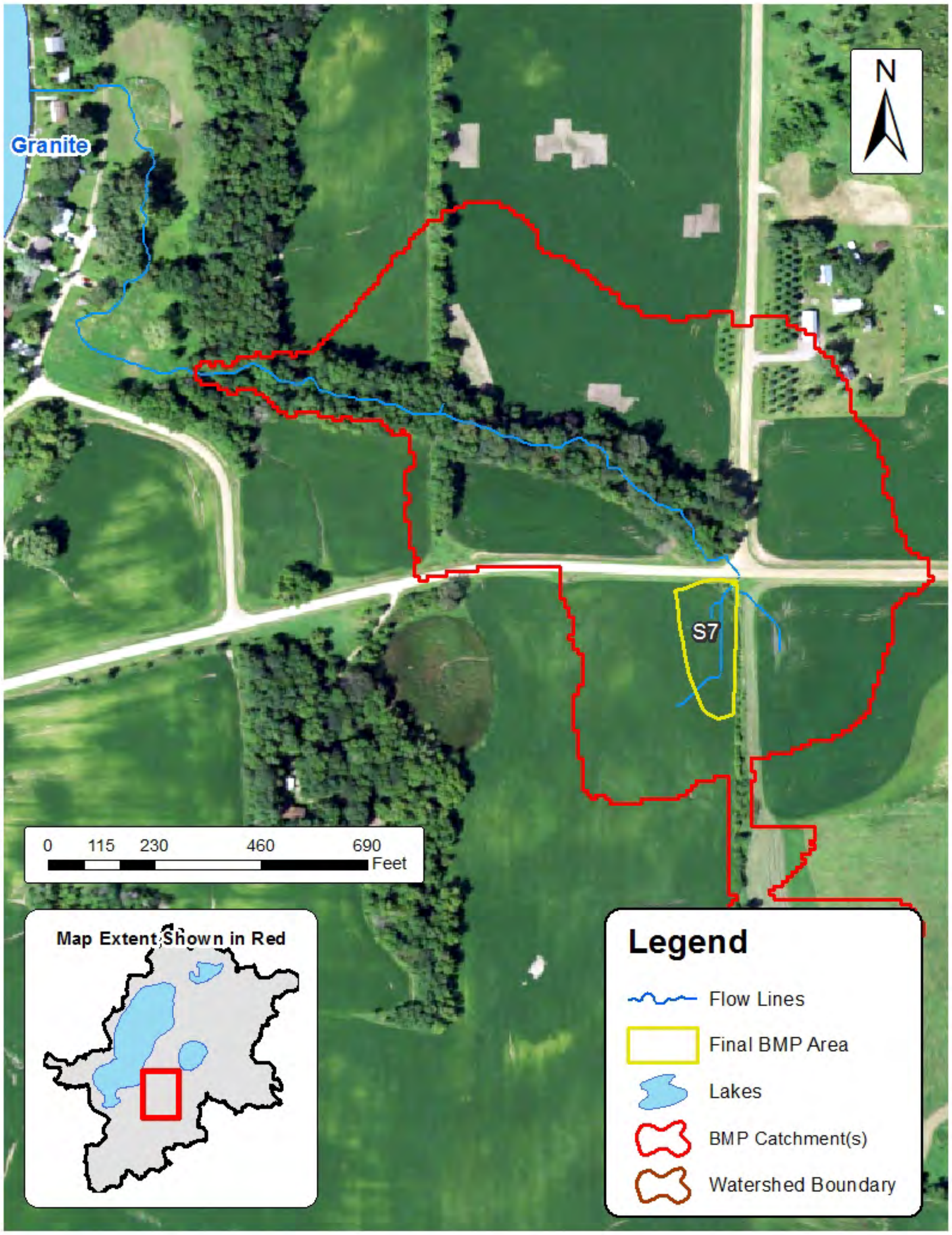

Figure 32. Field scale map of BMP F1, a filter strip. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S7 is a water and sediment control basin southeast of Granite Lake. The dominant soil type is Cordova clay loam, 0-2% slopes.

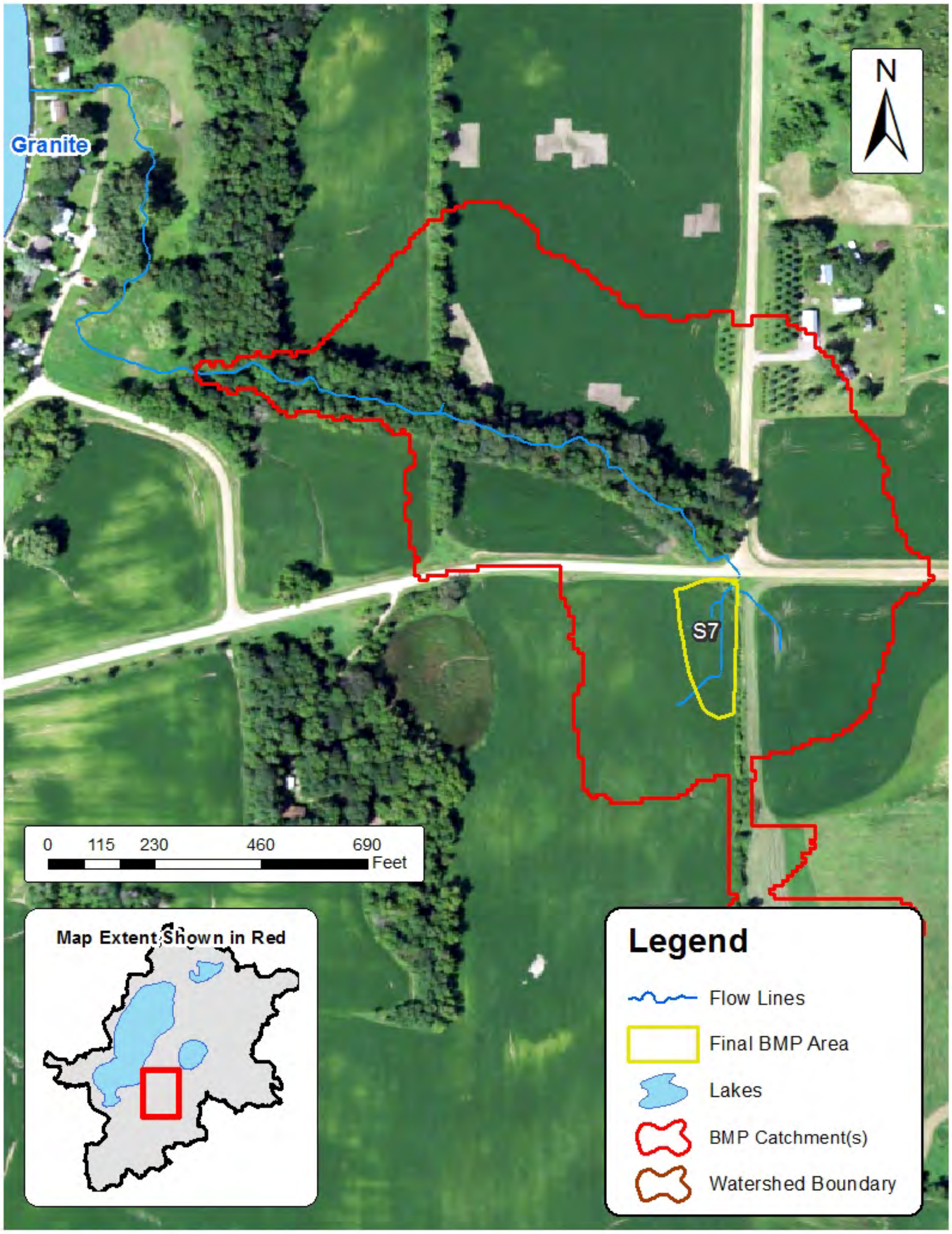

Figure 33. Catchment and flowpath for BMP F1

Catchment Description: Catchment Description: S7 is contained within one catchment and is located at the top of the catchment. Water leaving S7 will flow west through a forest area then continue to enter Granite Lake via overland land flow. Landuse in the catchment is dominated by cultivated crops (79.3%) but also includes some developed (13.9%) and forest (6.8%).

Table 27. Ranking parameters for BMP F1

BMP Name	**S7**
Rank	11
Project Type	Control Basin
Project Size (acres)	0.7
Cost Estimate	$21,000
BMP TSS Load Reduction (tons/year)	2.1
BMP TP Load Reduction (lbs/year)	0.2
Catchment Number(s)	179
Catchment Size (acres)	24.5
Catchment TSS Load (tons/year/acre)	0.8
Catchment TP Load (lbs/year/acre)	0.2

This BMP was sized and shaped well but staff suggested moving it into a natural depression. It is unlikely that S7 would be built without S6.

Table 28. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F1

	PTMApp Design	**Staff Design**
Size	2.5	0.7
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.5	0.7
TSS-Q2 (tons/year)	1.4	2.1
TSS-Q3 (tons/year)	1.8	2.6
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.2	0.2
TP-Q3 (lbs /year)	0.3	0.3
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.5	0.8
TSS-Q2 (tons/year)	1.4	2.4
TSS-Q3 (tons/year)	1.8	3.1
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.2	0.3
TP-Q3 (lbs /year)	0.3	0.5

S8

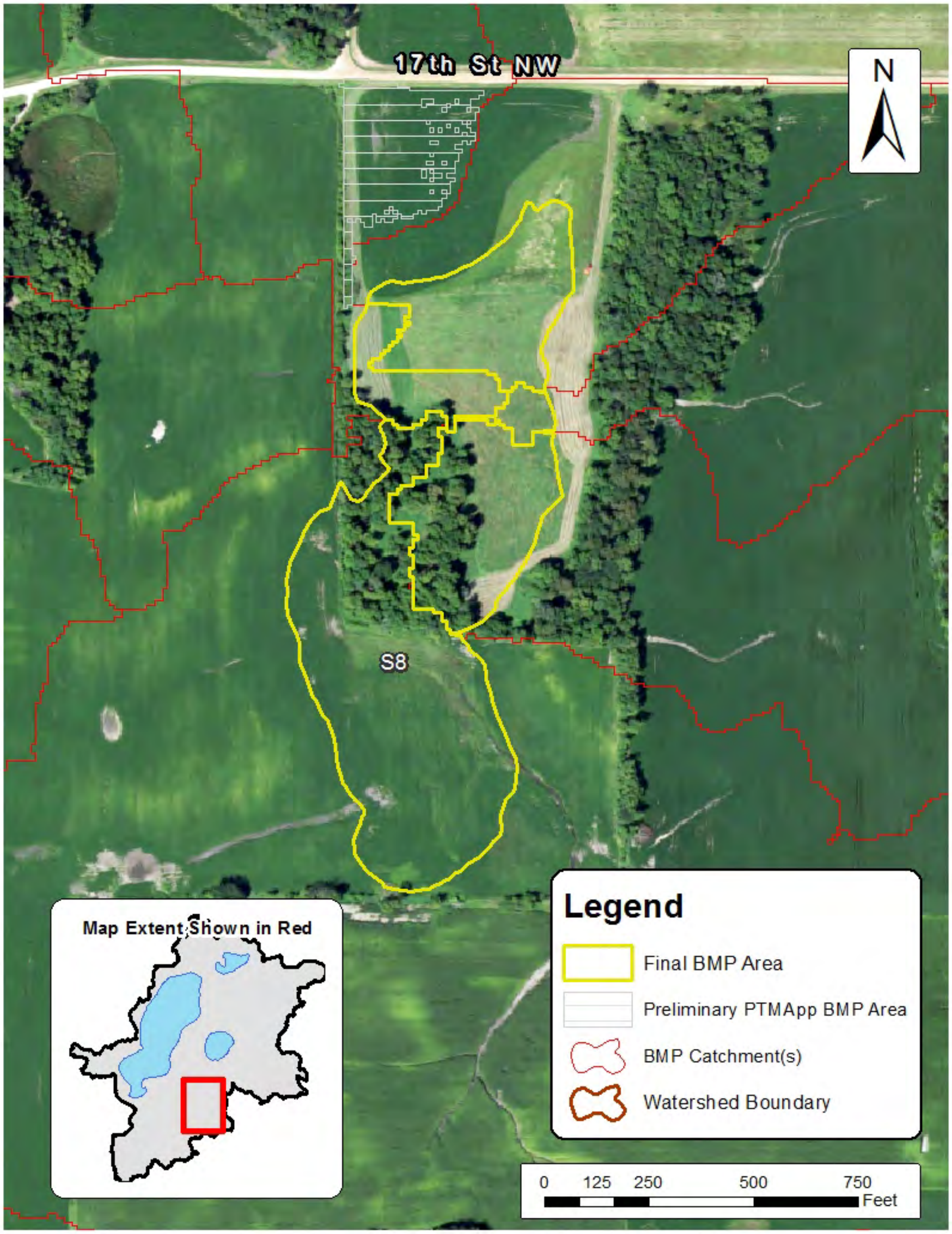

Figure 34. Field scale map of BMP F1, a filter strip. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: S8 is a water and sediment control basin southeast of Granite Lake. The dominant soil type is Houghton muck, depressional, 0-1% slopes.

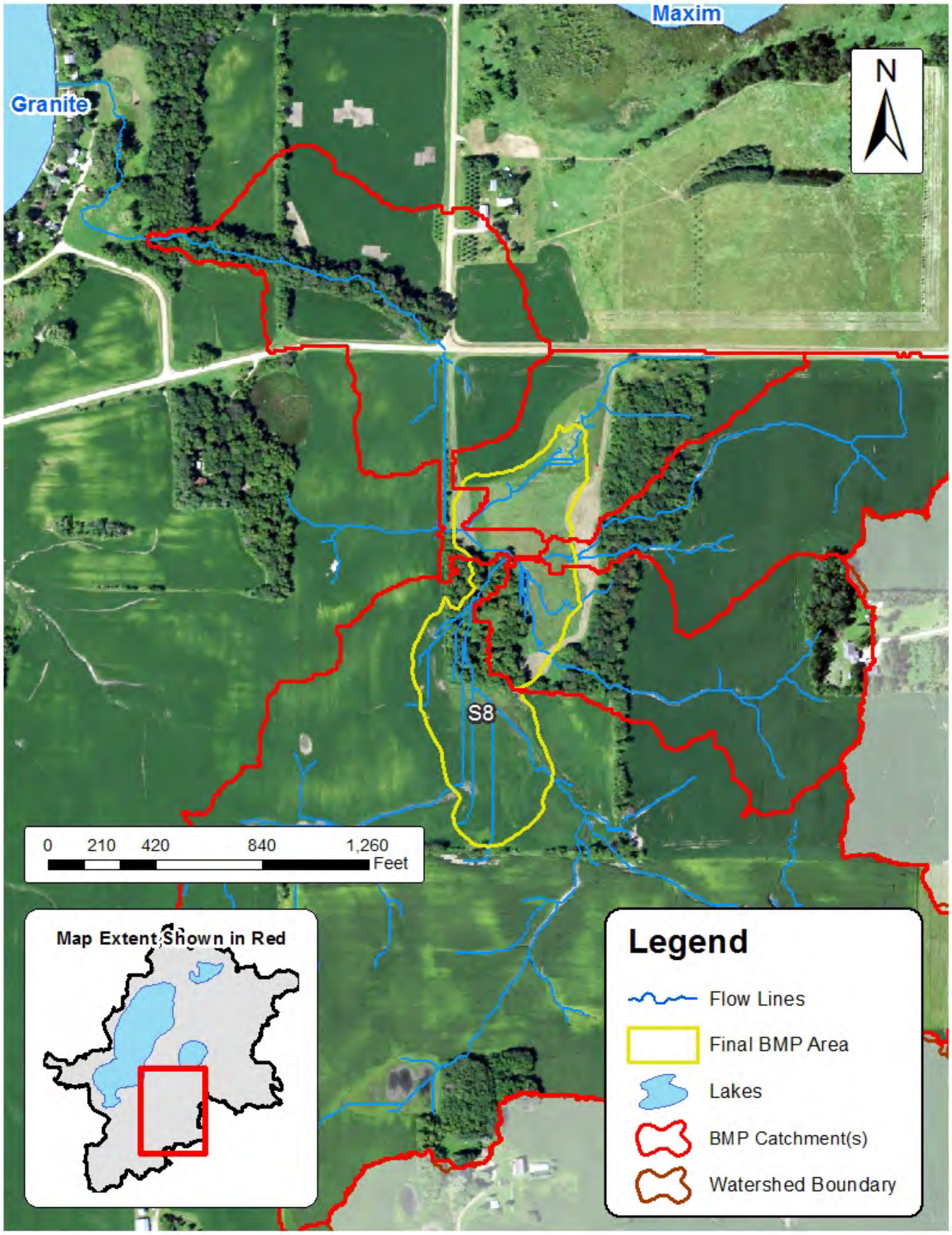

Figure 35. Catchment and flowpath for BMP F1

Catchment Description: S8 is divided among 5 catchments. Water leaving S5 would flow north through an open ditch to a forest creek and enter Granite Lake via a culvert. Landuse among the catchments is overwhelmingly cultivated crops (84.7%). Other landuse includes forest (5.7%), hay/pasture (5.6%), developed (2.1%) and wetlands (1.9%).

Table 29. Ranking parameters for BMP S8

BMP Name	S8
Rank	20
Project Type	Control Basin
Project Size (acres)	15.3
Cost Estimate	$11,000
BMP TSS Load Reduction (tons/year)	N/A
BMP TP Load Reduction (lbs/year)	N/A
Catchment Number(s)	179, 500198, 500215, 500234, 500217
Catchment Size (acres)	24.6, 13.2, 20.5, 21.8, 102.4
Catchment TSS Load (tons/year/acre)	0.8, 0.2, 0.6, 0.5, 1.0
Catchment TP Load (lbs/year/acre)	0.2, 0.1, 0.2, 0.1. 0.1

This BMP did not have an original PTMApp design, but it was noticed as a possibility near BMPs S6 and S7. Due to bugs in PTMApp no reductions were calculated for this practice.

Table 30. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP S8

	PTMApp Design	Staff Design
Size	N/A	15.3
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	N/A	N/A
TSS-Q2 (tons/year)	N/A	N/A
TSS-Q3 (tons/year)	N/A	N/A
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	N/A	N/A
TP-Q3 (lbs /year)	N/A	N/A
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	N/A	N/A
TSS-Q2 (tons/year)	N/A	N/A
TSS-Q3 (tons/year)	N/A	N/A
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	N/A	N/A
TP-Q3 (lbs /year)	N/A	N/A

Source Reduction

Source reduction practices are intended to reduce the amount of contaminants coming off of the field in the first place. These are generally management practices on farmland such as introducing a new crop rotation, adding a cover crop, using conservation tillage or improving nutrient management strategies.

Cost of implementing a source reduction practice is highly variable depending on the project choice. For example taking a field out of projection and into CRP would result in a loss of income from crop production but may net a profit based on federal compensation and current crop prices. A change in rotation may also yield an income loss because certain crops are less profitable. Cover crops require an additional planting but can have a profit if the land is rented for pasture. EQIPment changes due to any of these programs is also an indirect cost to the producer. Conservation tillage is a great example of this, less tillage saves a producer money but if he needs to buy a new piece of Equipment to do it his savings will be cut into for several years.

In an effort to standardize the costs for this project we use cover crop as our standard practice. This is in part because we assume that cover crops will have one of the highest direct costs per acre. Equipment changes are not included in this assumption. Wright SWCD is currently working on a new cost-share program to fund cover crop plantings (especially inter-seeding). NRCS also funds cover crops through EQIP. Both the Wright SWCD program and EQIP use a flat rate price of $35-$70/acre depending on seed mixes, this is assumed to cover seed and installation cost.

SR1

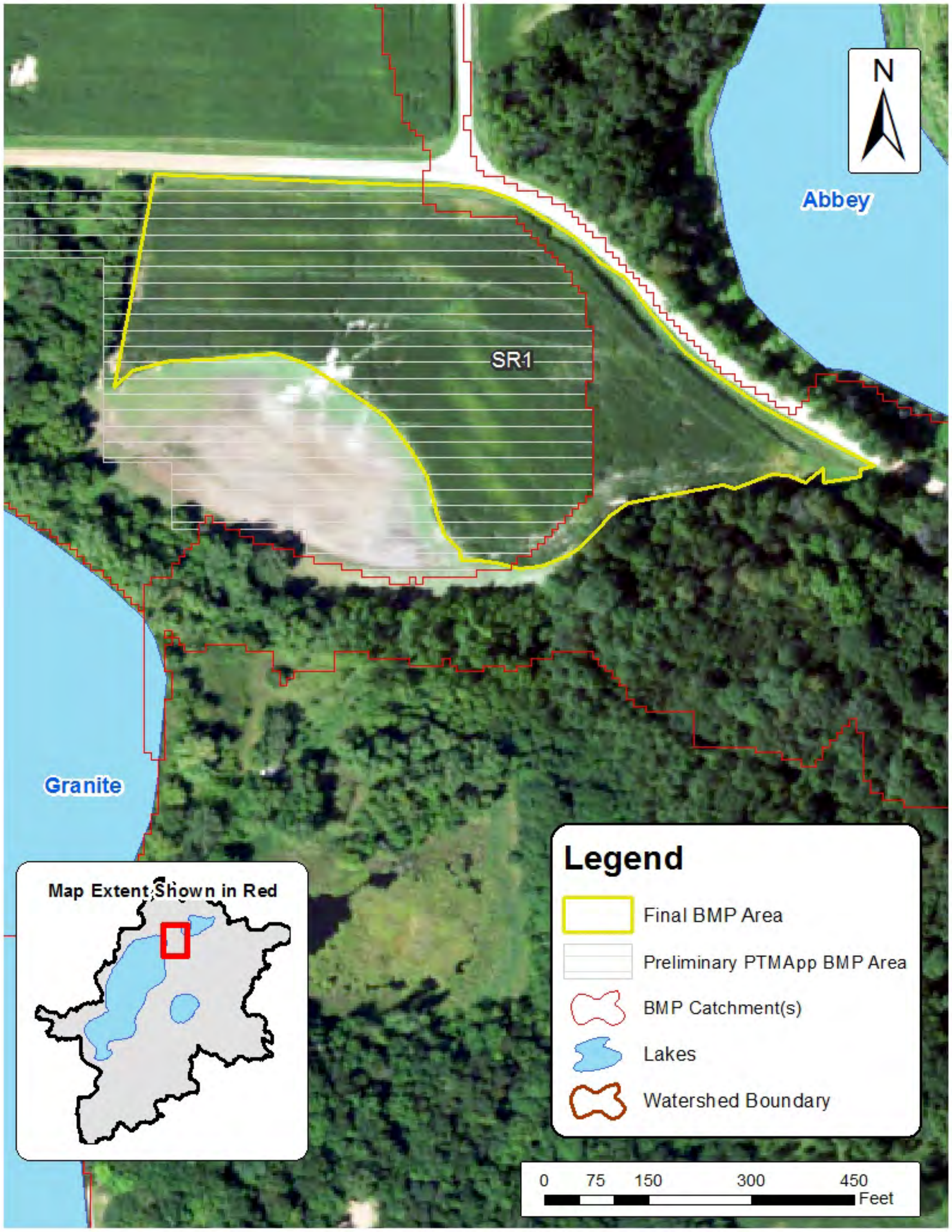

Figure 36. Field scale map of BMP SR1, a source reduction area.. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR1 is a source reduction field between Granite Lake and Abbey Lake. The dominant soil type is Lester loam, 12-18% slopes, eroded. Southwest of SR1 is an existing BMP designed to store water and allow it to infiltrate prior to entering Granite Lake. SR1 would help extend the life of that BMP

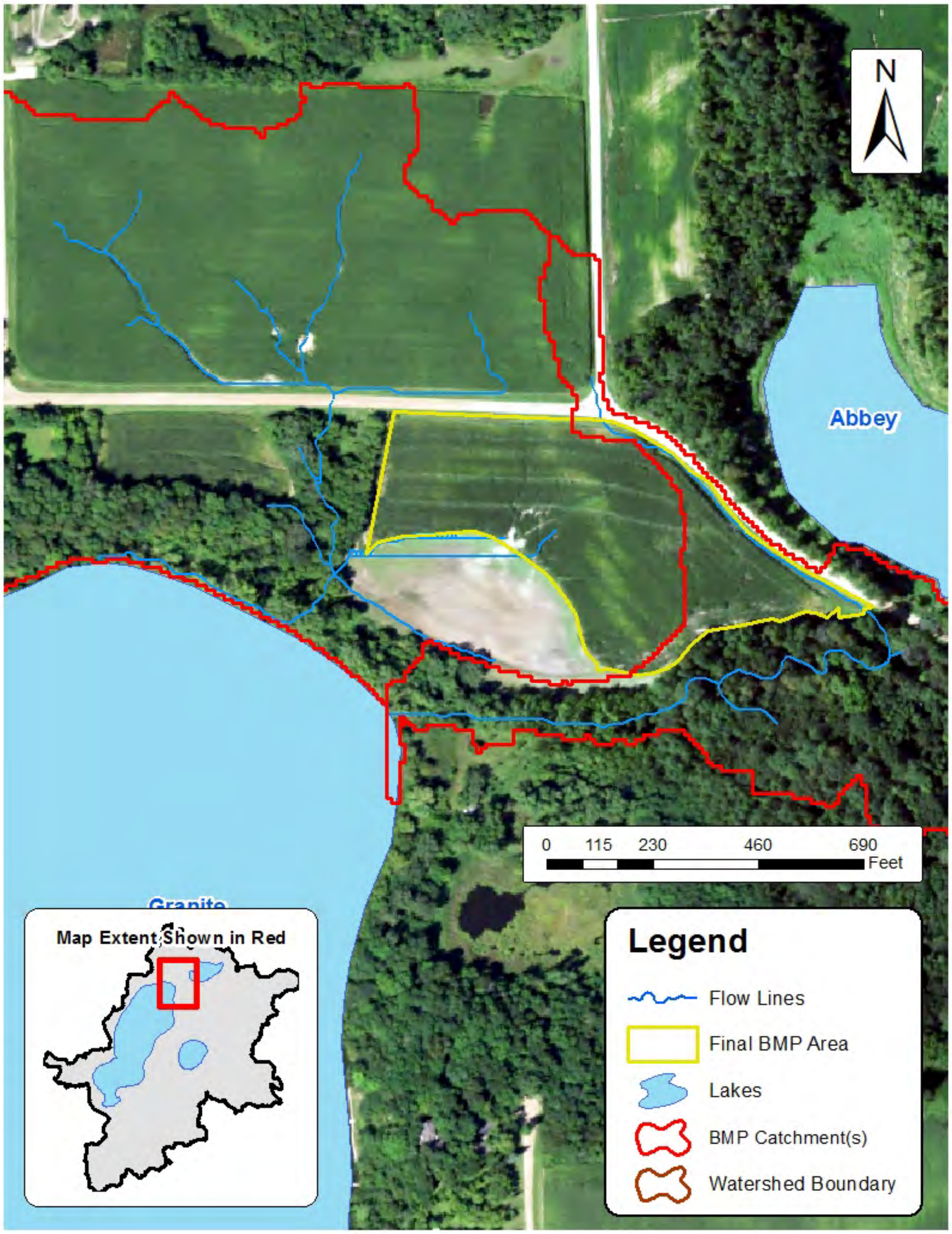

Figure 37. Catchment and flowpath for BMP SR1

Catchment Description: SR1 is spilt between two catchments and the water enters Granite Lake at two different points. Water flows southwest from SR1 through a forest and into Granite Lake from the west side of SR1. From the east side the water flows east to the forest and then west through the forest to Granite Lake. Landuse between the two catchments is dominated by cultivated crops (43.8%) and hay/pasture (19.3%). Other landuse includes: forest (13.1%), developed (13.1%), shrub (5.9%), wetlands (2.3%), open water (1.1%) and herbaceous (0.7%)

Table 31. Ranking parameters for BMP SR1

BMP Name	SR1
Rank	5
Project Type	Source Reduction
Project Size (acres)	7.1
Cost Estimate	$497
BMP TSS Load Reduction (tons/year)	20.0
BMP TP Load Reduction (lbs/year)	1.0
Catchment Number(s)	9906, 9915
Catchment Size (acres)	40.2, 53.4
Catchment TSS Load (tons/year/acre)	0.9
Catchment TP Load (lbs/year/acre)	0.1

This BMP was placed relatively well by PTMApp, however because the field is divided by a catchment line the practice was expanded to incorporate the additional area. In addition staff trimmed the extra PTMApp area so the practice only includes land that is in production.

Table 32. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F1

	PTMApp Design	Staff Design
Size	9.6	7.1
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	2.5	5.0
TSS-Q2 (tons/year)	10.1	20.0
TSS-Q3 (tons/year)	13.7	27.0
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.7	1.0
TP-Q3 (lbs /year)	0.8	1.2
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	2.5	5.0
TSS-Q2 (tons/year)	10.1	20.0
TSS-Q3 (tons/year)	13.7	27.0
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.7	1.0
TP-Q3 (lbs /year)	0.8	1.2

SR2

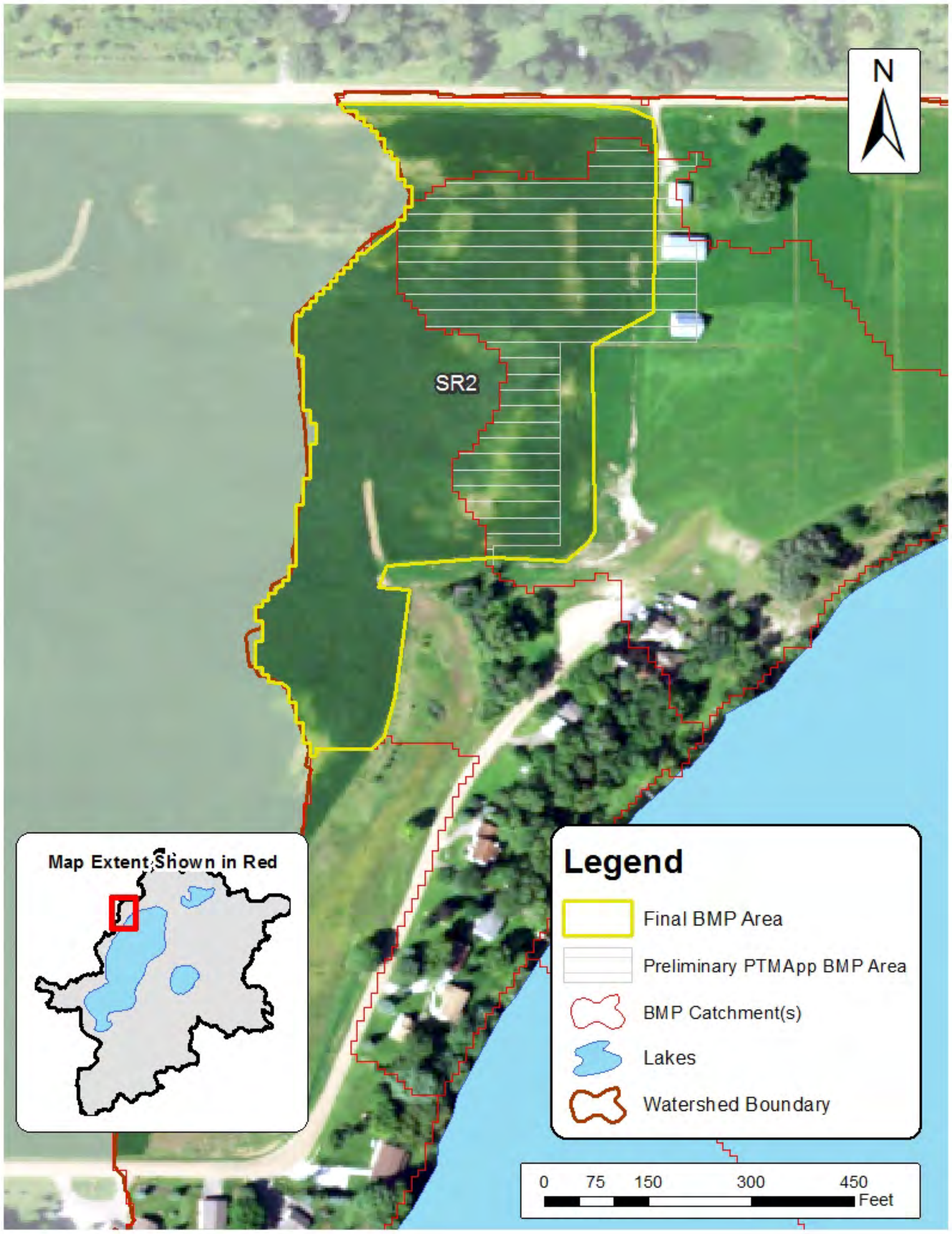

Figure 38. Field scale map of BMP F1, a filter strip. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR2 is a source reduction field on the northwest side of Granite Lake. There is a mix of soil type on this field including: Angus-Le Sueur complex 1-5% slopes, Lester Loam 6-18% slopes, eroded and Angus loam 2-5% slopes.

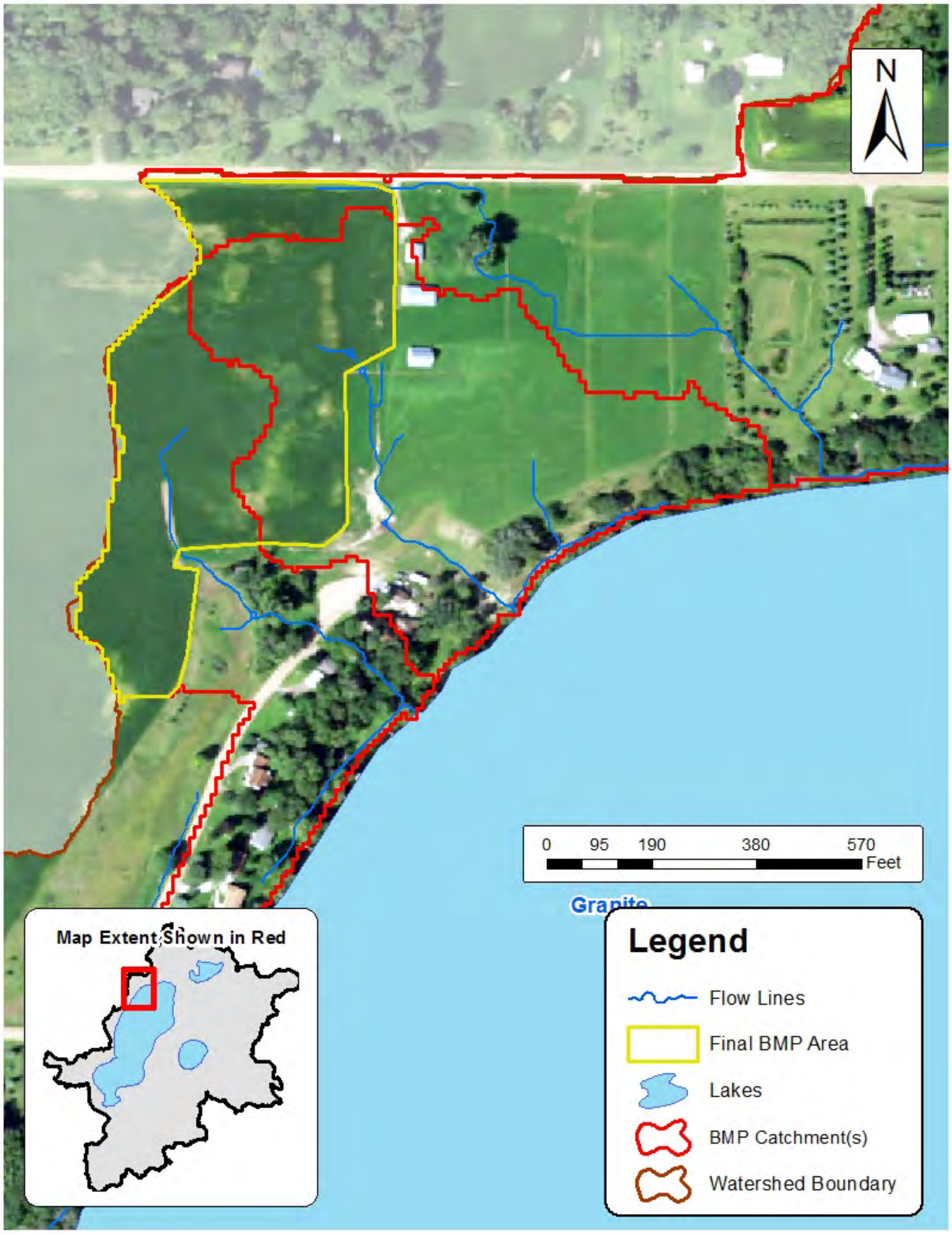

Figure 39. Catchment and flowpath for BMP F1

Catchment Description: SR2 is divided between to catchment and water draining from it will enter Granite Lake in two different areas. Water in general flows south but the field has a watershed divide that sends the water to two different culverts before it enters Granite Lake. The primary landuse between the catchments is cultivated crops (42.9%), and hay/pasture (37.0%) other landuses include forest (11.0%) and developed (9.0%).

Table 33. Ranking parameters for BMP F1

BMP Name	SR2
Rank	7
Project Type	Source Reduction
Project Size (acres)	7.4
Cost Estimate	$518
BMP TSS Load Reduction (tons/year)	5.1
BMP TP Load Reduction (lbs/year)	0.6
Catchment Number(s)	9907, 9908
Catchment Size (acres)	18.2
Catchment TSS Load (tons/year/acre)	1.2
Catchment TP Load (lbs/year/acre)	0.1

This BMP was placed relatively well by PTMApp, however because the field is divided by a catchment line the practice was expanded to incorporate the additional area. In addition staff trimmed the extra PTMApp area so the practice only includes land that is in production.

Table 34. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F1

	PTMApp Design	Staff Design
Size	3.2	7.4
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.7	1.3
TSS-Q2 (tons/year)	2.8	5.1
TSS-Q3 (tons/year)	3.8	6.9
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.2	0.6
TP-Q3 (lbs /year)	0.3	0.7
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.7	1.3
TSS-Q2 (tons/year)	2.8	5.1
TSS-Q3 (tons/year)	3.8	6.9
TP-Q1 (lbs /year)	0.0	0.0
TP-Q2 (lbs /year)	0.2	0.6
TP-Q3 (lbs /year)	0.3	0.7

SR3

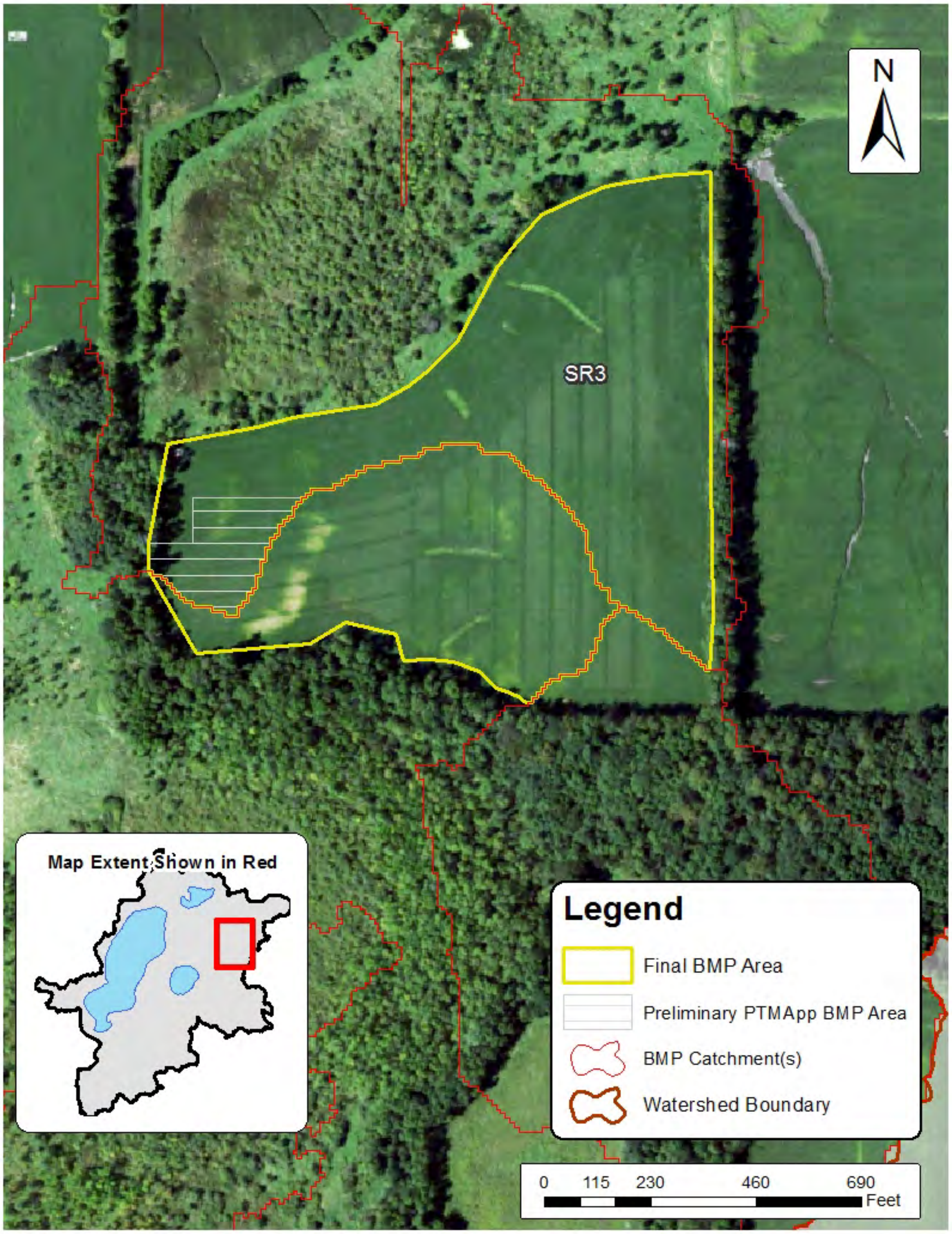

Figure 40. Field scale map of BMP SR23 a source reduction practice. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR3 is a source reduction field west of Granite Lake. The dominant soils are Angus loam 2-5% slopes and Lester loam 6-12% slopes, eroded.

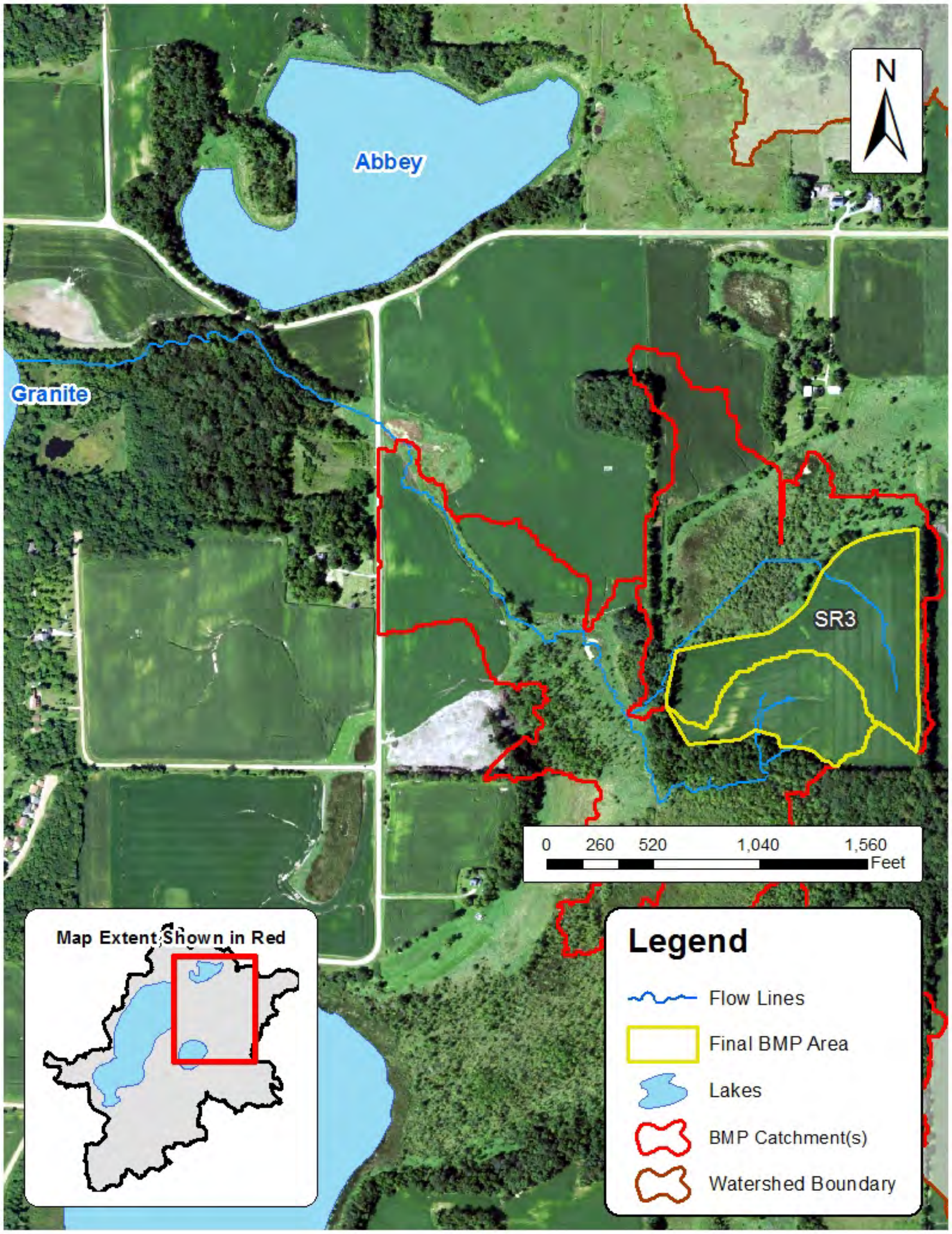

Figure 41. Catchment and flowpath for BMP SR3

Catchment Description: SR 3 is spilt between two catchments. SR3 is located at the top of both catchments. Water flows northwest from each over more cropland through and forest and enters Granite Lake through culvert. Landuses among the catchments is dominated by cultivated crops (33.2%), forest (27.8%) and hay/pasture (19.2%).Other landuse includes wetlands (8.2%), shrub (5.6%), herbaceous (4.5%) and developed (1.4%).

Table 35. Ranking parameters for BMP F1

BMP Name	**SR3**
Rank	8
Project Type	Source Reduction
Project Size (acres)	20.9
Cost Estimate	$1,463
BMP TSS Load Reduction (tons/year)	16.9
BMP TP Load Reduction (lbs/year)	1.0
Catchment Number(s)	73, 69, 500115
Catchment Size (acres)	131.9
Catchment TSS Load (tons/year/acre)	0.7, 0.4, 0.1
Catchment TP Load (lbs/year/acre)	0.1, 0.1, 0.05

This BMP was much too small to be a practical source reduction practice. Source reduction needs to cover an entire field. Staff expanded the practice to include the whole production area.

Table 36. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP F1

	PTMApp Design	**Staff Design**
Size	6.4	20.9
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	1.8	4.2
TSS-Q2 (tons/year)	7.3	16.9
TSS-Q3 (tons/year)	9.8	22.7
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	0.4	1.0
TP-Q3 (lbs /year)	0.5	1.2
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	1.8	4.2
TSS-Q2 (tons/year)	7.3	16.9
TSS-Q3 (tons/year)	9.8	22.7
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	0.4	1.0
TP-Q3 (lbs /year)	0.5	1.2

SR4

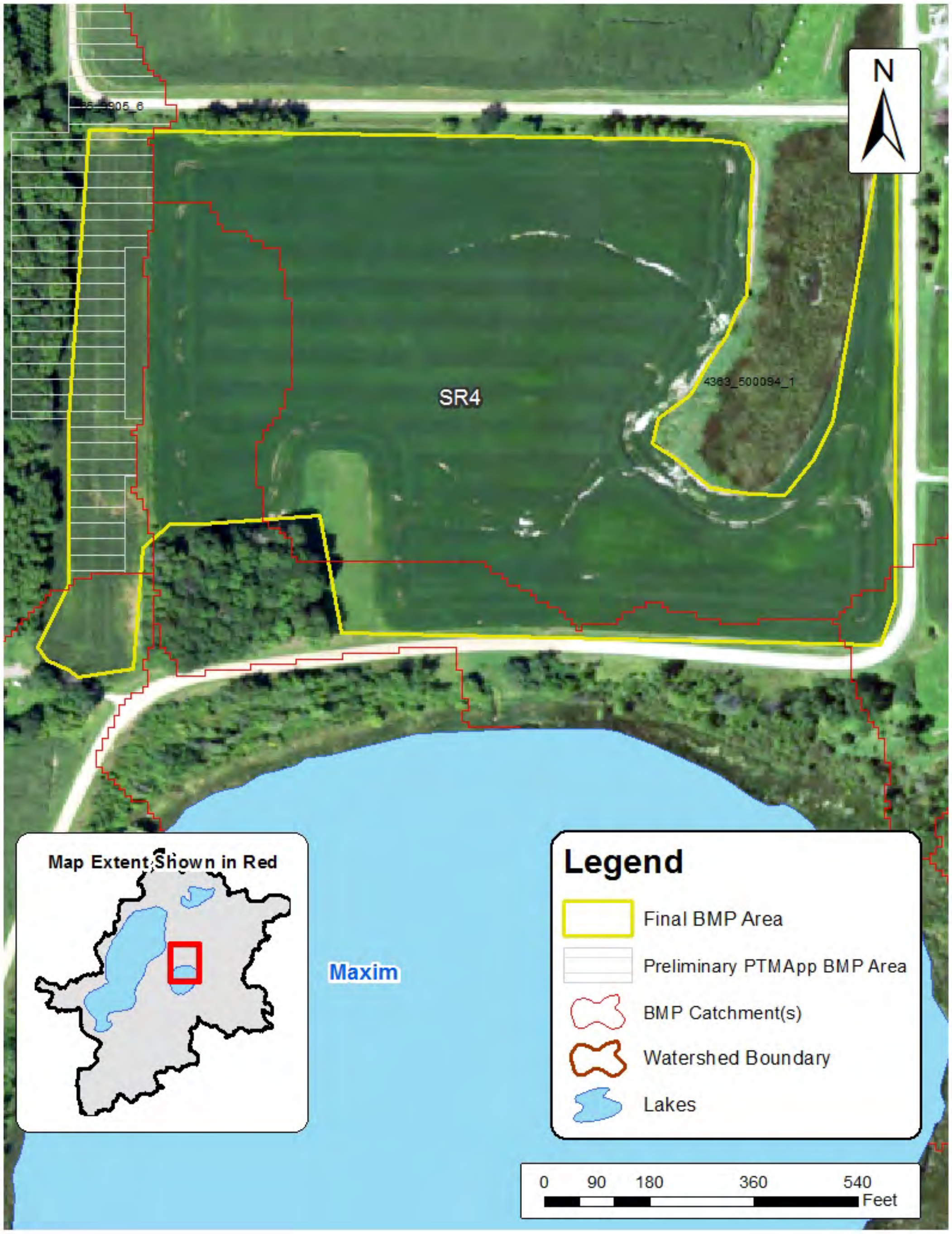

Figure 42. Field scale map of BMP SR4, a source reduction.. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR4 is a source reduction field west of Granite Lake and north of Lake Maxim. The dominant soil type is Lester loam 6-18% slopes, eroded.

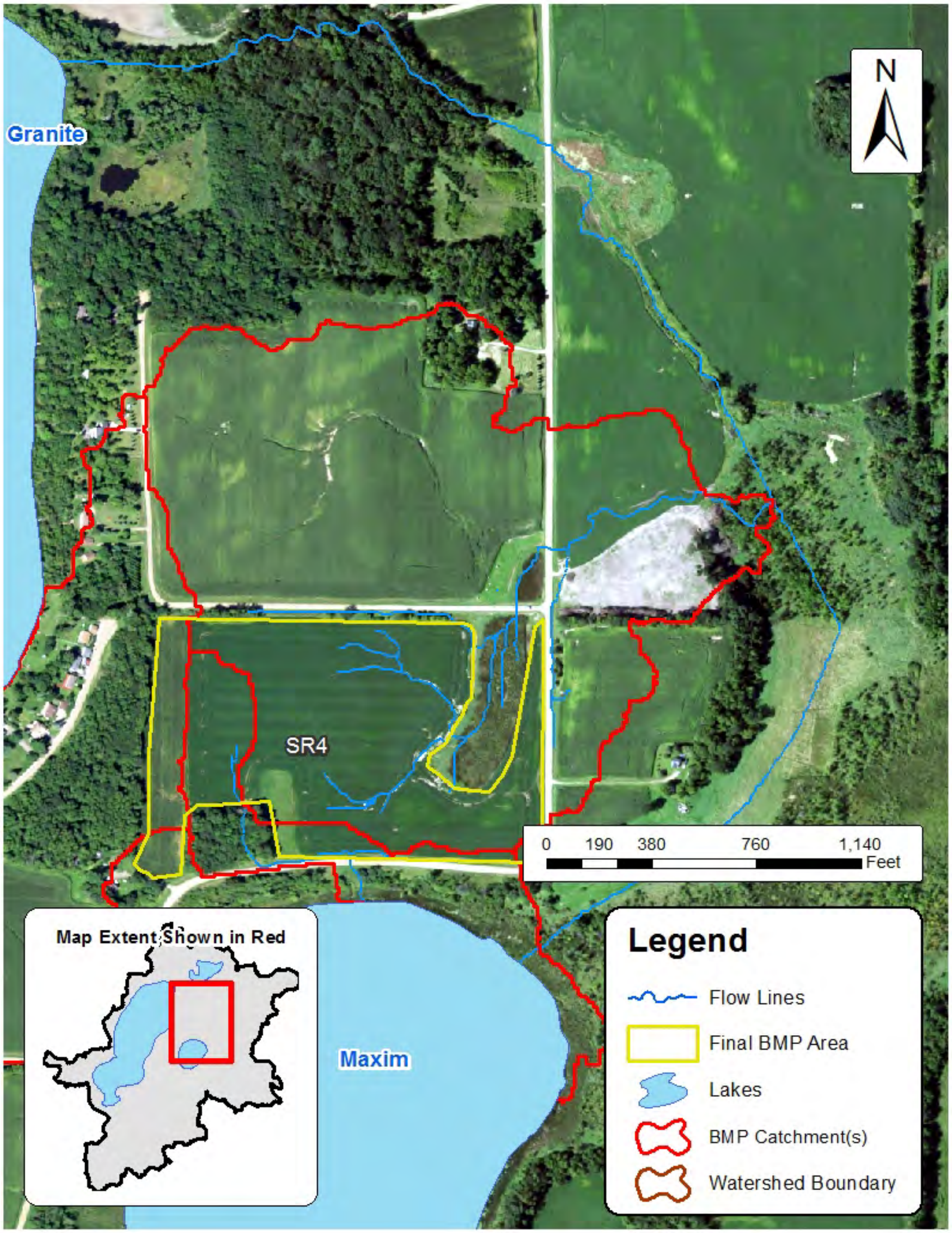

Figure 43. Catchment and flowpath for BMP SR4

Catchment Description: SR4 is primarily in one catchment but included in a total of three catchments. Water flows west overland and enters Granite Lake from a wetland on the south side of the lake. Landuse among the catchments is dominated by cultivated crops (40.2%), hay/pasture (25.1%) and forest (11.4%). Other landuse includes developed (10.4%), wetlands (1.8%), and herbaceous (1.5%).

Table 37. Ranking parameters for BMP F1

BMP Name	SR4
Rank	6
Project Type	Source Reduction
Project Size (acres)	21.1
Cost Estimate	$1,477
BMP TSS Load Reduction (tons/year)	14.9
BMP TP Load Reduction (lbs/year)	0.8
Catchment Number(s)	500094, 9912, 109
Catchment Size (acres)	102.1
Catchment TSS Load (tons/year/acre)	1.0, 0.05, 0.5
Catchment TP Load (lbs/year/acre)	0.1, 0.03, 0.09

This BMP was much too small to be a practical source reduction practice. Source reduction needs to cover an entire field. Staff expanded the practice to include the whole production area.

Table 38. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP SR4

	PTMApp Design	Staff Design
Size	4.4	21.1
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	0.8	3.7
TSS-Q2 (tons/year)	3.3	14.9
TSS-Q3 (tons/year)	4.4	20.0
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	0.3	0.8
TP-Q3 (lbs /year)	0.4	1.0
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	0.8	3.7
TSS-Q2 (tons/year)	3.3	14.9
TSS-Q3 (tons/year)	4.4	20.0
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	0.3	0.8
TP-Q3 (lbs /year)	0.4	1.0

SR5

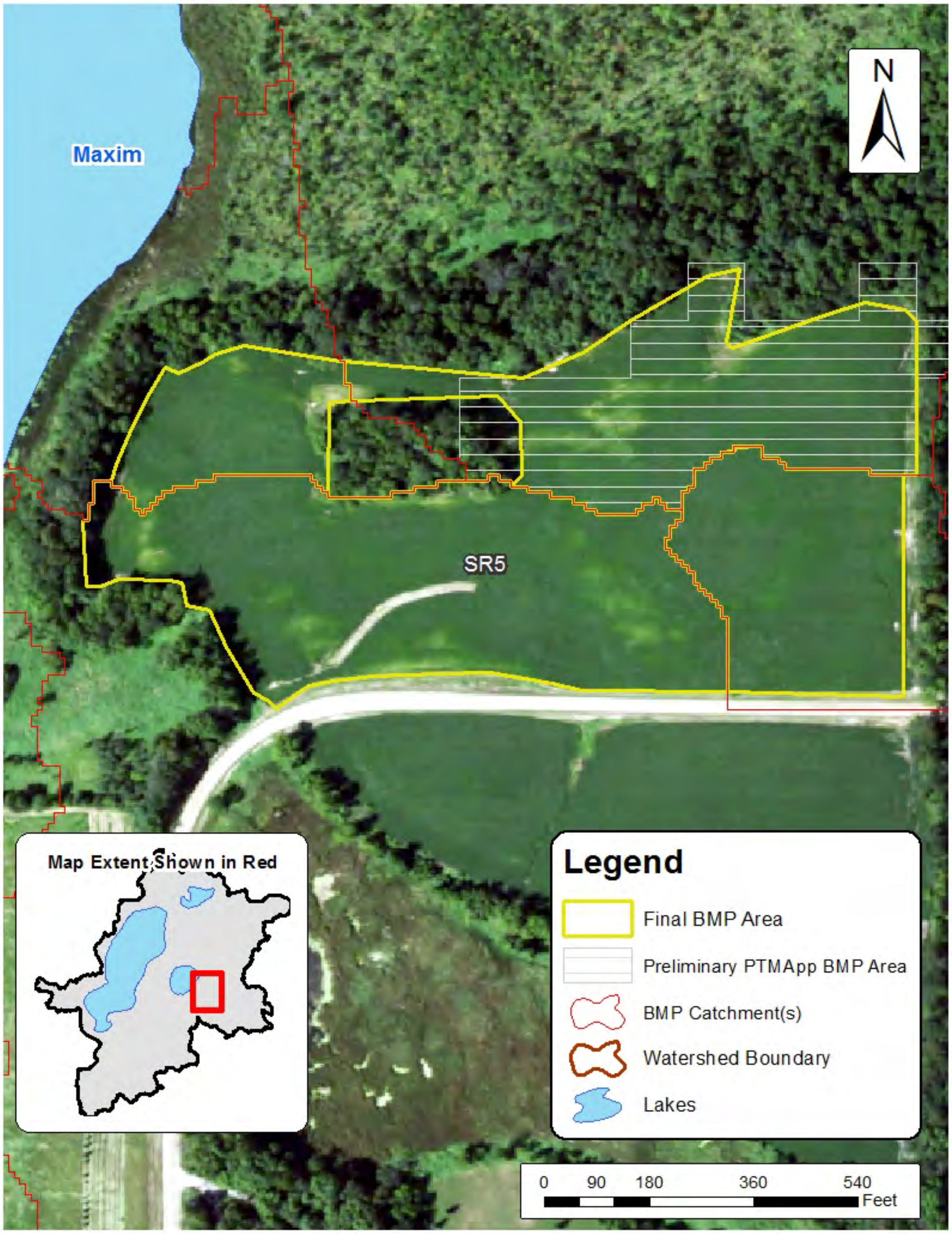

Figure 44. Field scale map of BMP SR5 a source reduction area. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR5 is a source reduction field west of Maxim Lake. Dominant soils are Lester loam 6-12% slopes eroded and Angus loam 2-5% slopes.

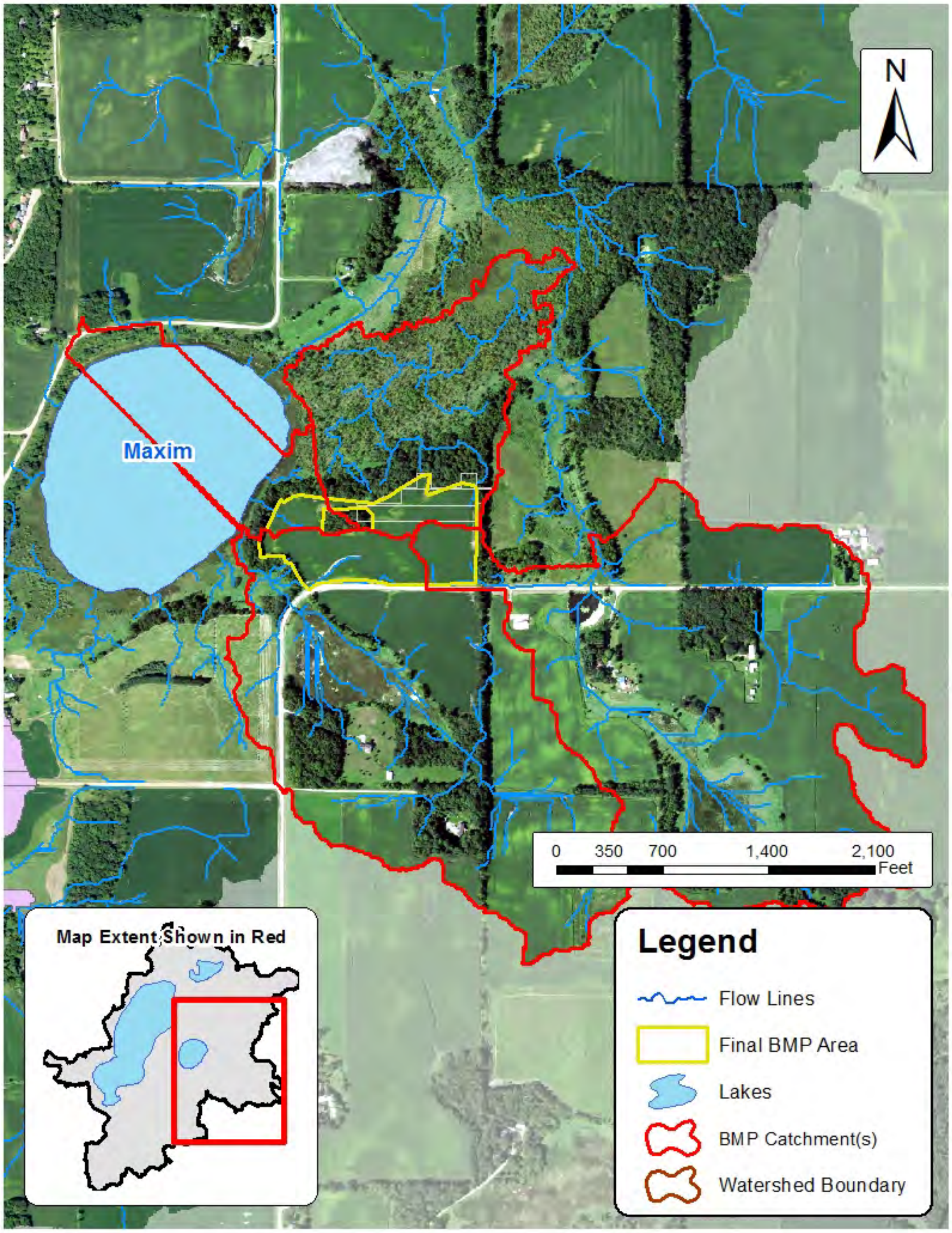

Figure 45. Catchment and flowpath for BMP SR5

Catchment Description: SR5 is spilt between four catchments. It is at the top of two of the catchments and the bottom of the other two catchments. The water flows overland to Maxim Lake before it travels through a creek to Granite Lake. Landuse among the catchments is dominated by cultivated crops (51.7%). Other landuses include forest (14.0%), hay/pasture

(12.7%), wetlands (6.8%), open water (5.8%), developed (4.35%), herbaceous (2.9%) and shrub (1.7%).

Table 39. Ranking parameters for BMP SR5

BMP Name	SR5
Rank	10
Project Type	Source Reduction
Project Size (acres)	16.8
Cost Estimate	$1,176
BMP TSS Load Reduction (tons/year)	13.9
BMP TP Load Reduction (lbs/year)	1.0
Catchment Number(s)	131, 500118, 500129,500150
Catchment Size (acres)	294.3
Catchment TSS Load (tons/year/acre)	0.02, 0.24, 0.53, 0.26
Catchment TP Load (lbs/year/acre)	0.01, 0.04, 0.12, 0.06

This BMP was much too small to be a practical source reduction practice. Source reduction needs to cover an entire field. Staff expanded the practice to include the whole production area.

Table 40. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP SR5

	PTMApp Design	Staff Design
Size	5.0	16.8
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	1.3	3.5
TSS-Q2 (tons/year)	5.2	13.9
TSS-Q3 (tons/year)	6.9	18.7
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	0.3	1.0
TP-Q3 (lbs /year)	0.3	1.2
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	1.3	3.5
TSS-Q2 (tons/year)	5.2	13.9
TSS-Q3 (tons/year)	6.9	18.7
TP-Q1 (lbs /year)	N/A	N/A
TP-Q2 (lbs /year)	0.3	1.0
TP-Q3 (lbs /year)	0.3	1.2

SR6

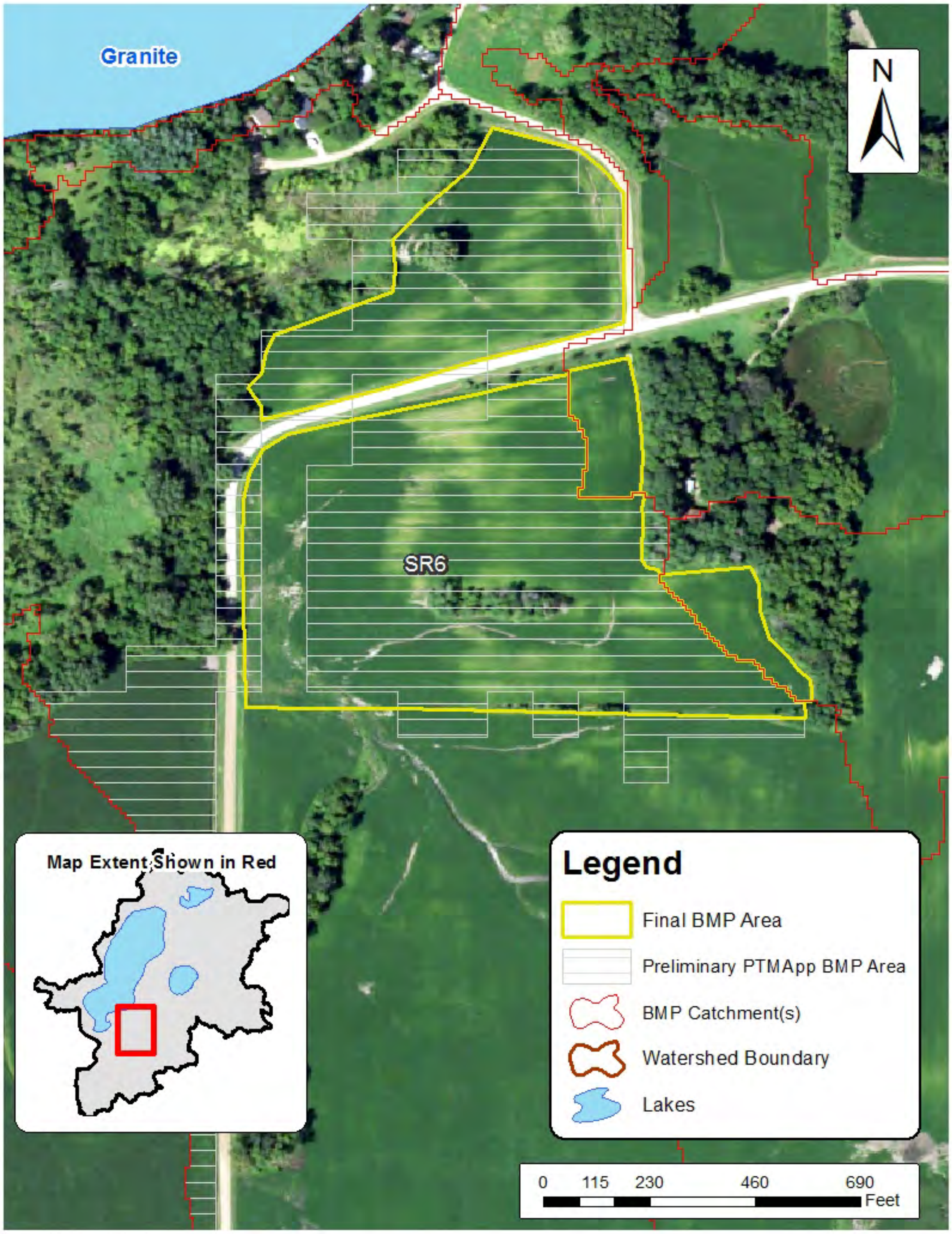

Figure 46. Field scale map of BMP SR6 a source reduction area. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR6 is two source reduction fields southeast of Granite Lake. The dominant soil types are Lester-Storden complex 12-18% slopes and Lester loam 6-12% slopes, both are eroded.

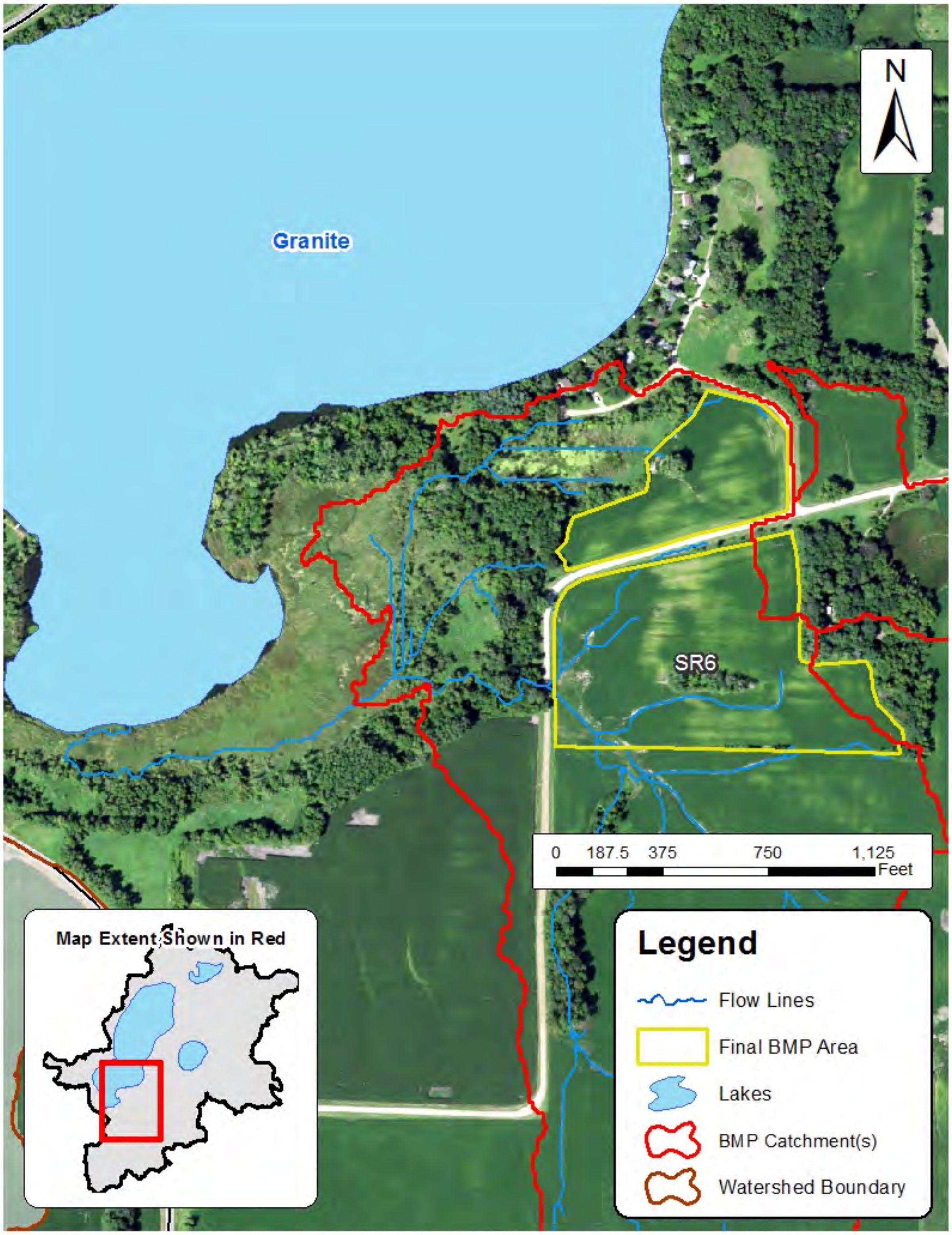

Figure 47. Catchment and flowpath for BMP SR6

Catchment Description: SR6 is primarily in one catchment but included in a total of three catchments. Water flows west overland and enters Granite Lake from a wetland on the south side of the lake. Landuse among the catchments is dominated by cultivated crops (49.5%) and hay/pasture (26.0%). Other landuse includes developed (6.2%), forest (6.0%), wetlands (4.9%), herbaceous (4.6%), and shrub (2.4%).

Table 41. Ranking parameters for BMP SR6

BMP Name	SR6
Rank	1
Project Type	Source Reduction
Project Size (acres)	21.4
Cost Estimate	$1,498
BMP TSS Load Reduction (tons/year)	78.0
BMP TP Load Reduction (lbs/year)	4.2
Catchment Number(s)	500192, 500209, 500208
Catchment Size (acres)	147.2
Catchment TSS Load (tons/year/acre)	0.55, 0.81, 1.05
Catchment TP Load (lbs/year/acre)	0.17, 0.15, 0.13

This BMP was placed relatively well by PTMApp, however because the field is divided by a catchment line the practice was expanded to incorporate the additional area. In addition staff trimmed the extra PTMApp area so the practice only includes land that is in production.

Table 42. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP SR6

	PTMApp Design	Staff Design
Size	12.5	21.4
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	5.4	19.5
TSS-Q2 (tons/year)	21.7	78.0
TSS-Q3 (tons/year)	29.2	104.9
TP-Q1 (lbs /year)	0.0	0.1
TP-Q2 (lbs /year)	0.8	4.2
TP-Q3 (lbs /year)	1.0	5.0
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	5.4	19.5
TSS-Q2 (tons/year)	21.7	78.0
TSS-Q3 (tons/year)	29.2	104.9
TP-Q1 (lbs /year)	0.0	0.1
TP-Q2 (lbs /year)	0.8	4.2
TP-Q3 (lbs /year)	1.0	5.0

SR7

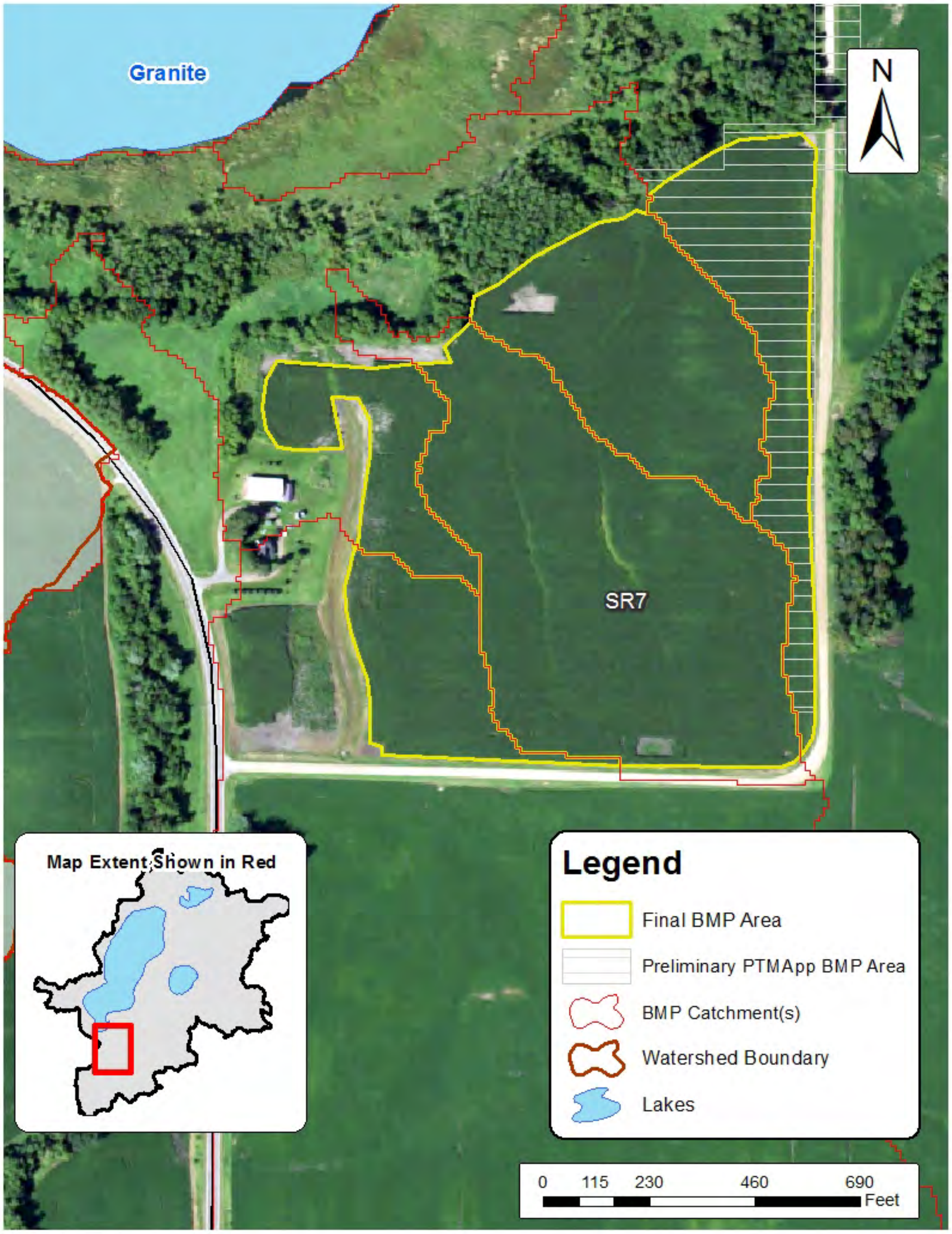

Figure 48. Field scale map of BMP SR7, a filter strip. The white shaded area is what PTMApp orginially dilineated and the yellow outline is Wright SWCD staff estimate

BMP Description: SR7 is a source reduction field south of Granite Lake. The dominant soil type is Angus-LeSueur complex 1-5% slopes.

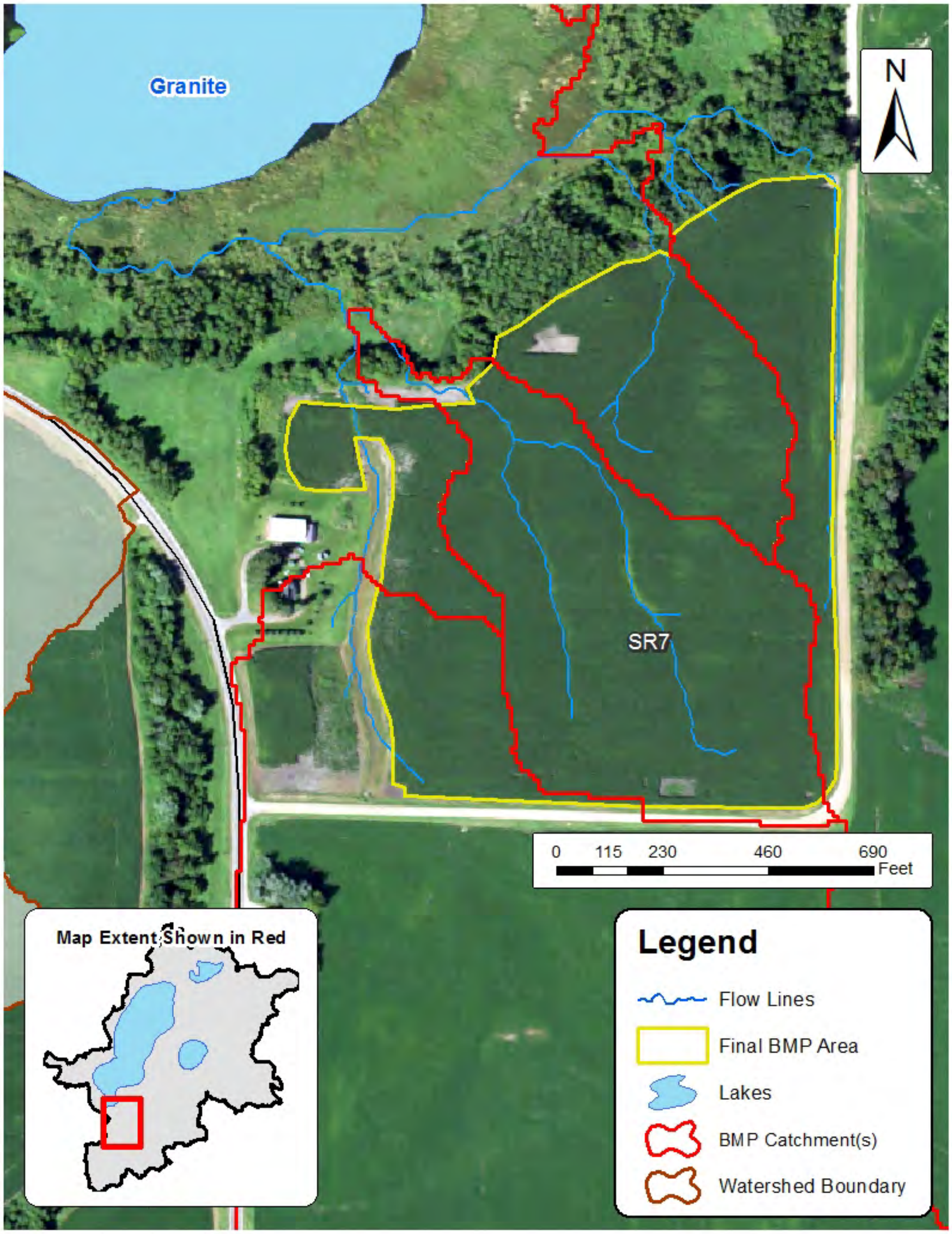

Figure 49. Catchment and flowpath for BMP SR7

Catchment Description: SR7 is spilt between four catchments. Water draining SR7 flows through a wetland to Granite Lake. Landuse among the catchments is dominated by cultivated crops (68.2%). Other landuse in the catchments includes hay/pasture (14.8%), developed (10.0%), forest (3.6%), wetlands (1.6%) and herbaceous (0.7%).

Table 43 Ranking parameters for BMP SR7

BMP Name	**SR7**
Rank	2
Project Type	Source Reduction
Project Size (acres)	26.2
Cost Estimate	$1,834
BMP TSS Load Reduction (tons/year)	12.9
BMP TP Load Reduction (lbs/year)	2.1
Catchment Number(s)	500208,9902,500233,500231
Catchment Size (acres)	285.9
Catchment TSS Load (tons/year/acre)	1.02, 0.42, 0.60, 0.58
Catchment TP Load (lbs/year/acre)	0.13,0.11, 0.20, 0.18

This BMP was much too small to be a practical source reduction practice. Source reduction needs to cover an entire field. Staff expanded the practice to include the whole production area.

Table 44. Comparison of size and estimated reduction between the PTMApp computer design and Wright SWCD staff design for BMP SR7

	PTMApp Design	**Staff Design**
Size	12.6	26.2
Load Reduction in a 10 year 24 hour storm event		
TSS-Q1(tons/year)	3.1	3.2
TSS-Q2 (tons/year)	12.3	12.9
TSS-Q3 (tons/year)	16.6	17.4
TP-Q1 (lbs /year)	0.0	0.1
TP-Q2 (lbs /year)	0.9	2.1
TP-Q3 (lbs /year)	1.0	2.5
Load Reduction in a 2 year 24 hour storm event		
TSS-Q1(tons/year)	3.1	3.2
TSS-Q2 (tons/year)	12.3	12.9
TSS-Q3 (tons/year)	16.6	17.4
TP-Q1 (lbs /year)	0.0	0.1
TP-Q2 (lbs /year)	0.9	2.1
TP-Q3 (lbs /year)	1.0	2.5

References

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354

Houston Engineering, Inc (HEI) 2016a, (PTMApp) theory and development documentation guide. Last Updated March 14 2016 http://ptmapp.rrbdin.org/files/PTMApp_User_Guide.pdf

Houston Engineering, Inc (HEI) 2016b, Prioritize, target, measure, application (PTMApp) desktop toolbar users guide. Last updated Jan 15 2016. Available at http://ptmapp.rrbdin.org/files/PTMApp_User_Guide.pdf

Minnesota Department of Natural Resources. 2016. List of Infested Waters. Last updated December 29, 2016. Available at: http://www.dnr.state.mn.us/invasives/ais/infested.html (accessed March 22, 2017).

Minnesota Department of Natural Resources. 2014, LiDAR elevation central lakes region Minnesota 2012. Minnesota Geospatial Commons Last updated April 25, 2014. Available at ftp://ftp.gisdata.mn.gov/pub/gdrs/data/pub/us_mn_state_mngeo/elev_lidar_centrallakes2012/metadata/metadata.html (accessed September 30, 2016)

National Oceanic and Atmospheric Administration. 2013. Precipitation-Frequency Atlas of the United States, Volume 8.

Natural Resources Conservation Service, 2016, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed September 30, 2016

Tribe, A., 1992, Automated recognition of valley lines and drainage networks from grid digital elevation models-a review and a new method: Journal of Hydrology, v.139, no. 1-4, p. 263-293

USDA, National Agricultural Statistics Service, 2014 Minnesota Cropland Data Layer. Last updated February 02, 2015. Available at http://nassgeodata.gmu.edu/CropScape/MN (accessed September 30, 2016)

Appendix A

As an alternative ranking process BMPs were ranked by SWCD staff using outputs from PTMApp. The ranking was based on two parameters load of sediment and phosphorus leaving the catchment (lbs/year/acre), load reduction of sediment and phosphorus to Granite Lake from the BMP (lbs/year). Catchment load and BMP load reduction were given equal weight in the ranking process. The following is a equation used to determine ranking.

$$(Catchment\ TSS\ Rank + Catchment\ TP\ Rank) + (BMP\ TSS\ Reduction\ Rank + BMP\ TP\ Reduction\ Rank) = BMP\ Rank$$

Note that some practices span two or more catchments. In these cases only the catchment with the highest load was used in the equation, the load reduction from the entire BMP was used. Due to an error in processing a portion of BMP SR4 were not analyzed for TSS and TP reductions. Since the majority of the practice was analyze it was ranked with the available data. S8 also encountered an error and was not analyzed at all for TSS and TP reduction. We kept it on the list but gave it the lowest rank.

Table 5. Priority ranking system for select BMPs in the Granite Lake Watershed

Rank	ID	Ranking Value	BMP Type	Size (acres)	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Estimated Project Cost
1	SR6	2.89	Source Reduction	21.4	78.0	4.2	$1,498
2	SR7	1.70	Source Reduction	26.2	12.9	2.1	$1,834
3	S4	1.54	Control Basin	1.4	0.5	1.9	$22,000
4	S3	1.41	Control Basin	2.4	18.6	0.8	$20,000
5	SR1	1.39	Source Reduction	7.1	20.0	1.0	$497
6	SR4	1.36	Source Reduction	21.1	14.9	0.8	$1,477
7	SR2	1.35	Source Reduction	7.4	5.1	0.6	$518
8	SR3	1.18	Source Reduction	20.9	16.9	1.0	$1,463
9	S2	1.07	Wetland Restoration	1.1	0.9	0.1	$14,000
10	SR5	1.03	Source Reduction	16.8	13.9	1.0	$1,176
11	S7	1.03	Control Basin	0.7	2.1	0.2	$21,000
12	F4	1.00	Grassed Waterway	0.5	3.8	N/A	$1,196
13	S6	0.99	Control Basin	0.7	1.1	0.1	$21,000
14	F5	0.98	Grassed Waterway	0.2	0.6	N/A	$609
15	F3	0.97	Grassed Waterway	0.6	1.4	N/A	$609
16	S1	0.96	Wetland Restoration	1.5	3.7	0.9	$10,000
17	S5	0.9	Wetland Restoration	2.2	0.6	0.2	$19,000
18	F1	0.73	Grassed Waterway	1.4	1.8	N/A	$2,258
19	F2	0.66	Buffer Strip	0.7	1.2	N/A	$356
20	S8	0	Control Basin	15.3	N/A	N/A	$11,000