South Creek Subwatershed Assessment Report

May 2016

Prepared for:

Vermillion River Watershed Joint Powers Organization and City of Lakeville

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List of Acronyms

BMP__________Best Management Practice
CN ___________ Curve Number
EPA __________ Environmental Protection Agency
GIS __________ Geographic Information System
LID __________ Low Impact Development
MIDS ________ Minimum Impact Design Standards
MPCA ________ Minnesota Pollution Control Agency
MS4 _________ Municipal Separate Storm Sewer Systems
NPDES _______ National Pollutant Discharge Elimination System
NRCS ________ National Resource Conservation Service
NURP ________ Nationwide Urban Runoff Program
P8 ___________ P8 Urban Catchment Model
ROW _________ Right of Way
SCM _________ Stormwater Control Measure
SCS __________ Soil Conservation Service
SSGI ________ Shared, Stacked-function Green Infrastructure
TMDL ________ Total Maximum Daily Load
TP ___________ Total Phosphorus
TSS __________ Total Suspended Solids
VRWJPO _____ Vermillion River Watershed Joint Powers Organization
WRAPS ______ Watershed Restoration and Protection Strategies

1.0 Summary

The Vermillion River Watershed Restoration and Protection Strategy (WRAPS) Report calls for best management practice (BMP) retrofit assessment studies in high-priority areas of Lakeville to reduce pollutant loads and runoff volumes to South Creek, a major tributary to the Vermillion River (MPCA, 2015a).

Downtown Lakeville and the Air-Lake Industrial Park are highly impervious areas located within the City of Lakeville MS4 boundary that developed with minimal stormwater controls. Both of these areas discharge directly to South Creek (AUID 07040001-527) which then flows to the mainstem of the Vermillion River. The mainstem of the Vermillion River (AUID 07040001-517) to which South Creek flows is currently impaired for TSS. A TMDL study was completed for the mainstem Vermillion reach in 2015 (MPCA, 2015b). The purpose of this study is to help the Vermillion River Watershed Joint Powers Organization (VRWJPO) and the City of Lakeville (City) reduce pollutant loads, mainly total suspended solids (TSS), and runoff volumes discharging to South Creek and the mainstem of the Vermillion River through implementation of stormwater BMPs.

The study focuses on providing the VRWJPO and the City a variety of stormwater management options that can be used in the Air-Lake Industrial Park and downtown areas to reduce stormwater runoff and improve water quality. The study is meant to illustrate Shared, Stacked-Function Green Infrastructure (SSGI) in a highly impervious watershed. "Shared, stacked-function" refers to situations where the green infrastructure is intended to provide service for more than one parcel (public or private). The entire facility also functions to provide additional amenities beyond solely managing stormwater.

The proposed green infrastructure is designed to meet MPCA Minimum Impact Design Standards (MIDS). The first 1.1 inches of runoff will be retained on-site and infiltrated where practical. If all of the proposed practices were implemented, TSS loading would be reduced by about 56,000 pounds annually. In addition, the SSGI would infiltrate 214 acre-feet of runoff per year. In effect, rainfall events in this area would be reduced by 1.1 inches on currently untreated property and the City storm sewer would be capable of managing larger rainfall events.

Section 3.0 of this report provides descriptions of specific types of green infrastructure, and Section 5.0 provides sample green infrastructure layouts to consider. Each page of Section 5.0 plans an approach to stormwater management in both public and private settings. The green infrastructure identified in this report could be implemented as shown and also viewed as an assortment of stormwater management methods that can be incorporated in reconstruction projects throughout the City.

2.0 Background

2.1 PURPOSE

The purpose of this study is to help the VRWJPO and the City reduce stormwater runoff within the area and reduce pollutant loads discharging to South Creek and the mainstem of the Vermillion River through implementation of Best Management Practices (BMPs). Vermillion River Reach 517 (see Figure 1) is impaired for aquatic life, dissolved oxygen (DO), bacteria and total suspended solids (TSS). The TSS TMDL for Vermillion River Reach 517 estimates sediment loading to the impaired reach needs to be reduced by 50% during the very high flow regime and 9% during the high flow regime. The TMDL study did not call for any reductions during the mid, low and very low flow regimes. On an annual basis, TSS loading throughout the entire watershed that drains to Vermillion River Reach 517 needs to be reduced by approximately 315,000 pounds per year (approximately 35% reduction) in order to achieve the TMDL. This number was calculated by extrapolating the TMDL daily load reductions for the very high and high flow regimes to the entire year.

South Creek Reach 527 flows through the Cities of Lakeville and Farmington and is currently impaired for aquatic life (fish and macroinvertebrates) and bacteria. South Creek Reach 527 is not impaired for TSS, however it is a major tributary to Vermillion River Reach 517 (Figure 1). Since South Creek currently meets State TSS impairment criteria, it is assumed a majority of the 315,000 pound reduction for Reach 517 will need to come from the rural portions of the impaired reach watershed upstream of South Creek. That said, monitoring data for South Creek indicate several exceedances of the TSS standard during high and very high flow conditions. Moreover, a majority of the South Creek Reach 527 watershed is covered by MS4s with a high percentage of impervious land cover. Downtown Lakeville and the Air-Lake Industrial Park (see Figure 1) have been identified by the VRWJPO and the City as high potential runoff and sediment loading areas in the South Creek watershed. These areas are located completely within the City of Lakeville MS4 boundary, are highly impervious, and developed under varying levels of stormwater management and BMPs. In this report, Wenck Associates will focus on areas within Downtown Lakeville and the Air-Lake Industrial Park with little or no stormwater BMPs and identify opportunities for implementing green infrastructure.

2.2 STUDY AREA

The areas identified for potential improvement are shown in Figure 1 of the attached figures. The downtown area is roughly 48 acres of commercial land comprised mostly of small shops and businesses. The Air-Lake Industrial Park is approximately 696 acres of industrial real estate which is intersected by Hamburg Ave and County Road 70 (215th St W). Both the downtown and industrial park areas discharge to South Creek, a major tributary to the Vermillion River. The study area covers a total of 744 acres which is approximately 5% of the watershed draining to South Creek Reach 527, and 2% of the watershed draining to Vermillion Reach 517 that is impaired for TSS.

Approximately 341 acres of the study area already incorporates some form of stormwater management. These stormwater practices are split between a few private and public properties and are mostly comprised of stormwater ponds. As part of ongoing street maintenance, the City reconstructed Hamburg Ave in 2015. During reconstruction, a series of infiltration trenches were installed along Hamburg Avenue in the existing ditches. These trenches are designed to infiltrate the first 0.5 inches of runoff from the contributing watersheds.

2.3 FRAMEWORK

Stormwater management in urban areas has evolved substantially over the past 20 years. Historically, the goal was to move water off the landscape quickly to reduce or eliminate flooding. Now, stormwater professionals focus on keeping a raindrop where it falls to mimic natural hydrology, recharge groundwater and minimize the amount of pollution reaching our lakes, rivers, and streams.

In 2009, the Minnesota Legislature allocated funds to "develop performance standards, design standards or other tools to enable and promote the implementation of low impact development and other stormwater management techniques." Minimum Impact Design Standards (MIDS) represent the next generation of stormwater management and is based on low impact development (LID). LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. Using the LID approach, the MIDS study determined this region should seek to retain 1.1 inches of runoff on-site from all impervious surfaces.

Many practices have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. By implementing LID principles and practices, water can be managed to reduce the impact of built areas and promote the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions. LID has been characterized as a sustainable stormwater practice by the Water Environment Research Foundation and others.

The City of Lakeville is also bound to the Municipal Separate Storm Sewer System Permit (MS4) which was originally issued in 2006 to address the federal Phase II National Pollution Discharge Elimination System (NPDES) stormwater regulations for small MS4s. The MS4 permit has since been updated to further comply with and exceed the standards set forth in the NPDES. The municipal MS4 permit now requires no increase in runoff volume, total suspended solids (TSS), and total phosphorus (TP) for new development, and redevelopment must reduce runoff volume, TSS, and TP discharged from the site.

MIDS is more stringent than the NPDES requirements because it attempts to return stormwater hydrology to pre-settlement conditions rather than existing conditions under the NPDES permit.

2.4 METHODOLOGY

Wenck evaluated stormwater runoff in the study area by reviewing existing conditions using Geographic Information Systems (GIS) and data provided by the City. Wenck modeled the existing area hydrology and water quality using the computer program P8. In some cases, green infrastructure hydrology was modeled in HydroCAD. HydroCAD is capable of developing the hydraulic inputs (rating curves) to the P8 model with confidence and efficiency. It is also a sufficient model to evaluate baseline flooding concerns for design storm events. The rating curve hydraulics from the HydroCAD models were input to the P8 model devices to predict the potential for runoff volume and pollutant loading reductions in the study area.

P8 (Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds) is a computer model used for predicting the generation and transport of stormwater runoff pollutants in urban watersheds. P8 is a useful diagnostic tool for evaluating and designing watershed improvements like green infrastructure. The model requires a user to input watershed characteristics, green infrastructure dimensions, local precipitation and temperature, and water quality parameters.

P8 calculates runoff separately from pervious and impervious areas. Calculations for pervious areas use the Soil Conservation Service (SCS) Curve Number (CN) method. Runoff from impervious areas begins once the cumulative storm rainfall exceeds the specified depression storage, with the runoff rate equal to the rainfall intensity.

The P8 model uses an hourly precipitation record (rain and snowfall) and daily temperature record. Precipitation and temperature data were obtained from the Minneapolis-St. Paul International Airport. Records from 2001 to 2010 were used for this study.

Wenck selected the NURP50 particle file for this study. The component concentrations in the NURP50 file represent the 50th percentile (median) values compiled in the EPA's Nationwide Urban Runoff Program (NURP).

2.5 LIMITATIONS AND ASSUMPTIONS

Potential SSGI locations shown in the following section will require further investigation before they can be implemented. Topography, soil types, utilities, and future land use will need to be investigated prior to proceeding with final design. The recommended SSGI designs were placed with the intention to fit the landscape and meet MIDS. The results of a final design may vary slightly from what is proposed in this report.

Impervious areas and runoff curve numbers were generated using NRCS Web Soil Survey data and county land use maps. The percent impervious and pervious area curve numbers were determined based on average literature values for different land uses and soil types. The use of literature values lends itself to inconsistencies with each individual site. However, curve numbers and impervious percentages were adjusted where needed to better reflect the current conditions.

Wenck assumed infiltration practices would occur in areas with soils conducive to infiltration and used an infiltration rate of 0.45 inches per hour for most proposed infiltration practices. This infiltration rate was consistent with the Web Soil Survey data for the area and was used area-wide unless more detailed data was available that suggested otherwise. A detailed soil investigation to determine site specific soil type and groundwater elevations is needed before design of any of the proposed practices.

3.0 Shared, Stacked-Function, Green Infrastructure

Infiltration Trench

Pervious Pavers

Stormwater Reuse

Stormwater Planter

Tree Trench

Infiltration Basin

Infiltration Catchbasin

Communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainability using green infrastructure. Typically stormwater infrastructure serves only a single purpose: to dispose of runoff. Green infrastructure uses vegetation and soil to manage rainwater where it falls. Modern engineering practices can entwine natural processes with fabricated environments to provide stormwater management, flood mitigation, improved air quality, groundwater recharge, and improved downstream conditions.

A wide scale of options is available within the realm of green infrastructure. The Low Impact Development (LID) approach to stormwater management incorporates green infrastructure as well as traditional best management practices (BMPs). "Shared, stacked-function" refers to designs that provide service to more than one parcel (public or private) and the entire facility may function to provide additional amenities including artwork, public interaction, and green space. Examples of green infrastructure are presented below. Specific uses for these technologies are summarized in Section 4.0.

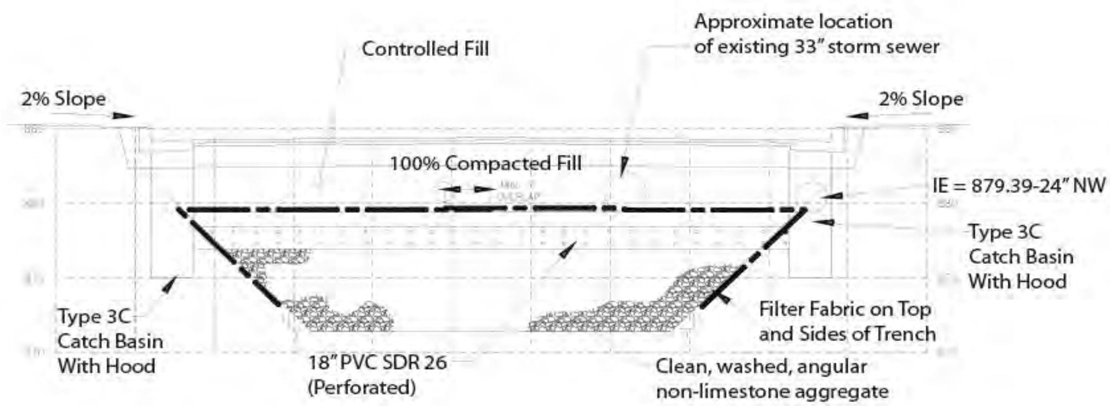
3.1 INFILTRATION TRENCH

Infiltration trenches are an adaptable stormwater management technique where space is limited, and is most suitable for highly urban areas or areas with large parking lots. Underground infiltration consists of perforated pipes or cisterns placed beneath a parking lot or open area. An example is shown below.

Stormwater runoff is directed to this area via storm sewer for storage and infiltration. A manhole, filter, or hydrodynamic device provides pretreatment for runoff entering the storage area. In large storm events, the storage volume above the outlet reduces flow rates and discharge is directed into the storm sewer. Large angular rock (1-3 inches) surrounds the perforated pipes and provides additional storage capacity and structural stability for soils above. The design can be modified to include a filtration layer when infiltration is not practical.

A cut view of an underground infiltration system. This system may be placed under a parking lot, park or other area to accommodate storage and infiltration of runoff.

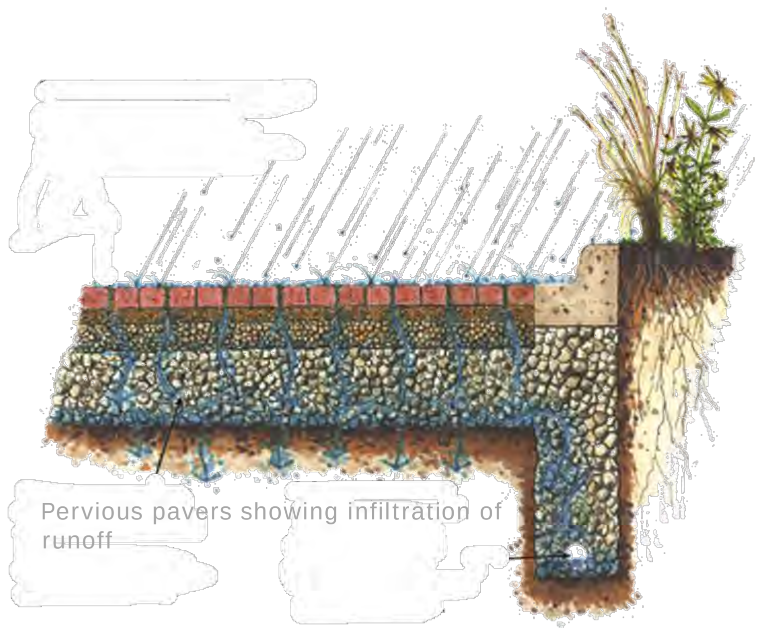
Street replacement also provides an opportunity for this type of shared, stacked-function green infrastructure. Infiltration trenches can be placed beneath roads where no utilities are present. During road reconstruction the infiltration trench can be added to the project to reduce downstream pollutant loads. Maintenance includes periodic removal of sediment accumulated in the pretreatment devices. To maintain system functionality, sediment deposition should not exceed 1 foot in depth or the manufacturers recommendation. This assessment assumes that infiltration trenches have an annual maintenance cost of $2,000.



Cross section of an infiltration trench beneath the road.

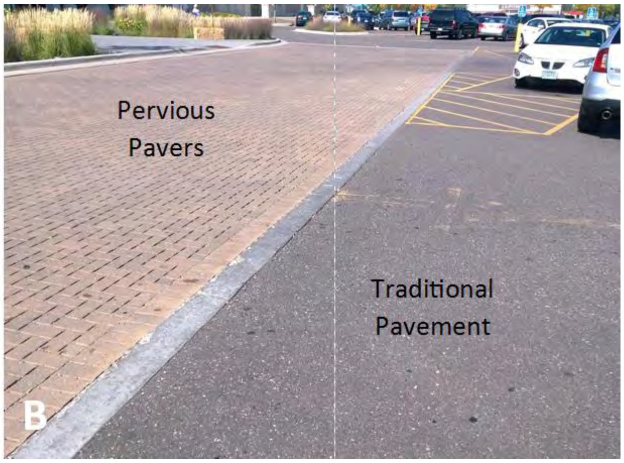
3.2 PERVIOUS PAVERS

Pervious pavers have several different designs that follow the same general structure and result in reduced runoff volumes. Impervious pavement (concrete or asphalt) is replaced with pavers that allow water to pass through to the sub-base via gaps between the blocks. The subbase consists of an angular rock with large void spaces to temporarily store and infiltrate water that passes through the pervious pavement above. This method of pavement construction provides a means of infiltrating runoff from paved surfaces as well as any other contributing surface areas. The figure to the right is an illustration of pervious pavers and how water flows through.



Pervious pavers showing infiltration of runoff

While pervious pavers remain unproven for heavy traffic, trucks, and high speeds, it is well-suited to handle light traffic and occasional heavy vehicles. Potential areas for implementation are parking lots, residential roads, driveways, sidewalks, walkways; curb islands and other similar surfaces as shown in the photos below.



Images of pervious pavement in a parking lot (A) and low traffic areas (B).

To ensure long performance of pervious pavers, it is important to maintain the pavement. This assessment assumes that porous pavement has an annual maintenance cost of $1,000. Periodic vacuuming is the key maintenance needed for pervious pavers and using little or no salt in the winter is recommended. Studies have shown that de-icing chemicals can be reduced or eliminated because snow-melt and ice infiltrates rather than refreezing. Maintenance of the surrounding landscaped areas will also ensure that the pavement does not become clogged with eroded sediment.

Pervious pavement has recently been shown to reduce the need for de-icing on roadways. In the images below, a section of porous asphalt is outlined in black. The image shows snow accumulating on the traditional pavement but not on the porous section. Snow and ice build-up is reduced substantially by pervious pavement, which allows municipalities to avoid applying salt as frequently. With recent increases in salt prices, pervious pavement in low traffic areas may be a valuable and a long-lasting alternative to salt application.

How snow accumulates on porous and traditional pavement in Robbinsdale, MN.

3.3 STORMWATER REUSE

Stormwater reuse is the practice of collecting rain water from impermeable surfaces and storing it for future use. There are a number of systems used for the collection, storage and distribution of rain water including rain barrels, cisterns, evaporative control systems, and irrigation.

Stormwater reuse facilities fit the shared, stacked-function mold by conserving groundwater, saving money through reduced groundwater pumping and treatment, and reducing pollutant loads to local lakes and rivers. Most commonly, these systems capture “free water” from a local pond and irrigate (after filtering) green space.

Cistern and artwork at the Maplewood Mall, MN

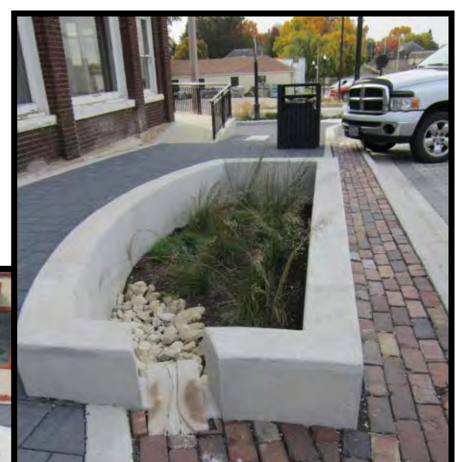
Recently implemented at the Maplewood Mall in Maplewood, MN (below), a large above-ground cistern was installed at the mall entrance to capture roof runoff. The Maplewood Mall cistern has a pump handle that, when pumped, cascades water down over a series of spinning gears and chimes and into an infiltration area. The system also serves to educate shoppers on stormwater management techniques and conservation. A tiled collage on the mall’s wall provides an artistic background that illustrates an urban water cycle.

Cisterns are not always the most cost effective means of managing stormwater. However, many cities encourage residents to reuse water by providing rain barrels at reduced or no cost to the users. This can be especially effective at providing opportunities for public involvement and art.

3.4 STORMWATER PLANTER

Stormwater planters are a familiar practice in urban areas to collect and infiltrate rainwater runoff. They are typically shallow depressions surrounded by poured concrete or landscaping block walls with soil engineered to quickly infiltrate water (within 48 hours).

Effective stormwater planters have vegetation that is accustomed to changes in moisture availability and known to remove pollutants. Stormwater planters are placed along roads and with an opening in the curb, allowing runoff from parking lots, sidewalks, and roads to enter the planter to be treated and infiltrated. The sidebar photo and the photo below show stormwater planters from West Union, IA. Stormwater planters vary in size and shape but operate similarly. Runoff enters through the curb cut. When filled, runoff will bypass the planter and continue to the next downstream catch basin, pipe, or pond.



Stormwater planters in West Union, IA

Pretreatment for stormwater planters is required by the Minnesota Pollution Control Agency (MPCA) to filter large debris and particles from runoff prior to entering the planter. Pretreatment options for stormwater planters include sumped catchbasins, forebays, or proprietary devices (i.e. Rain Guardian or Stauner sediment trap).

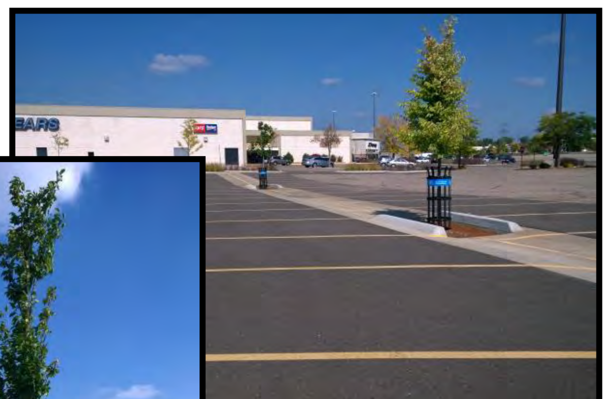
The design and maintenance of stormwater planters is similar to curb cut rain gardens. Stormwater planters can be located on or near storm sewer catch basins. Placing the curb cut upstream of the catch basin allows runoff to first enter and fill the stormwater planter before overflowing into the storm sewer. Maintenance includes mulch, trash removal, seasonal plant trimming, and plant replacement.

Stormwater planters have also been recently implemented on the Green Line between Minneapolis and St. Paul. The planters add needed green infrastructure into the 100% impervious corridor of University Avenue in St. Paul.

3.5 TREE TRENCH

Tree trenches provide underground storage for runoff while increasing green space on the surface. These practices are aesthetically pleasing and great for largely paved areas like roads, parking lots, and sidewalks. Below is an example of a fully functioning tree trench system in the Maplewood Mall parking lot. The trees spring up from the pavement while stormwater is directed underground.

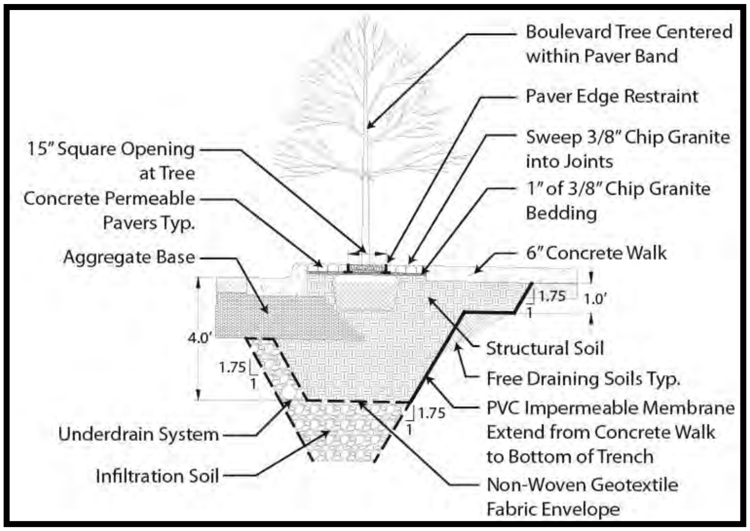
The Ramsey Washington Metro Watershed District (RWMWD) installed this tree trench system in the Maplewood Mall parking lot as part of a redevelopment effort. In this application, the tree trench extends between parking lot islands and below drive lanes and parking stalls. Trench drains connect parking lot islands and collect runoff from the parking lot to be stored and infiltrated in the engineered media below the parking lot surface.



Tree trenches installed in the Maplewood Mall parking lot in Maplewood, MN.

A common design in Europe is known as the Stockholm Tree Trench Method and was developed to provide suitable growing conditions for trees in highly urbanized environments. This method includes media with 2-4 inch angular rock layers that can support tree roots and provide storage for runoff.

To help sustain the growth of the trees in an urban environment, special measures are needed. The tree trenches installed by RWMWD used a patented structural soil developed by Cornell University. CU-Structural Soil™ (also known as CU-Soil™) was developed as a way to safely bear pavement loads after compaction and yet still allow root penetration and vigorous tree growth. The figures show healthy young trees in an entirely impervious landscape.



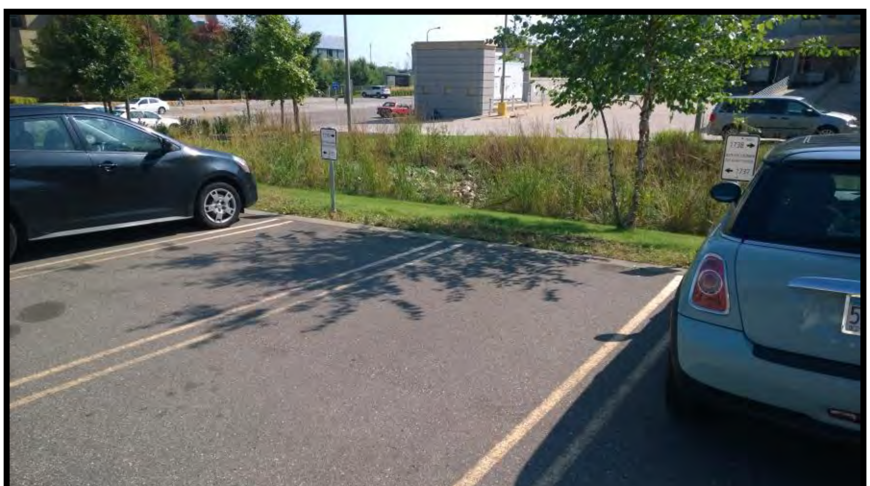
Example tree trench cross section used in St. Paul, MN.

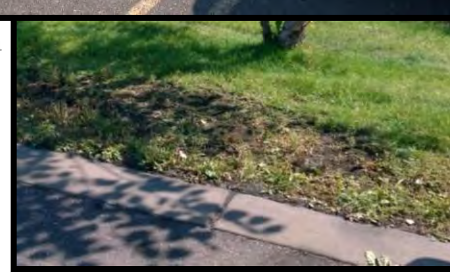
The Capitol Region Watershed District (CRWD), City of St. Paul and Metropolitan Council recently installed tree trenches on the Green Line in St. Paul. These trees are buried in a soil engineered to support the tree root system and collect runoff from the surrounding area. A cross-section of the design is shown below.

Maintenance of tree trenches is similar to other vegetated stormwater management. Newly planted trees need to be watered regularly. According to Johnson et al. 2008, trees need 1.5 gallons of water per inch of trunk diameter when soil is dry. This watering should be sustained for the first three years after planting. Young trees should also be protected from rodents by installing plastic tubing or mesh that extends 1 to 2 feet above the snow line. Trees should be pruned once (1) in each year 2 and 3, every three (3) years up to 10 years, and every five (5) years after that. Periodic removal of sediment from pretreatment sumps and removal of trash and debris will improve the longevity of the trenches. Wenck assumed that infiltration trenches have an annual maintenance cost of $5,000.

3.6 INFILTRATION BASIN

Infiltration basins combine surface storage, infiltration, biological treatment, plant uptake, and evapotranspiration into a single green infrastructure. Stormwater is collected into the treatment area which consists of a grass buffer strip, sand bed, ponding area, organic or mulch layer, planting soil, and plants. The infiltration system incorporates the more natural means of managing stormwater than any other treatment type.





Infiltration basin along a parking lot in St. Paul, MN.

The adjacent pictures show an infiltration basin along the perimeter of a parking lot in downtown St. Paul. Note the ribbon curb that defines the edge of the pavement but also allows runoff to flow over the curb, through the vegetated buffer and into the bioretention basin.

Opportunities to include infiltration systems in the landscape include landscaping islands, cul-de-sacs, parking lot margins, commercial setbacks, open space, rooftop drainage and streetscapes (i.e., between the curb and sidewalk). Infiltration basins are extremely versatile because of their ability to be incorporated into landscaped areas. Maintenance activities typically include sediment removal and maintenance of the vegetation. Invasive species need to be managed, dead vegetation must be removed, and dead plants must be replaced.

Similar to other green infrastructure, public art can be incorporated into infiltration basins. The picture below demonstrates how a basin in Oakdale, MN incorporated public art into the retaining walls and flow path. The decorative retaining walls create a "stepped" system that allows water to infiltrate or overflow to the next downstream step. The pictures below show the circular pretreatment sump at the upstream end of the steps and the decorative concrete spheres in the concrete flume that carries concentrated flow from the overflow of each step. This assessment assumes that infiltration basins have an annual maintenance cost of $2,500 for vegetative maintenance and removal of accumulated sediment.

"Stepped" infiltration basin in Oakdale, MN.

3.7 INFILTRATION CATCHBASIN

An infiltration catchbasin is constructed in place of a standard catch basin and serves to trap sediment, infiltrate runoff, and convey overflow to the storm sewer. A standard catchbasin can be reconstructed by installing a sump in the catchbasin and creating a porous bottom to allow runoff to infiltrate. Typically, the infiltration catchbasin will be constructed over a bed of porous rock media to increase the retention volume and disperse runoff. Sediment accumulates in the sump which requires periodic removal using a vacuum truck as shown in the figure to the right.

A sumped catchbasin with SAFL Baffle. Image from Upstream Technologies.

Infiltration catchbasins can be constructed in-line or in branches of the storm sewer. When designed in-line, a device should be installed to dampen flow, promote sediment deposition, and prevent sediment resuspension. There are a few proprietors that offer such devices. The SAFL Baffle, produced by Upstream Technologies, and The Preserver, produced by Momentum Environmental are two examples. These products dispense flow and increase the time that water has to settle out particulates and can further increase the sediment removal efficiency.

Storm sewer sumps need regular maintenance in order to be effective. Vacuum trucks are needed to remove accumulated sediment and other debris. It is good practice to clean sumps during the spring thaw and throughout the summer season. Sumps that are not maintained properly may cause previously trapped sediment to re-suspend and clog downstream practices.

3.8 SSGI IN COLD CLIMATES

In Minnesota, stormwater management is defined by managing rainfall runoff as well as snowmelt, whose characteristics are different. Design criteria focusing on rainfall runoff alone may not work well during cold periods resulting in increased maintenance costs. In years when snowfall is high, this becomes a major concern because a substantial percentage of annual runoff volume and loading can result from snowmelt.

A thorough description of the science of snowmelt and recommended management approaches can be found in the Minnesota Stormwater Manual. LID is effective because it relies on the natural interaction between runoff and soil biology. The manual discloses SSGI, such as permeable pavers, infiltration, and road drainage infiltration systems, are effective under cold climate conditions with proper maintenance.

Road salt application is an ever-increasing challenge for stormwater managers. High chloride concentrations damage and kill vegetation planted in infiltration basins, stormwater planters, and tree trench systems. Vegetation is a key ingredient to the performance of these systems and replacement can be costly. The following table from the Minnesota Stormwater Manual lists cold climate vegetation of the upper Midwest with known salt tolerance (sorted by growth form). These species should be considered for stormwater planters and tree trenches exposed to high chloride concentrations.

Table 1: Salt tolerant vegetation native to Minnesota.

Species	Soil Moisture	Salt Tolerance in Soil	Growth Form	Notes on Use
American Elm	Always Wet/Frequently Saturated	Medium/Low1	Tree	
Hackberry	Frequently Saturated/Mostly Drained	Medium	Tree	
Jack Pine	Mostly Drained	High1	Tree	
Poplars	Frequently Saturated/Mostly Drained	Medium1	Tree	Including aspen, cottonwood, black and silver-leaved poplar; fast growing; also provide good streambank stabilization; highly tolerant to salt spray

Species	Soil Moisture	Salt Tolerance in Soil	Growth Form	Notes on Use
Cutleaf Sumac	Mostly Drained	High	Shrub	
Smooth Sumac	Mostly Drained	Medium	Shrub	Colonizes and spreads in high sun
Staghorn Sumac	Mostly Drained	High	Shrub	
Canada Wild Rye	Frequently Saturated	Medium	Herbaceous Grass	
Karl Foerster Reed Grass	Frequently Saturated/Mostly Drained	High	Herbaceous Grass	This is a cultivar for landscaping
Alkali Grass	Mostly Drained	High	Herbaceous Grass	
Blue Gramma Grass	Mostly Drained	High	Herbaceous Grass	Selections being made for strongly salt-tolerant varieties; see University of Minnesota for latest
Little Bluestem	Mostly Drained	High	Herbaceous Grass	
Perennial Ryegrass	Mostly Drained	Medium	Herbaceous Grass	
Seed Mix: MN DOT Urban Prairie	Mostly Drained	High	Herbaceous Grass	
Seed Mix: MN DOT Western Tall Grass Prairie	Mostly Drained	Medium	Herbaceous Grass	
Tall Wheatgrass	Mostly Drained	High	Herbaceous Grass	

4.0 Assessment

Wenck reviewed existing conditions using Geographic Information Systems (GIS) and data provided by the City, and then modeled the area hydrology and water quality using the computer program P8. Wenck selected BMPs for the study that would achieve the goals of reducing flooding risks, managing runoff rates, and reducing sediment loads. These BMPs were tailored to fit each site and maximize the effects. A proposed model was constructed by incorporating the proposed BMPs into the existing conditions model.

4.1 EXISTING CONDITIONS

Wenck created the existing conditions model to mimic the watershed as it is today by routing runoff through the storm sewer, roadside ditches, stormwater ponds, and other practices. The majority of the downtown area is collected in storm sewer and discharged to South Creek. Most of runoff from the Air-Lake Industrial Park area is routed through roadside ditches that eventually flow to South Creek. The watershed is primarily commercial and industrial property with intermittent tax exempt and City owned property including schools and easements (Table 2). The study area is located completely within the City of Lakeville MS4 boundary (Figure 1). Table 2 and Figure 2 describe property ownership in the study area.

Table 2: Breakdown of property ownership.

Property Owner	Area (acres)	Percent of Watershed
Private	548.9	74%
Tax Exempt	121.9	16%
Other[1]	73.2	10%
Total	**744.0**	**100%**

[1]Note: this category refers to parcels within the Dakota County database that do not contain ownership information. Most of these parcels appear to be publically owned property including Dakota County ROW, City ROW, easements, railroads, power/transmission lines, etc..

The study area is broken into 78 subwatersheds. A map of the subwatershed delineations is shown in Figure 3 (attached).

Under existing conditions the study area generates approximately 95,640 pounds of TSS annually. This estimate includes the expected removals due to existing stormwater treatment in the study area: 28 stormwater ponds, 1 sediment trap, and 7 infiltration practices. Figure 3 shows the locations of the existing stormwater practices in the study area.

Figure 4 (attached) gives a breakdown of existing pollutant loads by area. It is clear from this figure that the subwatersheds with the highest annual pollutant loads tend to be those that do not have existing stormwater treatment in place and/or those with large amounts of impervious area.

4.2 PROPOSED PRACTICES

The future possibilities model incorporates new green infrastructure into the existing conditions model to demonstrate what can be achieved in different applications. The new green infrastructure was designed to meet MIDS where practical. The new stormwater management practices are placed strategically within the subwatersheds to capture the most runoff. These potential SSGI locations are described below. If all of the proposed practices were developed, South Creek and the mainstem Vermillion River Reach 517 would see reduced sediment loads of approximately 56,000 pounds per year (59% reduction from study area). Despite accounting for only 2% of the area draining to Vermillion River Reach 517, the 56,000 pounds per year reduction from the study area would help achieve approximately 18% of the 315,000 pound reduction required for Reach 517. In addition, the SSGI would infiltrate over 200 acre-feet of runoff per year.

The following section is dedicated to the proposed BMPs. Each page gives a breakdown of what the BMP achieves, how much it will cost, and what percentage of the property is publicly owned including streets. Please note that the estimated project costs only include construction and operation and maintenance costs and do not take into account easement and/or land acquisition and unexpected site specific costs. Therefore, it is recommended that the VRWJPO and City apply a contingency to the estimated project costs presented in this report, or conduct a more detailed feasibility assessment and cost estimate for specific projects they wish to pursue. The practices are presented in order of cost effectiveness in terms total cost per pound of sediment removed (See Tables 3 through 5). All of the City practices are presented first, followed by projects that are within county right of way and private parcels. Figure 5 (attached) show the net TSS loads by subwatershed as a result of the proposed BMPs.

5.0 Recommendations

The proposed green infrastructure have been prioritized based on the 30 year life cycle cost per pound of TP removed. The most cost effective projects are given first priority and less effective projects have lower priorities. These practices have been partitioned into City (Table 3), county (Table 4), and private (Table 5) projects. The tables and one page summaries presented in this section are presented in order of total life cycle cost per pound of TSS removed. The tables should be used to gauge the value of each proposed practice and plan for future projects.

5.1 CITY PROJECTS

In citing and developing the list of proposed projects, Wenck focused on all potential project locations, but gave additional attention to tax exempt properties (parks, schools, churches), easements, and areas within city right of way. City projects are ranked in Table 3 based on life cycle cost per pound of TSS removed. A breakdown of the percent of public and private property being treated by each practice is listed in Section 4.0. Wenck recommends the City focus its initial efforts on the sediment trap for the downtown area and the series of infiltration trenches throughout the industrial park. The sediment trap treats runoff form a large watershed and is the most cost effective option. The industrial park has limited public property available but placing infiltration trenches in the public ditch system is a great opportunity to improve stormwater management in this area. The last two practices (N-08 and N-25) in the table cannot be compared directly with the other practices and should be reviewed separately. These practices do not provide any direct TSS reductions, but do offer opportunities for public outreach, volume reduction and other water quality benefits.

Table 3: Priority list of City projects by life cycle cost per pound of TSS removed.

Priority	Project	TSS Removed (lbs/yr)	Volume Reduction (ac-ft/yr)	Construction Cost	Life Cycle Cost (30 yrs)	Life Cycle per Pound of TSS
1	N-07	2,000	0.0	$104,000	$149,000	$2.48
2	N-47	1,465	3.2	$62,773	$114,560	$2.61
3	N-01	4,367	14.5	$296,000	$371,000	$2.83
4	S-13	4,895	14.4	$230,070	$419,878	$2.86
5	S-09	5,278	18.0	$251,526	$459,035	$2.90
6	N-02	3,036	10.1	$206,034	$281,034	$3.09
7	N-30	1,521	6.2	$91,485	$166,960	$3.66

8	N-19	2,130	8.9	$170,640	$311,417	$4.87
9	N-06	847	2.8	$57,476	$132,476	$5.21
10	N-09	709	2.4	$48,278	$123,278	$5.79
11	N-48	1,111	1.5	$124,234	$226,727	$6.80
12	N-04	2,911	9.9	$489,226	$639,226	$7.32
13	N-13	1,184	6.4	$423,316	$498,316	$14.03
14	N-39	123	0.6	$8,353	$83,353	$22.64
15	N-08	NA	0.1	$25,000	$34,000	NA
16	N-25	NA	0.0	$100,000	$148,000	NA

N-07

County Parcel ID:
037-221105300010 (city owned); and County ROW

TSS Reduction:
2,000 lbs/yr

Volume Reduction:
None

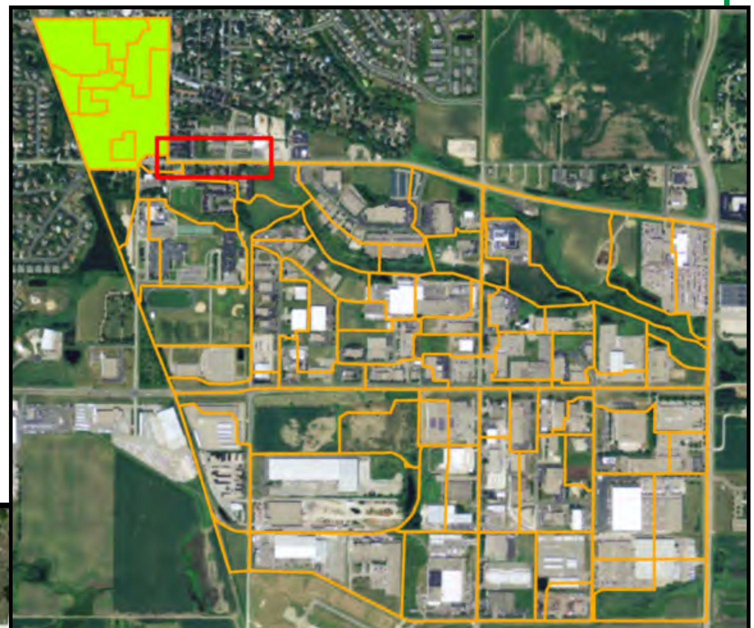
Construction Cost:
$104,000

Life Cycle Cost:
$149,000

Life Cycle / Pound TSS:
$2.48

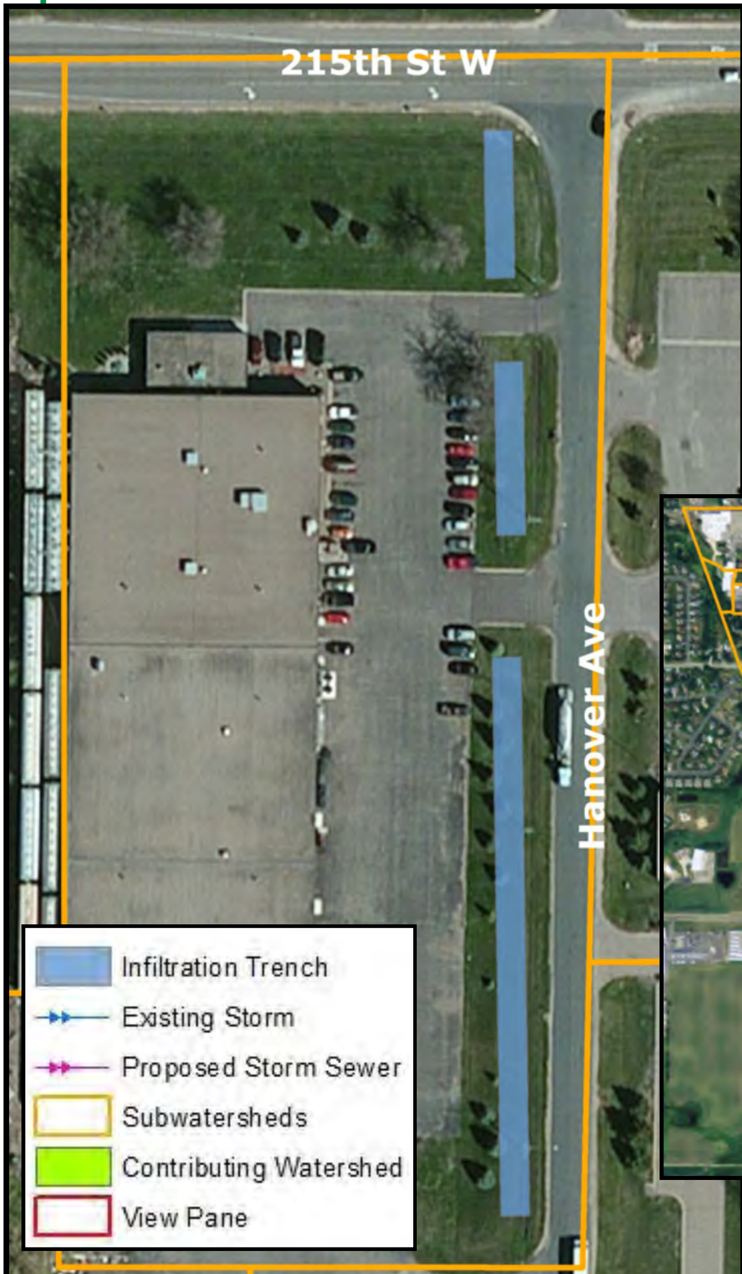
Percent Impervious:
63.3%

Drainage:
47.81 acres
51% Tax Exempt
49% Private



N-07 - is proposed as a large sediment trap at the downstream end of a City storm sewer trunk line. This system has the potential to treat runoff from a large watershed that is highly urbanized. In the goal of reducing sediment loads to downstream waters, this practice has a lot of potential. Depending on the vendor and size of the system, these traps can cost between $100,000—$200,000. In discussion with a representative from Contech Engineered Solutions, a Vortechs 7000 system would likely be the most appropriate model given the drainage area and sediment load for this site. Construction cost for this system would be approximately $104,000. As an alternative, upstream manholes can be retrofitted with a sump and SAFL Baffle which similarly trap sediment in runoff. However, these systems are not as effective as other proprietary separators and maintaining these units would be more costly than one central unit.

N-47



County Parcel ID:
037-221110002111;
City and Dakota Co. ROW

TSS Reduction:
1,465 lbs/yr

Volume Reduction:
3.2 ac-ft/yr

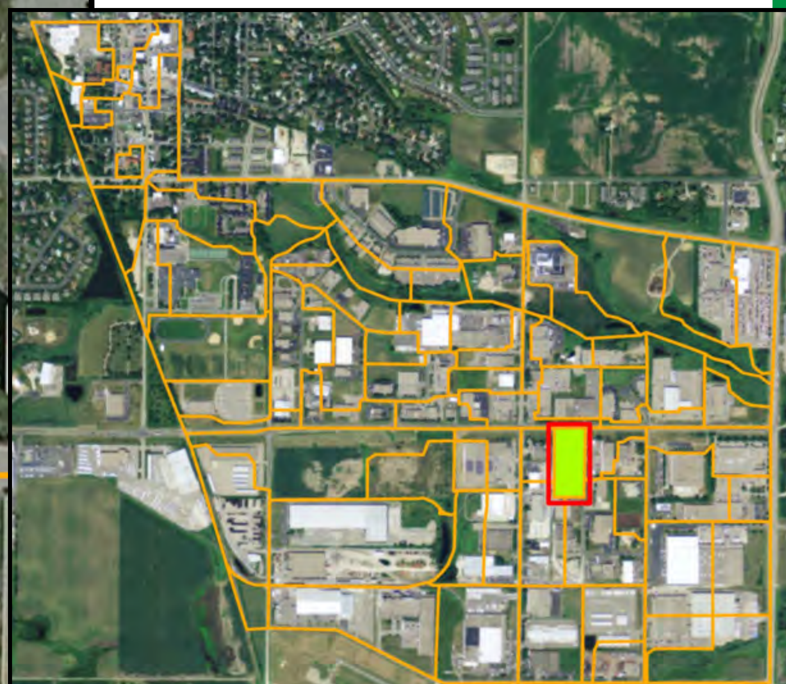
Construction Cost:
$62,773

Life Cycle Cost:
$114,560

Life Cycle / Pound TSS:
$2.61

Percent Impervious:
74.0%

Drainage:
5.32 acres
19% Tax Exempt
81% Private



N-47 - is similar to the other proposed infiltration trenches. If the City and Dakota County come to like this as a treatment system it could be used throughout the industrial park. The infiltration trenches are installed within the existing ditches to add an infiltration component to the drainage functionality. Stormwater is already conveyed to the proposed systems from the properties west of Hanover Avenue and the grass swales offer a form of pretreatment. Again, these trenches have a moderately high cost effectiveness and could manage runoff from an otherwise untreated area.

N-01

County Parcel ID:
NA—City ROW

TSS Reduction:
4,367 lbs/yr

Volume Reduction:
14.5 ac-ft/yr

Construction Cost:
$296,000

Life Cycle Cost:
$371,000

Life Cycle / Pound TSS:
$2.83

Percent Impervious:
78.0%

Drainage:
9.51 acres
45% Tax Exempt
55% Private

N-01 - is a proposed underground infiltration system in the boulevard of 208th Street W. This location intersects the current storm sewer and the drainage area is mostly industrial with a typically higher pollutant loading. There is an underground garage in the building to the south which may require the infiltration system be installed with flood proofing measures.

S-13

County Parcel ID:

City ROW and several private businesses

TSS Reduction:

4,895 lbs/yr

Volume Reduction:

14.4 ac-ft/yr

Construction Cost:

$230,070

Life Cycle Cost:

$419,878

Life Cycle / Pound TSS:

$2.86

Percent Impervious:

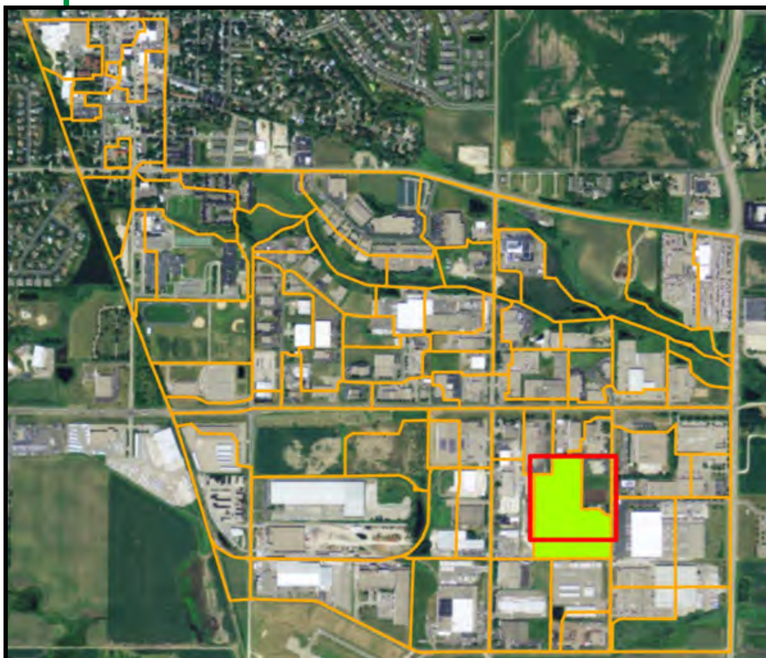
87.7%

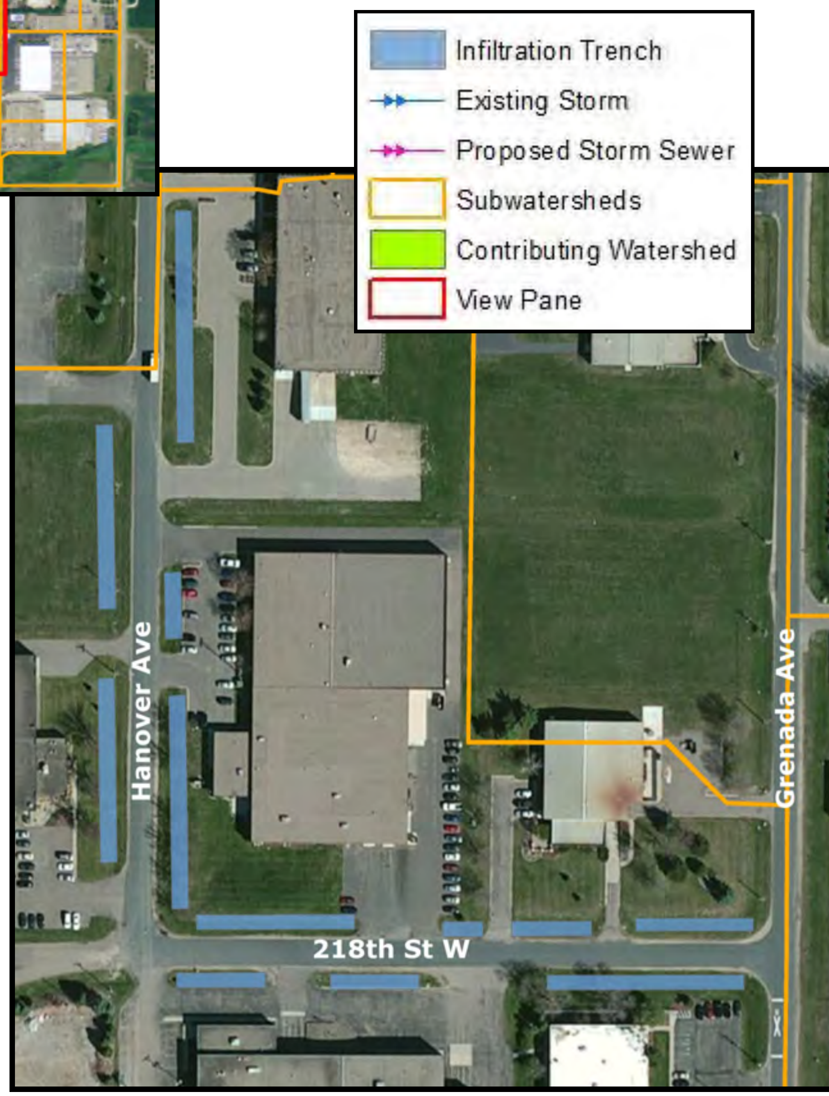
Drainage:

16.43 acres

3% Tax Exempt

97% Private





S-13 - is an industrial development along Hanover and 218th Street W. Similar to the work conducted along Hamburg Avenue, a series of infiltration trenches are proposed in the ditches of Hanover and 218th. The design would be similar to those already installed and effectively treat a large watershed using the existing stormwater infrastructure. This application is relatively cost effective and could be constructed within the street right of way.

S-09

County Parcel ID:
037-221110003050 (private business); City and County ROW

TSS Reduction:
5,278 lbs/yr

Volume Reduction:
18.0 ac-ft/yr

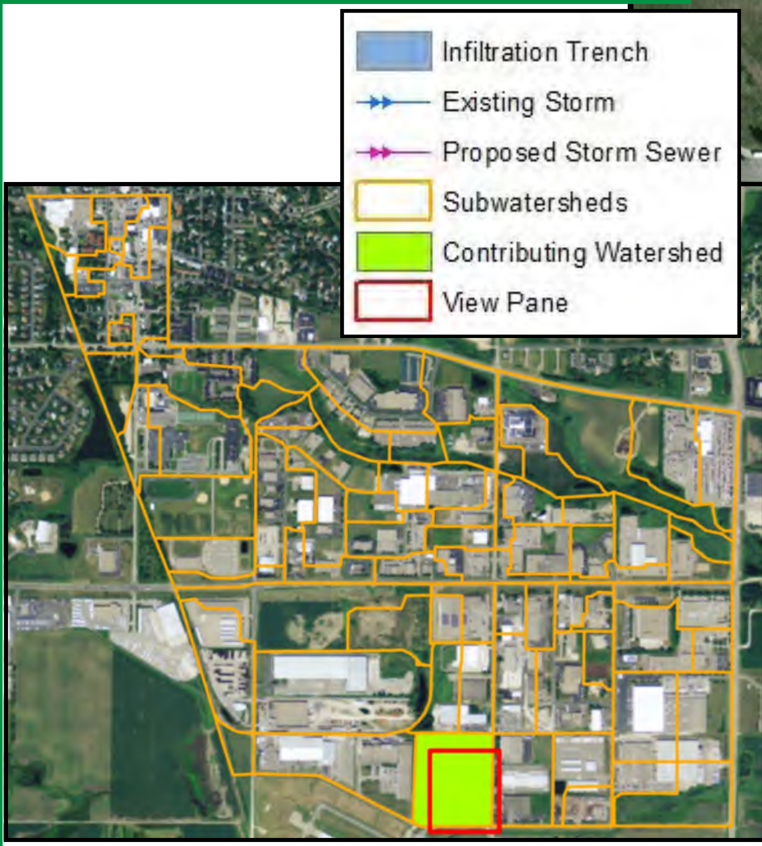
Construction Cost:
$251,526

Life Cycle Cost:
$459,035

Life Cycle / Pound TSS:
$2.90

Percent Impervious:
78.3%

Drainage:
20.14 acres
7% Public
93% Private



S-09 - Recently, infiltration trenches were installed along Hamburg Avenue which greatly reduced the TSS load from the contributing watershed. The northwest corner of the intersection of Hamburg Avenue and 220th Street would benefit from a couple of additional infiltration trenches. This location would receive runoff from a large industrial area with a highly impervious percentage. The proposed infiltration trenches are cost effective and would be similar to those already installed on Hamburg Avenue but may require a larger retention volume. This could be achieved by using larger perforated pipes and installing multiple pipes in parallel. If parallel pipes are infeasible, other options exist that would allow for additional volume retention including larger pipes and a deeper rock storage area.

N-02

County Parcel ID:
37-224445011100
(tax exempt property)

TSS Reduction:
3,036 lbs/yr

Volume Reduction:
10.1 ac-ft/yr

Construction Cost:
$206,034

Life Cycle Cost:
$281,034

Life Cycle / Pound TSS:
$3.09

Percent Impervious:
77.7%

Drainage:
6.65 acres
50% Tax Exempt
50% Private

N-02 - is an infiltration system proposed on a publicly owned parcel. Diverting the storm sewer in Howland Avenue W allows for capture of a large watershed with a highly impervious percentage. The cost estimate is based on installing an underground system which would allow the city to construct a park or find another public use for the property. That way, the property serves multiple purposes. Due to the proximity of adjacent buildings, any infiltration system located here would require that flood proofing be installed. Overall, the cost of flood proofing and storm sewer construction bring down the cost effectiveness slightly.

N-30

County Parcel ID:
37-221110102081;
37-223107601030;
and City ROW

TSS Reduction:
1,521 lbs/yr

Volume Reduction:
6.2 ac-ft/yr

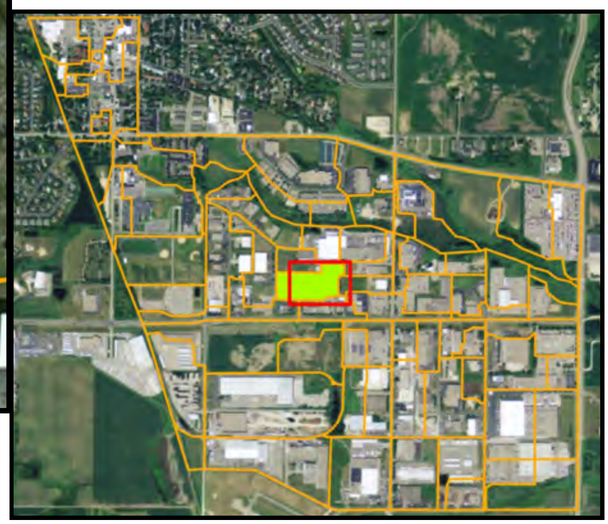
Construction Cost:
91,485

Life Cycle Cost:
$166,960

Life Cycle / Pound TSS:
$3.66

Percent Impervious:
66.7%

Drainage:
8.60 acres
17% Tax Exempt
83% Private



N-30 - is similar to the previously proposed infiltration trenches. The practices are installed within the existing ditches to add an infiltration component to the existing functionality. Stormwater is already conveyed to the proposed systems which minimizes the need for additional storm sewer and the grass swales offer a form of pretreatment. Again, these trenches have a moderately high cost effectiveness. A downstream pond in N-28 shows improved sediment removal efficiency and decreased overflow volume when these trenches are installed. The follow up design process would require further investigation to determine actual infiltration rates and groundwater elevations. If infiltration is not feasible, filtration may be an alternative to many of the proposed practices. Existing storm sewer infrastructure in the N-30 subwatershed could be used to collect runoff form an underdrain.

N-19

County Parcel ID:
City ROW and various private businesses

TSS Reduction:
2,130 lbs/yr

Volume Reduction:
8.9 ac-ft/yr

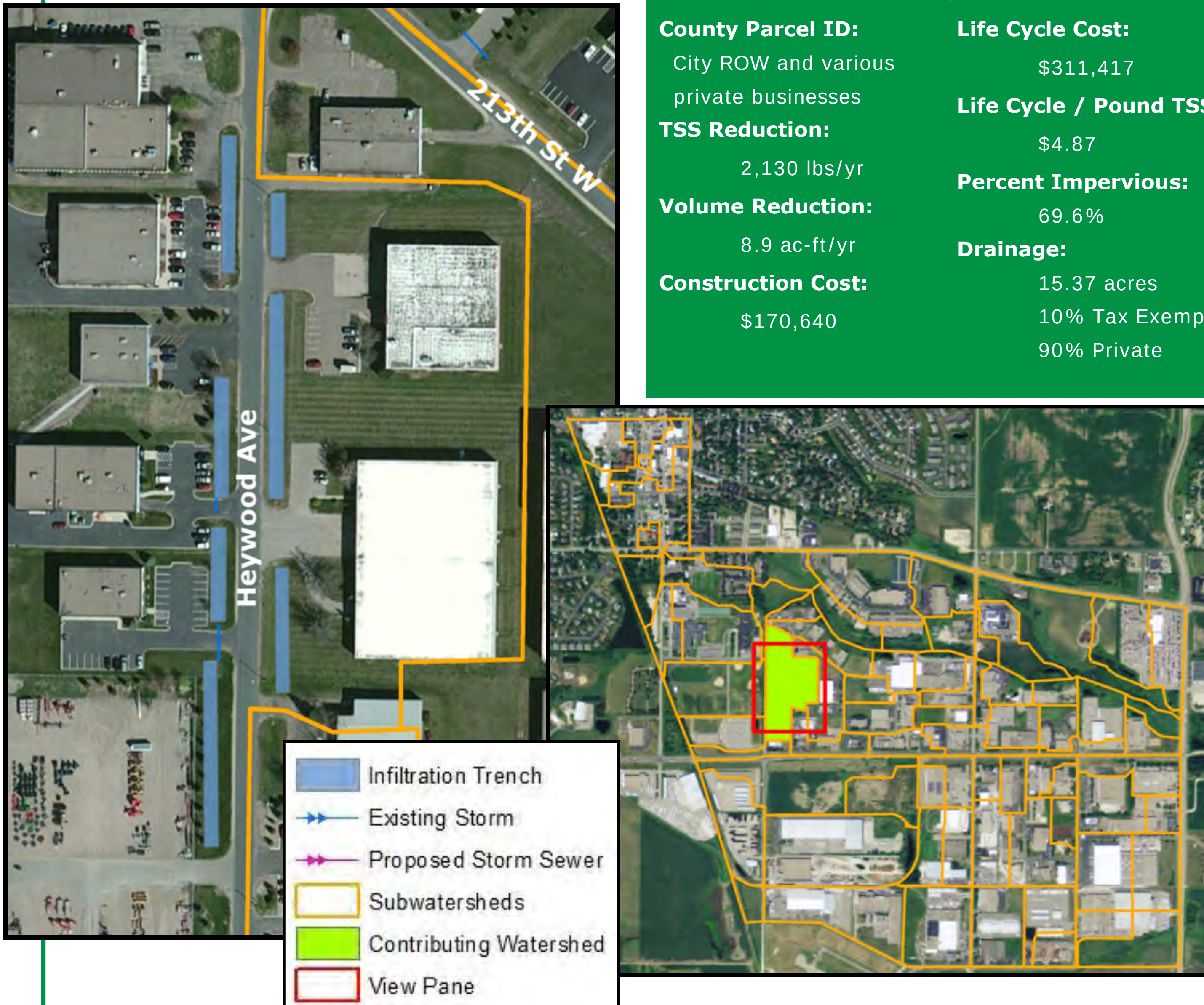
Construction Cost:
$170,640

Life Cycle Cost:
$311,417

Life Cycle / Pound TSS:
$4.87

Percent Impervious:
69.6%

Drainage:
15.37 acres
10% Tax Exempt
90% Private



N-19 - is similar to the infiltration trenches in N-18. The infiltration trenches are installed within the existing ditches to add an infiltration component to the existing functionality. Stormwater is already conveyed to the proposed systems which minimizes the need for additional storm sewer and the grass swales offer a form of pretreatment. Again, these trenches have a moderately high cost effectiveness and could manage runoff from an otherwise untreated area.

N-06

County Parcel ID:
City ROW (adjacent to public parking lot)

TSS Reduction:
847 lbs/yr

Volume Reduction:
2.8 ac-ft/yr

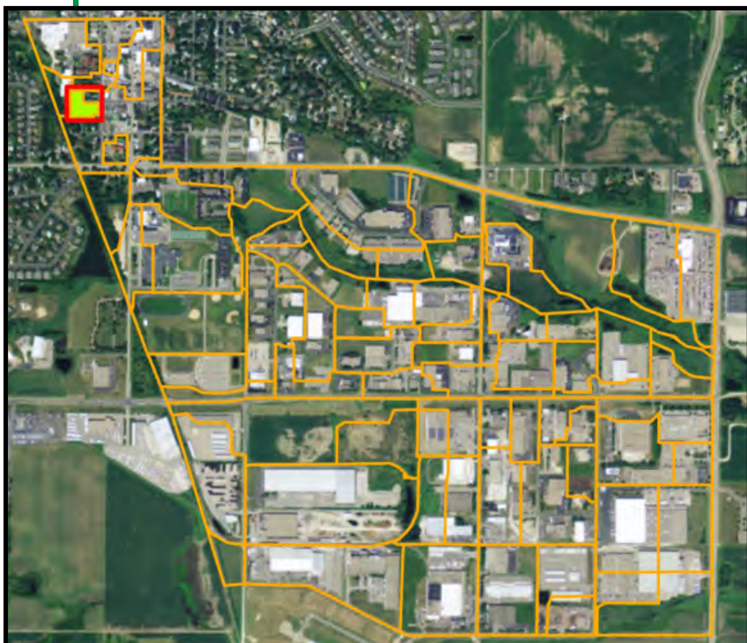
Construction Cost:
$57,476

Life Cycle Cost:
$132,476

Life Cycle / Pound TSS:
$5.21

Percent Impervious:
88.5%

Drainage:
1.63 acres
79% Tax Exempt
21% Private



N-06 - is an underground infiltration system with the purpose of capturing runoff from the adjacent parking lot before it discharges downstream. The parking lot is public property which eases the implementation process for the City. The proposed practice is strategically located to intercept the existing sewer infrastructure. This placement eliminates the costly process of replacing large sections of pavement while maintaining the system's effectiveness.

N-09

County Parcel ID:
037-220320005020
(School)

TSS Reduction:
709 lbs/yr

Volume Reduction:
2.4 ac-ft/yr

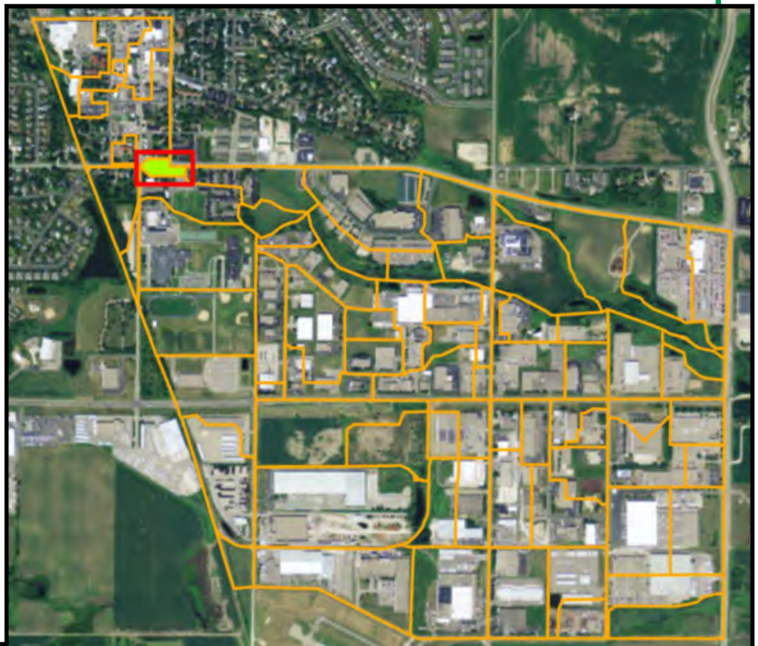
Construction Cost:
$48,278

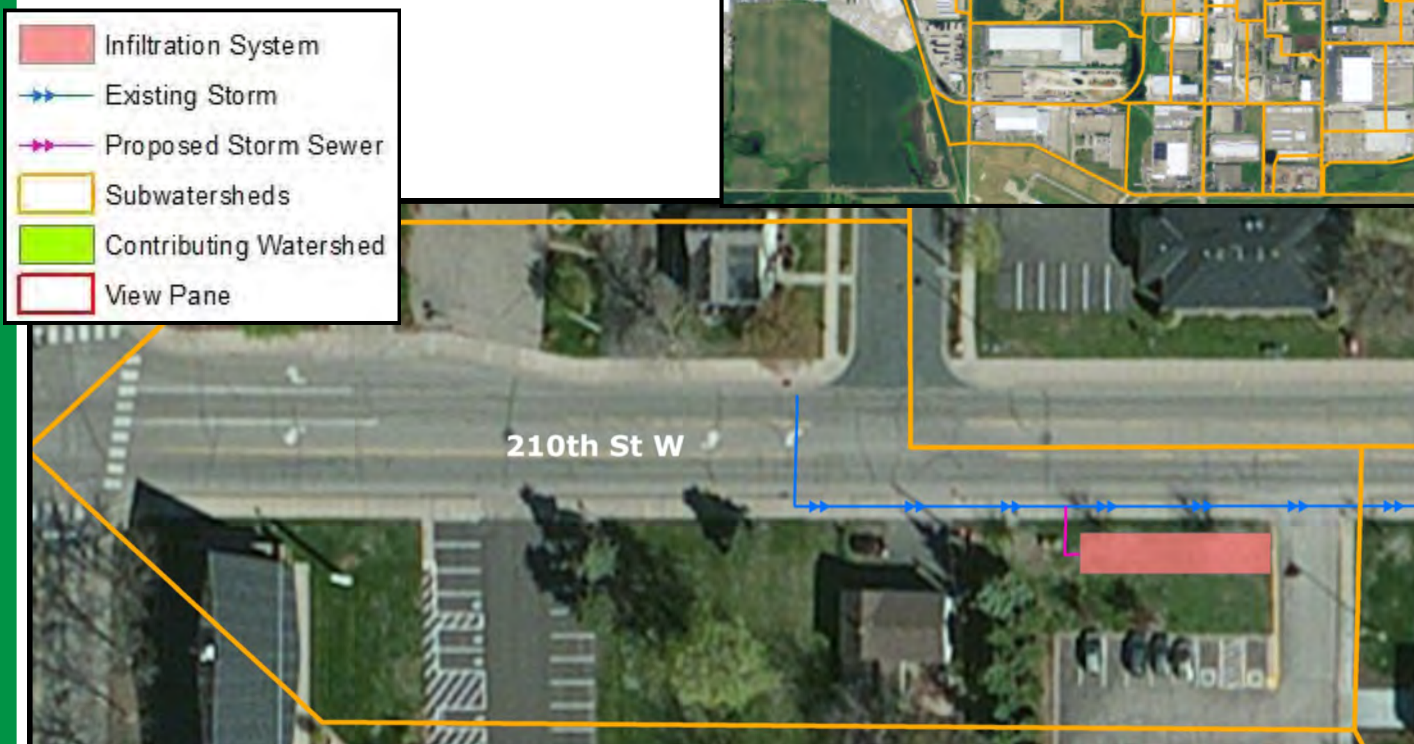
Life Cycle Cost:
$123,278

Life Cycle / Pound TSS:
$5.79

Percent Impervious:
70.9%

Drainage:
1.71 acres
81% Public
19% Private





N-09 - is a small infiltration system located within the boulevard on 210th Street W. The property belongs to the school district and the drainage area is mostly street. The design would divert runoff from the City storm sewer to the infiltration system. Once the system's volume capacity has been reached, runoff would flow through the existing storm sewer. Though the watershed is smaller, sediment from the street runoff will be higher which brings this practice to a moderate cost effectiveness.

N-48

County Parcel ID:
037-220330077010;
037-220330075016

TSS Reduction:
1,111 lbs/yr

Volume Reduction:
1.54 ac-ft/yr

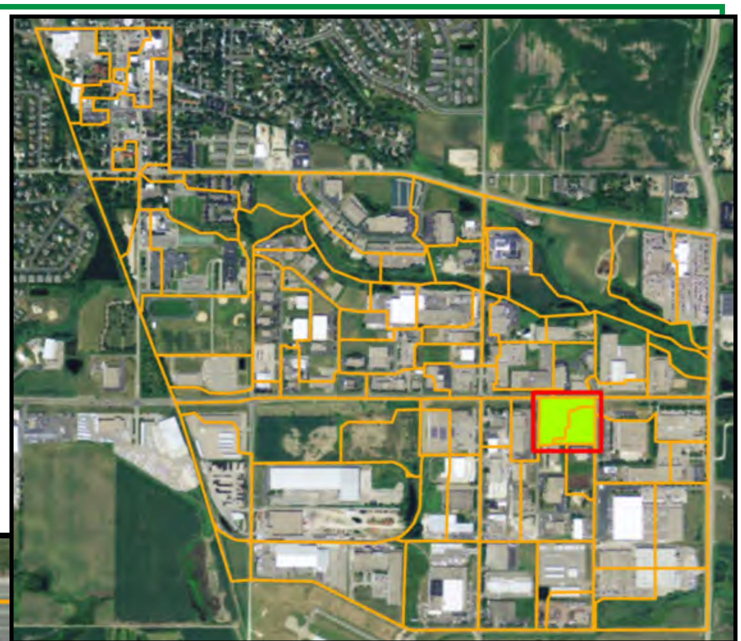
Construction Cost:
$124,234

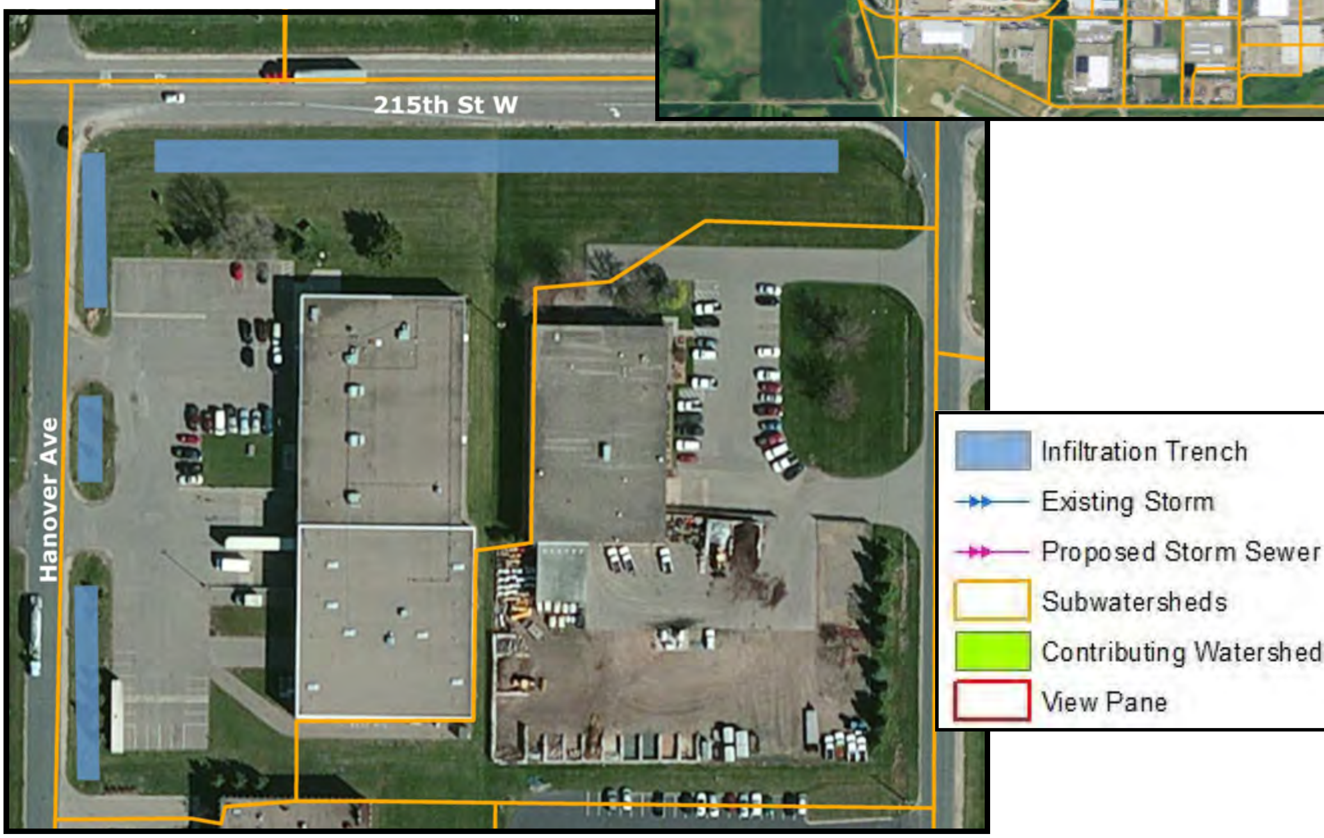
Life Cycle Cost:
$226,727

Life Cycle / Pound TSS:
$6.80

Percent Impervious:
58.0%

Drainage:
7.91 acres
8% Tax Exempt
92% Private





N-48 - is also proposed along 215th Street W (CR-70). These trenches are similar to those previously proposed but would need to offer an increased amount of volume retention due to a larger watershed. The additional volume retention increases the cost of these trenches while maintaining a moderate cost effectiveness. Stormwater is conveyed to the proposed systems from watersheds N-26, N-27, N-28, and N-29 and complement the proposed practice in those watersheds. The practices utilize existing culverts and the grass swales offer a form of pretreatment.

N-04

County Parcel ID:
Primarily city ROW

TSS Reduction:
2,911 lbs/yr

Volume Reduction:
9.9 ac-ft/yr

Construction Cost:
$489,226

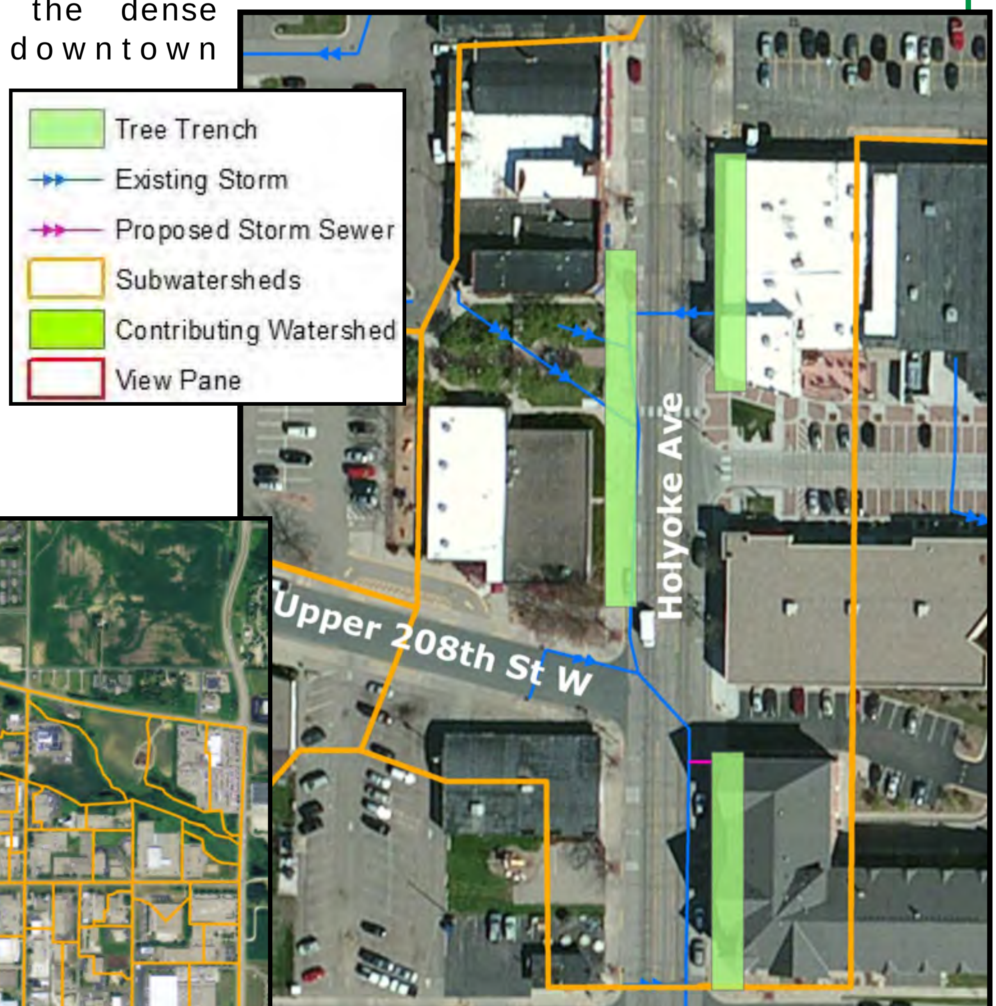
Life Cycle Cost:
$639,226

Life Cycle / Pound TSS:
$7.32

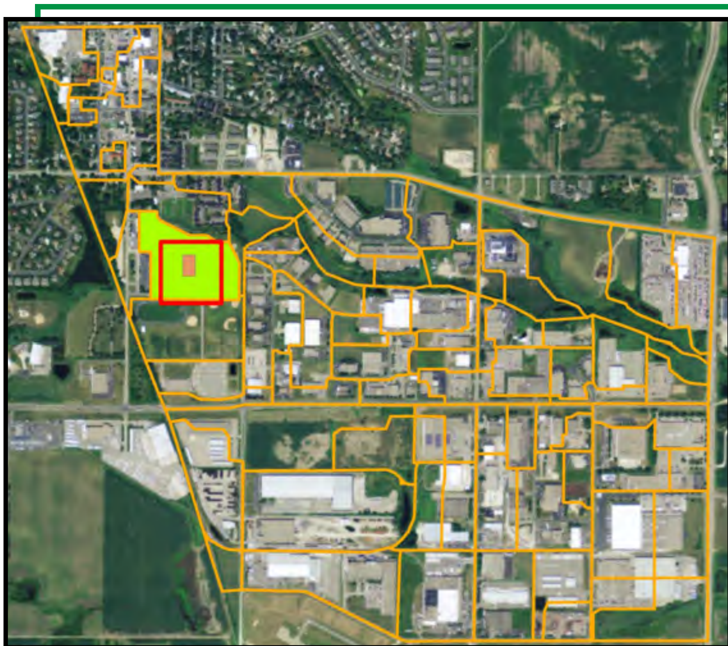
Percent Impervious:
82.5%

Drainage:
5.95 acres
44% Tax Exempt
56% Private

N-04 - is the watershed for most of downtown Lakeville and consists of the businesses along Holyoke Avenue. This area is densely developed with minimal space for surface stormwater management. In locations like this, boulevard tree trenches or stormwater planters offer a means of collecting runoff and improving the streetscape in a highly trafficked area. Both tree trenches and stormwater planters increase the amount of vegetative cover. Foliage is effective at increasing the amount of rainfall that evaporates, and as a result, further reducing runoff volumes. These options are more expensive than other forms of stormwater management. However, the dense development and downtown atmosphere are enhanced by the surface greenery. Flood proofing would be required on any type of infiltration system placed along Holyoke Avenue to prevent infiltrated water from seeping into adjacent basements.



N-13



County Parcel ID:
37-220320005020
(School)

TSS Reduction:
1,184 lbs/yr

Volume Reduction:
6.4 ac-ft/yr

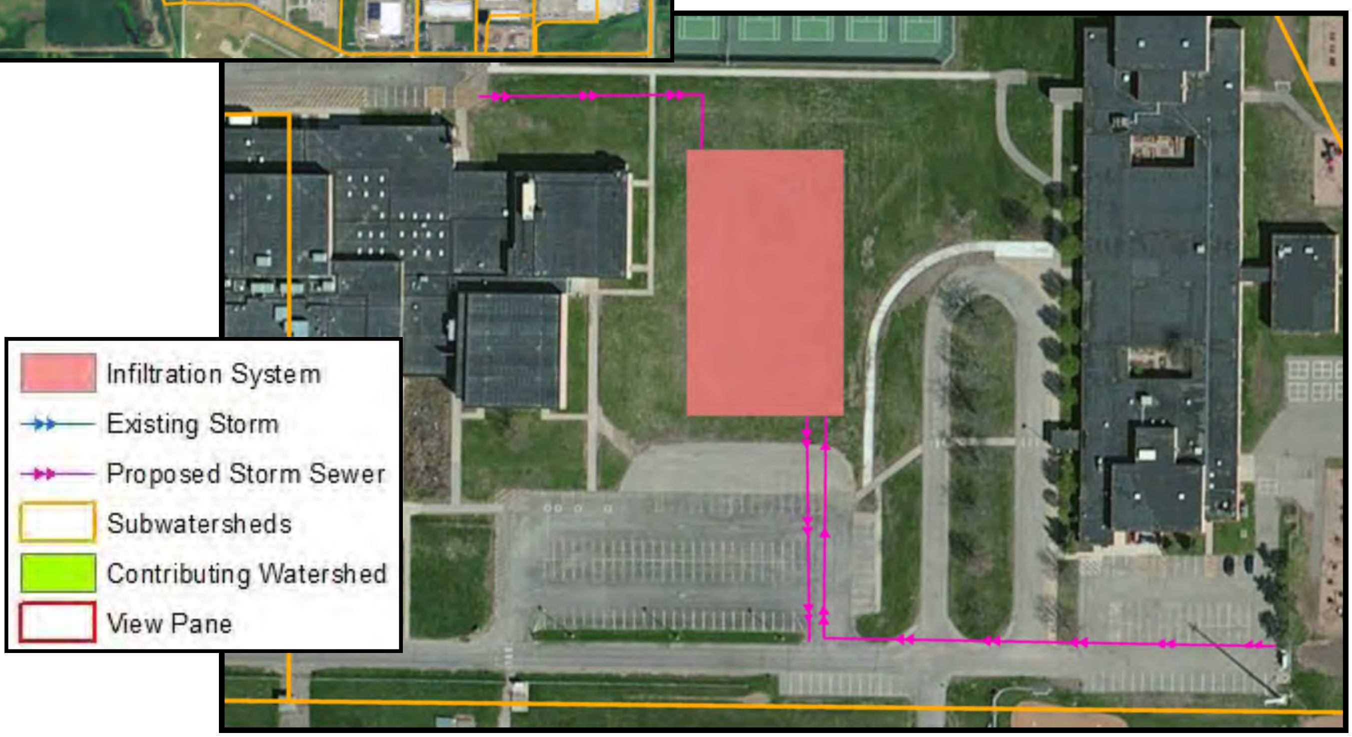
Construction Cost:
$423,316

Life Cycle Cost:
$498,316

Life Cycle / Pound TSS:
$14.03

Percent Impervious:
57.6%

Drainage:
18.43 acres
92% Tax Exempt
8% Private



N-13 - would most likely function as an underground infiltration system in order to preserve the field between the Middle (left) and Elementary (right) schools. storm sewer would need to be constructed in order to direct runoff to the intended location. Unfortunately, the additional cost for the storm sewer greatly decreases this practice's cost effectiveness.

N-39

County Parcel ID:
037-221175001020
(Tax exempt parcel)

TSS Reduction:
123 lbs/yr

Volume Reduction:
0.64 ac-ft/yr

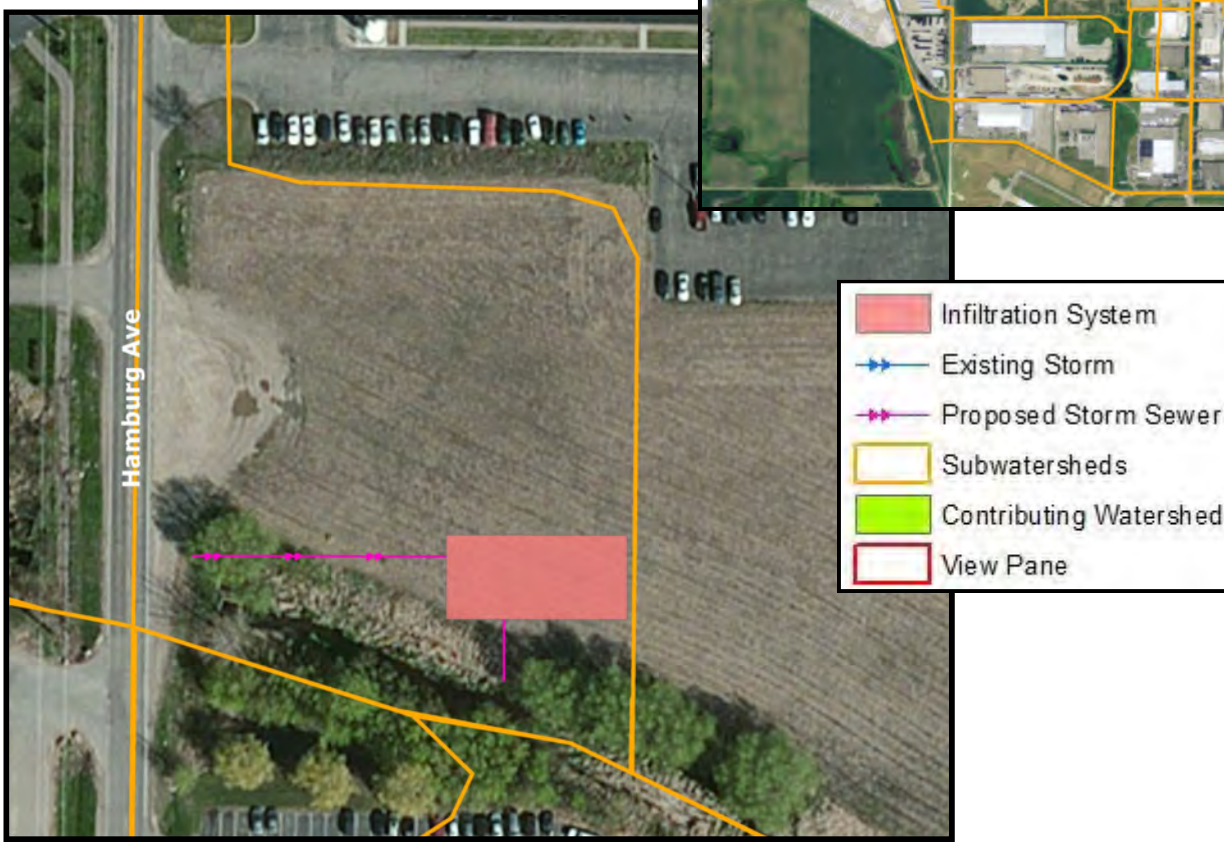
Construction Cost:
$8,353

Life Cycle Cost:
$83,353

Life Cycle / Pound TSS:
$22.64

Percent Impervious:
26.5%

Drainage:
2.64 acres
58% Tax Exempt
42% Private



N-39 - is owned by the City and previously hosted a waste water treatment facility. The drainage to this location is small and does not generate a large amount of sediment. The reduced TSS load combined with the need to construct storm sewer decreases its cost effectiveness. Additional investigation would be required to determine if infiltration is feasible. If this practice is pursued, its proximity to the creek may require that it be installed as a filtration basin which would increase construction costs to $16,705 but have similar maintenance costs. A filtration basin would have similar TSS reduction resulting in $24.91 per pound of TSS removal.

N-08

County Parcel ID:
037-224445006181
(Art Center—Tax Exempt)

TSS Reduction:
N/A

Volume Reduction:
0.05 ac-ft/yr

Construction Cost:
$25,000

Life Cycle Cost:
$34,000

Life Cycle / Pound TSS:
N/A

Percent Impervious:
39.3%

Drainage:
1.71 acres
100% Tax Exempt

N-08 - is a cistern located at the Arts Center. This system would primary function to collect runoff from the building which can then be used to irrigate the property's green space. The cistern itself would offer a public display of stormwater management and a space to educate the public about the area's effort to be good stewards of water resources. It is also fitting that the cistern be a form of artwork in itself to serve the purposes of promoting both public artwork and stormwater management.

N-25

County Parcel ID:
37-221105300010
(Tax exempt parcel)

TSS Reduction:
N/A lbs/yr

Volume Reduction:
N/A ac-ft/yr

Construction Cost:
$100,000

Life Cycle Cost:
$148,000

Life Cycle / Pound TSS:
N/A

Percent Impervious:
62%

Drainage:
10.76 acres
34% Tax Exempt
66% Private

N-25 - is a wetland and stream revitalization project. The project would help meet watershed goals by reducing erosion in this degraded stream and the additional vegetation in the waterway would help reduce runoff temperatures. Stormwater management wetlands are typically viewed as neutral, not adding or removing sediment and phosphorus. The project would help improve the stream health though it does not offer the same benefits as other stormwater improvements presented in this report.

The proposed design is on a city-owned parcel and does not require a land acquisition. An existing trunk storm sewer line runs through the area. The City would have the option to install a break in the storm line and allow water to discharge to the wetland or leave the sewer undisturbed. In the latter option, the wetland would receive runoff form the immediate watershed but could later be expanded to include some of the downtown watershed by installing the break in the storm sewer.

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5.2 COUNTY PROJECTS

The county roads throughout the industrial park offer similar opportunities to that of Hamburg Avenue. These projects are all infiltration trenches similar to those that have already been implemented. The county should plan to incorporate these practices into future street reconstruction projects. The infiltration trenches along 215th Street should be a priority as they receive runoff from the largest tributary area. Table 4 gives a breakdown of what will be needed to meet MIDS on the county roads within the study area.

Table 4: Cost and pollutant removal summary for Dakota County project.

Priority	Project	TSS Removed (lbs/yr)	Volume Reduction (ac-ft/yr)	Construction Cost	Life Cycle Cost (30 yrs)	Life Cycle per Pound of TSS
1	N-31	2,631	4.2	$172,078	$314,043	$3.98
2	N-50	392	1.2	$28,831	$52,617	$4.48
3	N-18	1,330	3.7	$101,531	$185,295	$4.64
4	N-32	617	2.9	$61,571	$112,367	$6.07
5	N-51	1,026	5.0	$110,119	$200,966	$6.53

N-31

County Parcel ID:
037-221110101021;
037-221110004080;
and Dakota Co. ROW

TSS Reduction:
2,631 lbs/yr

Volume Reduction:
4.2 ac-ft/yr

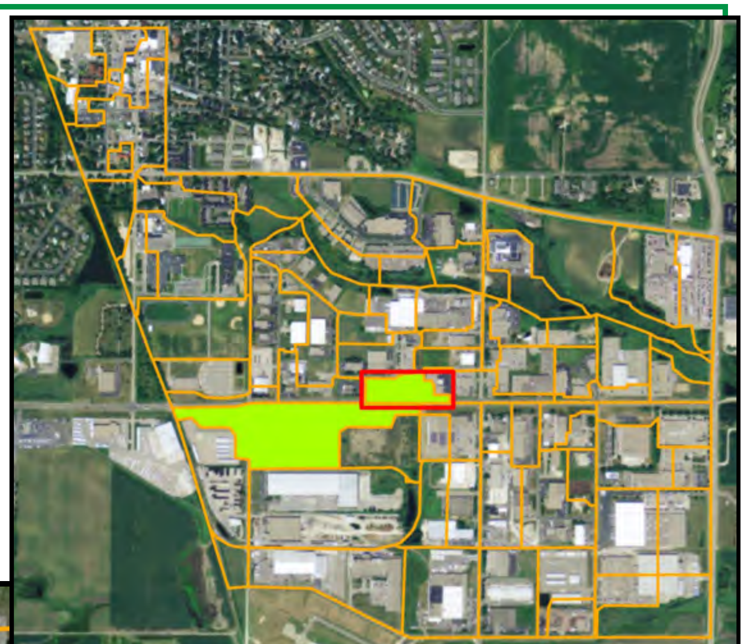
Construction Cost:
$172,078

Life Cycle Cost:
$314,043

Life Cycle / Pound TSS:
$3.98

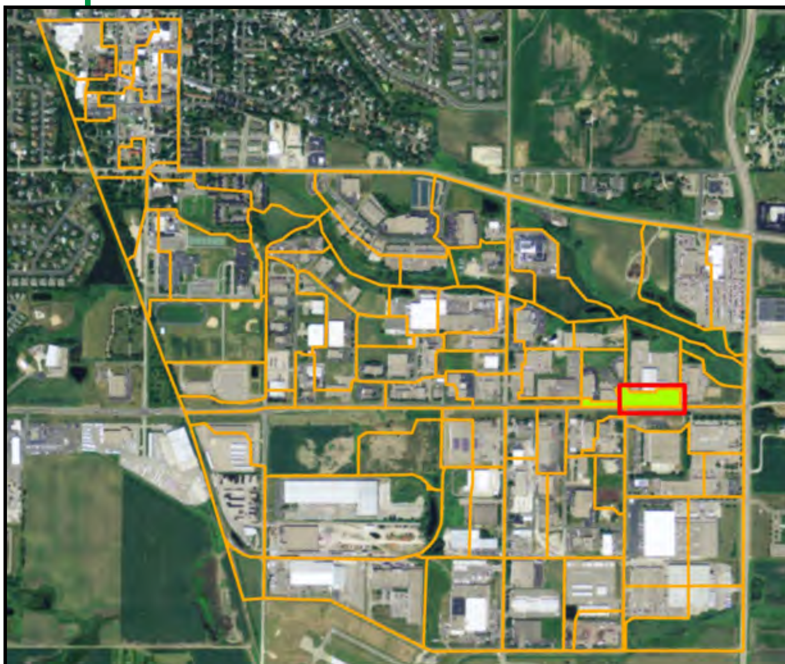
Percent Impervious:
51.2%

Drainage:
33.69 acres
30% Tax Exempt
70% Private



N-31 - is one set of a series of infiltration trenches proposed along 215th Street W (CR-70). These trenches are similar to those previously proposed but would need to offer an increased amount of volume retention. The additional volume retention increases the cost of these trenches. The practices are installed within the ditches along 215th Street W to add an infiltration component to the existing functionality. Stormwater is already conveyed to the proposed systems from the properties to the north and the south side of 215th Street W. The practices utilize existing culverts and the grass swales offer a form of pretreatment. Again, these trenches have a moderately high cost effectiveness and manage an otherwise untreated watershed.

N-50



County Parcel ID:
037-221105101010; and Dakota Co. ROW

TSS Reduction:
392 lbs/yr

Volume Reduction:
1.2 ac-ft/yr

Construction Cost:
$28,831

Life Cycle Cost:
$52,617

Life Cycle / Pound TSS:
$4.48

Percent Impervious:
50%

Drainage:
3.62 acres
40% Public
60% Private

N-50 - is similar to the other proposed infiltration trenches along 215th Street W. If the City comes to like this as a treatment system it could be used throughout the industrial park. The infiltration trenches are installed within the existing ditches to add an infiltration component to the drainage functionality. Stormwater is already conveyed to the proposed systems from the properties to the north and west and the grass swales offer a form of pretreatment. Again, these trenches have a moderately high cost effectiveness and could manage runoff from an otherwise untreated area.

N-18

County Parcel ID:
Primarily City and County ROW

TSS Reduction:
1,330 lbs/yr

Volume Reduction:
3.7 ac-ft/yr

Construction Cost:
$101,531

Life Cycle Cost:
$185,295

Life Cycle / Pound TSS:
$4.64

Percent Impervious:
59.1%

Drainage:
11.34 acres
46% Tax Exempt
54% Private

N-18 - consists of a series of infiltration trenches similar to those recently installed on Hamburg Avenue. The industrial park in Lakeville uses ditches to convey stormwater runoff downstream. The infiltration trenches capitalize on the ditch system by adding an infiltration component to the existing functionality. Stormwater is already conveyed to the proposed systems which minimizes the need for additional storm sewer and the grass swales offer a form of pretreatment. Overall, the infiltration trenches have a moderately high cost effectiveness.

N-32

County Parcel ID:
Dakota Co. ROW

TSS Reduction:
617 lbs/yr

Volume Reduction:
2.9 ac-ft/yr

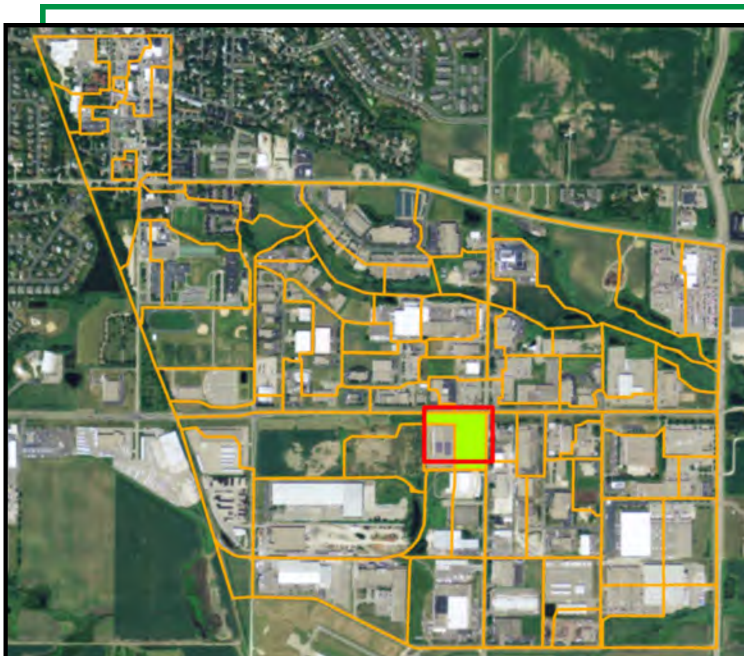
Construction Cost:
$61,571

Life Cycle Cost:
$112,367

Life Cycle / Pound TSS:
$6.07

Percent Impervious:
61.0%

Drainage:
6.32 acres
24% Tax Exempt
76% Private



N-32 - is another infiltraiton trench along 215th Street W (CR-70). These trenches are similar to those previously proposed. The practices are installed within the ditches along 215th Street W to add an infiltration component to the existing functionality. Stormwater is already conveyed to the proposed systems from the properties to the south of 215th Street W. This particular trench has a small watershed which may reduce its cost effectiveness.

N-51

County Parcel ID:
County ROW

TSS Reduction:
1,026 lbs/yr

Volume Reduction:
5.0 ac-ft/yr

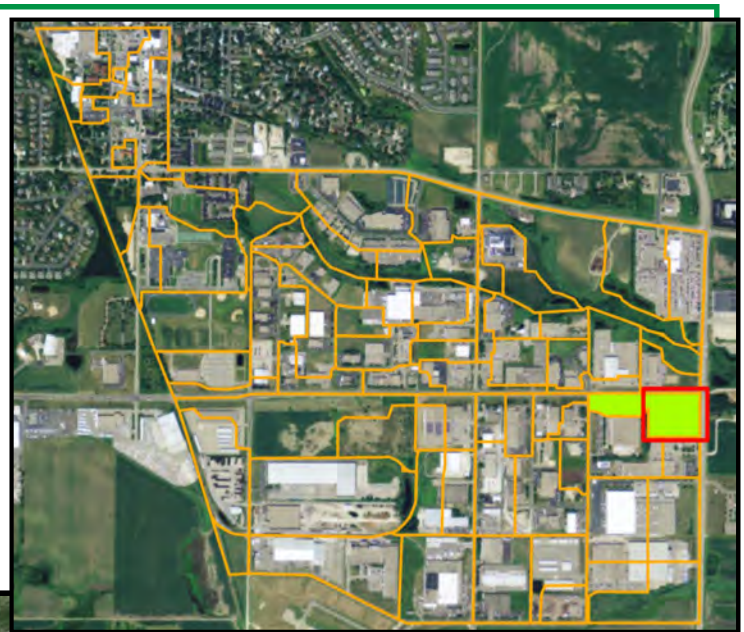
Construction Cost:
$110,119

Life Cycle Cost:
$200,996

Life Cycle / Pound TSS:
$6.53

Percent Impervious:
62.2%

Drainage:
11.10 acres
26% Public
74% Private



N-51 - is similar to the other proposed infiltration trenches along 215th Street W. If the City comes to like this as a treatment system it could be used throughout the industrial park. The infiltration trenches are installed within the existing ditches to add an infiltration component to the drainage functionality. Stormwater is already conveyed to the proposed systems from the properties from the south and the grass swales offer a form of pretreatment. This particular trench has a lower cost effectiveness but would manage runoff from an otherwise untreated area.

5.3 PRIVATE PROJECTS

The green infrastructure proposed on private property is meant to make property owners aware of their environmental impacts and encourage them to lessen that impact. The plans will start a conversation about how to reduce stormwater runoff and increase water quality on private property. These options set the stage for a positive impact on the community. The VRWJPO and/or City should endeavor to contact the properties, make them aware of the stormwater plan, and make the plan accessible for use. Table 5 prioritizes these projects based on life cycle cost per pound of TP removed. All of these practices are cost effective options for improving stormwater management. The VRWJPO and City should emphasize the projects that provide the most impact to the watershed.

Table 5: Priority list of private projects by life cycle cost per pound of TP removed.

Priority	Project	TSS Removed (lbs/yr)	Volume Reduction (ac-ft/yr)	Construction Cost	Life Cycle Cost (30 yrs)	Life Cycle per Pound of TP
1	S-05	5,551	19.3	$226,943	$301,943	$1.81
2	S-17	1,735	5.5	$48,232	$123,232	$2.37
3	S-18	5,285	16.2	$219,219	$400,075	$2.52
4	S-20	2,772	8.5	$205,069	$235,069	$2.83
5	N-20 Option 3a	2,428	10.7	$148,000	$233,030	$3.06
6	S-12	783	3.4	$42,535	$77,627	$3.31
7	S-16	1,746	6.8	$102,907	$177,907	$3.40
8	N-20 Option 2	1,348	5.8	$76,120	$138,915	$3.44
9	N-20 Option 1	503	1.5	$46,720	$76,720	$5.08
10	N-20 Option 3b	2,428	NA	$296,060	$371,060	$5.09
11	N-03	285	1.0	$19,019	$49,019	$5.74

S-05

County Parcel ID:
037-220330052043
(private business)

TSS Reduction:
5,551 lbs/yr

Volume Reduction:
19.3 ac-ft/yr

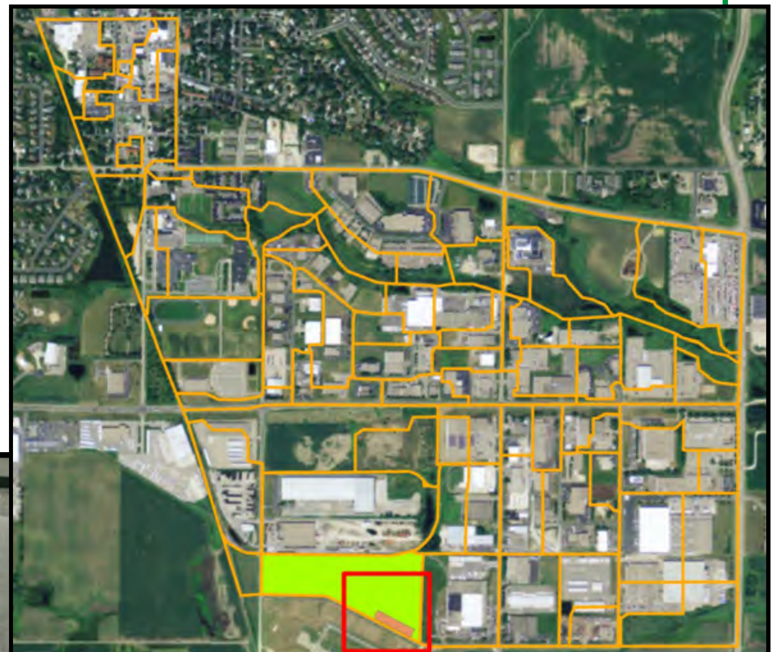
Construction Cost:
$226,943

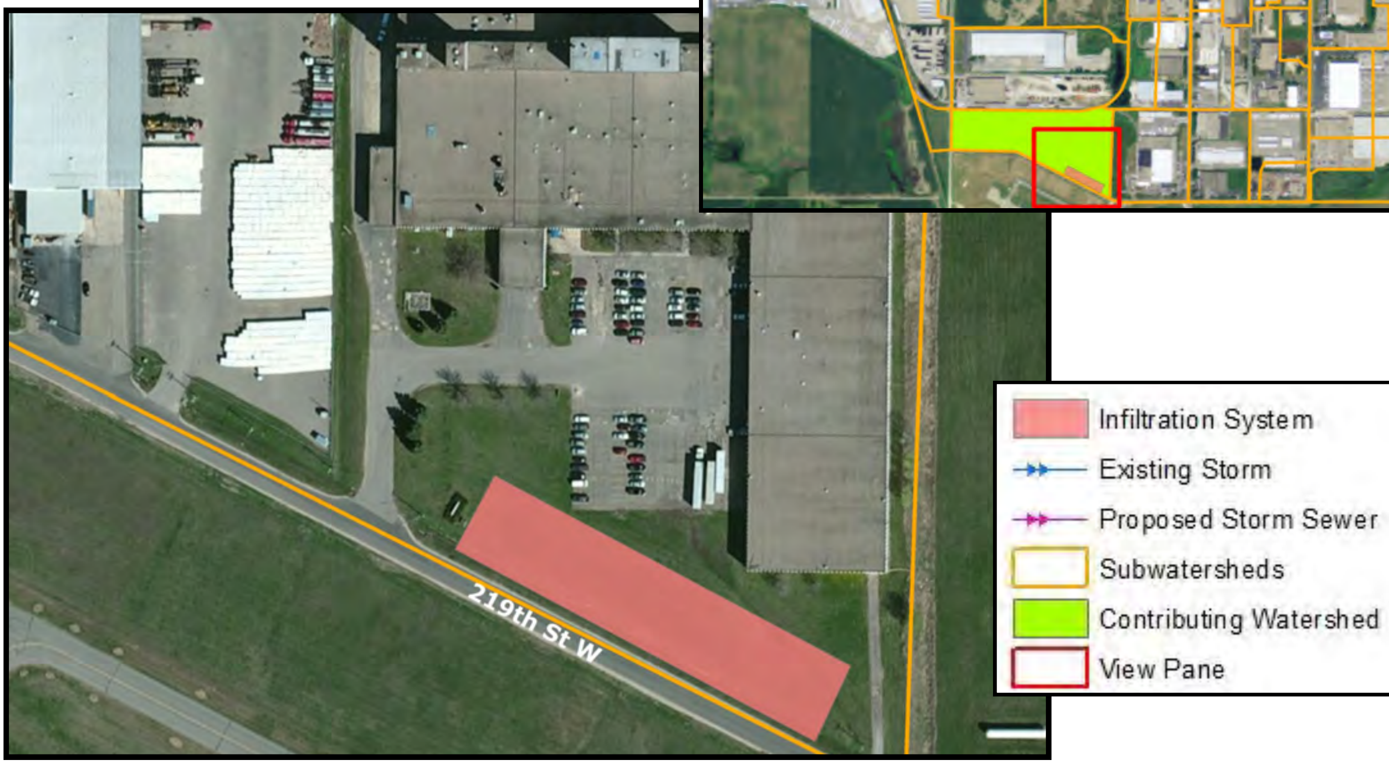
Life Cycle Cost:
$301,943

Life Cycle / Pound TSS:
$1.81

Percent Impervious:
76.4%

Drainage:
24.86 acres
<1% Tax Exempt
99% Private





S-05 - is a large industrial watershed just north of the airport. The watershed drains to a series of ditches and ultimately to a creek southeast of the watershed. A large open green space offers the opportunity to infiltrate runoff before discharging downstream. The airport has previously expressed concern about open waterbodies attracting fowl that could interfere with flights. It would be important that any system constructed not have standing water for more than 48 hours which is standard for BMPs. This practice is cost effective but may become less so if property would need to be acquired for installation.

S-17

County Parcel ID:
Not available

TSS Reduction:
1,735 lbs/yr

Volume Reduction:
5.5 ac-ft/yr

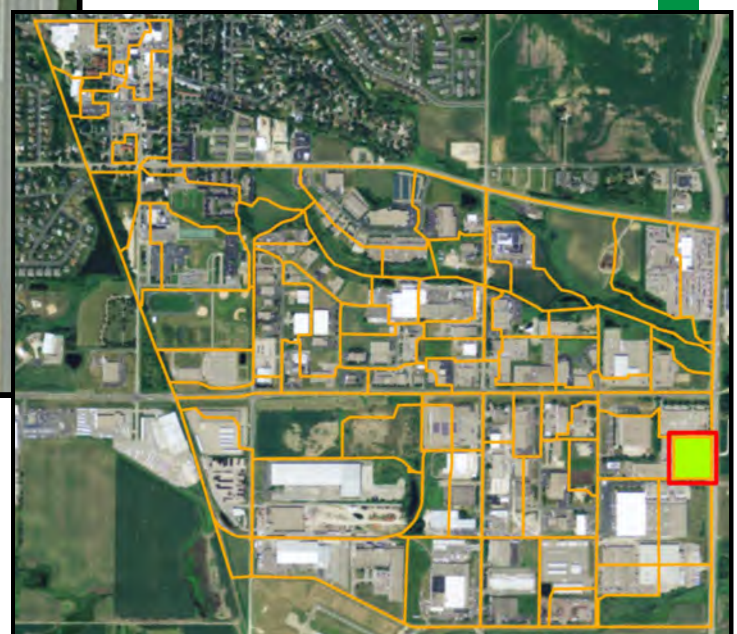
Construction Cost:
$48,232

Life Cycle Cost:
$123,232

Life Cycle / Pound TSS:
$2.37

Percent Impervious:
85.5%

Drainage:
4.72 acres
61% Tax Exempt
39% Private



S-17 - This small subwatershed has a section of green space that could be used to infiltrate runoff before it discharges to Cedar Avenue. A series of curb cuts along the flow path would work to direct runoff to an infiltration basin in the center of the watershed. When the basin is full, runoff would continue down the curb line to the storm sewer. This practice is located entirely on private property and may be difficult to implement but is a relatively cost effective option for stormwater management.

S-18

County Parcel ID:
037-220330080020;
037-220330083012

TSS Reduction:
5,285 lbs/yr

Volume Reduction:
16.2 ac-ft/yr

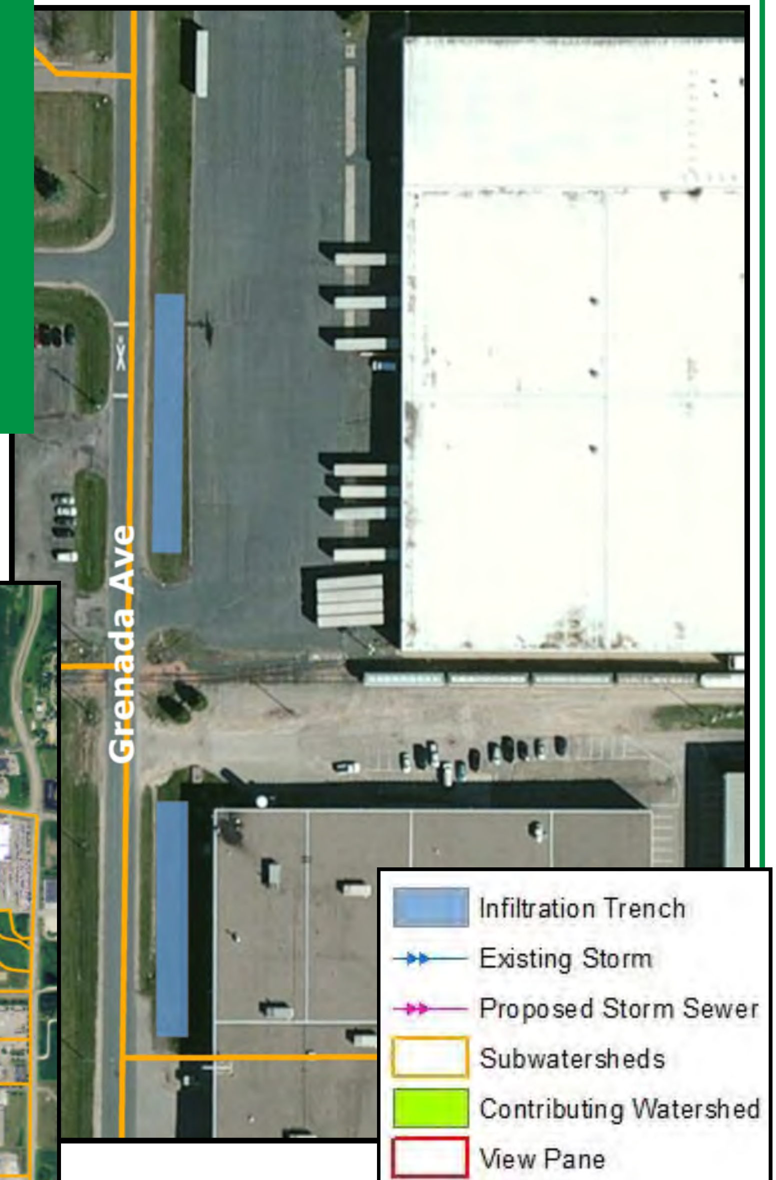
Construction Cost:
$219,219

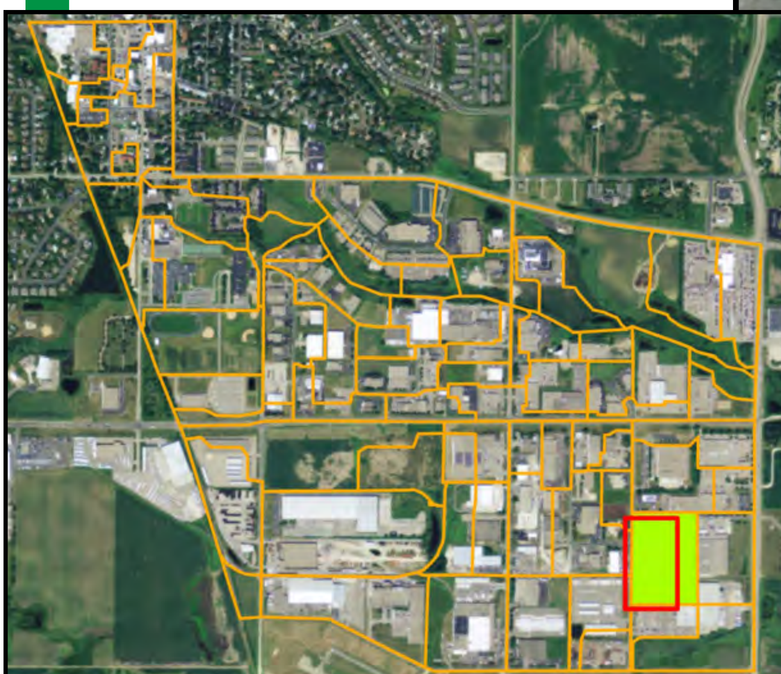
Life Cycle Cost:
$400,075

Life Cycle / Pound TSS:
$2.52

Percent Impervious:
86.4%

Drainage:
15.89 acres
2% Tax Exempt
98% Private





S-18 - proposes a couple infiltration trenches along Grenada Avenue. Similar to the work conducted along Hamburg Avenue, the infiltration trenches are proposed in the ditches that collect runoff form adjacent industrial properties. These trenches would need to hold a larger volume which increases the cost. Additional volume may be achieved by increasing the length of the system to the north if it is determined more volume is needed to effectively treat this subwatershed. The design would treat a large watershed using the existing stormwater infrastructure. This application is relatively cost effective and could be constructed within the street right of way.

S-20

County Parcel ID:

037-220330083012

037-220330083011

TSS Reduction:

2,772 lbs/yr

Volume Reduction:

8.5 ac-ft/yr

Construction Cost:

$205,069

Life Cycle Cost:

$235,069

Life Cycle / Pound TSS:

$2.83

Percent Impervious:

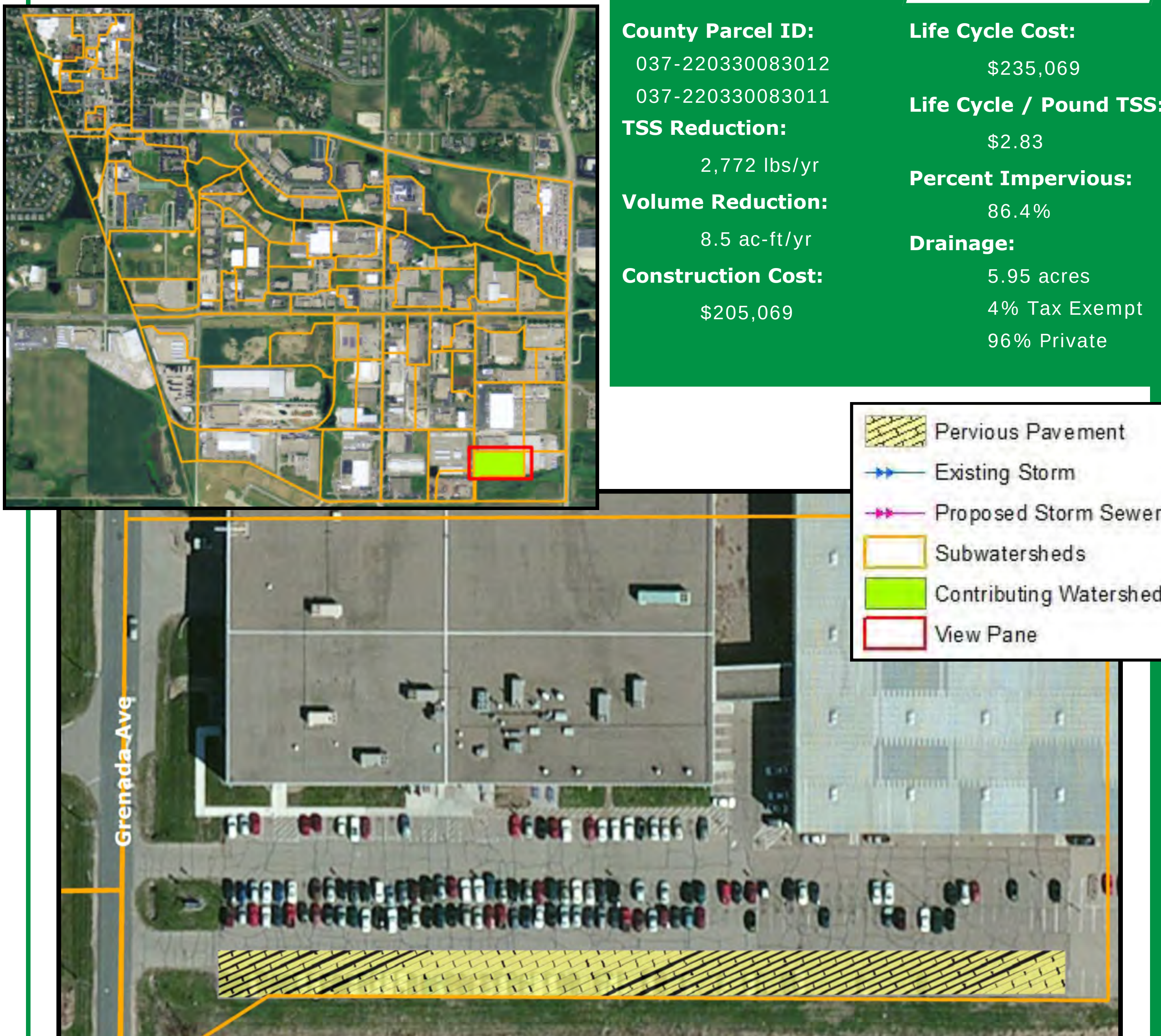
86.4%

Drainage:

5.95 acres

4% Tax Exempt

96% Private

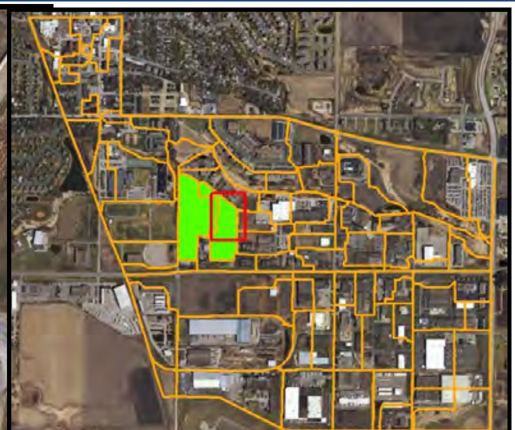


S-20 - is a section of pervious pavement proposed in a parking lot just north of the creek. The configuration of the parking lot is ideal for a strip of pervious pavement. Runoff flows from the north to the south so the pavement would collect runoff form the entire watershed without altering the site's functionality. The pavement is capable of handling the intermittent traffic loads so pavement viability would not be an issue. The existing parking lot is approaching disrepair and will need to be replaced in the near future. The City should plan to approach the owner with this project before that happens.

N-20

County Parcel ID:
37-221105300010
Property Owner:
Parker Hannifin Corp.
Reductions & Costs:
See table

	Option 1	Option 2	Option 3a	Option 3b
Practice Type	Pervious pavement	Infiltration trench	Infiltration basin	Filtration basin
Drainage area [acres]	1.3	14.9	22.4	22.4
Percent impervious	91%	50%	55%	55%
TSS reduction [lbs/yr]	503	1,348	2,428	2,428
Volume reduction [acre-ft/yr]	1.5	5.8	10.7	NA
Construction Cost	$46,720	$76,120	$148,000	$296,060
30-year life cycle cost	$76,720	$138,915	$223,030	$371,060
Life cycle/pound TSS	$5.08	$3.44	$3.06	$5.09



N20 - presents three different options for stormwater treatment on the Parker Hannifin Corp. property. The first option is a strip of pervious asphalt/ pavers on the eastern edge of the company's current parking lot. This strip would be located on the low end of the parking lot and would cause runoff from the parking lot and half of the building to infiltrate before discharging to the roadside ditch. This option is the least cost effective of the three proposed options and treats the smallest area. The second option is a series of infiltration trenches in the existing ditch system on the east (along Hemlock Ave) and northern edge (along 213th St W) of the property. The infiltration trenches are similar to the trenches that are currently in place along Hamburg Avenue and would also treat runoff from adjacent properties to the south and west of this property. These trenches are reltaviely cost effective and remove more TSS than option 1. The third option is a large infiltration/ filtration basin located on the north end of the property. This basin would act as a regional system and treat water from several surrounding properties. Due to proximity to the creek, soil samples and groundwater depths would need to be analyzed to determine if filtration or infiltration is the most appropriate design for this site. Both options are presented in the table. The infiltration basin (option 3a) has a similar cost efficiency to option 2, but treats a larger area and removes significantly more TSS. A filtration basin (option 3b) would remove a similar amount of sediment, however potential construction costs would be higher.

S-12

County Parcel ID:
037-220330075020
(private business)

TSS Reduction:
783 lbs/yr

Volume Reduction:
3.4 ac-ft/yr

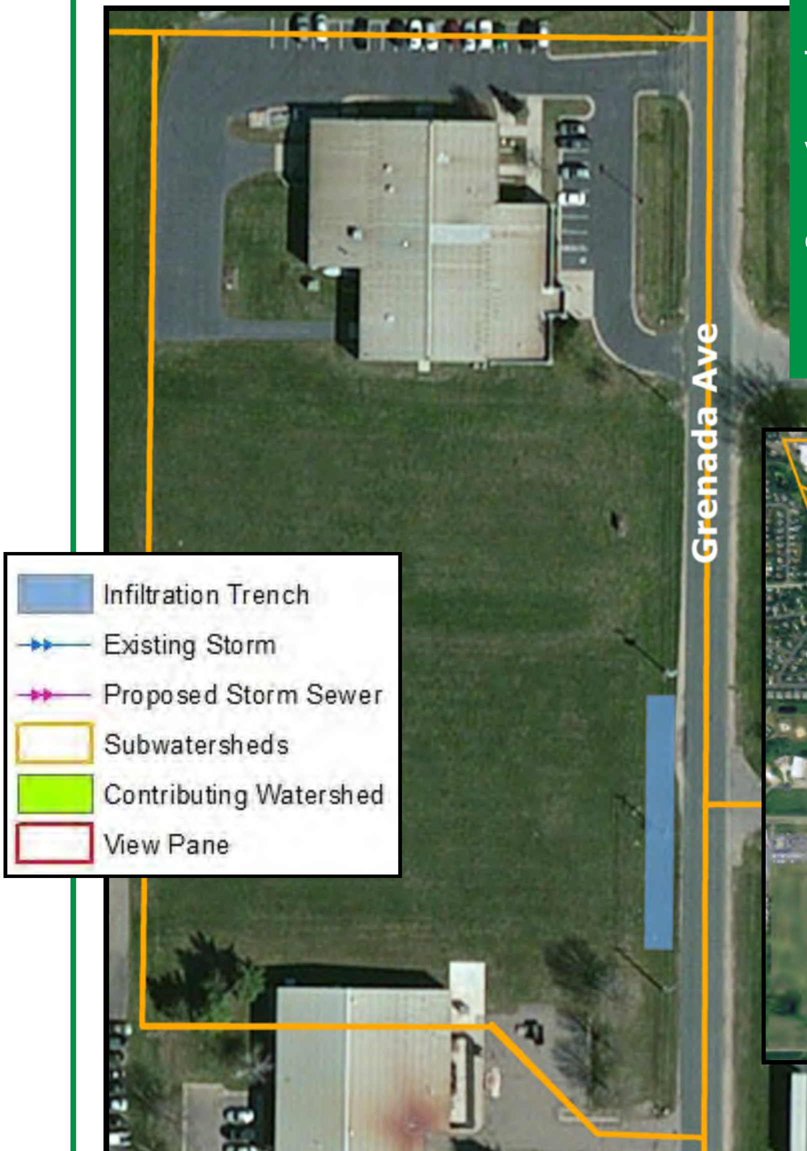
Construction Cost:
$42,535

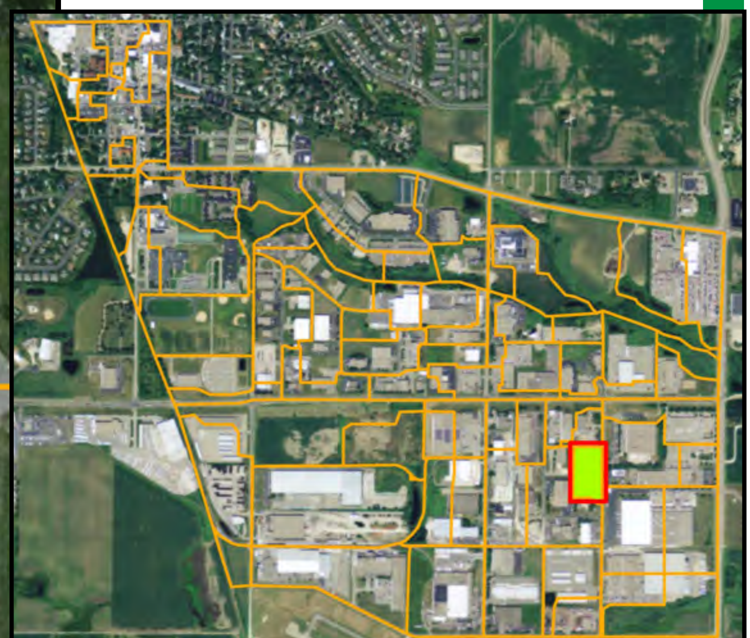
Life Cycle Cost:
$77,627

Life Cycle / Pound TSS:
$3.31

Percent Impervious:
60.1%

Drainage:
4.44 acres
0% Tax Exempt
100% Private





S-12 - is a small watershed with minimal impervious area. However, a plot within this watershed is prime for development. When that time comes, the City should approach the developer and try to integrate their stormwater management with treatment of street runoff. The property owner may benefit by leaving maintenance to the City. An infiltration trench, similar to the others proposed, could treat runoff form the existing impervious and future development.

S-16

County Parcel ID:
037-220330075018
(private business)

TSS Reduction:
1,746 lbs/yr

Volume Reduction:
6.8 ac-ft/yr

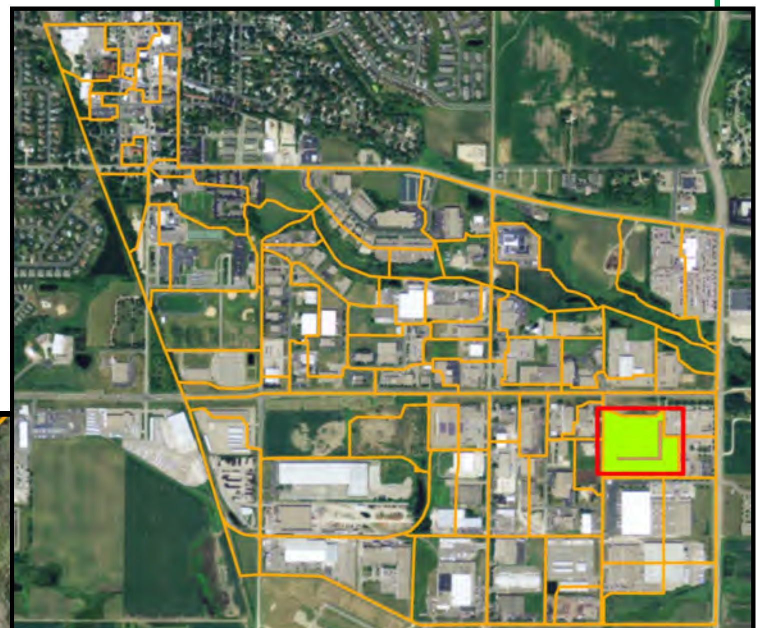
Construction Cost:
$102,907

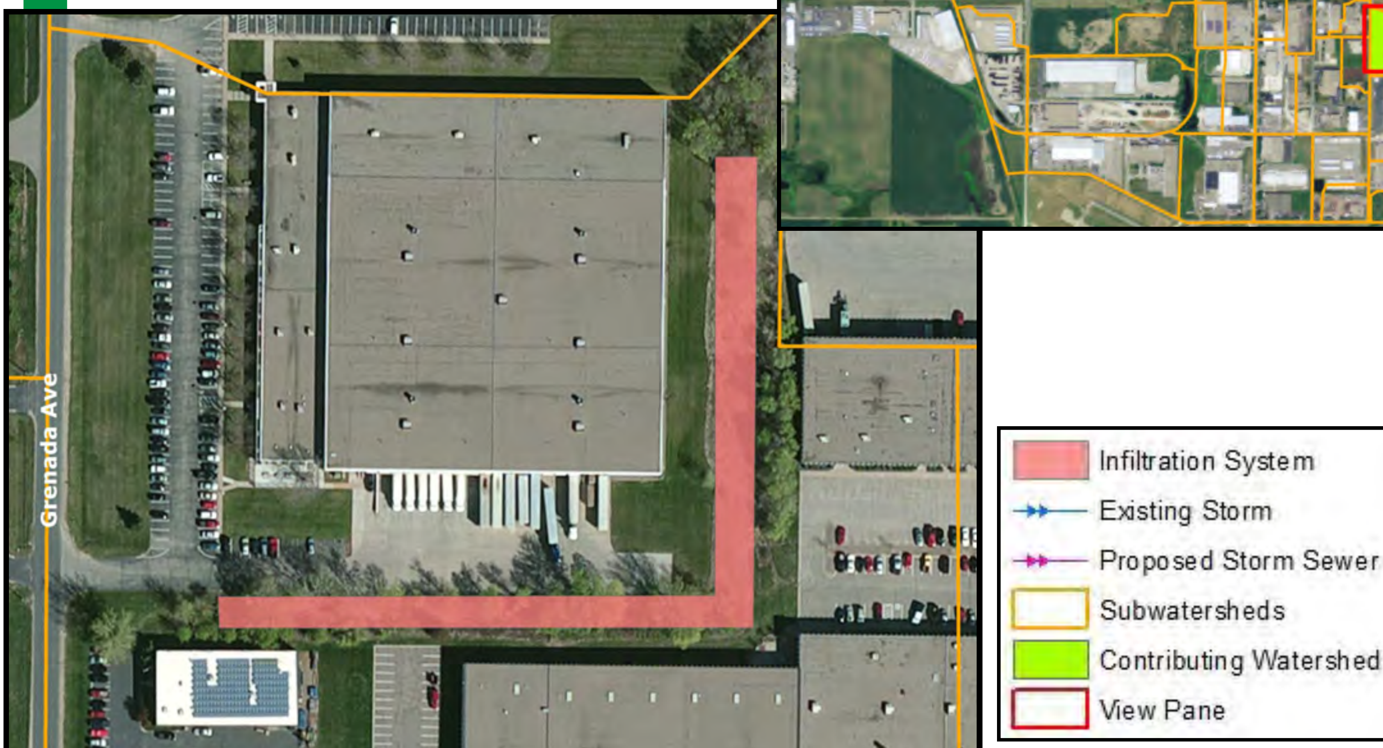
Life Cycle Cost:
$177,907

Life Cycle / Pound TSS:
$3.40

Percent Impervious:
62.9%

Drainage:
13.68 acres
22% Tax Exempt
72% Private





S-16 - is a proposed infiltration practice that would optimize an existing low spot. An existing vegetated ditch runs between several buildings and collects runoff. By enhancing the ditch to retain rainfall an infiltration basin would be created. Additional investigation may be needed to determine if the project is feasible. The location is also entirely private property, so implementation may be more difficult.

N-03

County Parcel ID:
037-220290078051
(private business)

TSS Reduction:
285 lbs/yr

Volume Reduction:
1.0 ac-ft/yr

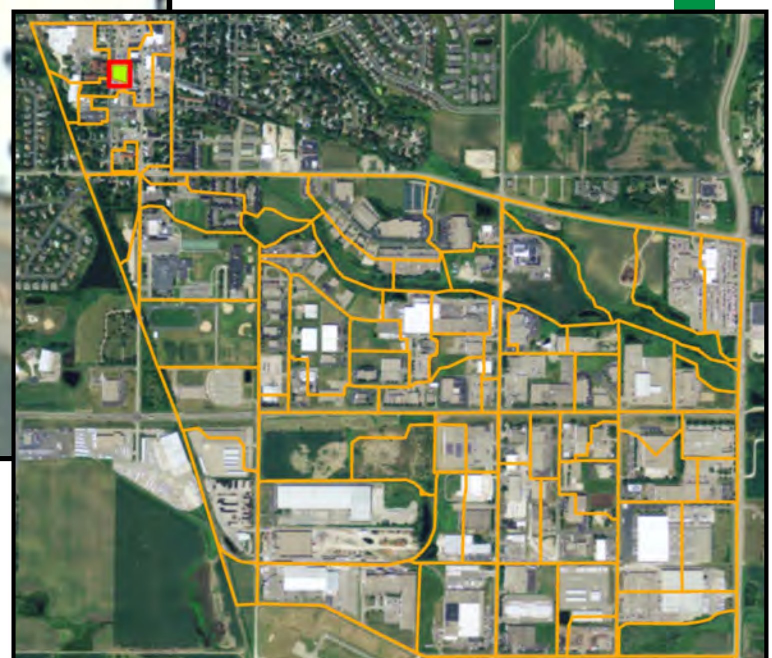
Construction Cost:
$19,019

Life Cycle Cost:
$49,019

Life Cycle / Pound TSS:
$5.74

Percent Impervious:
87.5%

Drainage:
0.55 acres
13% Tax Exempt
87% Private



N-03 - proposes pervious pavement in the parking lot of the Community Education Building. Replacing the center rows of the parking lot with pervious pavement offers stormwater management while maintaining the location's functionality. With this design, runoff is captured before it enters the storm sewer system which alleviates some of the strain on the sewer system. A similar practice was recently installed to the west on 208th Street W. The design manages stormwater and improves the street aesthetics. The system requires periodic maintenance including repairing any damage and vacuuming the pavement to prevent clogging.

5.4 NEXT STEPS

In order to accomplish improved water quality within the study area, the VRWJPO and City should take the following steps:

- **Select** projects that are ready to construct within the foreseeable future.
- **Estimate** the total suspended sediment reduction resulting from the projects to see if the TMDL goals will be met.
- **Form** relationships with private entities where coordinating may be required.
- **Apply** for grants. The Minnesota Clean Water Fund is receiving applications for funding on projects that improve water quality throughout the state.
- **Notify** property owners this report is available and request feedback from interested parties.
- **Contact** Dakota County to begin the planning process for practices along county roads.
- **Evaluate** any area impacts resulting from the selected projects.
- **Fully Design and Construct** projects that receive funding.

Wenck is available to assist with securing funding, if needed, and can help answer questions from other interested parties.

6.0 References

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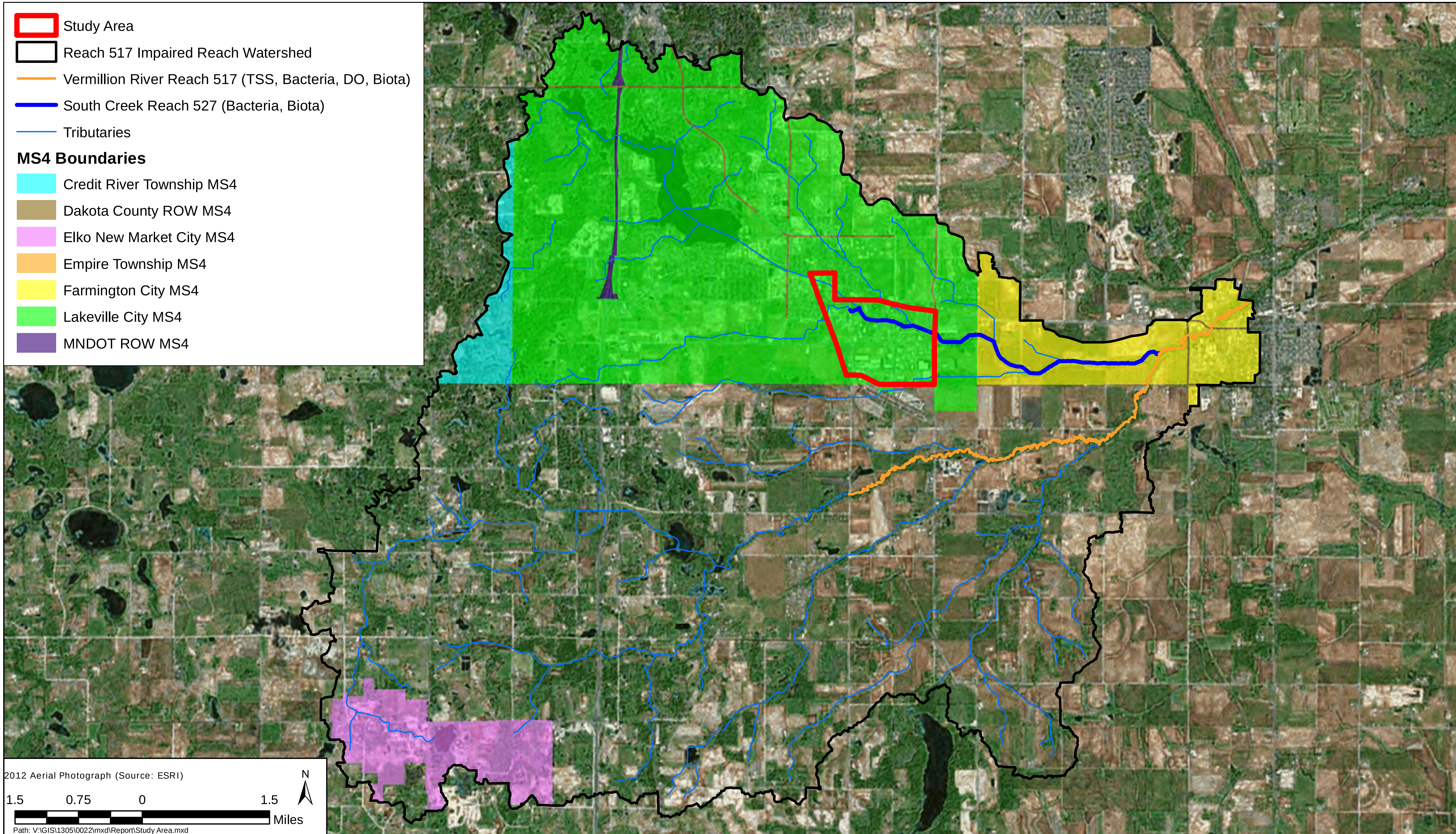
Figures



SOUTH CREEK SUBWATERSHED ASSESSMENT

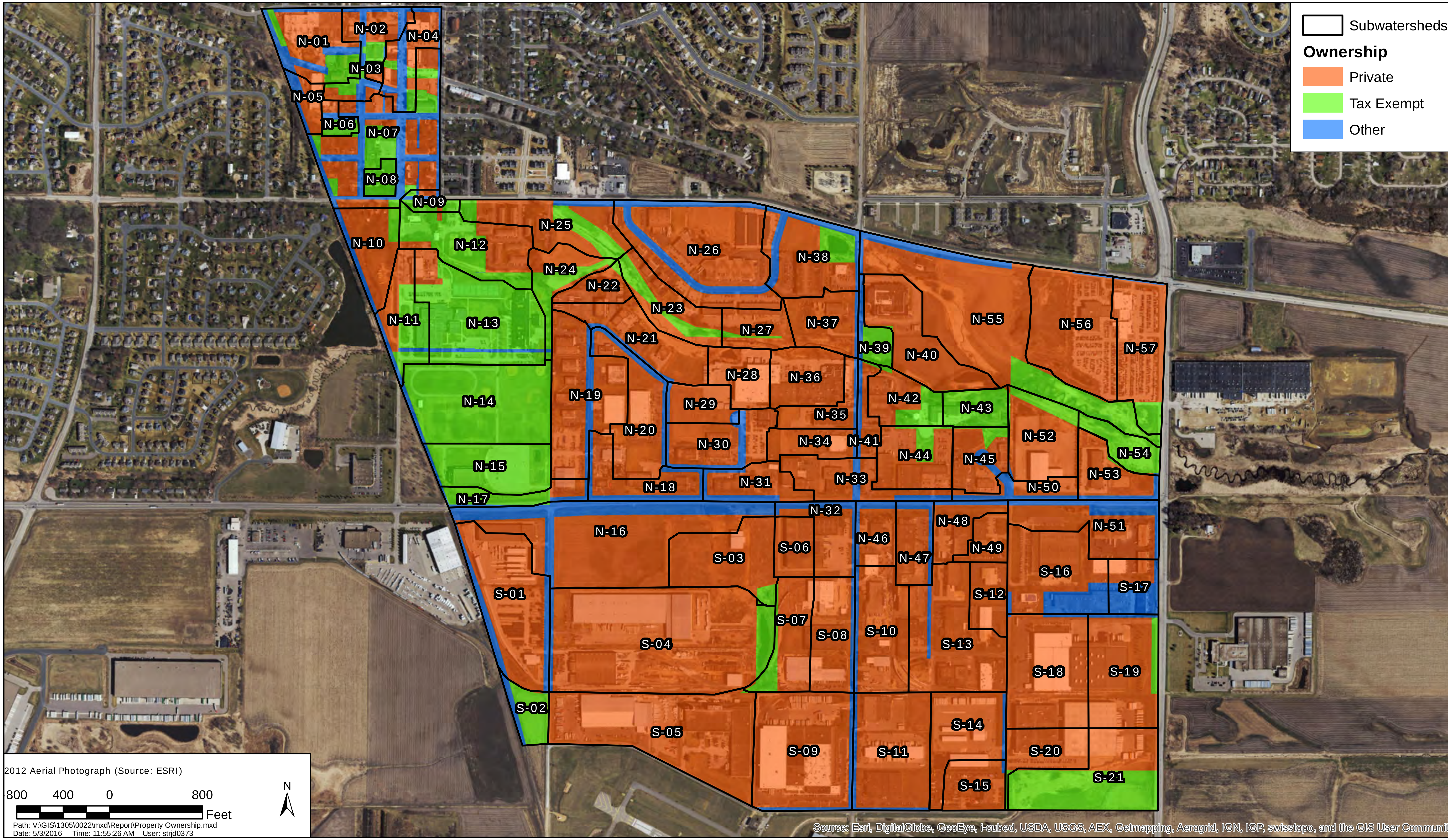
Study Area and Impaired Reach Overview

WENCK ASSOCIATES

Responsive partner. Exceptional outcomes.

MAY 2016

Figure 1



SOUTH CREEK SUBWATERSHED ASSESSMENT

Property Ownership

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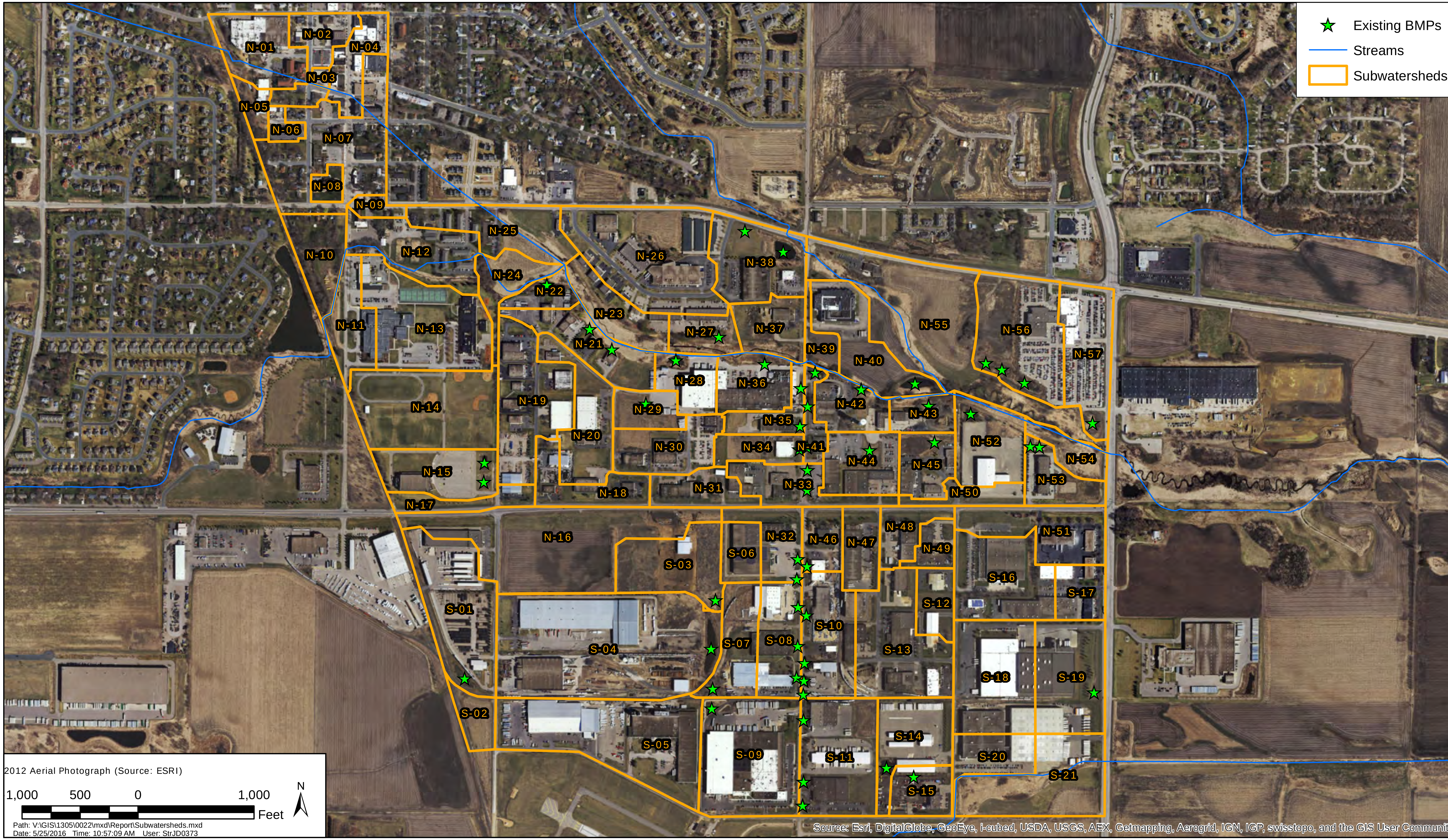
Figure 2



SOUTH CREEK SUBWATERSHED ASSESSMENT

Subwatersheds and Existing Stormwater Practices

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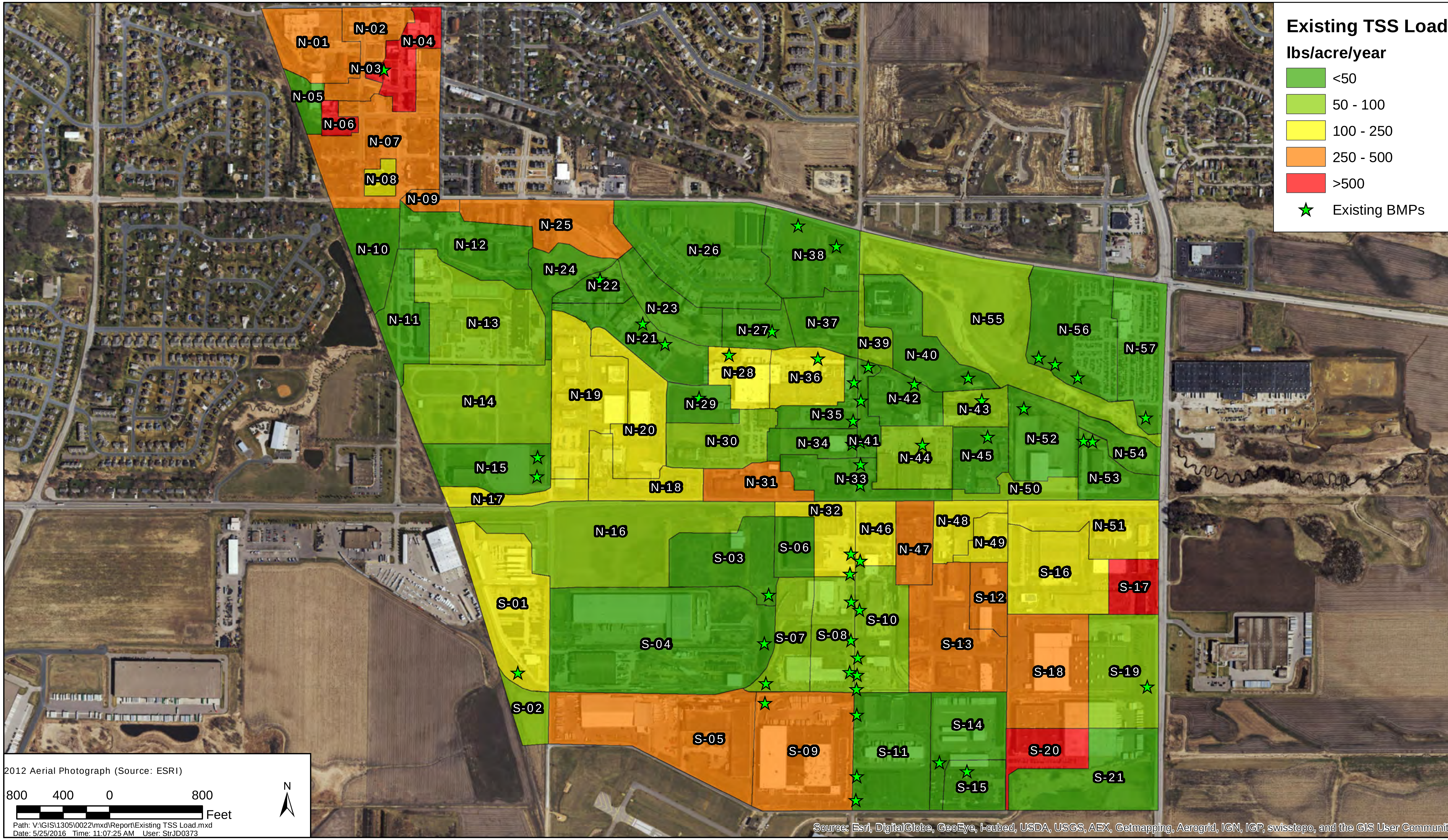
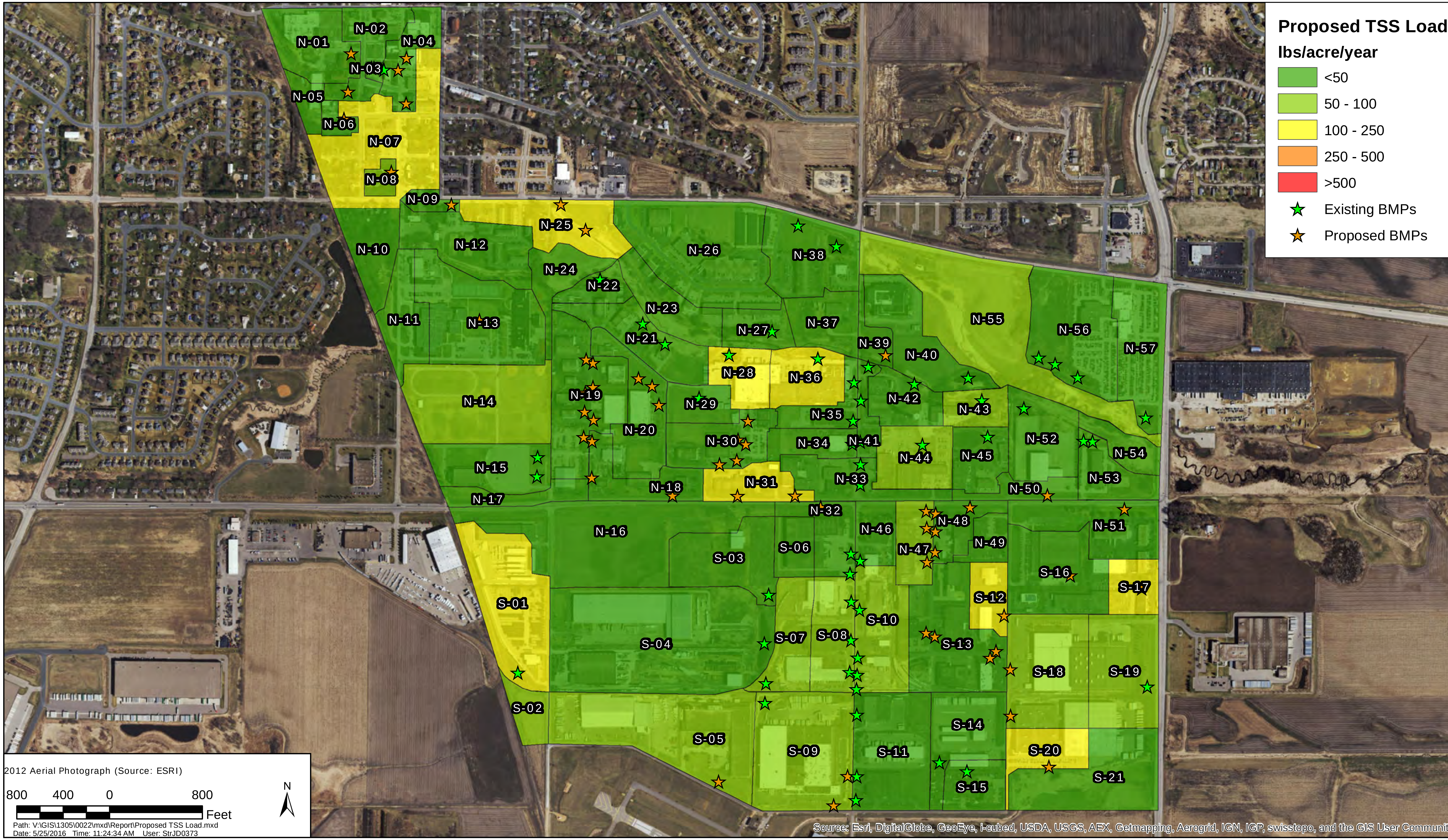
Figure 3



SOUTH CREEK SUBWATERSHED ASSESSMENT	WENCK ASSOCIATES Responsive partner. Exceptional outcomes.	MAY 2016
Existing TSS Loading		Figure 4



SOUTH CREEK SUBWATERSHED ASSESSMENT	WENCK ASSOCIATES	MAY 2016
Proposed TSS Loading	Responsive partner. Exceptional outcomes.	Figure 5