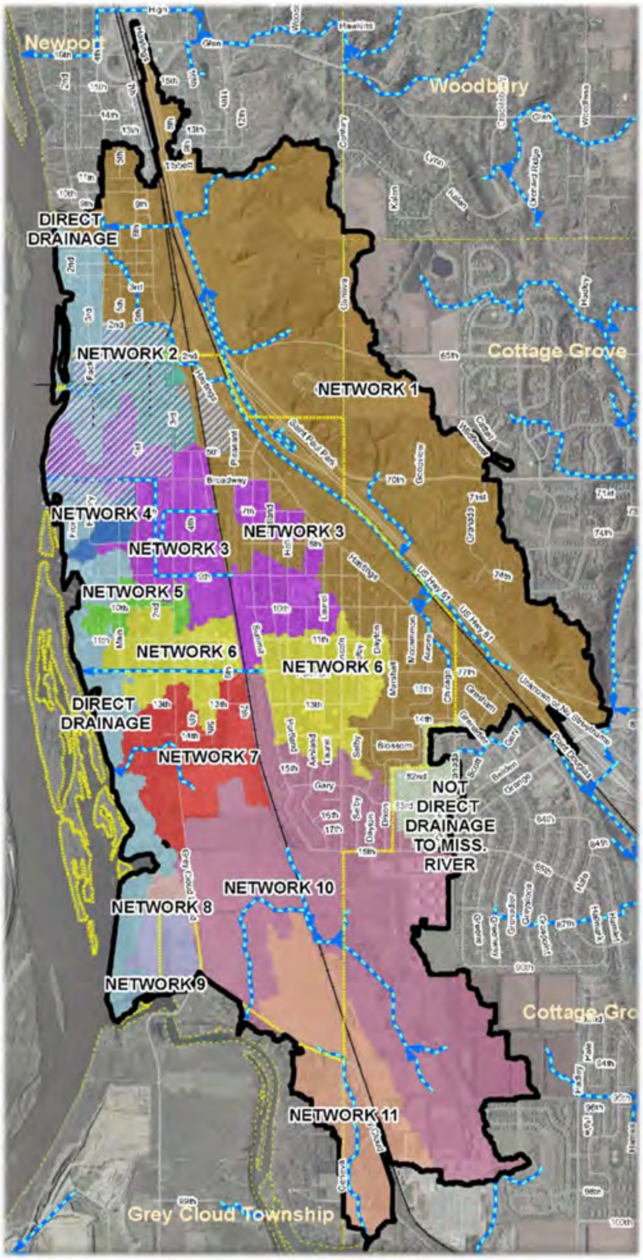
EAST MISSISSIPPI – ST. PAUL PARK SUBWATERSHED RETROFIT ANALYSIS



SOUTH WASHINGTON WATERSHED DISTRICT

MAY, 2022

Contents

Executive Summary

This report and analysis provides a prioritized list (ranked by cost effectiveness) of stormwater retrofit recommendations to primarily reduce Total Suspended Solids (TSS) loading to the Mississippi River from the East Mississippi Subwatershed – St. Paul Park, a 3,681 acre modeled area within the South Washington Watershed District (SWWD) boundary. TSS is the target pollutant as this section of the Mississippi river is listed as impaired for TSS by the South Metro Mississippi TMDL.

For this analysis, we used existing lidar, landuse, soils, parcel data and stormsewer infrastructure data among others to develop a WinSLAMM model for the subwatershed. For areas that did not fit WinSLAMM modeling (e.g. rural ravine), the BWSR Pollution Reduction Estimator was used to model gully erosion and soil loss volumes, the MIDS calculator was used to estimate and calculate swale benefits and manufactures literature was used to calculate benefits. Catchment networks, consisting of multiple catchments sharing the same outfall to the Mississippi river were identified.

The proposed stormwater management practices within each catchment network were analyzed for annual pollutant loading - Total Phosphorus (TP), Total Suspended Solids (TSS) and Water Quality Volume (WQV) specifically. All known existing BMPs and their load reductions were accounted for in the modeling process. The existing loading was compared to a loading value of 154 lbs./acre, identified as the goal maximum loading value for the subwatershed by the South Metro Mississippi TMDL. All identified and modeled catchment networks received field reconnaissance visits including all identified BMP opportunities. In some cases, entire subwatersheds are located on private lands so access was limited. In most of these watersheds, review of the outfalls, aerial photography analysis and remote data assessment indicate minimal nutrient and sediment loading or potential, so modelling and BMP identification was not conducted.

Proposed BMP options were compared for each sub-catchment, given their specific site opportunities, constraints and characteristics. Each final stormwater practice was selected and ranked by weighing cost, pollution reduction benefits, ease of installation and maintenance, and ability to serve multiple functions.

Nearly the entire subwatershed sits on shallow bedrock, and is thus is rated with low suitability for the use of infiltration practices with a very small, two block area having only marginal potential. For this reason, only filtration practices are considered as BMPs in St. Paul Park. Areas with infiltration potential (based on soil survey data) are identified in Map 1 on page 6. Filtration practices require relatively small footprints to limit excavation costs in areas of shallow bedrock.

Twenty-two projects were identified within the City. The Table and Map on the following pages (and in Appendix 1) provides the cost/benefit ranking of these projects for removal of TSS. Filterable Phosphorus Alternatives (6W-LUD1(FP alt), 6W-LUD2 (FP alt) and 3B-LUD1 (FP alt)) are not shown on the map, but are ranked in the tables as these are alternatives in the same locations as base BMPs. This value was calculated by including costs for Design and Engineering, Total Project Installation Costs, and assumed cost for maintenance over a 20-year period based on specific practice needs.

The cost-benefit value for annual TSS reduction over 20 years ranges from $311 to $27,790 per ton. Other factors may be important in project selection, including constructability, willingness of landowner and funding.

Cost-benefit for annual TP reduction was also calculated and is provided in Appendix A. In some cases, practices are TP targeted alternatives in the same locations as those that target TSS. Whether a practice that specifically targets TP reduction will be constructed is likely be based on available funding.

Table 1: Ranking Table: All Proposed Practices Ranked by Cost Per LB of Total Suspended Sediment removed per year (over 20 years)

TSS Rank	Project ID	Network / Project Location	BMP Treatment Area (ac)	BMP Type	Model	Eng. / Design Cost	Project Install Cost	Annual O&M	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	20-yr Cost /Ton-TSS/Yr	TP Rank	TSS Rank
1	1D-SWL1	**1D / Swale South of City Hall**	2.4	Swale along field edges	WinSLAMM	$2,500	$10,000	$400	2.72	607	$311	3	**1**
2	6W-LUD2	**6W / Pullman Avenue west of Main Street at Existing Lift Station**	240	Large Underground Device	WinSLAMM	$30,000	$320,000	$1,200	126.40	70,617	$672	7	**2**
3	6W-LUD1	**6W / Pullman Avenue at Axelrod Park**	161	Large Underground Device	WinSLAMM	$35,000	$350,000	$1,200	**33.68**	55,647	$735	8	**3**
4	1D-CCRG1	**1D / Corner of Portland Avenue and Broadway Ave.**	1.7	Curb Cut Raingarden	WinSLAMM	$4,000	$15,000	$400	3.37	1,105	$746	4	**4**
5	6W-LUD2 (FP alt)	**6W / Pullman Avenue west of Main Street at Existing Lift Station**	240	Large Underground Device with FP filter	WinSLAMM	$35,000	$600,000	$12,000	36.10	66,463	$1,239	2	**5**
6	3A-PWQ1-4	**3A / Four Prinsco Underground units along 2nd Street and 8th Avenue**	134.8	Large Underground Device	WinSLAMM, Mfr. Lit.	$32,000	$300,000	$2,500	7.44	30,360	$1,258	12	**6**
7	3B-PWQ1	**3B / Prinsco Underground Unit South of Public Works Building along 5th Street ROW**	29.5	Large Underground Device	WinSLAMM, Mfr. Lit.	$20,000	$72,000	$500	3.23	7,950	$1,283	13	**7**
8	6E-PWQ1	**6E / 11th Avenue North end of Dingle Park**	40.4	Large Underground Device	WinSLAMM	$25,000	$120,000	$1,200	**5.16**	12,144	$1,392	15	**8**
9	6W-LUD1 (FP alt)	**6W / Pullman Avenue at Axelrod Park**	161	Large Underground Device with FP filter	WinSLAMM	$35,000	$550,000	$12,000	**143.10**	59,125	$1,395	1	**9**
10	M	**3A / Catchbasin Insert in Public Works Parking Lot**	1.73	Catchbasin Insert	WinSLAMM, Mfr. Lit.	$200	$600	$300	0.51	436	$1,560	9	**10**
11	5-PWQ1	**Prinsco Water Quality 6040 unit east of Broadway and 10th Ave**	**15.1**	Large Underground Device	WinSLAMM, Mfr. Lit.	$20,000	$75,000	$600	**3.23**	6,795	$1,968	16	**11**
12	3C-LUD1	**3C / South of 9th Street at Nuevas Fronteras (in place)**	83.2	Large Underground Device with FP filter	WinSLAMM, Mfr. Lit., engineer's report (HR Green)	$25,000	$400,000	$12,000	20.70	28,274	$2,352	14	**12**
13	1E-PND1	**1E / Hastings Avenue Pond Retrofit and Expansion**	172.1	Pond Retrofit and Expansion	WinSLAMM	$40,000	$400,000	$1,500	42.50	14,238	$3,301	6	**13**
14	5-PWQ3	**Prinsco Water Quality 4820 unit at west end of Broadway**	**6.1**	Large Underground Device	WinSLAMM, Mfr. Lit.	$12,000	$65,000	$500	**1.01**	2,386	$4,254	18	**14**
15	1D-IESF1	**1D / North of City Water Tower along CP Rail Line**	12.9	Iron Enhanced Sand Filter at Pipe Outlet	WinSLAMM, BWSR SW Manual	$30,000	$180,000	$1,880	25.86	5,377	$4,605	5	**15**
16	5-PWQ2	**Prinsco Water Quality 4820 unit west of Broadway and 10th Ave**	**6.6**	Large Underground Device	WinSLAMM, Mfr. Lit.	$12,000	$65,000	$500	**1.01**	2,325	$4,677	19	**16**
17	1E-LUD1	**1E / Abdella Park South Side of Park along Hastings Ave.**	40.4	Large Underground Device	WinSLAMM, Mfr. Lit.	$25,000	$250,000	$3,000	4.70	7,040	$4,759	17	**17**
18	DD-VB1	**DD / Lions Park Parking Lot Edge**	1	Vegetation Restoration	MIDS Calculator	$500	$5,000	$600	0.10	265	$6,169	22	**18**
19	3B-LUD1 (FP alt)	**3B / South of Public Works Building along 5th Street ROW**	29.5	Large Underground Device with FP filter	WinSLAMM	$25,000	$400,000	$10,000	21.68	8,342	$7,492	11	**19**
20	3A-IPR1	**3A / Inlet Protection at Public Works Yard**	2.73	Swale Improvements and Inlet Protection	MIDS Calculator	$3,000	$6,000	$600	**0.93**	330	$8,502	10	**20**
21	1B-PND1	**1B / North of Broadway along BNSF Rail Line**	22.30	Pond Expansion	WinSLAMM	$6,000	$90,000	$500	0.67	386	$27,461	21	**21**
22	10B-PND1	**10B / Along BNSF Railroad**		Pond Cleaning	City Engineer's Report (WSB)	$4,000	$108,000	$250	**0.99**	421	$27,790	20	**22**

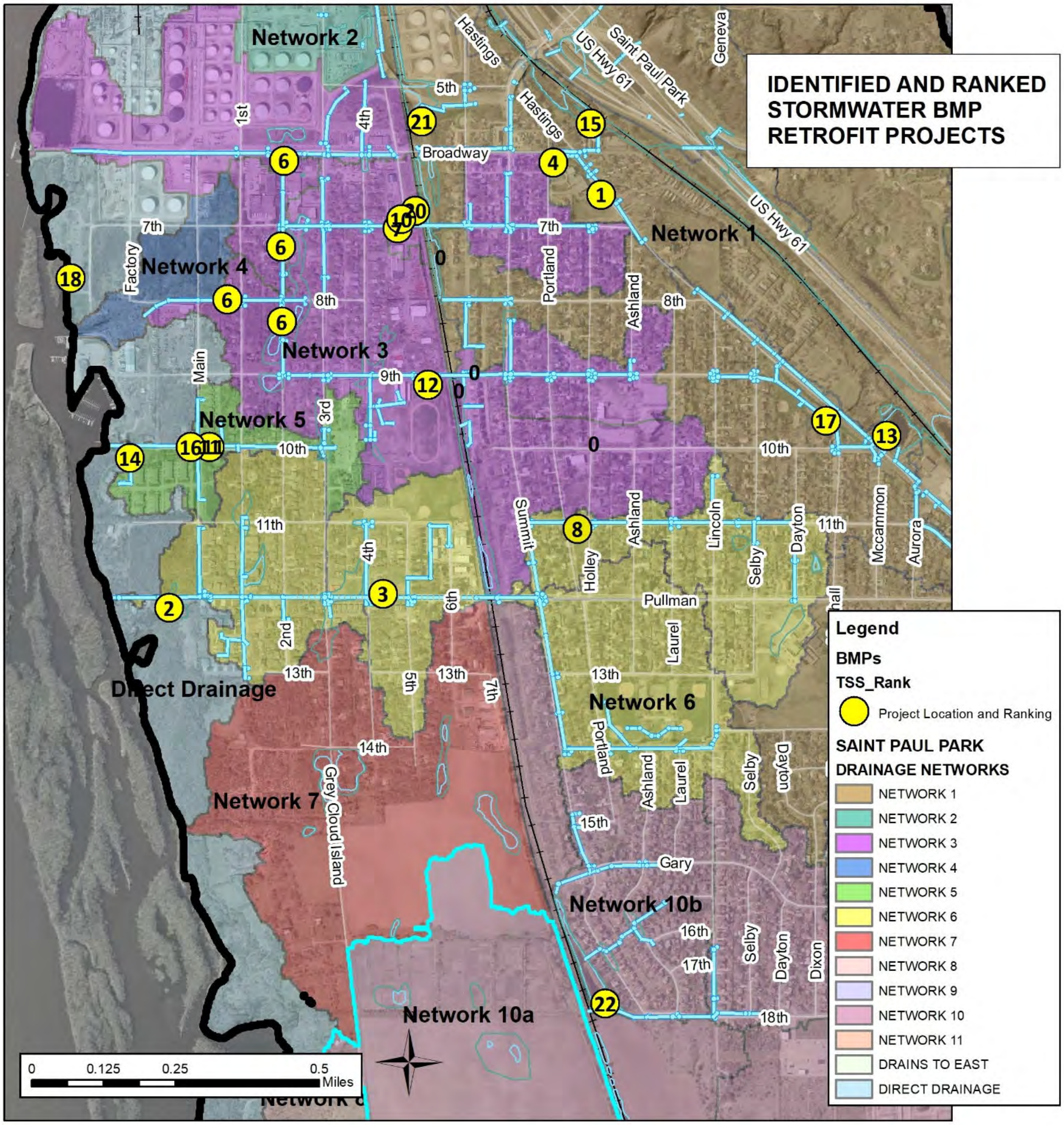


Figure 1: BMP Ranking Map.

Note: Practices ranked 5, 9 and 19 for TSS are not shown as these are alternate practices targeting additional treatment of Total Phosphorus in the same locations as shown practices ranked 2, 1 and 11, respectively.

Introduction

This Subwatershed Stormwater Retrofit Analysis is a watershed management tool to help prioritize stormwater retrofit projects by performance and cost effectiveness. This process helps maximize the value of each dollar spent.

This document is organized into three major sections. *Subwatershed Analysis Methods* looks at the data collection and input techniques used to assess existing conditions within the study area. *Retrofit Analysis* explores options for stormwater management within the context of existing network, environmental and community constraints, and other factors that determine the likelihood of future project successes. *Stormwater BMP Profiles and Recommendations* provide detailed explorations of the Networks and their associated Subwatersheds. Recommendations provide preliminary concepts appropriate for the location and treatment goals.

Subwatershed Analysis Methods

Retrofit Scoping

Retrofit scoping includes determining the objectives of the retrofits (volume reduction, target pollutant, etc.) and the level of treatment desired. It involves meeting with local stormwater managers, city staff and watershed management organization members to determine the issues in the subwatershed. The *Surface Water Management Plan* completed for the city in 2018 provides guidance and background on surface water management projects and goals. Additionally, an XPSWMM Model was developed for the city in 2018 to identify problem areas and suggest potential locations. Catchments developed for this model were used as catchment boundaries for this analysis and findings helped to inform BMP selection.

In this analysis, the focus area was all catchments within the City of St. Paul Park. In some cases, catchments cross city boundaries, and were modeled as appropriate. In some cases, existing stormwater facilities located on railroad, state highway and industrial facilities were not included in the assessment. These areas do not provide opportunities for the city of St. Paul Park or the Watershed District to incorporate best management practices into the system. Included are areas of residential, commercial, industrial, institutional, and agricultural land uses, as well as undeveloped areas of mature woodlands. The subwatershed was divided into subcatchments relying on the previous work contained with the 2018 XPSWMM model. Corrections to these polygons were made based on field observances.

Subwatershed Identification

The East Mississippi – South St. Paul Subwatersheds were determined from existing SWWD catchment delineation data. Catchment drainage networks were delineated based existing catchment data, stormsewer data, and ground trothing. Initial polygons were derived from the XPSWMM model of 2018 with modifications based on updates through stormsewer updates and ground trothing. The numbering system for identifying the drainage networks is only for use in this report, whereas individual catchment identification numbers correlate with catchment datasets. Many factors are considered when choosing which subwatershed to analyze for stormwater retrofits. Of particular focus are subwatersheds with distinct stormsewer networks that have opportunities to capture and treat stormwater at source locations or where opportunities to modify the existing network exist. Stormwater retrofit analyses supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data, etc.) to greater facilitate the process ranks highly. Local governmental support for treatment systems makes long term success and collaboration more likely. For some communities a stormwater retrofit analysis complements their MS4 stormwater permit. The focus is always on a priority waterbody.

For this analysis, the City of St. Paul Park was chosen for the study as it drains entirely to the Mississippi River and at present has limited treatment of runoff. The Mississippi River is listed on the EPA's 303(d) list of impaired water bodies, including the South Metro Mississippi TMDL, listed for Turbidity. Identifying areas that receive little to no pretreatment become a priority as these areas typically have a large impact on water quality.

Stormwater runoff from impervious surfaces like pavement and roofs can carry a variety of pollutants. While stormwater treatment to remove these pollutants is adequate in some areas, other areas were built before modern-day stormwater treatment technologies and requirements or have undersized treatment devices.

Subcatchment Assessments

Within each catchment profile is a table that summarizes basic catchment information including acres, dominant land use, and estimated existing annual pollutant and volume loading. A brief description of the land use, stormwater infrastructure, exceedance of acceptable TSS loading in comparison to the Mississippi River TMDL, and any other important general information is also described. This step further identifies appropriate locations where BMPs are likely to be most successful from a construction, implementation and long term management standpoint. These locations are shown in Table 1, describing potential BMP types in a given landscape.

Table 2: Desktop retrofit analysis features to look for and potential stormwater retrofit projects.

Feature	Potential Retrofit Project
Existing Ponds	Add storage and/or improve water quality by excavating pond bottom, improving pre-treatment, modifying riser, raising embankment, and/or modifying flow routing.
Open Space	New regional treatment (pond, bioretention, swales).
Public Rights of Way and Public Parcels	Large scale open space, and wide roadways may offer space for underground or modifications to the ROW to improve storage or treatment.
Outfalls	Split flows or add storage below outfalls if open space is available.
Conveyance system	Add or improve performance of existing swales, ditches and non-perennial streams.
Large Impervious Areas (campuses, commercial, parking)	Stormwater treatment on site or in nearby open spaces.
Neighborhoods	Utilize right of way, roadside ditches, curb-cut rain gardens, or filter systems before water enters storm drain network.

Excluded Areas

In the process of subcatchment assessment, some are excluded from consideration for modelling based on a variety of factors that limit their suitability for the installation BMPs at present. Factors include:

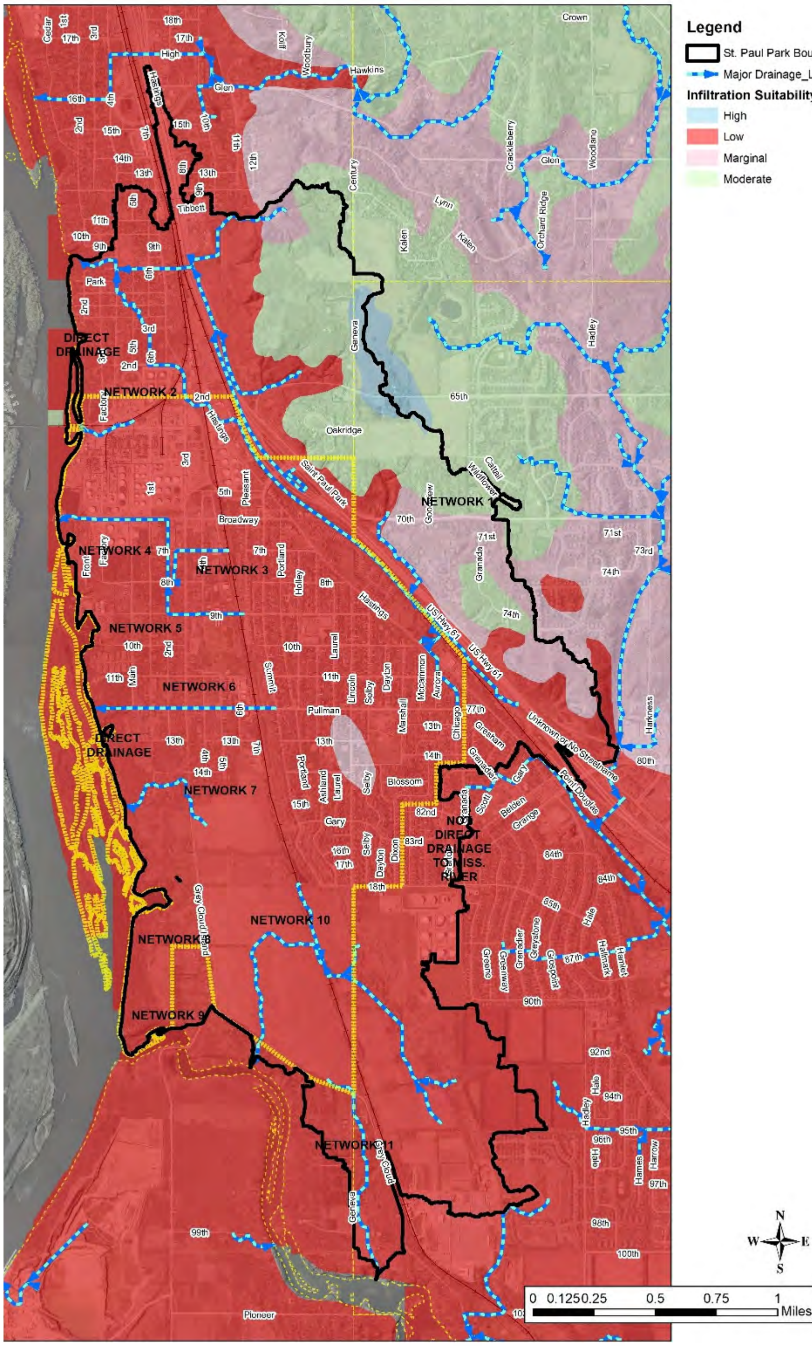
- Coverage under State Permit (Subcatchment 2)
- Subcatchment disconnection from target water body (large pond capture) (Subcatchment 10B)
- Natural land cover surface conveyance with minimal erosion or slope (Subcatchments 8, 9 and 10A)
- Rural section roads with no urban stormwater infrastructure (Subcatchment 7)
- Widely dispersed infiltration in scattered lowland settings disconnected from target water body (Subcatchment 4)

Some opportunities may exist within these subcatchments, particularly as the city makes upgrades to street and stormwater infrastructure. In particular, the addition of pavement and stormsewers provides opportunities to incorporate better stormwater treatment integrated into these additions. City staff, planners and engineers should consider opportunities for incorporating BMPs into the planning of these upgrades.

Retrofit Analysis

Best-Fit Stormwater BMP Types

Due to the infiltration and shallow bedrock limitations present throughout St. Paul Park, best-fit BMPs are limited to filtration practices. Figure 1 shows



Map 1: Infiltration Suitability

The targeted pollutant for this study was Total Suspended Solids (TSS), though Total Phosphorus (TP) and Water Quality Volume (WQV) were also modeled and reported. Reductions in total (particulate and soluble) phosphorus as well as volume control are issues that the Watershed District and the City of St. Paul Park consider significant as well, so they are identified and considered in the BMP selection process.

Stormwater Filtration Practices

BioInfiltration and BioFiltration

Figure 2: BioInfiltration (Raingarden)

Biofiltration and BioInfiltration are the primary BMPs chosen for residential areas where rate control or pollution reduction is needed.

BioInfiltration: BioInfiltration basins infiltrate stormwater into the native soil fast enough to allow for a fully drained basin within 48 hours. There are no underdrains in a BioInfiltration Basin. The use of this type of basin is limited in the St. Paul Park area due to very shallow bedrock throughout much of the city. In addition, these basins require regular maintenance, and while effective, a lack of maintenance can lead to low community acceptance based on poor aesthetics. Where maintained, raingardens are both embraced for their beauty and effective at treating small catchments.

Proposed Locations: 1D-CCRG1

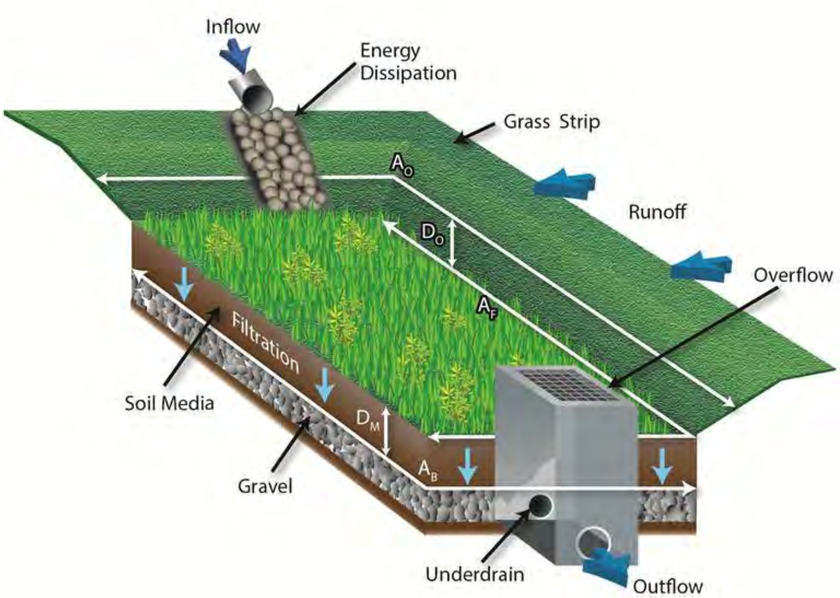


Figure 3: BioInfiltration Basin

BioFiltration: BioFiltration basins may or may not encourage infiltration into the native soil. Placement and sizing of an underdrain in soil media determines infiltration vs. flow through. Treatment is provided by soils media and plantings, providing storage and transpiration benefits prior to leaving the site via direct outlet to the stormwater network.

Proposed Locations: 1D-CCRG1 (depending on subsurface conditions)

Sand Filters and Iron Enhanced Sand Filter (IESF)

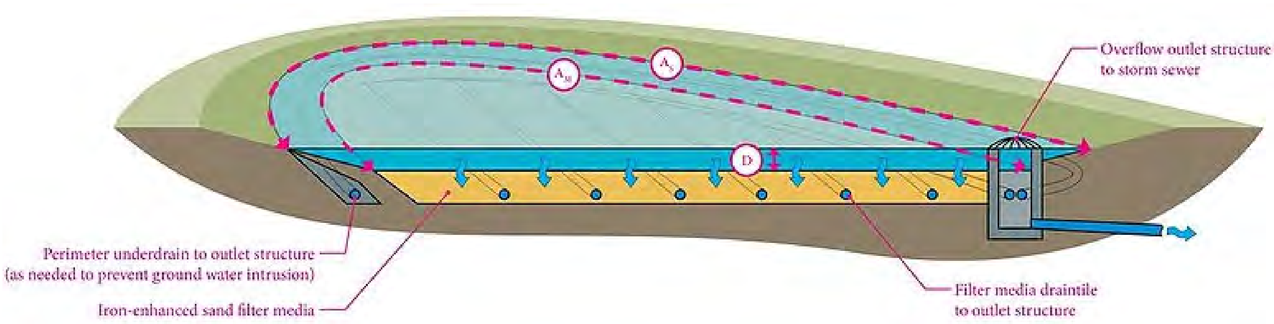


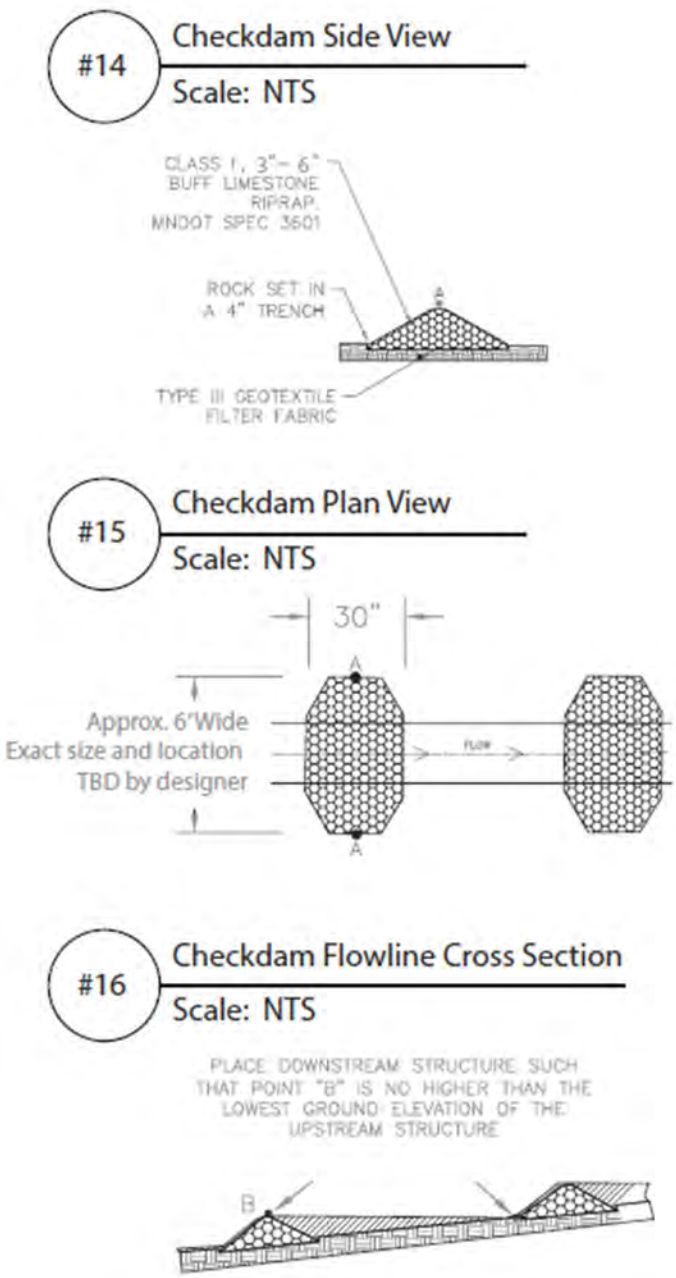
Figure 4: Iron Enhanced Sand Filter Basin

Figure 5: Iron Enhanced Sand Filter Basin

Iron Enhanced Sand Filter: IESF basins are filtration basins that incorporate iron into a sand media. They operate very similar to BioFiltration in that stormwater flows through the media to an underdrain rather than infiltrate into soils. The iron removes, phosphate from stormwater, among other dissolved constituents. These basins require pre-treatment to prevent clogging and full, regular drawdown to prevent iron loss.

Proposed Locations: 1D-IESF1

Dry Swale with Check Dams and Underdrain



Dry Swale with Check Dams: Used for grade stabilization, flow control, and rate control. Dry swales with check dams can be used in a shallow sloped ditches to impound water temporarily, allowing sediment to drop out.

These are only recommended for practices that are upstream of ravines, where longer duration ponding can occur and scour is unlikely.

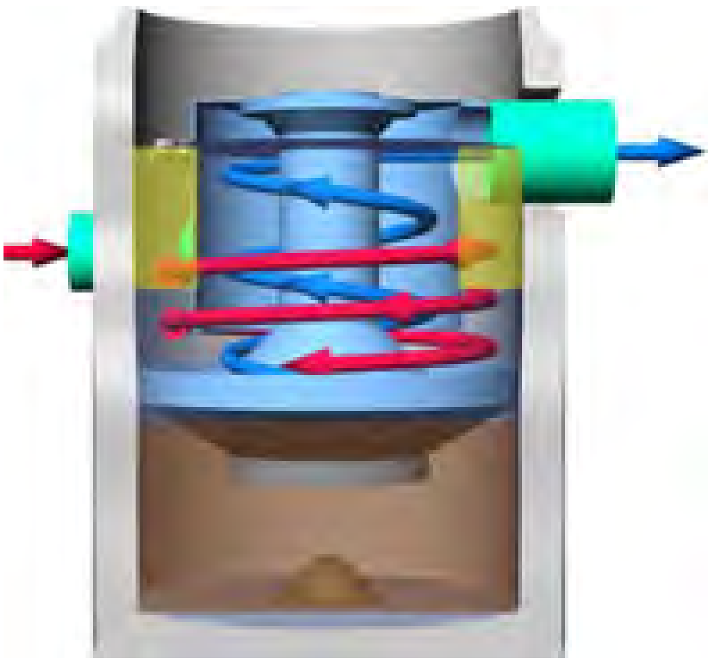
Modelling Pollutant Load Reductions for Checkdams: Checkdams used for ponding and settling are modelled in WinSLAMM and are treated like an infiltration basin with minimal ponding. The underlying soils are classified as HSG C (unless replacement soils and underdrains are introduced). Pollution reductions are only significant if many are installed in succession and the slopes are shallow.

Erosion losses in the channel are typically only accounted for in modelling of Headcut Repairs, where direct losses of the eroded soil are accounted for.

Proposed Locations: 1D-SWL1, 3A-IPR1

Filtration Devices

Underground Sediment Chambers



Hydrodynamic Separators (Swirl Chamber Type): Hydrodynamic separators are flow-through devices, that use a cylindrical chamber to create a rotating, high speed flow that allows large and more dense particles to drop out as they hit the outside walls. These particles can then be periodically removed from the device using vacuum truck. The devices are usually placed near, but offline of the stormwater pipe network where stormwater is diverted and treated before reentering the system.

These are usually proprietary devices placed underground with access by means of a series of manhole covers. These devices often contain a series of chambers and/or screens to capture a variety of sizes of sediment as well as floatables including garbage and leaves.

Figure 6: Hydrodynamic Separator (Swirl Chamber Type)

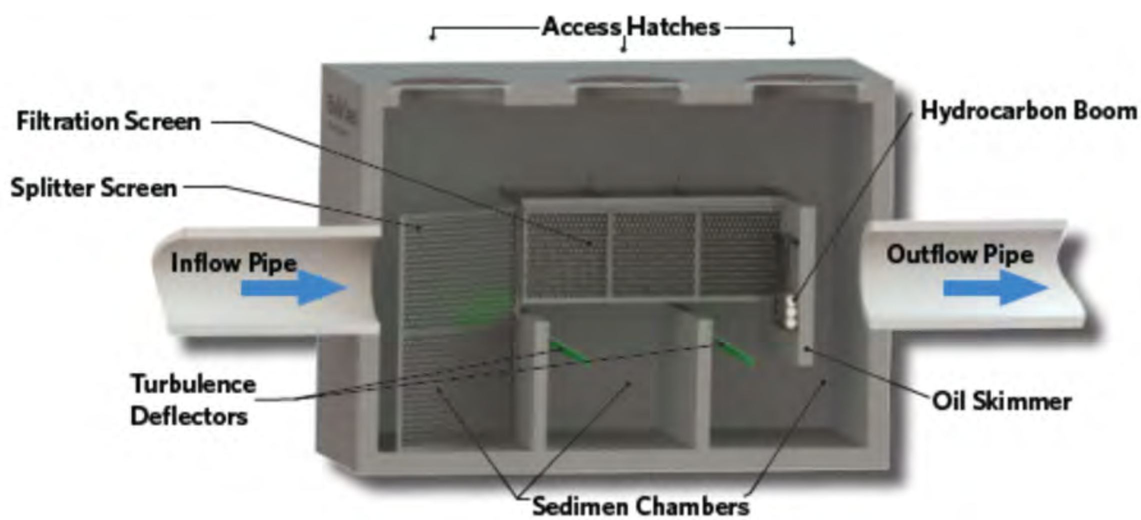


Figure 7: Hydrodynamic Separator (Chambers and Screen Type)

Hydrodynamic Separators (Chambers and Screen): Hydrodynamic separators come in a variety of sizes and types that offer practitioners to find solutions for differences in site settings. Chamber type separators rely on swirls within sediment chambers, but may also contain a combination of baffles and screens to separate trash and varieties of sediments. The differences in sizes and shapes often determine best fits for a variety of locations, especially where bedrock is present.

Proposed Locations: 1E-LUD1, 3B-LUD1, 3C-LUD1, 6W-LUD1, 6W-LUD2

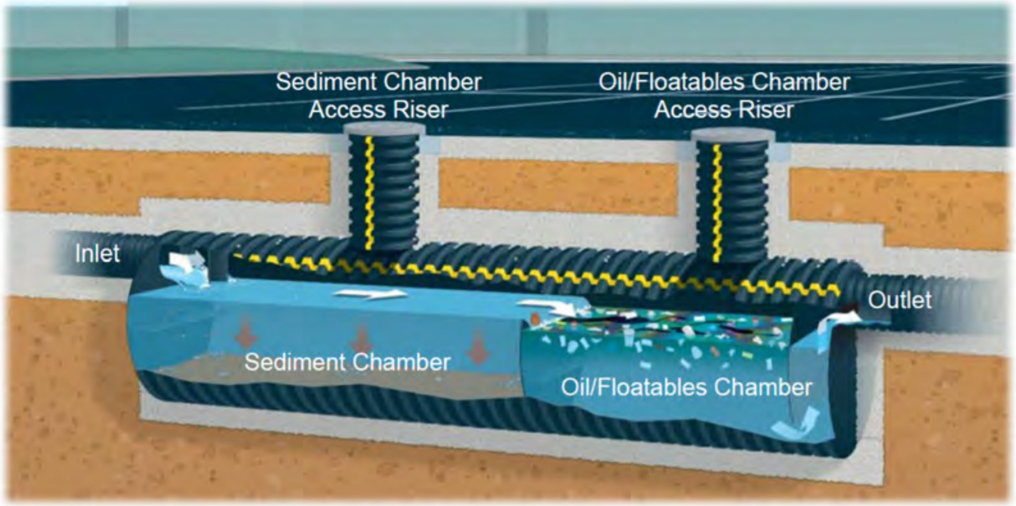


Figure 8: Hydrodynamic Separators (Pipe Chamber Type) (Source: Prinsco, Inc.)

Hydrodynamic Separators (Pipe Chambers Type): A typically less expensive type device is a sediment chamber type device fitted with a series of baffles that trap sediment and floatables. Water flows along the linear unit where sediment drops out into chambers separated by internal walls. Benefits were calculated in this report by using the total storage capacity of each device and assuming an effective capture rate of 20% of this total. Up to this capacity, the device literature has tested at 80% efficiency at 1.2 CFS. These devices can be sized according to watershed, and their annual treatment capacity increased through regular monitoring and cleanout

Proposed Locations: 3A-PWQ1 (4 units), 3B-PWQ1, 5-PWQ1, 5-PWQ2, 5-PWQ3, 6-PWQ1

Catchbasin Inserts

Figure 9: Catchbasin Inserts (Source: REM, Inc.)

Catchbasin Inserts: Catchbasin inserts are often used in active construction zones to trap sediment and pollutants while work is taking place on a site. These inexpensive inserts trap sediment in a drop filter that can target a variety of pollutants. If provided with adequate overflow, these can be placed into existing systems to trap trash, sediment and debris while allowing the inlet to fully function. These small units require frequent monitoring to assess whether a cleanout is needed, but due to simplicity of design and affordability, they offer an effective small scale solution in areas where monitoring and cleanout is easy and accessible. They are effective to 50% full and can be maintained as often as needed.

Proposed Locations: 3A-CBI1

Underground Chambers with Filtration

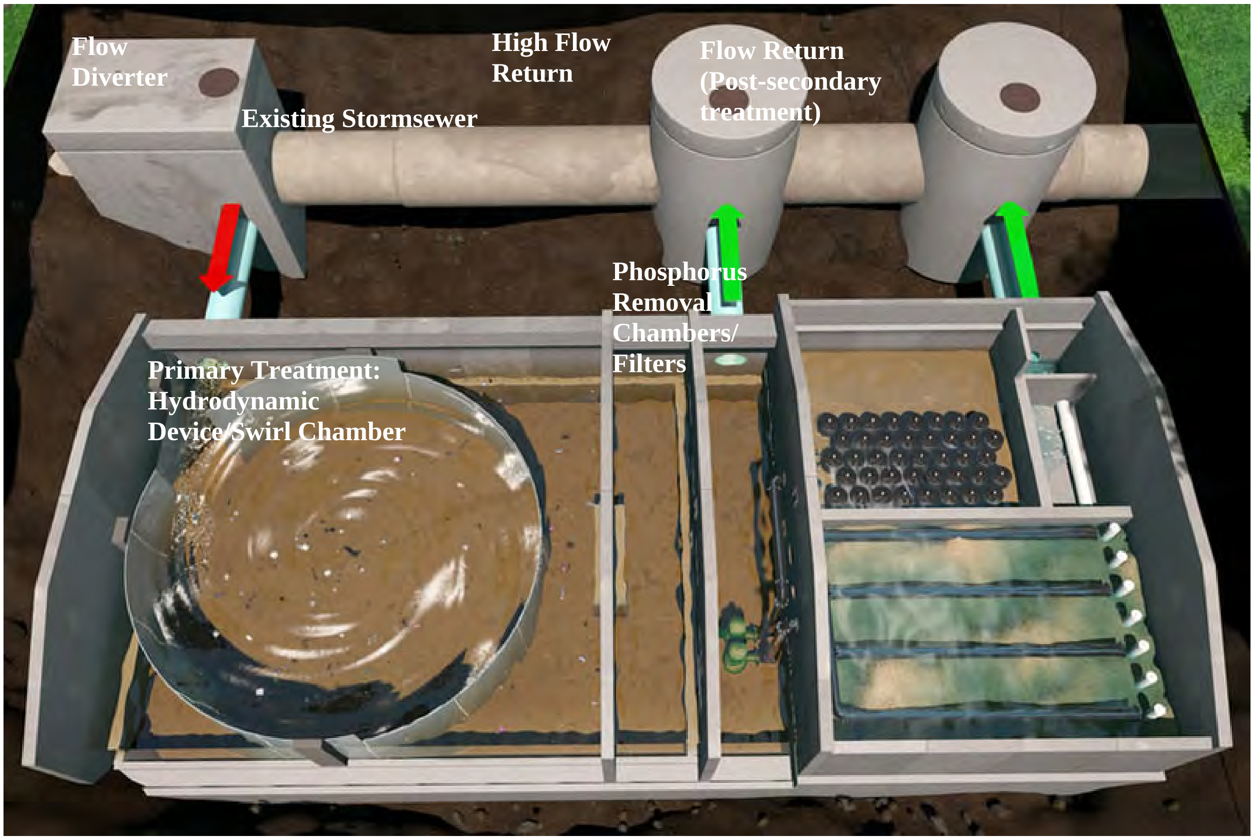


Figure 10: Underground Dissolved Pollutant Filtration Device

Underground Dissolved Pollutant Filtration: While not identified as a target pollutant in the Lower Mississippi TMDL, phosphorous is a key concern in waterbodies. Where possible and feasible, capturing the difficult to treat dissolved pollutant component is considered when identifying projects. These units typcically contain a combination of sediment chamber to trap TSS and a series of filters to capture dissolved pollutants, with a focus on phosphorus.

Stormwater Ponds

Stormwater Ponds, Pond Retrofits and Pond Maintenance

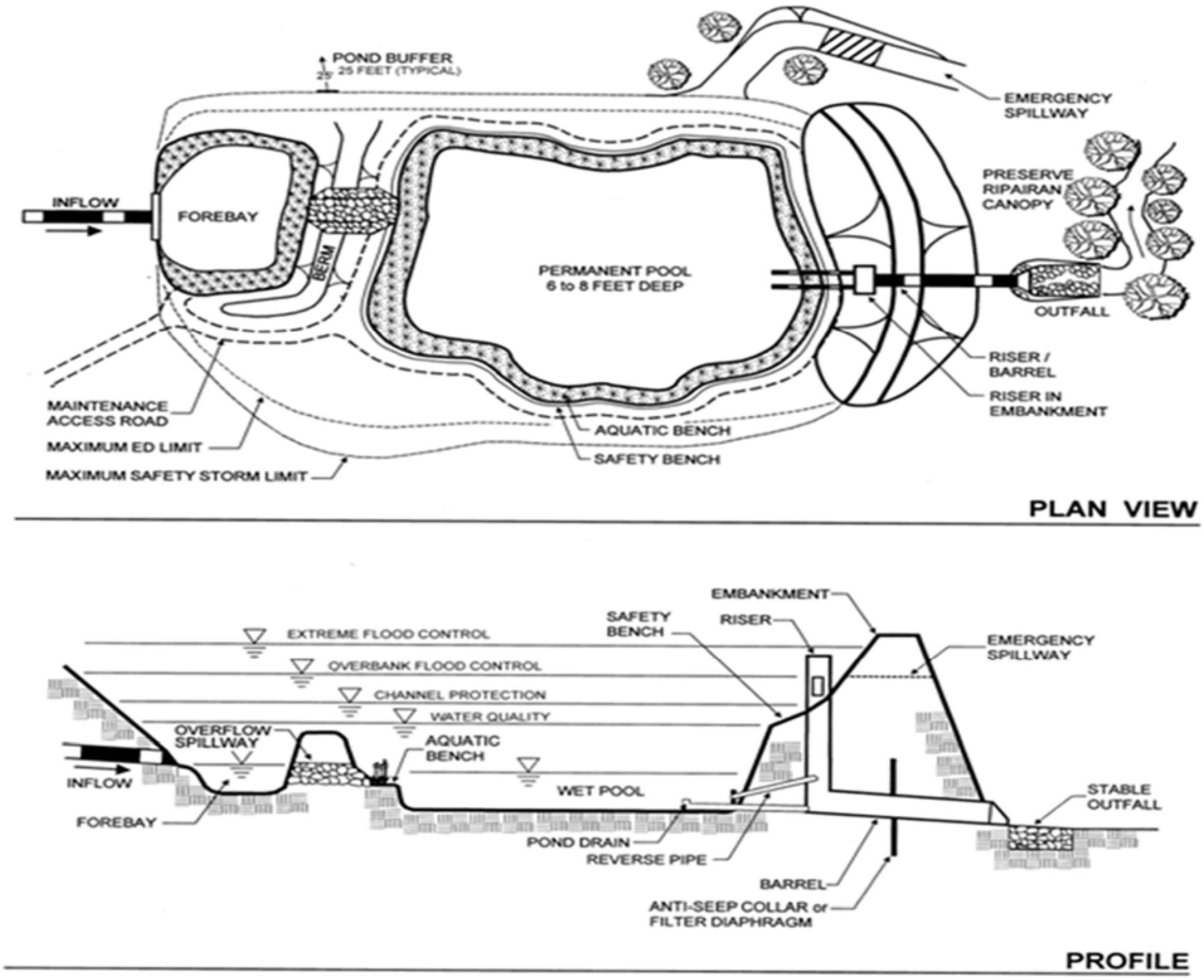


Figure 11: Wet Pond Design

Wet Stormwater Ponds: Ponds are one of the most effective and cost-effective ways to provide stormwater storage (quantity treatment), offering protection for channels and flood control as well by release can be controlled.

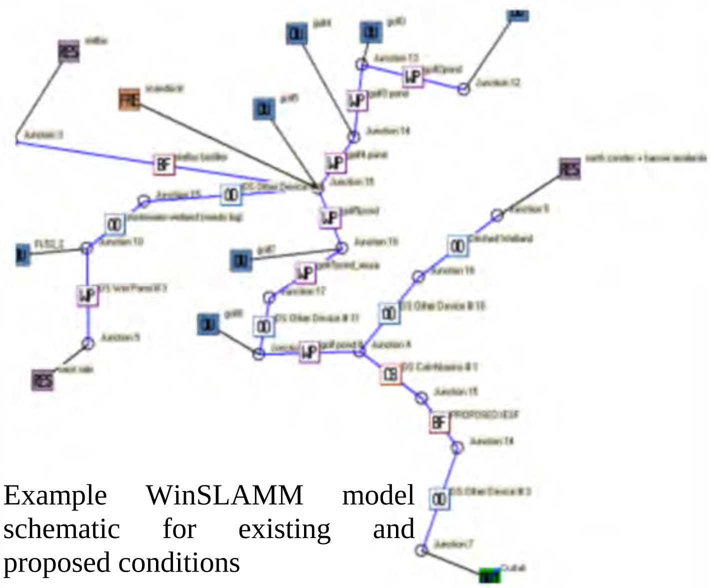
Water quality is provided by ponds through the settling of particulates and associated pollutants as they settle and reside in ponds. Both emergent as well as aquatic vegetation can also contribute to the capture of pollutants through uptake, plant growth, chemical breakdown and transpiration.

Pond maintenance is essential to provide the most effective storage and treatment of water and pollutants. Regular monitoring of inlets and outlets, trash removal, inspection for structure issues along embankments and gullies repair should happen regularly and when issues arise. Non-routine maintenance includes dredging the primary pool every 25 years or after 50 percent of the pool capacity has been reached. Ponds in St. Paul Park were not constructed with pretreatment, which provide increased holding capacity, pollutant removal and longevity benefits if properly installed and maintained/cleaned.

Treatment analysis

Desktop Assessments and Initial Model Runs

WinSLAMM was used to analyze existing conditions and proposed BMP scenarios and iterations in most situations. Models of existing conditions were modeled in WinSLAMM for full Networks then calculated at Subwatershed scales at major concentration points. This allowed for the modelling of appropriate BMPs in targeted locations. The MIDS Calculator was used where appropriate, in particular where measuring the effectiveness of vegetated and swale practices.



Example WinSLAMM model schematic for existing and proposed conditions

WinSLAMM uses stormwater data from the upper Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It is useful for determining the effectiveness of proposed stormwater control practices. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model "landscape" that reflects the actual landscape being considered. The user is allowed to place a variety of stormwater treatment practices that treat water from various parts of this landscape. It uses rainfall and temperature data from a typical year, routing stormwater through the user's model for each storm. Typically, in the Twin Cities Metropolitan Area, and in this analysis, 1959 is the model year chosen as a year typical of area weather.

The initial step was to create a "base" model which estimated pollutant loading from each catchment in its present-day state. Existing BMPs (Pond, Raingardens, etc…) were identified and included in this modeling, reflecting the current condition. Street cleaning, while practiced in the City of St. Paul Park does not abide by a regular set of rules and as such, was not included in the "existing conditions" model. While Street Cleaning is recognized as a very effective tool for pollutant removal, the practice was not modeled in this analysis, but is recommended as a separate program in conjunction with structural BMPs. To accurately model the land uses in each catchment, we delineated each land use in each catchment using geographic information systems (ArcMap 10.6.1), and assigned each a WinSLAMM standard land use file. A site specific land use file was created by adjusting total acreage and accounting for local soil types. In this case, all soils were modeled as silt given the extent to which urban soil disturbance is widespread within all subcatchments modeled. This process resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment.

Once the existing model was established, stormwater treatment practices were added to this model to assess pollutant reductions. These practice additions were added individually to assess each practices' overall effectiveness and to be able to assess cost effectiveness as compared to other practices. The model generated load reduction outcomes of TSS (target pollutant) as well as total phosphorous and volume. The BWSR gully calculator was used to determine an appropriate rate of phosphorus capture associated with the modeled rate of TSS retained in modeled BMPs. Where Engineer's reports were available, the more detailed reporting was used to determine effectiveness and costs. For underground treatment units, an 80% TSS removal rate over 126 microns was applied for each unit assuming devices will be sized to accommodate loads delivered by the contributing watershed. The outfall and downstream load for the Pond in Network 10 (10B-PND1) was calculated using the BWSR Spreadsheets (GULLY tab) to determine sediment, soil and P removal at the given location and at the approximate distance from the Mississippi River outfall. Because neither a detailed design of each practice nor in-depth site investigation was completed, a generalized design for each practice was used. Whenever possible, site-specific parameters were included. Design parameters were modified to obtain various levels of treatment. It is worth noting that we modeled each practice individually, and the benefits of projects may not be additive, especially if serving the same area. Reported treatment levels are dependent upon optimal site selection and sizing.

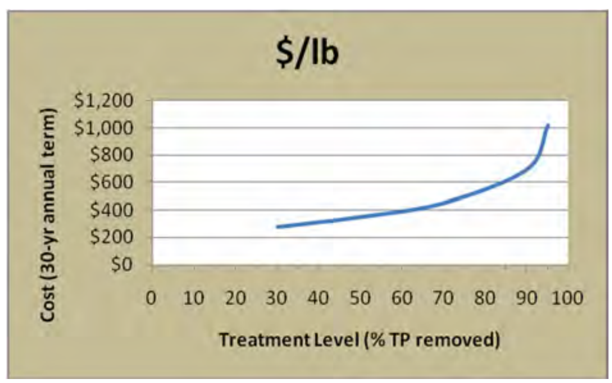
Field Verification

After identifying potential retrofit sites through this desktop search, a field investigation was conducted to evaluate each site and identify additional opportunities. During the investigation, the drainage area and stormwater infrastructure mapping data were verified. Site constraints were assessed to determine the most feasible retrofit options as well as eliminate sites from consideration. The field investigation may have also revealed additional retrofit opportunities unnoticed during the desktop search. Following Field Verifications, Desktop Assessments and Model Runs are reconsidered and practices altered to reflect best fit practices based on field conditions at the time of the study.

Cost Estimation

All estimates were developed using 2022 dollars. Cost estimates were annualized costs that incorporated design, installation, installation oversight, and maintenance over a 20-year period. Design assistance from an engineer is assumed for practices in-line with the stormwater conveyance system, involving complex stormwater treatment interactions, or posing a risk for upstream flooding. It should be understood that no site-specific construction investigations were done as part of this stormwater retrofit analysis, and therefore cost estimates account for only general site considerations.

The costs associated with several different pollution reduction levels were calculated. Generally, more or larger practices result in greater pollution removal. Practices explored ranged in estimated cost of installation from \$600 to \$600,000 with additional analysis of maintenance and design costs added in to derive a cost per year over a 20-year period. The range in costs provides for a variety of options based on available funding, landowner willingness and design constraints. By comparing costs of different treatment levels, the cities and watershed district can best choose the project sizing that meets their goals.



Retrofit Recommendations

Sites most likely to be conducive to addressing the cities' and watershed district's goals and appear to have implementable design, installation, and maintenance were chosen for a cost/benefit analysis. Estimated costs included design, installation, and maintenance annualized across a 20-year period. Estimated benefits included are pounds of total suspended solids and pounds of phosphorus removed as well as acre feet of water retained on site.

Stormwater BMP Profiles and Recommendations

Evaluation and Ranking

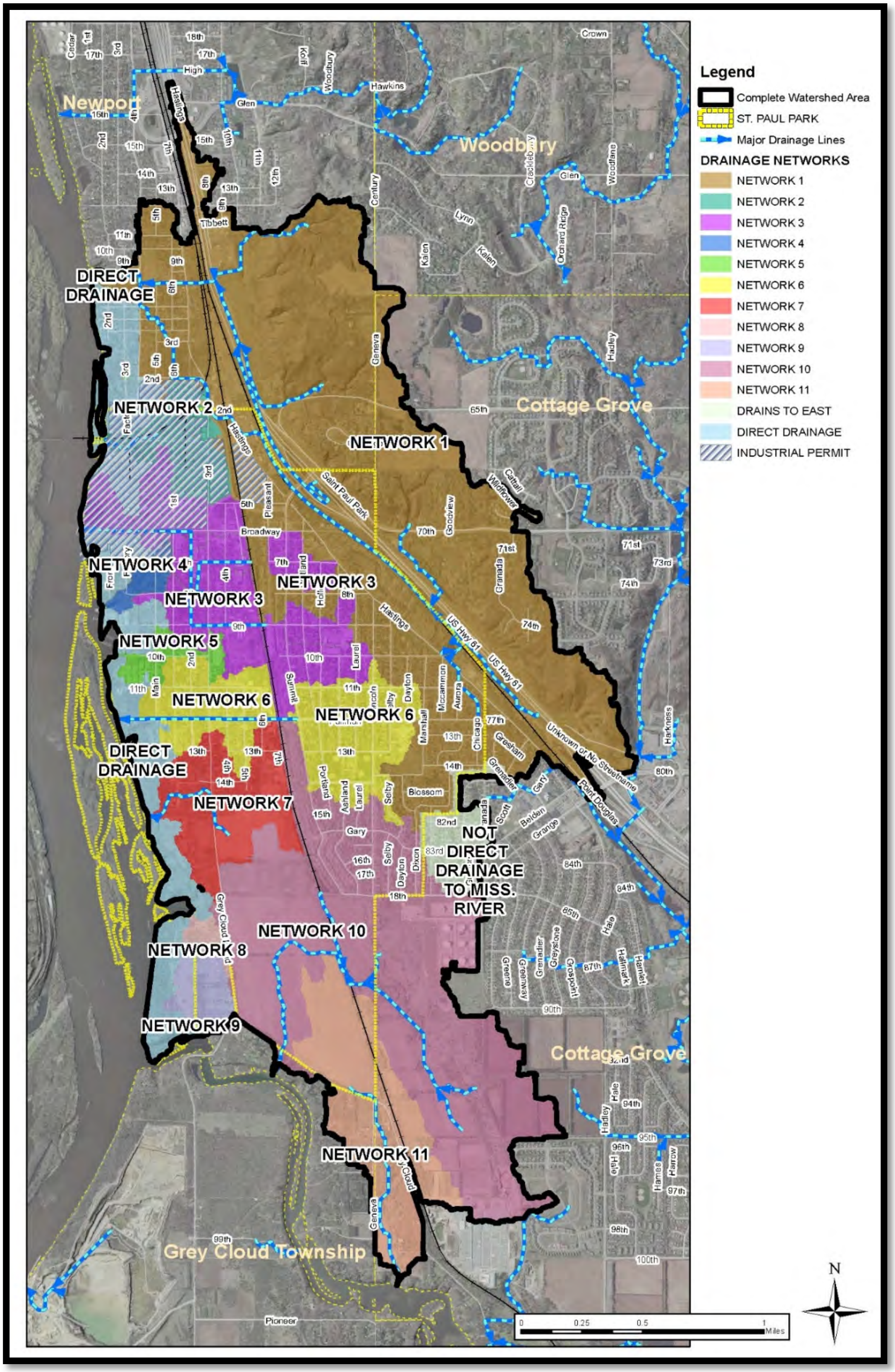
This section ranks stormwater retrofit projects across all catchments to create a prioritized project list. The list is sorted by cost-per-pound of total suspended solids removed for each project over 20 years. The final cost-per-pound treatment value includes design, installation, and maintenance costs (in 2022 dollars). Cost estimates vary in precision due to exposure to real-world bids for specific practices, and will also vary when unknown site parameters are addressed during the design phase.

The recommendation section describes the conceptual retrofit(s) that were identified. It includes tables outlining the estimated pollutant removals by all practices proposed, as well as costs and overall cost-benefit ranking. Following this Retrofit Recommendations summary page, each practice has its own page which includes a map, individual cost-benefit analysis, and site specific comments on the individual proposed retrofit.

There are many possible ways to prioritize projects, and the list provided is merely a starting point. Other considerations for prioritizing installation may include:

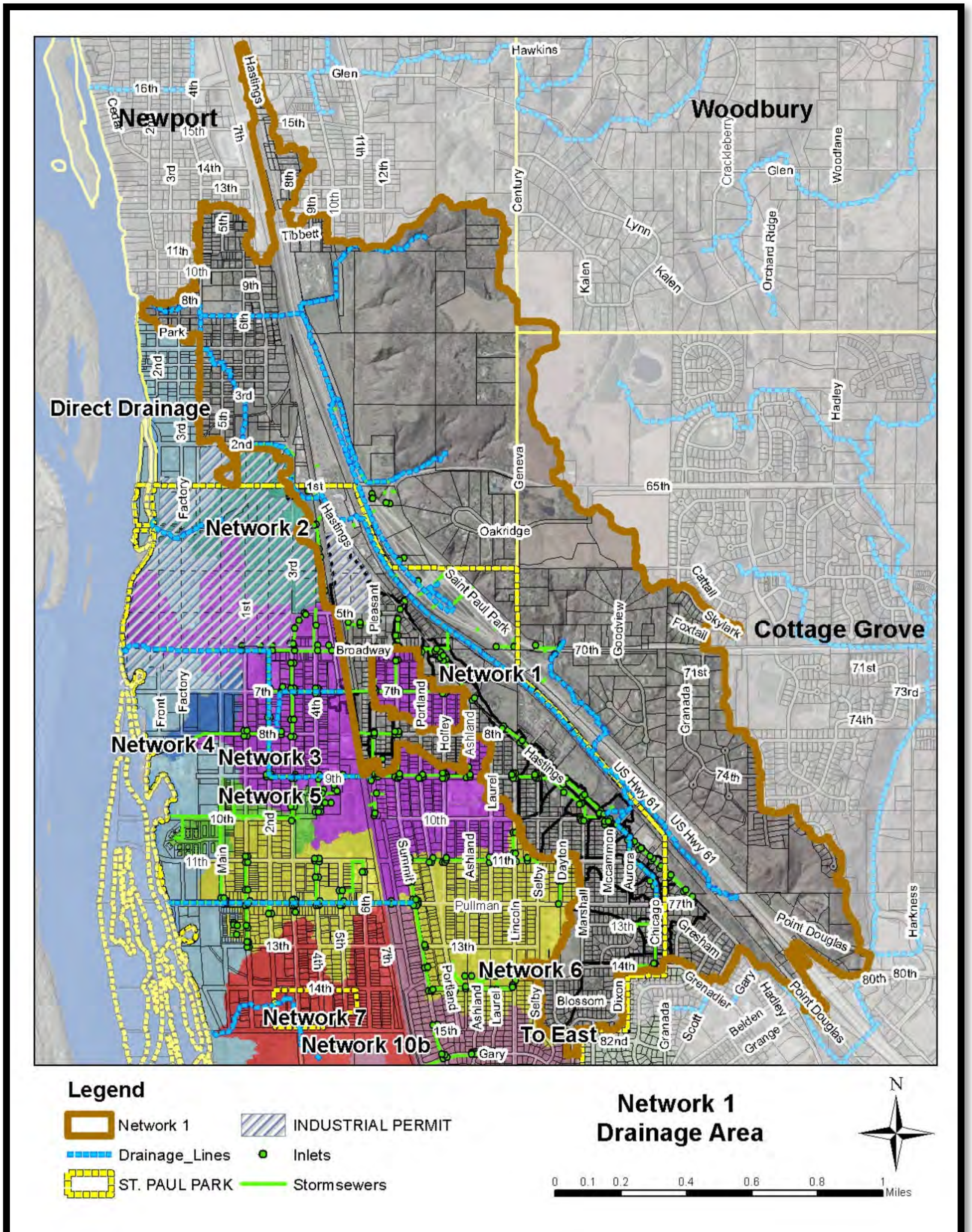
- Ease and likelihood of implementation based on land ownership
- Non-target pollutant reductions
- Timing projects to occur with other CIPs
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Additional ecological and habitat connectivity value

The cost per ton of TSS treated was calculated for each potential retrofit project. Only projects that seemed realistic and feasible were considered. The recommended level was the level of treatment that would yield the greatest benefit per dollar spent while being considered feasible and not falling below a minimal amount needed to justify crew mobilization and outreach efforts. Local officials may wish to revise the recommended level based on water quality goals, finances, or public opinion

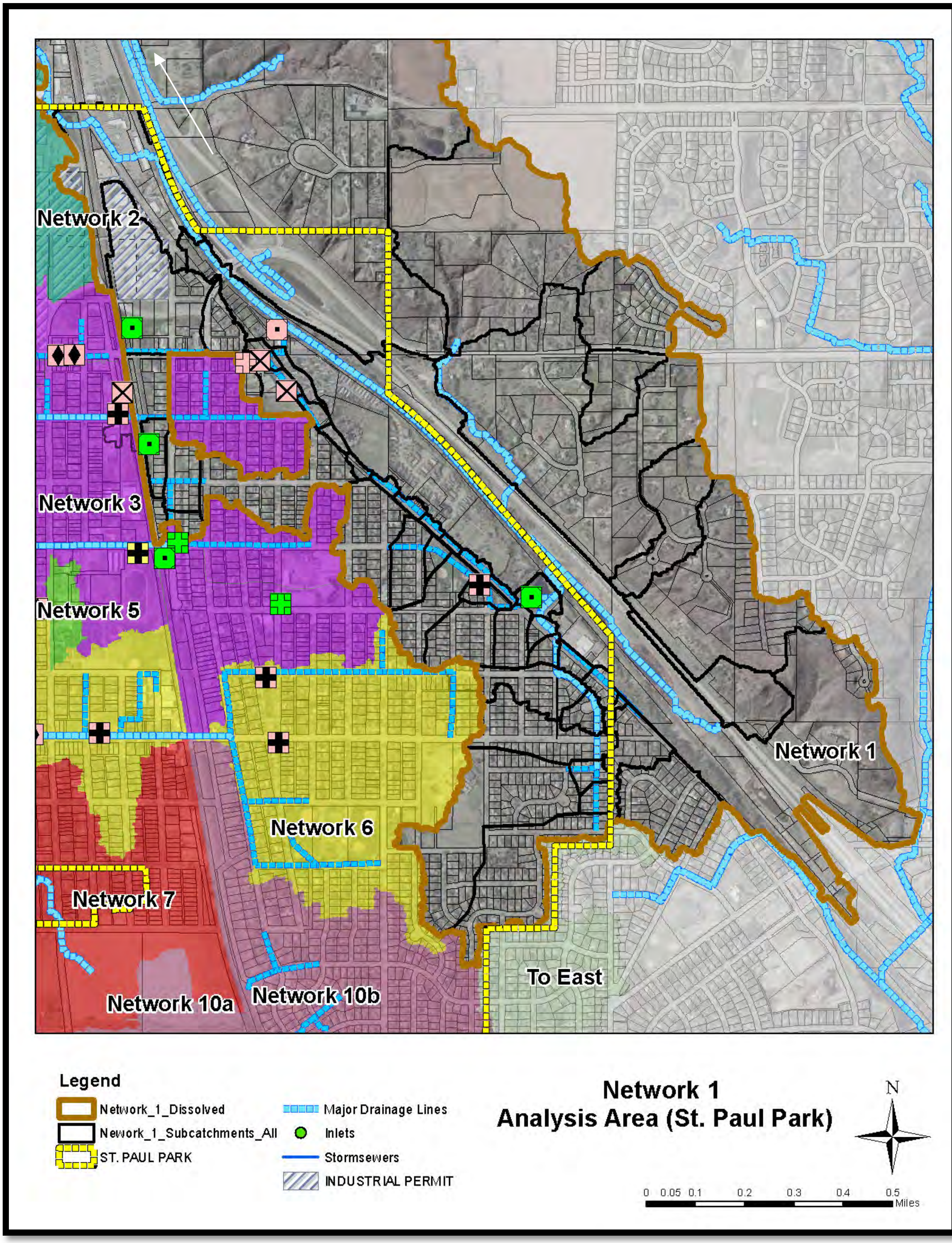


Map 2: Drainage Networks

Catchment Drainage Network 1



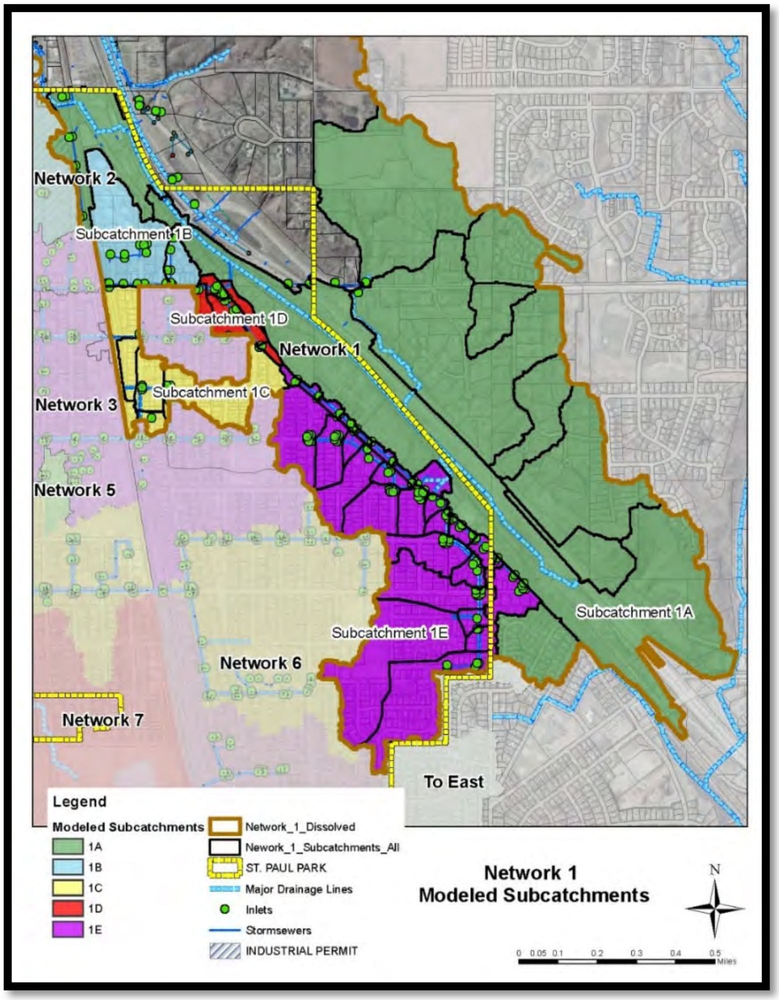
Map 3: Network 1 Drainage Area



Map 4: Network 1 Analysis Area (contained within City of St. Paul Park Boundary)

CATCHMENT DRAINAGE NETWORK 1 DESCRIPTION

Catchment drainage network 1 is 1471 acres with portions of the Network located in Cottage Grove, Woodbury and Newport. This is a highly complex stormwater network with a wide range of subcatchments and existing, aging treatment systems. The ultimate outlet of the Network is located in the City of Newport, north of the St. Paul Park Refinery facility.



Map 5: Network 1 Modeled Subcatchments

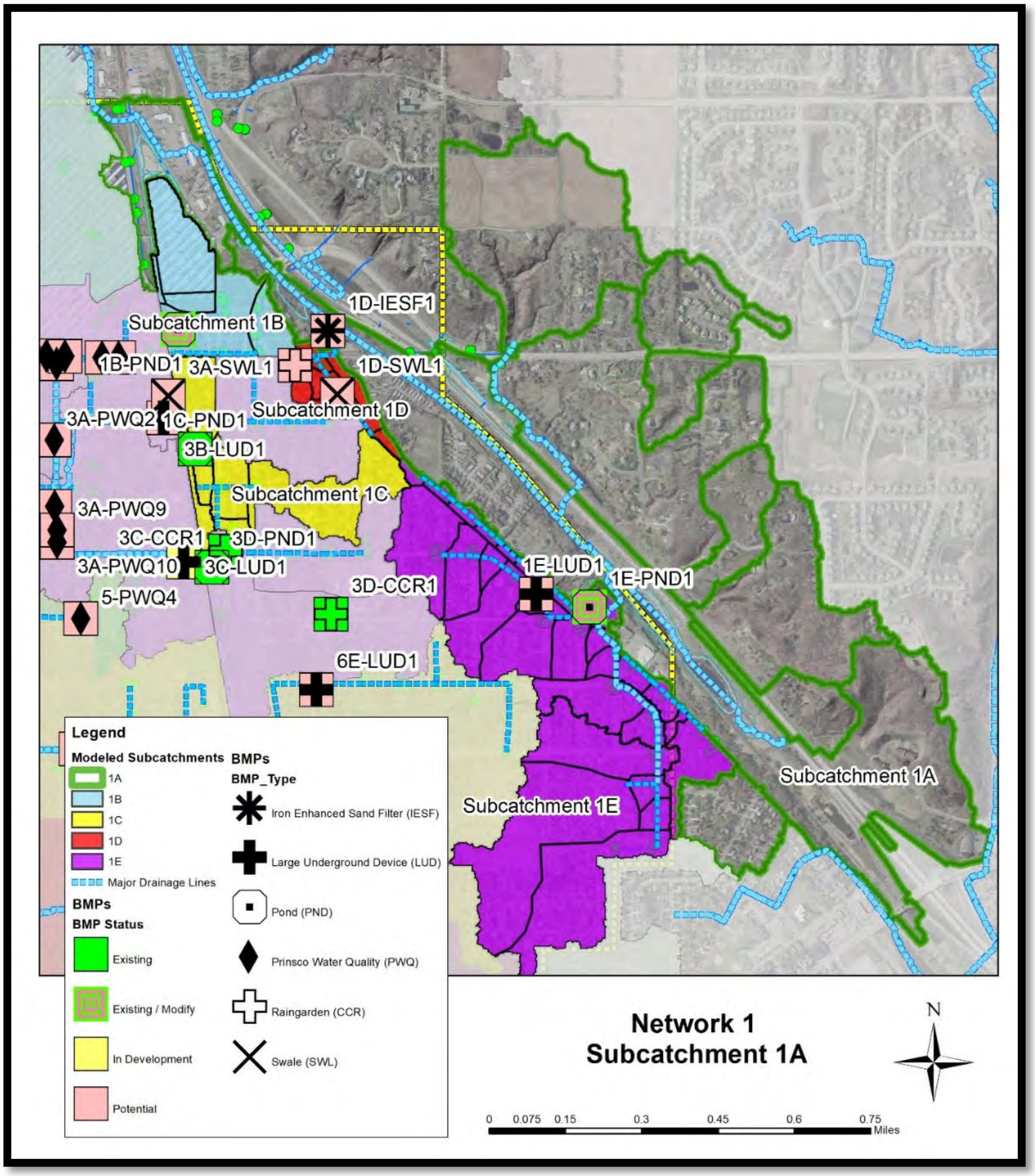
399 acres of the catchment area are located within the City of St. Paul Park. The eastern portion of this Network is dominated by State Trunk Highway 10 and its associated stormwater facilities. For the purposes of this study, only those areas within the City are under consideration for Best Management Practices, however, the catchment area includes portions of Woodbury and Cottage Grove. The analysis area, including those portions outside of Saint Paul Park is These areas are included in modelling, but are not under consideration for BMP locations.

Drainage issues have been identified in the northern portions of this Network as flows move north into the City of Newport. These drainage problems would benefit from projects that provide additional volume control in addition to pollutant capture practices.

Network 1 is divided into five discrete planning units based on concentrated outfall for each subcatchment. Subcatchments 1A is located along Highway 61 and active rail corridors whose ditches act as the primary conveyance of stormwater north through the network. Subcatchments 1B thru 1E are discrete units with identifiable outlets into Subcatchment 1A, and volume/pollutant control BMPs will provide benefits throughout the downstream network along BNSF ditch network.

Land cover is mixed single and multi-family residential, industrial, institutional and transportation corridors. Subcatchments are described and modeled individually below.

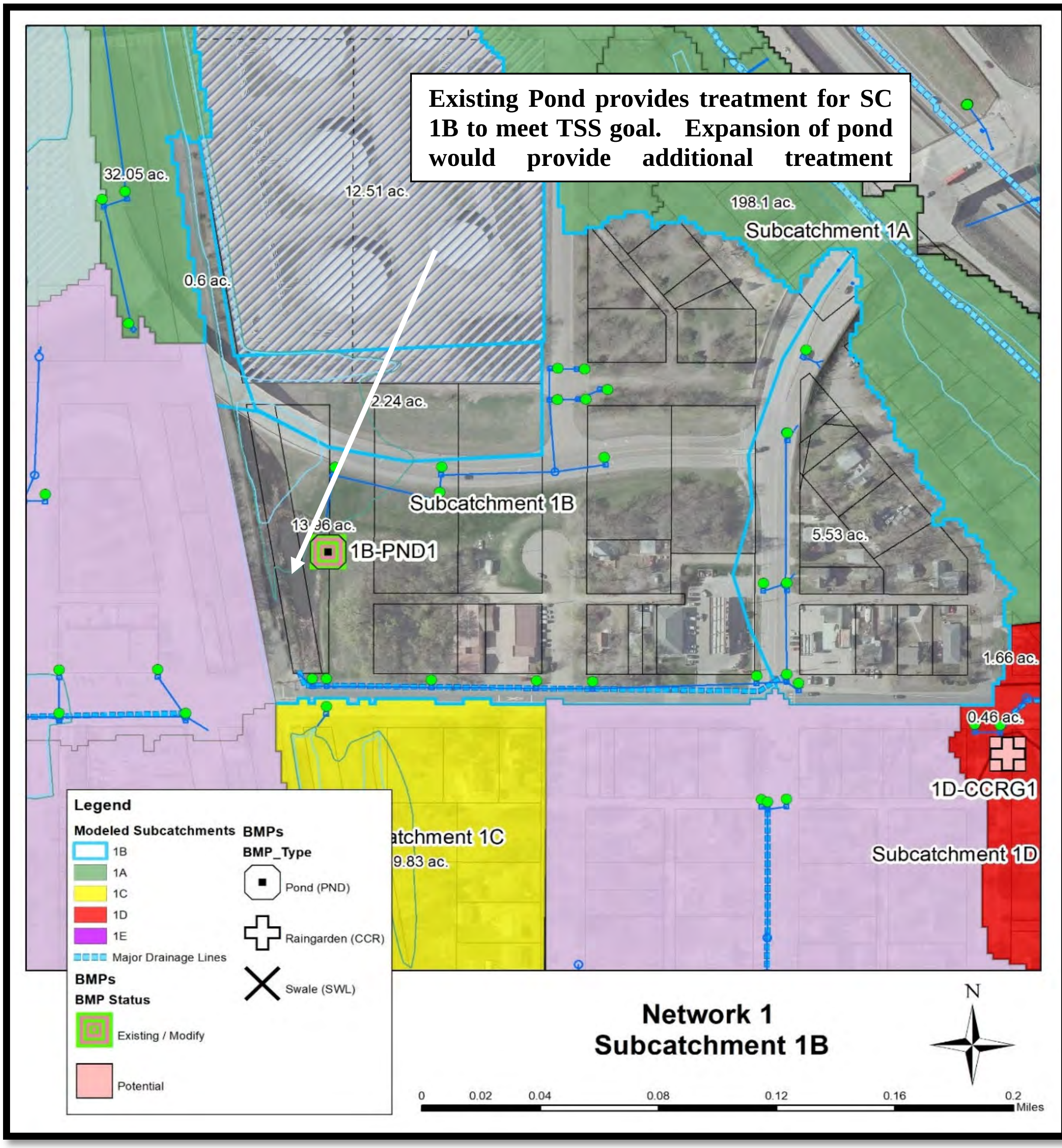
Subcatchment 1A



Map 6: Network 1 Subcatchment 1A

This 538 acre subcatchment is largely located outside of the City of St. Paul Park and those areas that are found within the city are generally located within BNSF Railroad and Minnesota Department of Transportation Rights of Way. Stormwater and nutrient flows deriving from within other portions of Network 1 flow into the these Transportation network stormwater facilities, and thus, reducing the loading from Subcatchments 1B, 1C, 1D and 1E will provide reductions within the railroad ditch and downstream to the Mississippi River. Because this subcatchment is located almost entirely outside of St. Paul Park, and is treated within the highly complex networks of the MnDOT treatment systems and railroad ROWs, the subcatchment was not modelled, but all other subcatchments feeding it were assessed for potential improvements.

Subcatchment 1B



Map 7: Network 1 Subcatchment 1B

This 34.85 acre subcatchment is a mix of commercial, highway access roads and ramps, residential and open space landcover types. The 22.33 acres that drain to the existing pond north of Broadway were modeled for TSS and Phosphorous. North of St. Paul Park Road, drainage is directed immediately north into the railroad ditch, or the area is contained within the MPCA permitted area of the St. Paul Park Refinery. These areas were not modeled. The existing pond in Subcatchment 1B provides substantial TSS and TP treatment (66% for each) above baseline. With the existing pond, TSS loading in the modeled area at 108 lbs/yr, falls below the Mississippi TMDL goal 154 lbs/yr.

	Existing Conditions Network 1 Subcatchment 1B	Base Loading	Existing Treatment	Net Treatment %	Existing Loading	Avg Loading per acre (existing)	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	18.66	12.35	66.17%	6.31	**0.28**	**n/a**
	TSS (lb/yr)	7004	5,112	65.59 %	2410	**108**	**-46**
	Volume (acre-feet/yr)	10.62	2.16	20.41%	8.46	**0.63**	**n/a**
	Number of BMP's	1 Existing Pond					
	BMP Size/Description	Ponded Area @ 0.96 Acres					

Catchment 1B BMP OPTIONS

Expansion of the large stormwater basin (1B-PND1) east of the BNSF Railroad and North of Broadway was the only BMP identified for this Subcatchment. There is an opportunity to double the size of the pond storage area by expanding into City of St. Paul Park unused Road Right of Way. This expansion would provide additional storage and treatment for large storm events and increase capacity, reducing the frequency of outfalls from of Subcatchment 1B to Subcatchment 1A.Providing improved nutrient capture as well storage capacity will provide some relief for the outfall to Catchment 1A which drains north to Newport and eventually to the Mississippi River.

Pond Expansion (1B-PND1)

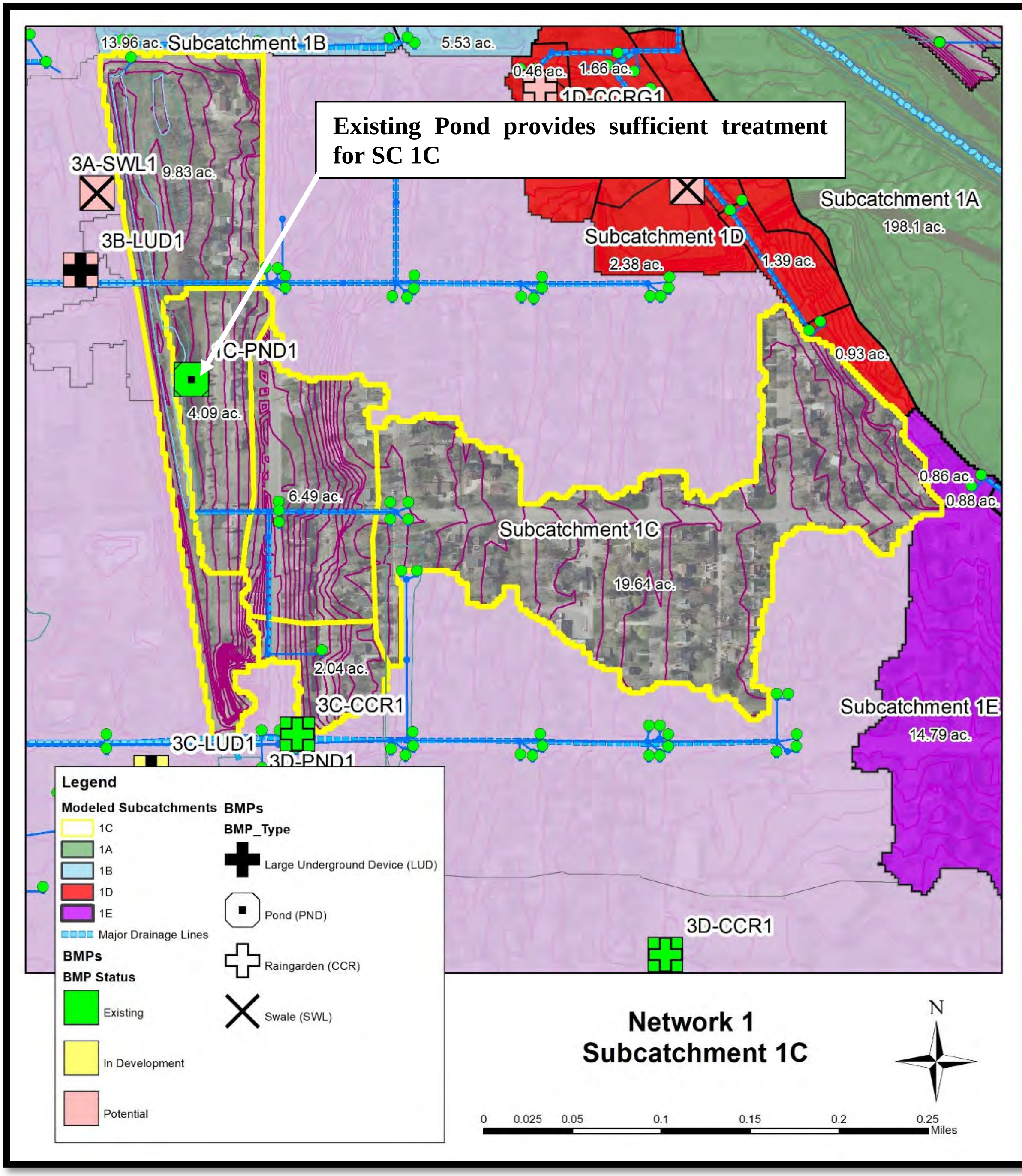
TSS Rank
21 of 22

Drainage Area – 22.33 acres
Location – East of Broadway at BNSF Railroad
Property Ownership – Public

Expansion of the existing pond (1B-PND1) provides some reductions in TP and TSS loads. A volume reduction of 1.05 acre feet would provide some relief to downstream flows where periodic flooding has been noted. Expansion of the pond capacity would reduce TSS loading at the outfall to below TMDL goal. TP reductions beyond existing pond treatment are marginal as the existing pond provides TP capture.

	BMP BENEFIT / COST ESTIMATE 1B-PND1 - BMP Network 1 Subcatchment 1B	1B-PND1 Network 1 (Subcatchment 1B)			
		Existing Loading	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	6.31	5.64	0.67	11%
	TSS (lb/yr)	2410	2148	386	11%
	Volume (acre-feet/yr)	8.46	7.61	1.05	10%
	Number of BMP's	1 Expanded and Cleaned Pond			
	BMP Size/Description	Pond @ 1.1 Acres, bottom lowered by 1’ and ponding area expanded (cleanout)			
Cost	Design/Engineering	$6,000.00			
	Probable Project Cost	$90,000.00			
	Annual O&M	$500.00			
	20-yr Cost/lb-TP/yr	$7,910			
	20-yr Cost/2,000lb-TSS/yr	$27,461			

Subcatchment 1C

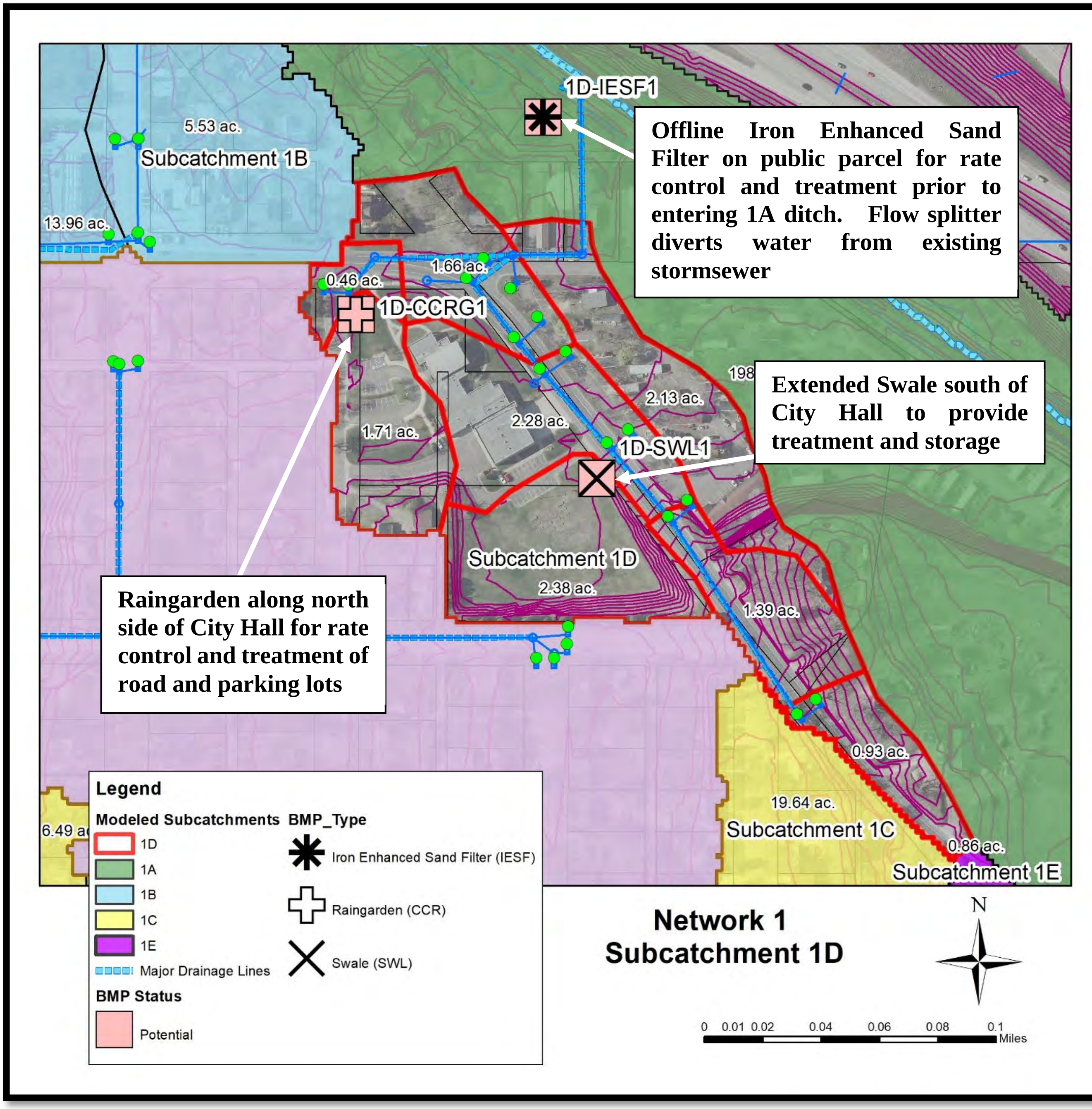


Map 8: Network 1 Subcatchment 1C

This 42.09 acre subcatchment is predominantly residential and open space. The entire subcatchment drains to the west to a stormwater basin along the railroad embankment located between 7th Avenue and 9th Avenue, then north across Broadway into 1B-PND1 . Because stormwater collects in the basin with a large infiltration area at the lowest portion of this catchment, significant treatment is currently being provided by the existing system.

	Existing Conditions Network 1 Subcatchment 1C	Base Loading	Existing Treatment	Net Treatment %	Existing Loading	Avg Loading per acre (existing)	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	35.18	21.22	60.31%	13.96	**0.25**	**n/a**
	TSS (lb/yr)	13,203	7,826	59.27%	5,377	**128**	**-1,094**
	Volume (acre-feet/yr)	20.02	2.61	20.94%	13.06	**0.38**	**n/a**
	Number of BMP's	1 Pond					
	BMP Size/Description	Pond @ 0.66 Acres					

Subcatchment 1D



Map 9: Network 1 Subcatchment 1D

This 12.94 acre subcatchment is a combination of residential, mobile home, and city institutional buildings with associated open space. The subcatchment outfall is located north of the city water tower via a 24" concrete stormsewer with flared end section. TSS loading into the railroad ditch is modelled at 1301 lbs/yr, substantially above the 154 lbs/yr target.

	Existing Conditions Network 1 Subcatchment 1D	Base Loading	Existing Treatment	Net Treatment %	Existing Loading	Avg Loading per acre (existing)	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	57.09	0.0	0%	57.09	**4.41**	**n/a**
	TSS (lb/yr)	16830	0.0	0%	16830	**1301**	**14,842**
	Volume (acre-feet/yr)	19.05	0.0	0%	19.05	**1.47**	**n/a**
	Number of BMP's	None Noted					
	BMP Size/Description	None Noted					

Catchement 1D BMP OPTIONS

City hall buildings are directly connected to the stormsewer network, and disconnects would be prohibitively expensive. However, opportunities exist within the public lands surrounding the City Hall and police buildings in the form of regrading along the edge of the field to the south (1D-SWL1), and creating a curb cut raingarden to the west (1D-CCRG1).

North of the City of Cottage Grove water tower, a combination of city parcel and public road ROW provides an opportunity for a filtration device to treat the entire subcatchment. 1D-IESF1 is a proposed Iron Enhanced Sand filter located adjacent to and offline of the existing outlet stormsewer. The proposed basin is approximately 9000 sq. ft. in size with 2’ of filtration media and 8” underdrain outletting directly to railroad ditch (Subcatchment 1A).

TSS Rank
4 of 22

City Hall Curbcut Raingarden (1D-CCRG1)

Drainage Area – 1.71 acres
Location – Northwest Corner of City Hall Site
Property Ownership – Public

A large curb cut raingarden (1D-CCRG1) near the city hall signage at the corner of Portland Avenue and Hastings Avenue provides treatment for a portion of Portland Avenue, grassy open space and parking lots. Unfortunately, capturing rooftop runoff could be prohibitively expensive as drainage from the site buildings are integrated into the existing stormsewer network. This 1000 sq. ft. raingarden would require a pretreatment device (RainGuardian type), sand/compost media mix and standpipe with connection to adjacent catch basin. This raingarden could be planted with predominantly medium height shrubs to reduce maintenance.

	BMP BENEFIT / COST ESTIMATE 1D-CCRG1 - BMP Network 1 Subcatchment 1D	***1D-CCRG1*** Network 1 (Subcatchment 1D)			
		Existing Loading	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	57.09	53.72	3.37	6%
	TSS (lb/yr)	16830	15,725	1,105	7%
	Volume (acre-feet/yr)	19.05	17.84	1.21	0%
	Number of BMP's	1 Curb Cut Raingarden			
	BMP Size/Description	1000 sq. ft. curbcut raingarden. No underdrain with vertical standpipe @3” above bottom. Sedges planted in center with shrub margins.			
Cost	Design/Engineering	$4,000			
	Probable Project Cost	$15,000			
	Annual O&M	$400			
	20-yr Cost/lb-TP/yr	$401			
	20-yr Cost/2,000lb-TSS/yr	$746			

Park Edge Swale (1D-SWL1)

Drainage Area – 2.38 acres
Location – Northern Edge of City Hall Greenspace (south portion of site)
Property Ownership – Public

TSS Rank
1 of 22

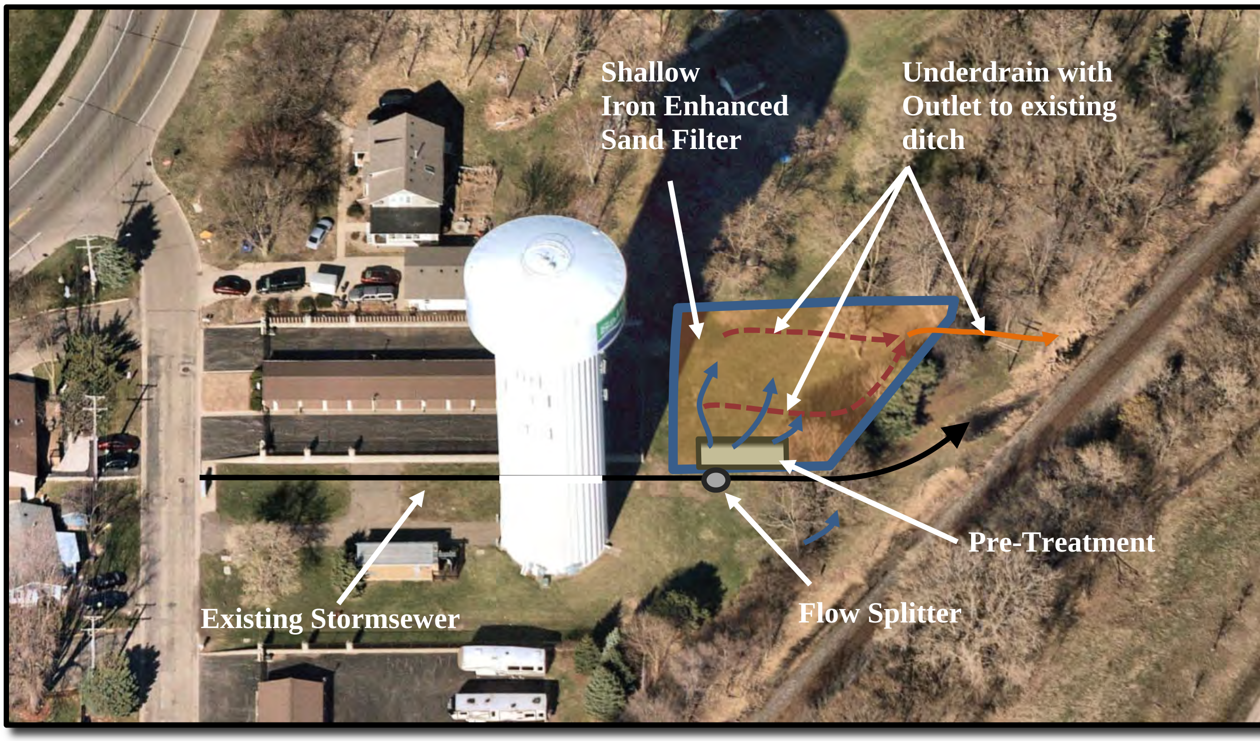
A swale along the south side of the parking area to the south of the buildings would capture drainage from the fields to the south. While these fields are currently capturing stormwater through sheetflow over turf, a swale along the edge of the parking would provide infiltration prior to entering stormwater and impervious surfaces. This practice is primarily a minor grading exercise but may require small pathways with piping to provide foot traffic during times of wet soils.

	BMP BENEFIT / COST ESTIMATE* *1D-SWL1 - BMP* *Network 1* *Subcatchment 1D	***1D-SWL1*** **Network 1 (Subcatchment 1D)**			
		Existing Loading	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	57.09	54.83	2.72	4%
	TSS (lb/yr)	16830	16,323	607	3%
	Volume (acre-feet/yr)	19.05	18.93	0.38	1%
	Number of BMP's	1 Infiltration/Filtration Swale			
	BMP Size/Description	Mowed turf swale on north and east of field captures slopes, field and half of parking spaces. Swale is 350' in length with 1' depth and 5' wide bottom.			
Cost	**Design/Engineering**	$2,500			
	Probable Project Cost	$10,000			
	Annual O&M	$400			
	20-yr Cost/lb-TP/yr	$377			
	20-yr Cost/2,000lb-TSS/yr	$311			

Water Tower Iron Enhanced Sand Filter (1D-SLF1)

Drainage Area – 12.94 acres
Location – East of Broadway at BNSF Railroad
Property Ownership – Public

TSS Rank
16 of 22



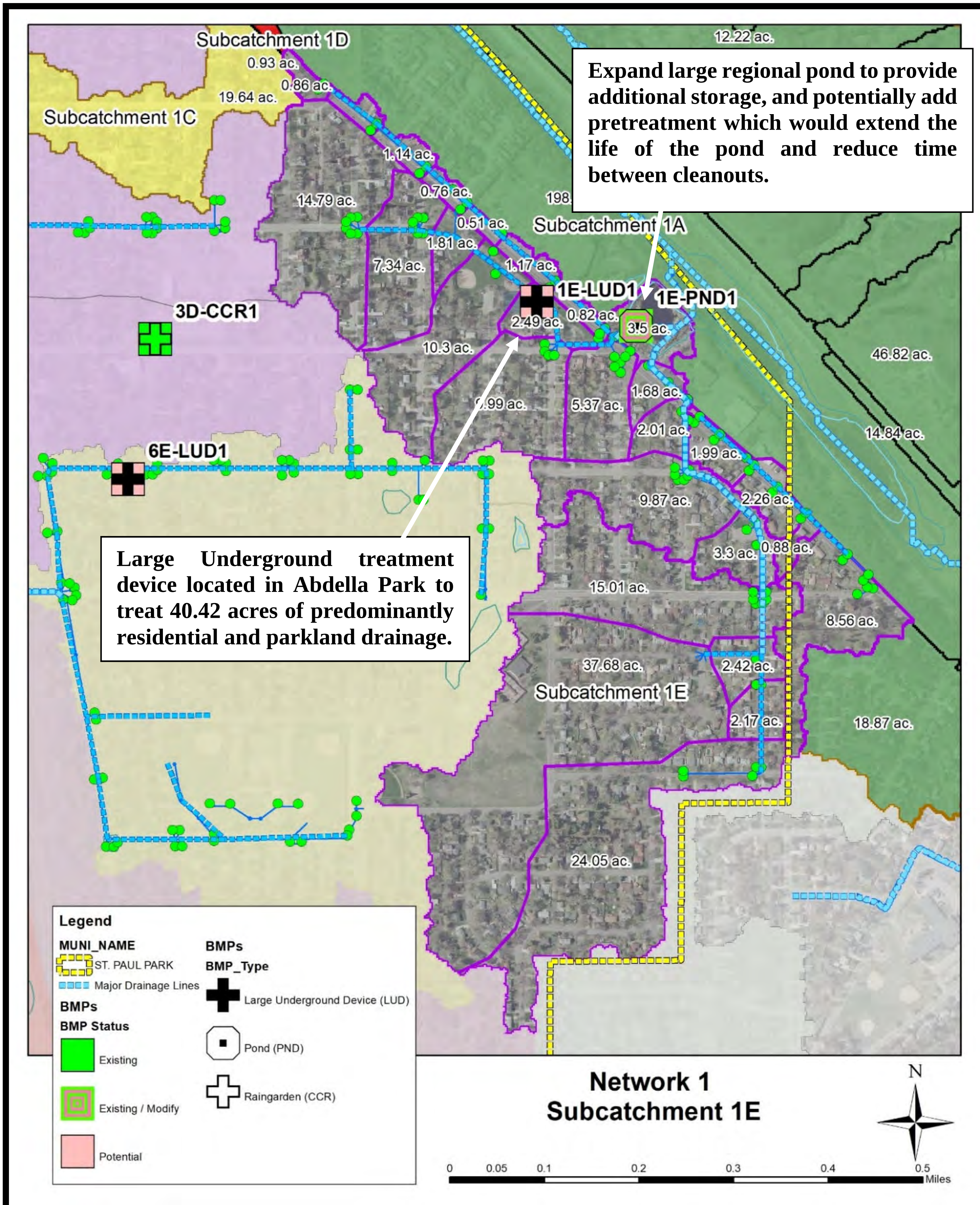
The storm sewer outfall located north of the city water tower may provide an opportunity for a shallow basin for treatment of TSS and Phosphorous (ID-SLF1). Using gravity flow, any system in this location would need to be very shallow with rapid drawdown. The site was modeled as an offline biofiltration basin with a sand/compost media.

The Minnesota PCA determines that 60% of Dissolved Phosphorous passing through an iron enhanced system is removed. Using this calculation, and IESF would remove an additional 10.9 pounds of dissolved phosphorous annually. This system would require a pretreatment device, emergency overflow and underdrains out-letting directly into the railroad drainage ditch at in Subcatchment 1A.

	BMP BENEFIT / COST ESTIMATE ***1D-SFL1 - BMP*** ***Network 1*** ***Subcatchment 1D***	***1D-SFL1*** Network 1 (Subcatchment 1D)			
		Existing Loading	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	57.09	31.23	25.86	45%
	Filterable P (lb/yr)	18.16	7.26*	10.90*	60%
	TSS (lb/yr)	16,832	11,455	5,377	32%
	Volume (acre-feet/yr)	19.31	16.71	2.6	0%
	Number of BMP's	1 Iron Enhanced Sand Filter (with pretreatment)			
	BMP Size/Description	9000 sq. ft. Iron Enhanced Sand Filter 1.5' media depth and pretreatment device at inlet.			
Cost	**Design/Engineering**	$30,000			
	Probable Project Cost	$180,000			
	Annual O&M	$1,880			
	20-yr Cost/lb-TP/yr	$479			
	20-yr Cost/2,000lb-TSS/yr	$4,605			

*assumes 60% Filterable P removal passing through IESF

Subcatchment 1E



Map 10: Network 1 Subcatchment 1E

This 172.13 acre subcatchment is predominantly residential is a combination of mostly residential landscapes with a large school green, a neighborhood park, and an arterial road at the edge of the subcatchment. The entire subcatchment drains to the east and deposits into a single 1.5 acre basin between Hudson Road and Railroad Tracks. Pond outlets to Subcatchment 1A where erosion and scouring at pipe outlet is apparent.

	Existing Conditions Network 1 Subcatchment 1E	Base Loading	Existing Treatment	Net Treatment %	Existing Loading	Avg Existing Loading per acre	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	214.7	70.7	32.92%	144.0	**0.84**	**n/a**
	TSS (lb/yr)	69,615	23,556	33.84%	46,059	**268**	**21,620**
	Volume (acre-feet/yr)	100.3	3.61	6.00%	95.59	**0.56**	**n/a**
	Number of BMP's	One Existing 1.5 acre Pond					
	BMP Size/Description	1.5 acre existing pond estimated at 3' deep					

Subcatchement 1E BMPs

Two potential BMPs are identified in Subcatchment 1E. The Large Underground Unit (1E-LUD1) at Abdella Park is likely not needed if large scale improvements to the pond at Hasting Avenue (1E-PND1 are possible. While they would provide some reductions, the improvements to the pond inflow and size are likely more effective for both pollutant removal and accessible maintenance.

Abdella Park Large Underground Device (1E-LUD1)

Drainage Area – 40 acres
Location – East Side, Abdella Park
Property Ownership – Public

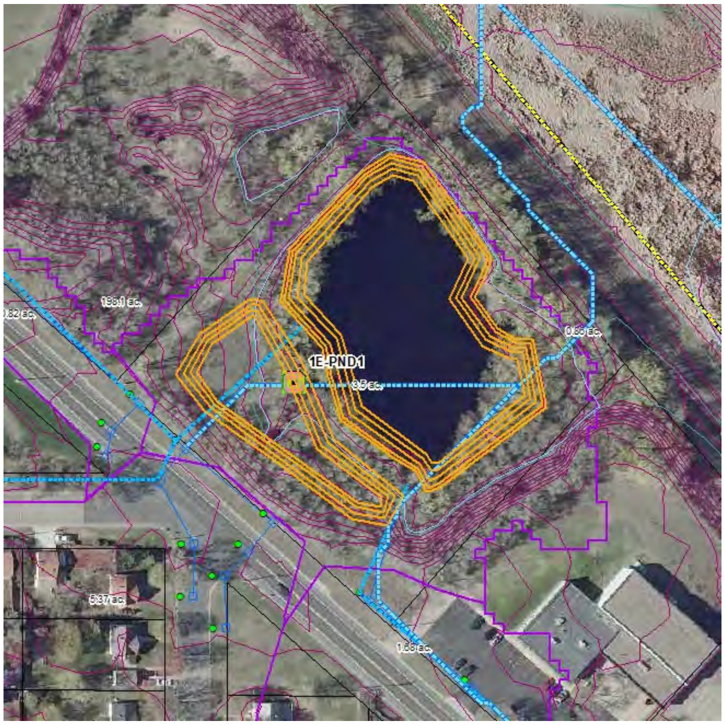
TSS Rank
17 of 22

Abdella Park may offer treatment opportunities particularly along the eastern boundary of the park where few directed activities are located. Assuming shallow bedrock is present, infiltration is not ideal. A shallow stormwater treatment system like a 10'X15' underground Vortechs treatment chamber may be appropriate for sediment and associated TP capture.

	BMP BENEFIT / COST ESTIMATE ***1E-LUD1 - BMP*** ***Network 1*** ***Subcatchment 1D***	***1D-LUD1*** Network 1 (Subcatchment 1D)			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	23.61	18.91	4.7	20%
	TSS (lb/yr)	8,800	1,760	7,040	80%
	Volume (acre-feet/yr)	12.37	12.37	0	0%
	Number of BMP's	Underground Vortechs Type Unit			
	BMP Size/Description	10x15' underground treatment chamber to capture TSS and associated TP			
	Design/Engineering	$25,000			
	Probable Project Cost	$250,000			
	Annual O&M	$3,000			
	20-yr Cost/lb-TP/yr	$3,564			
	20-yr Cost/2,000lb-TSS/yr	$4,759			

Pond Retrofit and Expansion (1E-PND1)
Drainage Area – 172 acres
Location – East Side of Hastings Avenue at 10th Street
Property Ownership – Public

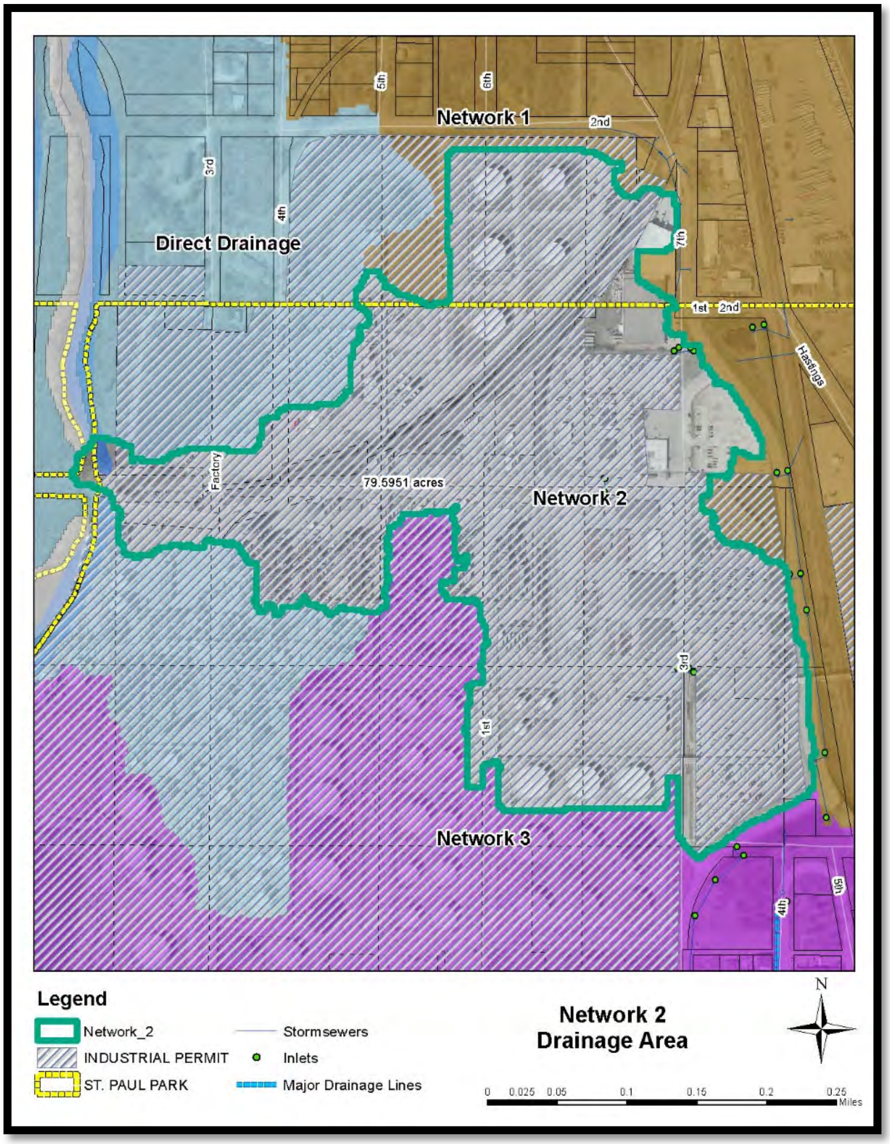
TSS Rank
13 of 22



The pond located along Hasting Avenue provides substantial treatment of TSS (22,219 lbs/yr) and Phosphorous (65.8 lbs/yr) for the entire watershed prior to discharge into the railroad ditch along 1A. Scouring at inlets and the outfall suggests beefing up this pond with expanded capacity and providing a forebay to reduce loading within the pond will serve multiple benefits to downstream waters and offer easier access for regular maintenance.

	BMP BENEFIT / COST ESTIMATE 1E-PND1 - BMP Network 1 Subcatchment 1D	***1D-PND1*** Network 1 (Subcatchment 1D): Existing Loading (inc. exist. Pond)	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	144.0	101.5	42.5	30%
	TSS (lb/yr)	46,059	31,821	14,238	31%
	Volume (acre-feet/yr)	95.59	67.65	27.94	29%
	Number of BMP's	One Expanded Pond			
	BMP Size/Description	Pond @ 2.2 Acres (combined), cleaned, deepened and with forebay added for more efficient treatment and maintenance			
Cost	Design/Engineering	$40,000			
	Probable Project Cost	$400,000			
	Annual O&M	$1,500			
	20-yr Cost/lb-TP/yr	$553			
	20-yr Cost/ton-TSS/yr	$3,301			

Catchment Drainage Network 2

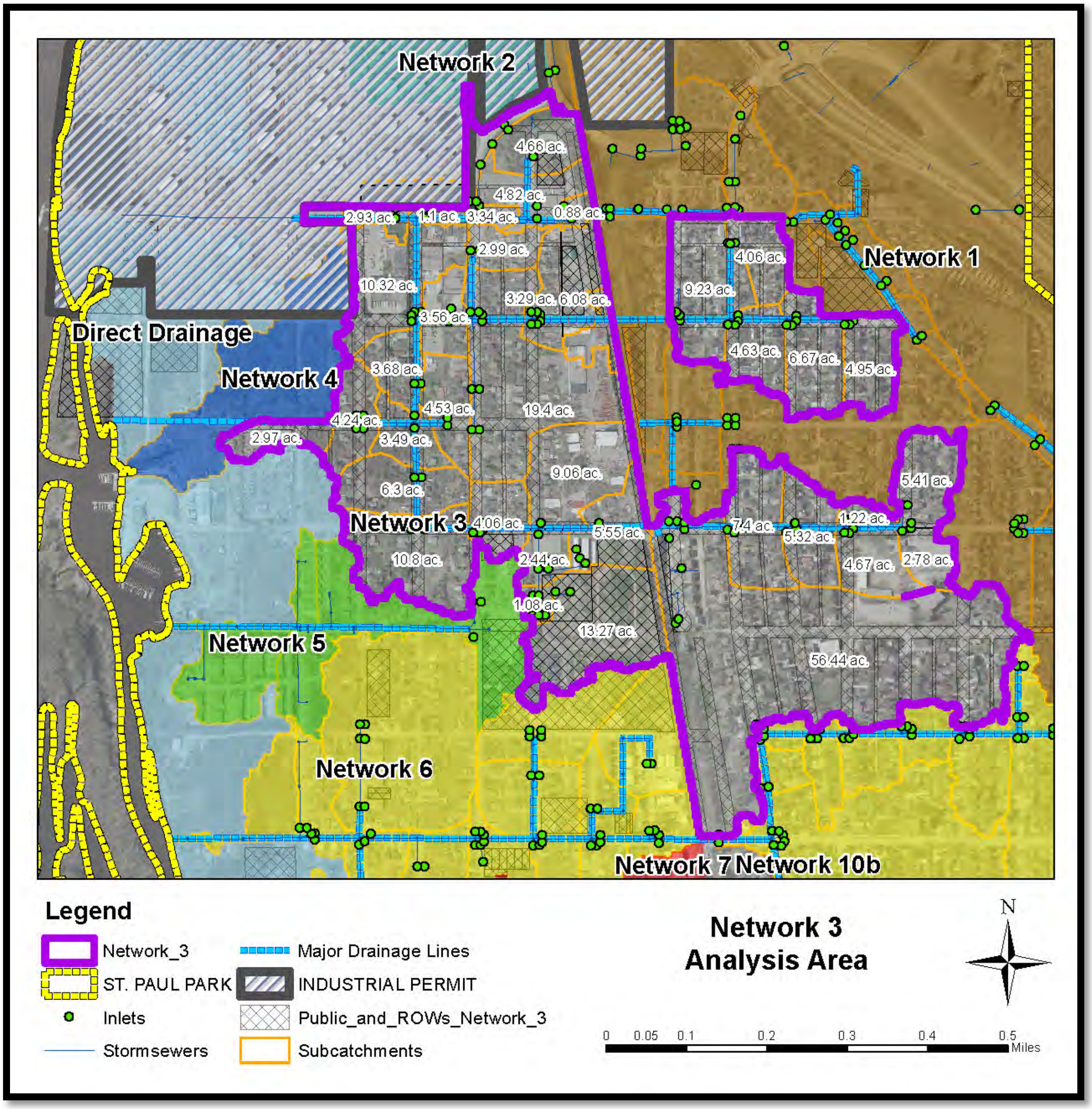


Map 11: Network 2

CATCHMENT DRAINAGE NETWORK 2 DESCRIPTION

Catchment drainage network 5 is 79.6 acres comprised of five subcatchments. The land cover is entirely located within the St. Paul Park Refining Company property. The site operates under an Industial Stormwater Permit issued by the Minnesota Pollution Control Agency (MPCA), renewed in . Surface discharge is monitored by the MPCA at four locations, and thus, the site was not modeled, nor considered for BMP projects.

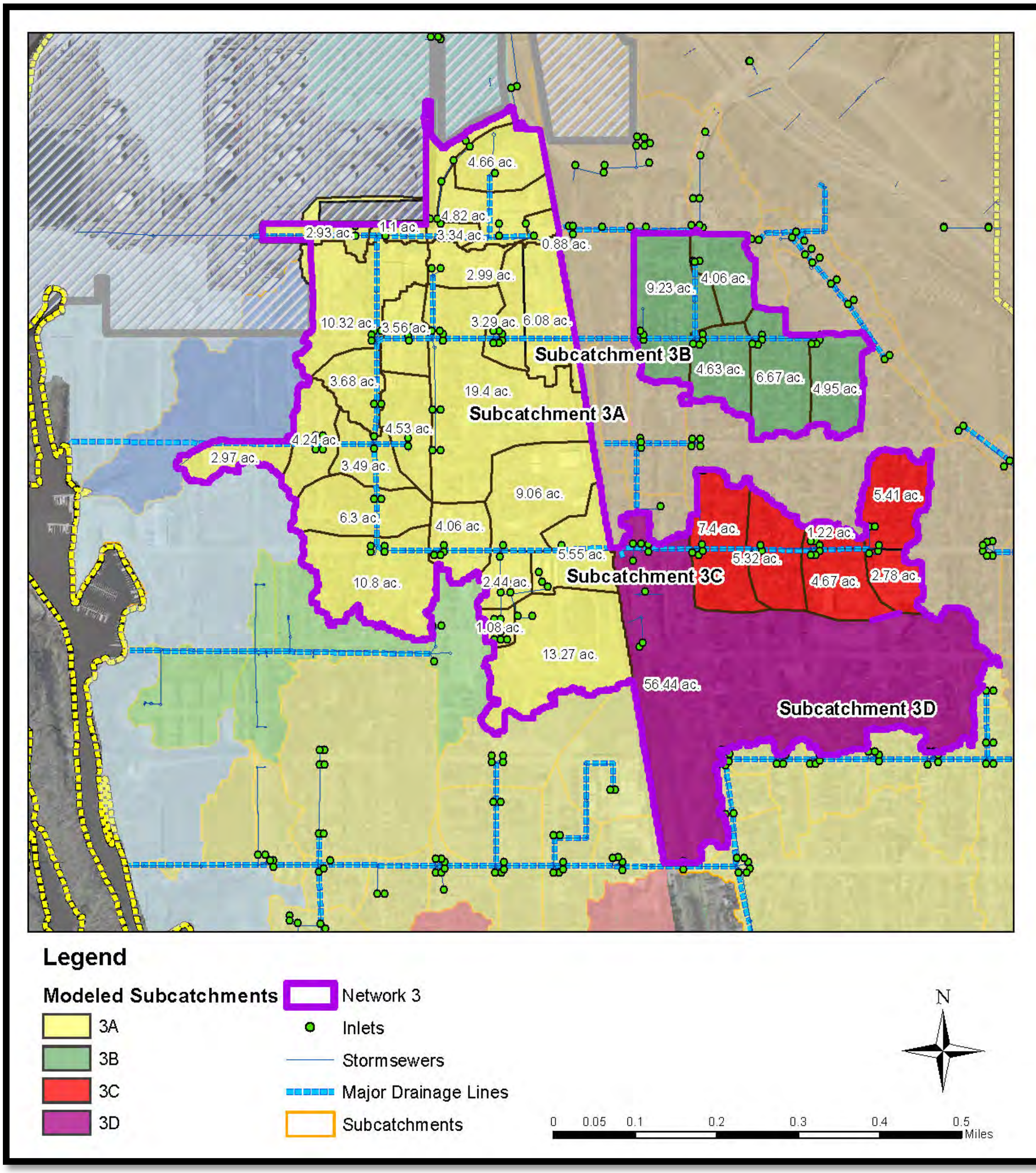
Catchment Drainage Network 3



Map 12: Network 3

CATCHMENT DRAINAGE NETWORK 3 DESCRIPTION

Catchment drainage network 3 is 248 acres located entirely with the city of St. Paul Park. This stormwater network is comprised of four distinct, and entirely urban subcatchments. Three of these subcatchments are located east of the railroad corridor and connected via stormsewers along 9th Street and 7th Avenue/5th Street at the City Public Works facility. Subcatchment 3D contains one stormwater pond and two curbcut raingardens that capture, store and treat waters east of the rail corridor. An additional underground BMP



Map 13: Network 3 Subcatchments

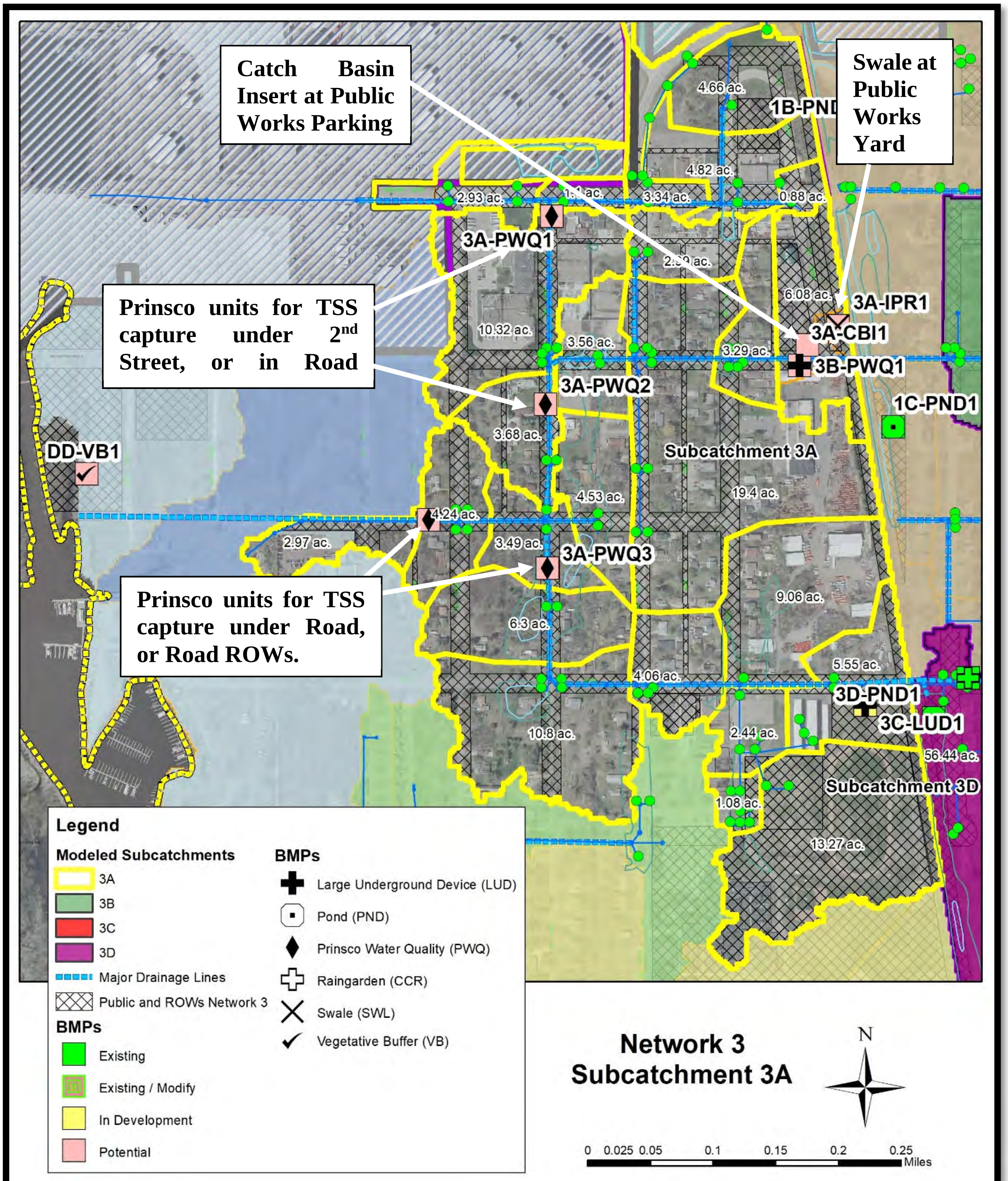
is being developed and installed by the South Washington Watershed District in conjunction with the South Washington County School District to treat waters from Subcatchments 3C and 3D. No other BMPs were identified in the Network. The Network outlet to the Mississippi River is located immediately south of Lion's Park at the end of 8th Avenue.

This subcatchment contains a mix of residential, industrial and downtown commercial landcovers. Subcatchment 3A is comprised of the greatest mix, containing the downtown and industrial portions of the city, while Subcatchments 3B, 3C and 3D, located east of the railroad corridor are almost entirely residential landcover types. TSS loading for the Network is more than double the TMDL target (415 lbs/yr). Opportunities to treat the three subcatchments east of the railroad corridor exist at the railroad crossings as stormwater is concentrated in sewers at the crossing.

	Existing Conditions Network 3	**Base Loading**	**Existing Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	201.2	0	0%	201.2	**0.05**	**n/a**
	TSS (lb/yr)	102,932	0	0%	102,932	**415**	**64,728**
	Volume (acre-feet/yr)	150.51	0	0%	150.51	**0.63**	**n/a**
	Number of BMP's	4					
	BMP Size/Description	Two curbcut raingardens and one stormwater pond are located in Subcatchment 3D and an additional underground BMP was recently installed to treat stormwater from Subcatchments 3C and 3D. This device is modeled and ranked in this report.					

Subcatchment 3A

This 134.84 acre subcatchment is a combination of residential landscapes with a large school green, as well as downtown commercial and industrial areas. Subcatchments 3B, 3C and 3D contribute to the network from locations east of the BNSF railroad. Each of those subcatchments either has existing, or proposed treatments prior to entering Subcatchment 3A. The Network merges at 2nd Street and 8th Avenue before outletting to the Mississippi River at Lion's Levee Park.



TSS Rank
20 of 22

Intlet Protection at Public Works Yard (3A-IPR1)

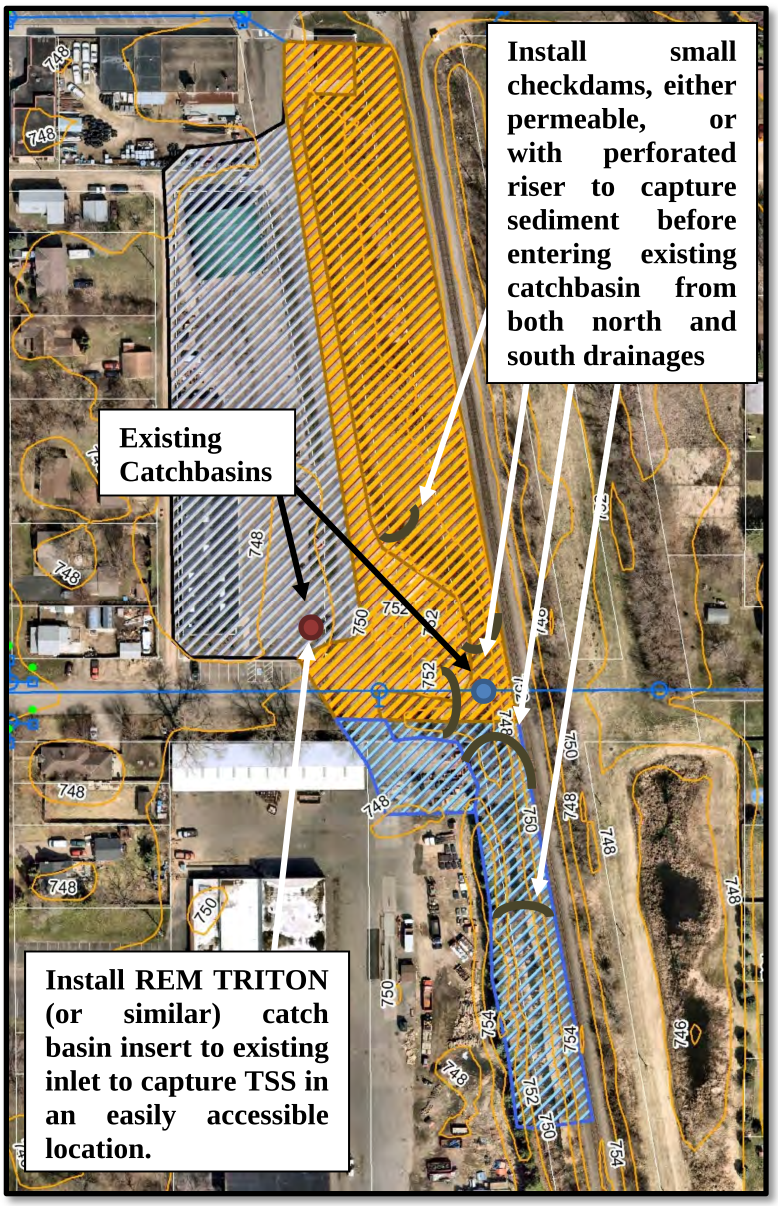
Drainage Area – 2.73 acres

&

Catchbasin Insert at Public Works Parking (3A-CBI1)

TSS Rank
10 of 22

Drainage Area – 1.73 acres
Location – East of Public Works Building between 5th Street and BNSF Railroad
Property Ownership – Public



The Public Works Yard and Storage Facility offers opportunities to capture and treat stormwater in easily accessible locations in the upper reaches of Network 3A. At present, two stormwater inlets are present within or adjacent to the public works parcel that offer opportunities for small devices near the city facility.

3A-IPR1: One inlet has been installed within the existing swale near the BNSF railroad. Stormwater enters this this inlet is often clogged by debris, grit and garbage coming from both north and south along the railroad. Opportunities exist in this location to enhance the swale by adding permeable check dams to both slow water and provide a sediment trap that can be periodically cleaned out to remove gross solids. The small basins formed behind these check dams could be fitted with perforated overflow pipes to slow water and provide sediment capture.

3A-CBR1: A second inlet is located within the parking lot of the Public Works Garage. This site has the potential to be easily monitored and quickly cleaned on an as needed basis. An REM Clean Catch Basin Insert is a product that fits into an existing catchbasin and offers easy access at the site of the yard. Cleaned three times per year, the filter has the potential to capture more than the total load of TSS per year. Model assumes 80% efficiency of the filter at TSS capture.

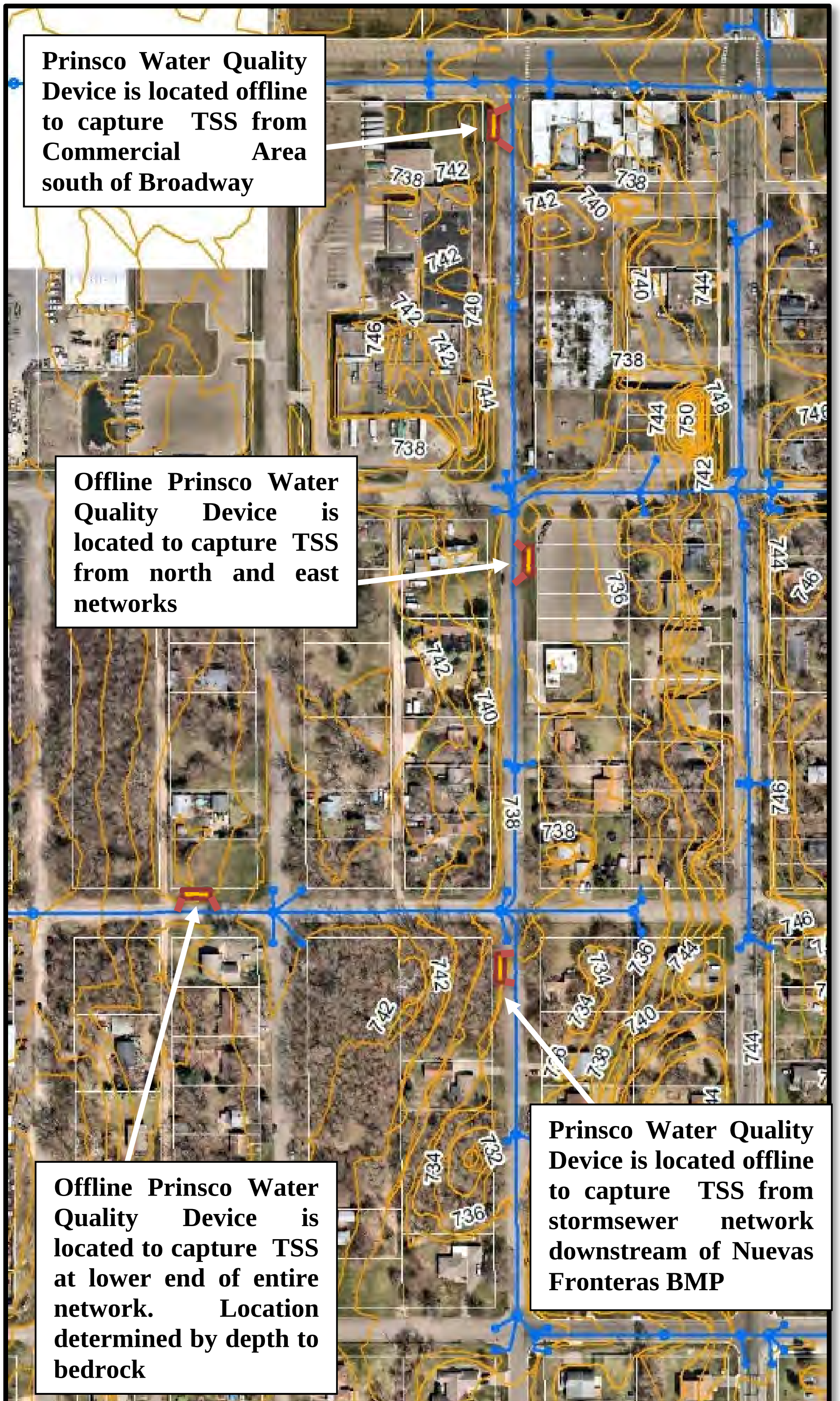
	BMP BENEFIT / COST ESTIMATE 3A-IPR1 - BMP Network 3 Subcatchments 3A	3A-IPR1 Network 3 (Subcatchment 3A)			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	1.81	0.88	0.93	**51%**
	TSS (lb/yr)	330	82	247	**75%**
	Volume (acre-feet/yr)	0.06	0.05	0.01	**11%**
	Number of BMP's	2 combined devices			
	BMP Size/Description	Improvements to existing swales to include Check Dams and riser in easily accessible location to capture TSS and trash.			
Cost	Design/Engineering	$3,000			
	Probable Project Cost	$6,000			
	Annual O&M	$600			
	20-yr Cost/lb-TP/yr	$1,129			
	20-yr Cost/2,000lb-TSS/yr	$8,502			

	BMP BENEFIT / COST ESTIMATE 3A-CBI1 - BMP Network 3 Subcatchments 3A	3A-CBI1 Network 3 (Subcatchment 3A)			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	3	2.49	.51	**17%**
	TSS (lb/yr)	545	109	436	**80%**
	Volume (acre-feet/yr)	3.7	3.7	0	**0%**
	Number of BMP's	2 combined devices			
	BMP Size/Description	Install catch basin insert within existing structure to capture TSS and trash in an easily cleanable manner at Public Works Garage Site. Assume 3 cleanouts per year			
Cost	Design/Engineering	$200			
	Probable Project Cost	$600			
	Annual O&M	$300			
	20-yr Cost/lb-TP/yr	$667			
	20-yr Cost/2,000lb-TSS/yr	$1,560			

2nd Street PRINSCO Underground Units (3A-PWQ 1-4)

Drainage Area – 134.84 acres
Location – East of Public Works Building between 5th Street and BNSF Railroad
Property Ownership – Public

TSS Rank
6 of 22



The PRINSCO WQ6040 is a 40 foot long, 60 inch underground treatment device with internal baffles that trap sediment and floatables. Each unit has a sediment storage capacity area of 375.9 Cubic Feet. Storage is effective to 20% of fill capacity, so each unit is assumed to have an actual capacity of 75.9 cubic feet of effective storage before requiring cleanout. Product reporting indicates TSS removal efficiency rates exceeding 80% in all events below 1.2 cfs. Units installed offline in road rights of way would be placed to maximize potential capture along main stormsewer lines, each capturing the full 75.9 cubic feet of sediment on an annual basis. These units would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 75.9 cubic feet over 20 years produced an estimated reduction of 3.23 lbs/yr of total phosphorous.

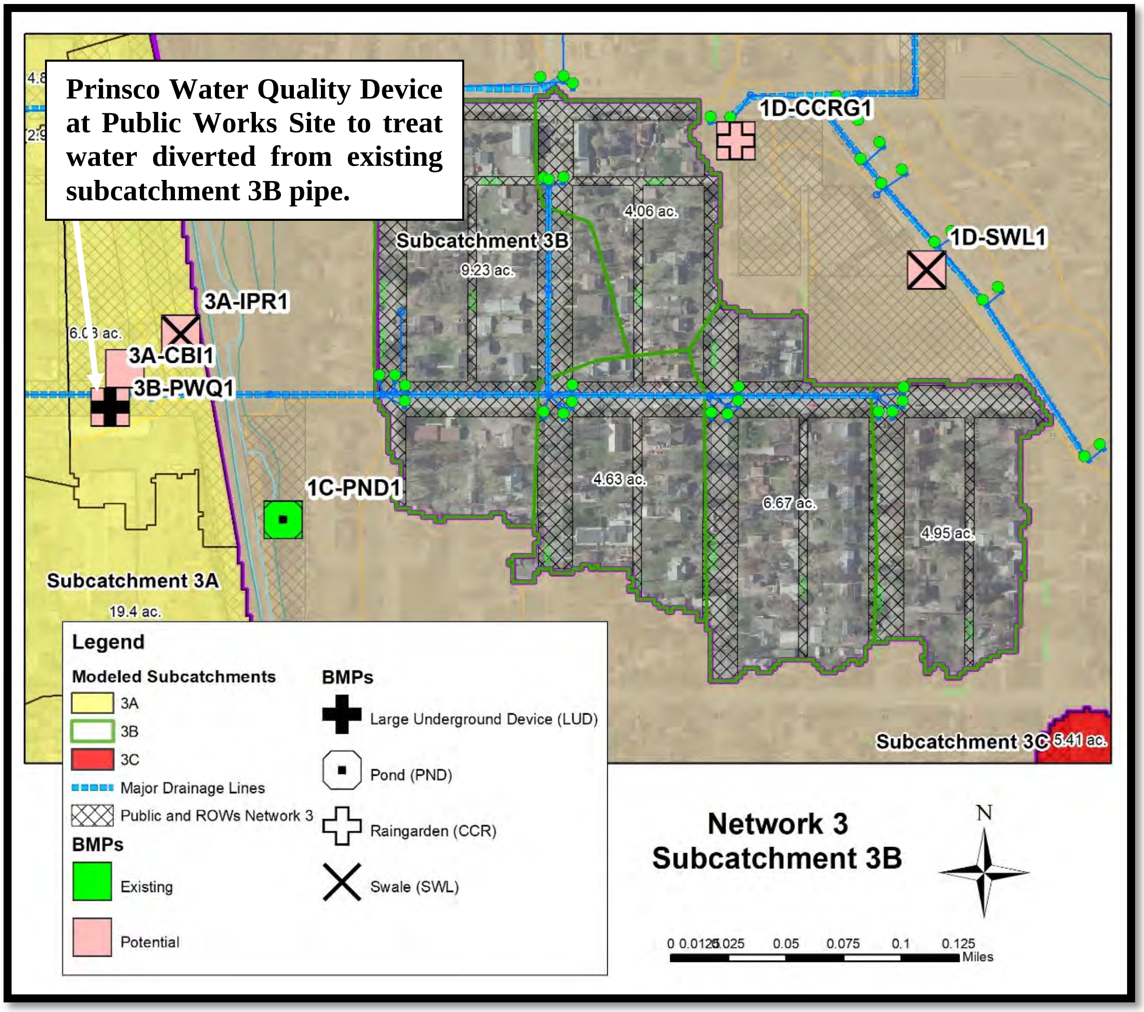
Each unit has the potential to capture 7,590 lbs/yr of TSS assuming one cleanout per year. Each of the subwatersheds modeled along 2nd Street within network within Subcatchment 3C exceeded 80% of the estimated load and thus it is assumed that 100% of the potential capture will be achieved. Assuming four are installed along 2nd Street and 8th Avenue, potential TSS removal with an annual cleanout would amount to 31,800 lbs/yr. These units would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 75.9 cubic feet over 5 years produced an estimated reduction of 3.23 lbs/yr of total phosphorous per unit.

With regular and well-timed cleanouts (biannual), these units combined have the potential to capture up 80% of TSS and 20 of TP.

	BMP BENEFIT / COST ESTIMATE 3A-PWQ 1-4 - BMP Network 3 Subcatchments 3C and 3D	***3A-PWQ1-4 (combined)*** **Network 3 (Subcatchment 3C & 3D)**			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	131.7*	124.26	12.92	**10%**
	TSS (lb/yr)	73,905*	43,545	30,360	**41%**
	Volume (acre-feet/yr)	150.51*	150.51	0	**0%**
	Number of BMP's	4 PRINSCO WZU6040 Type Units			
	BMP Size/Description	Four Prinsco units installed to capture lateral stormsewer lines throughout the Network			
Cost	**Design/Engineering**	$32,000			
	Probable Project Cost	$300,000			
	Annual O&M	$2,500			
	20-yr Cost/lb-TP/yr	$1,478			
	20-yr Cost/2,000lb-TSS/yr	$1,258			

*Network 3A includes inputs from Networks 3B, 3C and 3D. Existing load assumes installed DSBB at Nuevas Fronteras and Prinsco Unit at Public Works that specifically target Networks 3B, 3C and 3D.

Subcatchment 3B



Map 15: Network 3 Subcatchment 3B

Subcatchment 3B is located east of the BNSF railroad and outlet to Subcatchment 3A via an underground sewer at 7th Street. Subcatchment 3B is 29.54 acres.

	Existing Conditions Network 3 Subcatchment 3B	Base Loading	Existing Treatment	Net Treatment %	Existing Loading	Avg Loading per acre	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	26.54	0	0%	26.54	**0.90**	**n/a**
	Filterable P (lb/yr)	7.73	0	0%	7.73	**0.26**	**n/a**
	TSS (lb/yr)	10,267	0	0%	10,267	**348**	**5,717**
	Volume (acre-feet/yr)	14.22	0	0%	14.22	**0.48**	**n/a**
	Number of BMP's	None Identified					
	BMP Size/Description	None Identified					

Public Works Underground Device (3B-PWQ1)

Drainage Area – 29.54 acres
Location – Between Railroad and Public Works Facility
Property Ownership – Public

TSS Rank
7 of 22

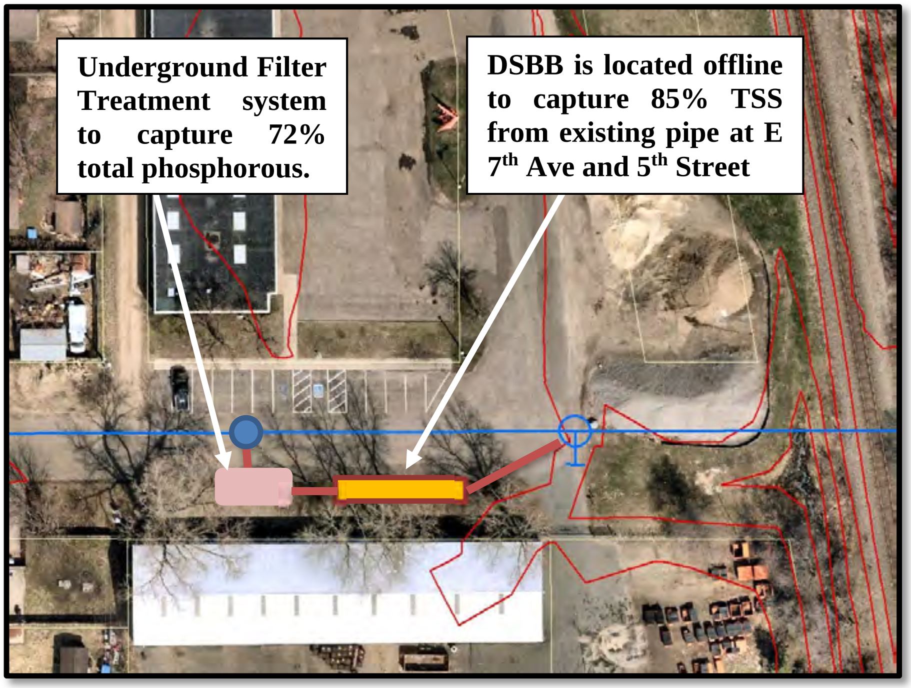
The PRINSCO WQ6040 is a 40 foot long, 60 inch underground treatment device with internal baffles that trap sediment and floatables. Each unit has a sediment storage capacity area of 375.9 Cubic Feet. Storage is effective to 20% of fill capacity, so each unit is assumed to have an actual capacity of 75.9 cubic feet of effective capture. Units installed offline in road rights of way would be placed to maximize potential capture along main stormsewer lines, each capturing the full 75.9 cubic feet of sediment, assuming cleanout on an annual basis. These units would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 75.9 cubic feet over 5 years produced an estimated reduction of 3.23 lbs/yr of total phosphorous.

	BMP BENEFIT / COST ESTIMATE 3B-PWQ1 - BMP Network 3 Subcatchment 3B	***3B-PWQ1*** Network 1 (Subcatchment 1D)			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	26.54	24.68	3.23	12%
	TSS (lb/yr)	10,267	2,317	7,950	77%
	Volume (acre-feet/yr)	14.22	14.22	0.0	0%
	Number of BMP's	One PRINSCO WZU6040 Type Unit			
	BMP Size/Description	40 foot by 60” PRINSCO Underground treatment chamber to capture 7,950 lb/yr TSS and associated TP			
Cost	Design/Engineering	$20,000			
	Probable Project Cost	$72,000			
	Annual O&M	$500			
	20-yr Cost/lb-TP/yr	$1,579			
	20-yr Cost/2,000lb-TSS/yr	$1,283			

Public Works Underground Device (3B-LUD1 (FP alt))

Drainage Area – 29.54 acres
Location – Between Railroad and Public Works Facility
Property Ownership – Public

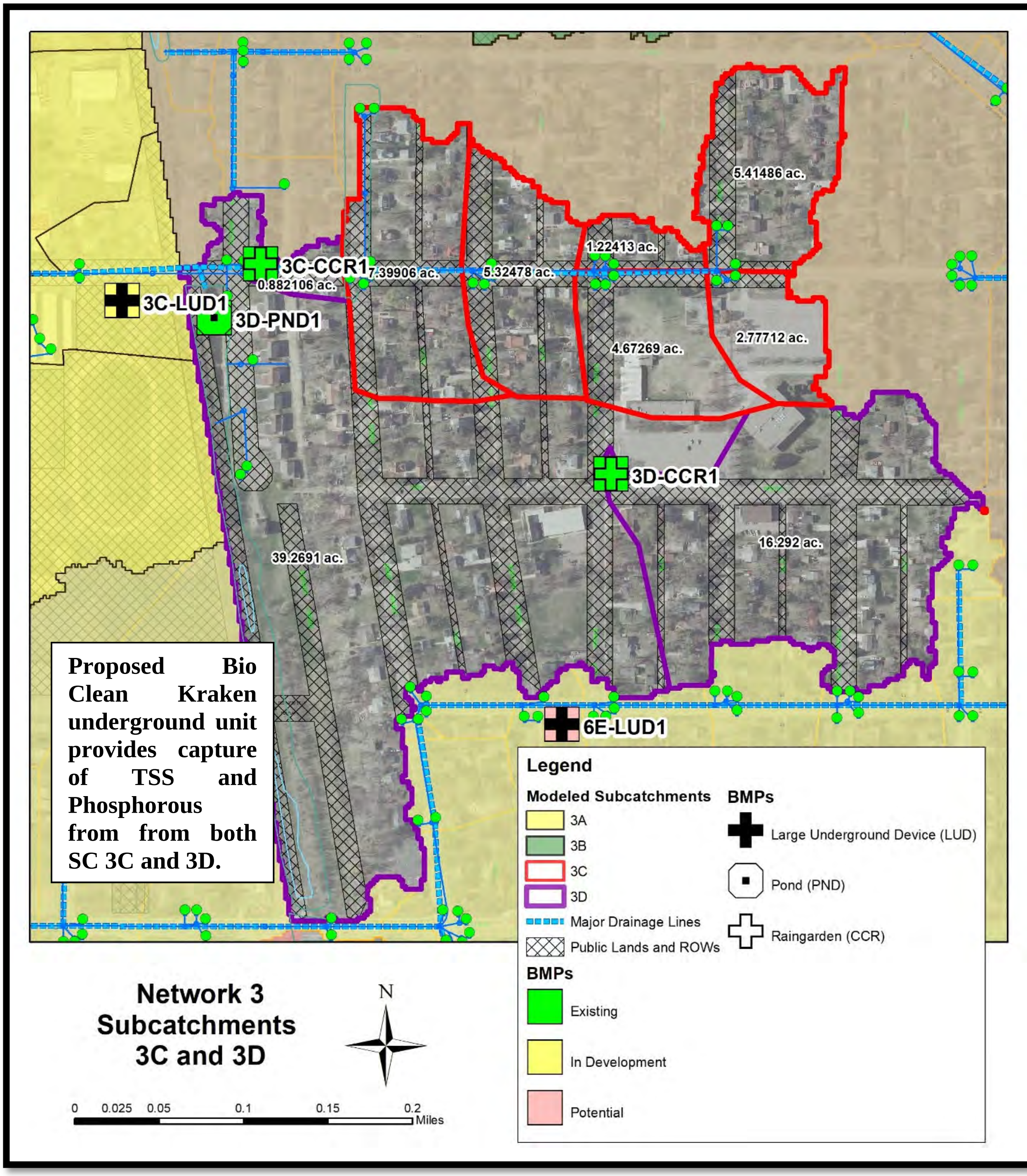
TSS Rank
19 of 12



3B-LUD1 is a Bio Clean Kraken filter system combined with Dual Stage Hydrodynamic Separator (BioClean DSBB). These units installed together provide a high level of both TSS and TP treatment. The combined units are modeled to provide 85% treatment of TSS and 72% of TP. The combined TSS and filtration unit substantially reduce loading from Network 3B to Network 3A located west of the BNSF railroad tracks. Placement of this unit near the public works facility provides nearby cleanout and monitoring and would be located away from residences.

	BMP BENEFIT / COST ESTIMATE 3B-PWQ1 - BMP Network 3 Subcatchment 3B	*3B-LUD1 (FP alt*			
		Network 1 (Subcatchment 1D)			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	26.54	4.86	21.68	72%
	TSS (lb/yr)	10,267	1,925	8,342	85%
	Volume (acre-feet/yr)	14.22	14.22	0.0	0%
	Number of BMP's	Two Devices: One DSBB (TSS) and One Kraken Filter (TP)			
	BMP Size/Description	Underground TSS filter to capture 85% of TSS and Soluble Filter captures 72% of Filterable P, providing for 85% TP capture			
Cost	Design/Engineering	$25,000			
	Probable Project Cost	$400,000			
	Annual O&M	$10,000			
	20-yr Cost/lb-TP/yr	$1,441			
	20-yr Cost/2,000lb-TSS/yr	$7,492			

Subcatchments 3C and 3D



Map 16: Network 3 Subcatchment 3C and 3D

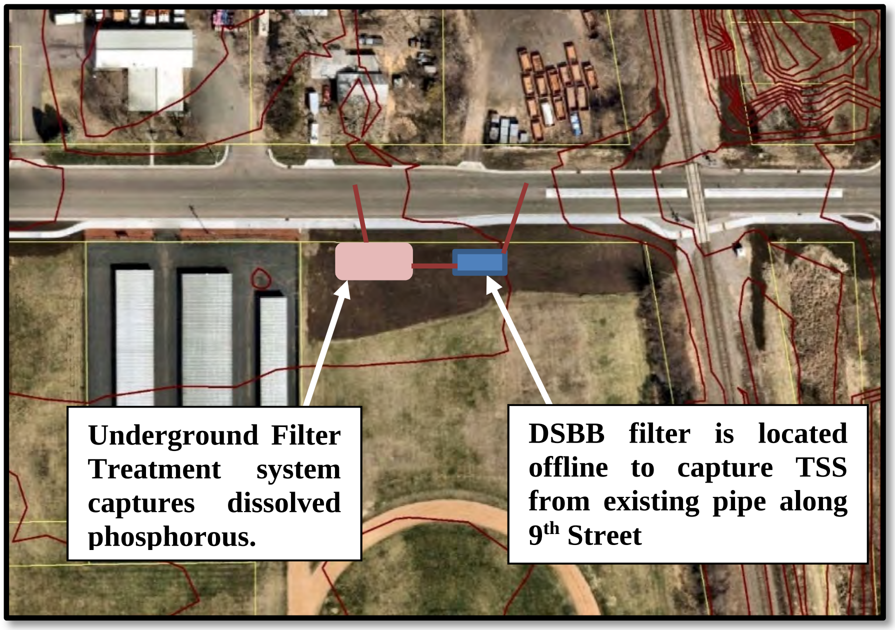
Subcatchments 3C and 3D are both located east of the BNSF railroad and outlet to Subcatchment 3A via an underground sewer at the 9th Street railroad crossing. The combined area of the Subcatchments is 83.27 acres. Subcatchment 3C is fully captured within the 9th street sewer and catchbasin network prior to the railroad crossing. Subcatchment 3D contains two curbcut raingardens (one small residential and one large institutional). The outlet of the Subcatchment is treated in a wet pond located along and within the BNSF railroad ditch. The combined BMPs within the two subcatchments provide sufficient treatment to capture TSS to the TMDL target. However, opportunities to further capture and treat stormwater for TSS and Phosphorous exist on public/school property along the stormsewer along 9th Street. During the course of this study, the Watershed District installed a combined Soluble Filter (BioClean Kraken) and Dual Stage Biodynamic Separator (BioClean DSBB) on public school property. This additional treatment removes greater than 93% of TSS and TP loading into the 3A stormsewer system. This sytem is included below as 3C-LUD1.

	Existing Conditions Network 3 Subcatchment 3c and 3D	**Base Loading**	**Existing Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	75.57	50.28	66.53%	25.29	**0.3**	**n/a**
	Filterable P (lb/yr)	18.81	12.69	67.47%	6.12	**0.07**	**n/a**
	TSS (lb/yr)	30,362	19,450	64.06%	10,912	**131**	**-1,915**
	Volume (acre-feet/yr)	43.43	26.46	60.99%	16.97	**0.2**	**n/a**
	Number of BMP's	1 Existing Pond, 2 Curb Cut Raingardens					
	BMP Size/Description						

Nuevas Fronteras Large Underground Device (3C-LUD1)

Drainage Area – 83.27 acres
Location – South of Ninth Street at Nuevas Fronteras School Yard
Property Ownership – Public

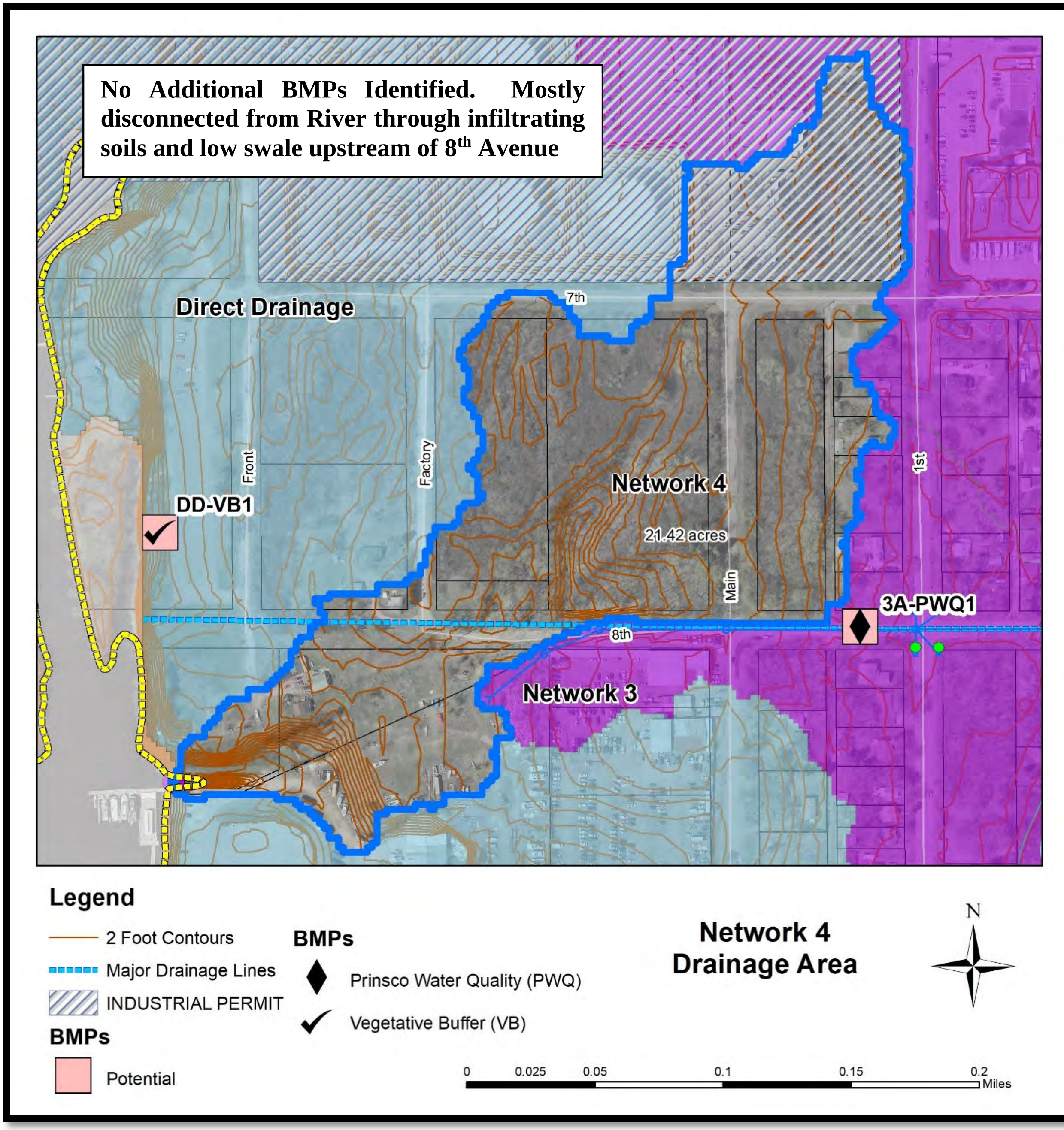
TSS Rank
12 of 22



3C-LUD1 is a Bio Clean Kraken filter system combined with Dual Stage Hydrodynamic Separator. These units were installed during the course of this study. The combined units are modeled to provide 85% treatment of TSS and 72% of TP. The combined TSS and filtration unit substantially reduce loading from Networks 3C and 3D to Network 3A located west of the BNSF railroad tracks. Combined with existing Wet Pond immediately east of the railroad, and a raingarden at 9th Street and pleasant Avenue, this combined treatment captures 93% of TSS load and 94% of Total Phosphorus load from Networks 3C and 3D as modeled in WinSLAMM.

	BMP BENEFIT / COST ESTIMATE ***3C-LUD1 - BMP*** ***Network 3*** ***Subcatchments 3C and 3D***	***3C-LUD1*** **Network 3 (Subcatchment 3C & 3D)**			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	25.29	4.59	20.7	**72%**
	TSS (lb/yr)	30,362	2,088	28,274	**85%**
	Volume (acre-feet/yr)	17.18	17.18	0	**0%**
	Number of BMP's	2 combined devices			
	BMP Size/Description	Bio Clean DSBB and Kraken filters in combination provide TSS removal and protection for Kraken filters which provide FP and TP capture			
Cost	**Design/Engineering**	$25,000			
	Probable Project Cost	$400,000			
	Annual O&M	$12,000			
	20-yr Cost/lb-TP/yr	$1,606			
	20-yr Cost/2,000lb-TSS/yr	$2,352			

Catchment Drainage Network 4



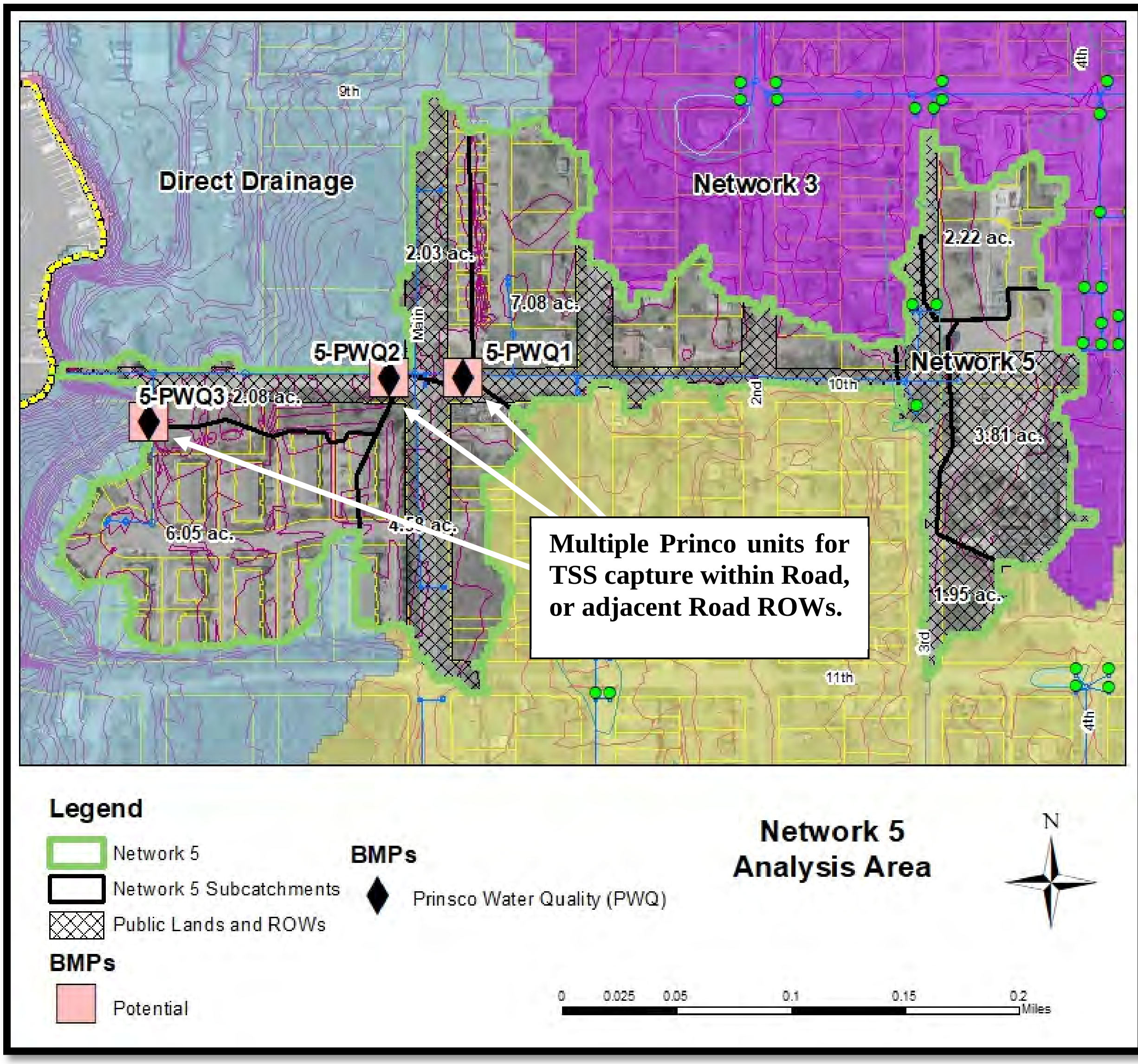
Map 17: Network 4

CATCHMENT DRAINAGE NETWORK 4 DESCRIPTION

Catchment drainage network 4 is 21.4 acres comprised of a single catchment. The dominant land cover is forested with a road network dividing the wooded lots. A small area of industrial land is located at the top of the watershed, and long, unmown grasses dominated the lower portions of the watershed with scattered gravel roads. There are no stormwater ponds or any other water treatment practices located within the network. As modeled, the TSS loading in the network is well below the Mississippi TMDL TSS goal. As the network develops, opportunities may arise for stormwater retention and treatment. At present, no practices are identified for this network.

	Existing Conditions	**Base Loading**	**Existing Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	3.27	0.0	0%	3.27	**0.15**	**n/a**
	TSS (lb/yr)	1,459	0.0	0%	1,459	**68.18**	**-1,837**
	Volume (acre-feet/yr)	2.1	0.0	0%	2.1	**0.1**	**n/a**
	Number of BMP's	none					
	BMP Size/Description	none					

Catchment Drainage Network 5



Map 18 Network 5

CATCHMENT DRAINAGE NETWORK 5 DESCRIPTION

Catchment drainage network 5 is 29.8 acres comprised of five subcatchments. The dominant land cover is mixed single and multi-family residential with institutional (school) landuse dominating the upper reach. There are no stormwater ponds or any other water treatment practices located within the network.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading	Avg Loading per acre	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	36.39	0	0%	36.39	**1.2**	**n/a**
	TSS (lb/yr)	13,669	0	0%	13,669	**459**	**9,059**
	Volume (acre-feet/yr)	21.11	0	0%	21.11	**0.7**	**n/a**
	Number of BMP's	None Present					
	BMP Size/Description	None Present					

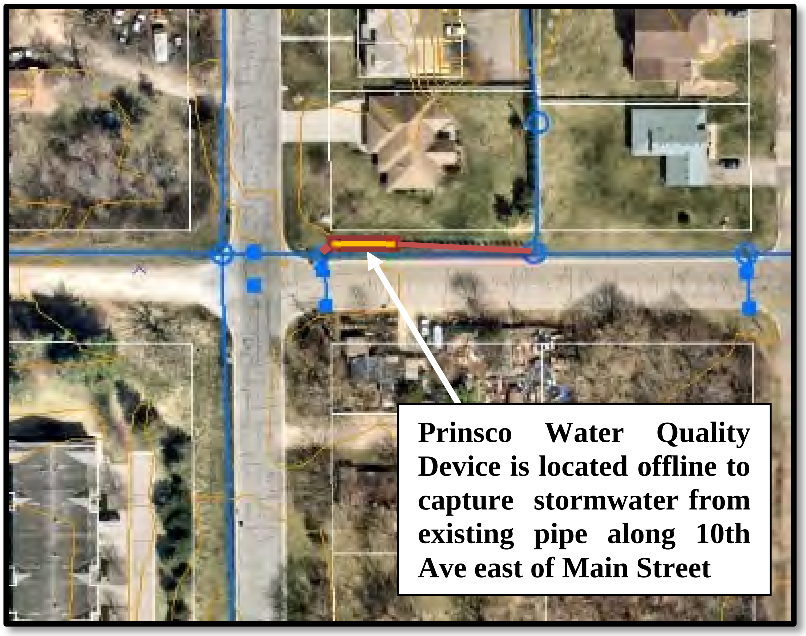
Catchment Drainage Network 5 Potential BMPs

Three potential BMPs are identified in Subcatchment 5. The Prinsco Water Quality units are recommended for this catchment as relatively small, inexpensive and shallow units that can be installed offline and parallel to existing storm sewer networks in narrow Rights-of-Ways. Installing along a main trunk line before and after input locations offers opportunities to capture TSS in multiple locations along a run. Unit sizes were identified using product literature to the highest potential load or to exceed modelled loading levels.

10th Avenue Unit 1 (5-PWQ1)

TSS Rank
11 of 22

Drainage Area – 15.05 acres
Location – ROW North Side of 10 Street Immediately East of Main Street
Property Ownership – Public



The PRINSCO WQ6040 is a 40 foot long, 60 inch underground treatment device with internal baffles that trap sediment and floatables. Each unit has a sediment storage capacity area of 375.9 Cubic Feet. Storage is effective to 20% of fill capacity, so each unit is assumed to have an actual capacity of 75.9 cubic feet of effective capture. Product reporting indicates TSS removal efficiency rates exceeding 80% in all events below 1.2 cfs. This Unit could be installed offline in road rights of way and placed to maximize potential capture along the main stormsewer line under 10th Avenue. The storage capacity of 75.9 cubic feet of sediment, assuming cleanout on an annual basis is estimated at 7,590 lbs, and exceeds the 6,795 load modeled in WnSlamm. At 80% efficiency, the unit would capture 5,436 assuming regular losses per event. This unit would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 75.9 cubic feet over 5 years produced an estimated reduction of 3.23 lbs/yr of total phosphorous.

	BMP BENEFIT / COST ESTIMATE 3B-PWQ1 - BMP Network 3 Subcatchment 3B	*5B-PWQ1* Network 1 (Subcatchment 1D)			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	14.87	13.01	2.31	15.5%
	TSS (lb/yr)	6,795	0	5,436	80%
	Volume (acre-feet/yr)	10.7	10.7	0.0	0%
	Number of BMP's	One PRINSCO WZU6040 Type Unit			
	BMP Size/Description	40 foot by 60” PRINSCO Underground treatment chamber to capture 80% TSS and associated TP			
Cost	Design/Engineering	$20,000			
	Probable Project Cost	$75,000			
	Annual O&M	$600			
	20-yr Cost/lb-TP/yr	$2,316			
	20-yr Cost/2,000lb-TSS/yr	$1,968			

10th Avenue Unit 2 (5-PWQ2)

Drainage Area – 6.6 acres
Location – ROW North Side of 10 Street Immediately Westt of Main Street
Property Ownership – Public

TSS Rank
16 of 12

The PRINSCO WQ4820 is a 20 foot long, 48 inch underground treatment device with internal baffles that trap sediment and floatables. Each unit has a sediment storage capacity area of 119.3 Cubic Feet. Storage is effective to 20% of fill capacity, so each unit is assumed to have an actual capacity of 23.86 cubic feet of effective capture. This unit could be installed within the gravel drive, or within right—of-way north or south of the road. Bedrock is shallow in this location, but tends to be relatively friable and soft. The storage capacity of 23.86 cubic feet of sediment, assuming cleanout on an annual basis is estimated at 2,386 lbs, and exceeds the 2,325 lbs/yr load modeled in WnSlamm. At 80% efficiency, the unit would capture 1,860 lbs/yr assuming regular losses per event. This unit would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 18.60 cubic feet over 5 years produced an estimated reduction of 0.79 lbs/yr of total phosphorous.

	BMP BENEFIT / COST ESTIMATE 3B-PWQ1 - BMP Network 3 Subcatchment 3B	***5B-PWQ1***			
		Network 1 (Subcatchment 1D)			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	5.83	5.04	.79	14%
	TSS (lb/yr)	2,325	465	1,860	80%
	Volume (acre-feet/yr)	3.9	3.9	0.0	0%
	Number of BMP's	One PRINSCO WZ4820 Type Unit			
	BMP Size/Description	20 foot by 48” PRINSCO Underground treatment chamber to capture 100% TSS and associated TP			
Cost	**Design/Engineering**	$12,000			
	Probable Project Cost	$65,000			
	Annual O&M	$500			
	20-yr Cost/lb-TP/yr	$5,506			
	20-yr Cost/2,000lb-TSS/yr	$4,677			

10th Avenue Unit 3 (5-PWQ3)

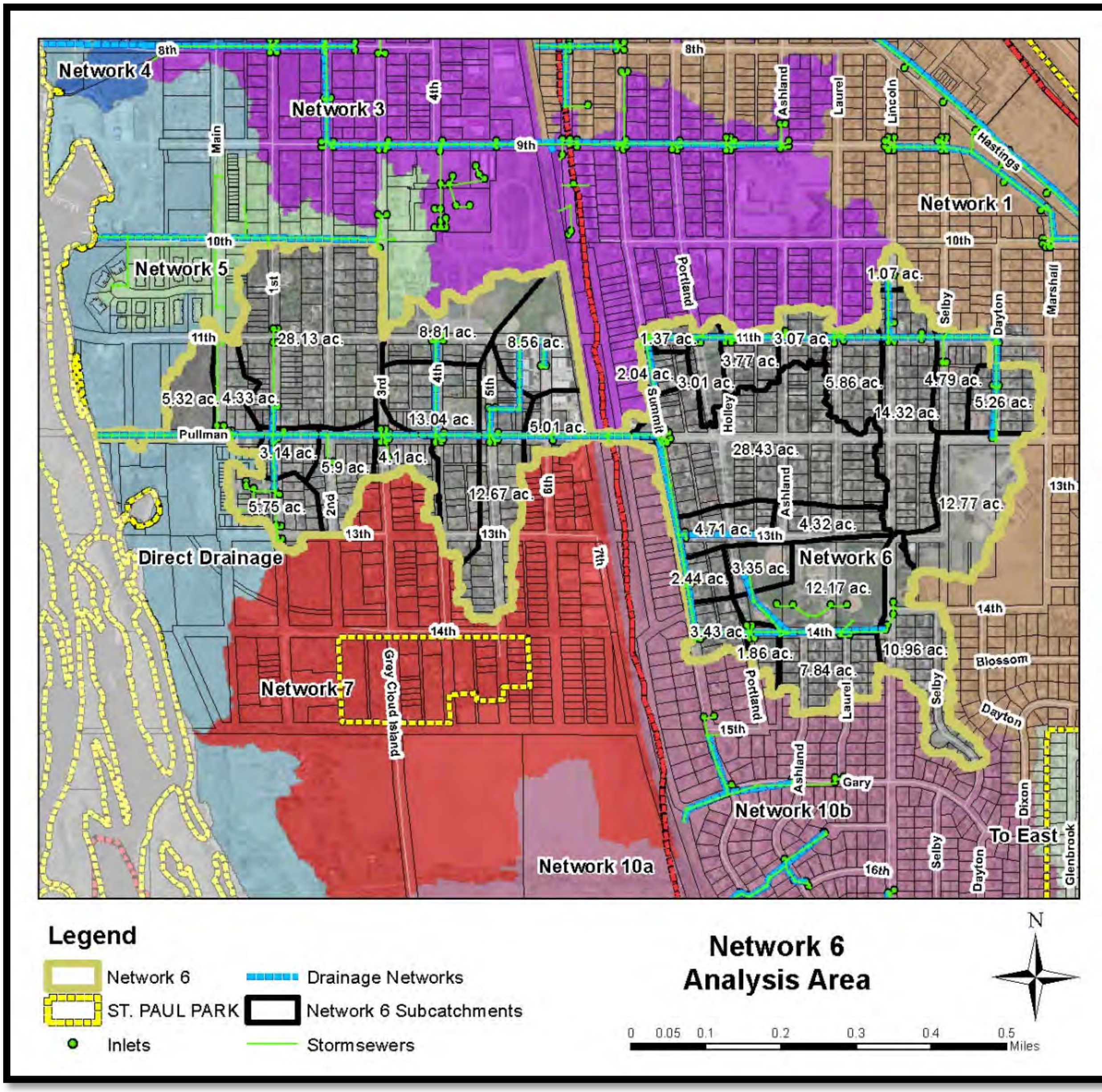
Drainage Area – 6.05 acres
Location – ROW South Side of the west end of 10 Street
Property Ownership – Public with small area of private for connection

TSS Rank
14 of 12

The PRINSCO WQ4820 is a 20 foot long, 48 inch underground treatment device with internal baffles that trap sediment and floatables. Each unit has a sediment storage capacity area of 119.3 Cubic Feet. Storage is effective to 20% of fill capacity, so each unit is assumed to have an actual capacity of 23.86 cubic feet of effective capture. This unit could be installed within the gravel drive, or within right—of-way north or south of the road. Bedrock is shallow in this location, but tends to be relatively friable and soft. The storage capacity of 23.86 cubic feet of sediment, assuming cleanout on an annual basis is estimated at 2,386 lbs, and 93% the 2,325 lbs/yr load modeled in WnSlamm. Assuming 80% efficiency, the unit would capture 2,045 lbs/yr assuming regular losses per event. This unit would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 20.45 cubic feet over 5 years produced an estimated reduction of 0.79 lbs/yr of total phosphorous.

	BMP BENEFIT / COST ESTIMATE 3B-PWQ1 - BMP Network 3 Subcatchment 3B	*5B-PWQ1*			
		Network 1 (Subcatchment 1D)			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	5.75	4.88	0.87	15%
	TSS (lb/yr)	2,556	511	2,045	80%
	Volume (acre-feet/yr)	5.2	5.2	0.0	0%
	Number of BMP's	One PRINSCO WZ4820 Type Unit			
	BMP Size/Description	20 foot by 48" PRINSCO Underground treatment chamber to capture 100% TSS and associated TP			
Cost	Design/Engineering	$12,000			
	Probable Project Cost	$65,000			
	Annual O&M	$500			
	20-yr Cost/lb-TP/yr	$5,000			
	20-yr Cost/2,000lb-TSS/yr	$4,254			

Catchment Drainage Network 6



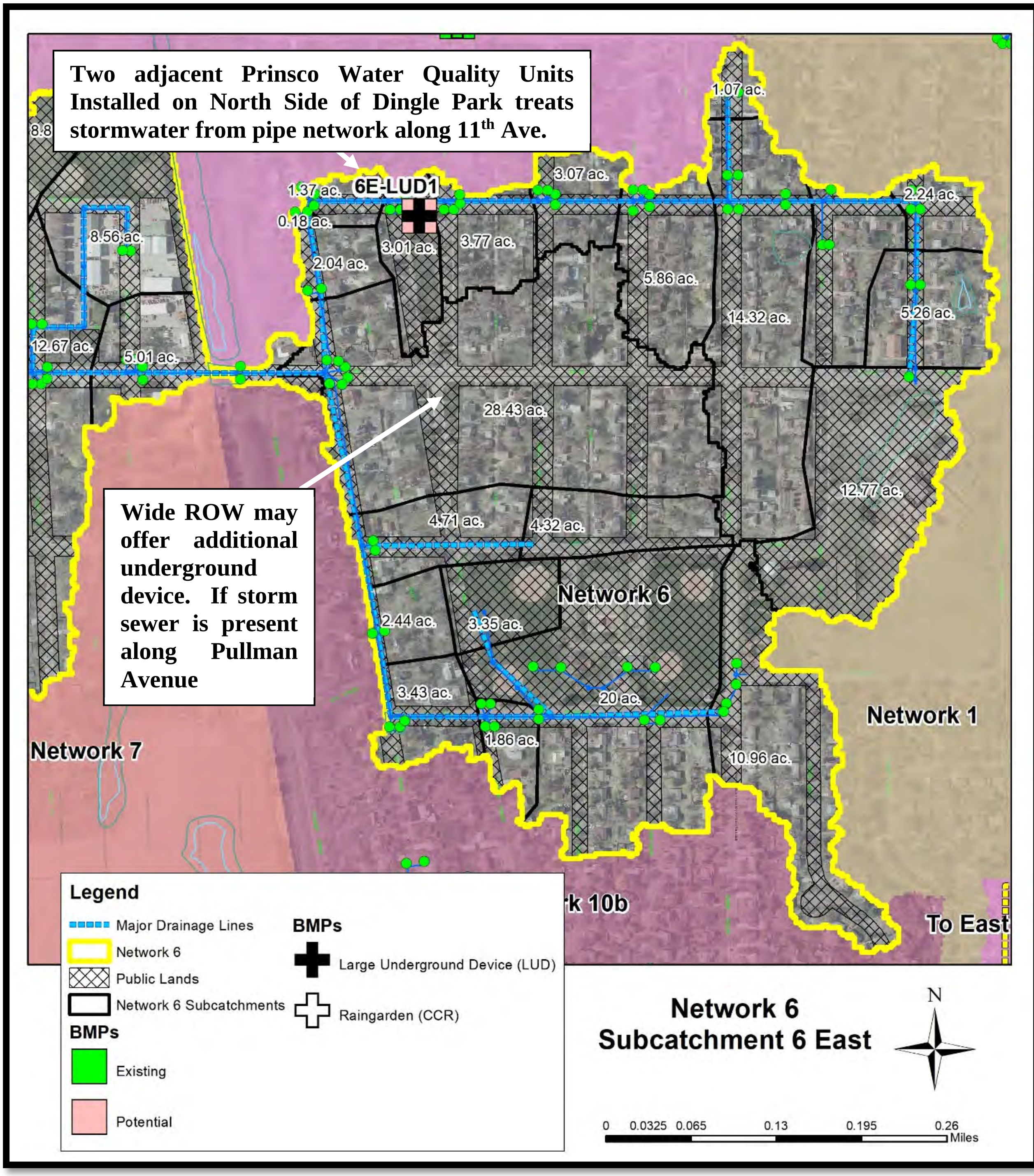
Map 19: Network 6

CATCHMENT DRAINAGE NETWORK 6 DESCRIPTION

Catchment drainage network 6 is 239.7 acres comprised of 34 minor subcatchment areas two major subcatchments divided by the BNSF rail corridor. The dominant land cover is mixed single and multi-family residential with scatters school, park and industrial landuses throughout. There are no stormwater ponds or any other water treatment practices located within the network. In order to meet the TMDL goal for TSS loading to the Mississippi River, an additional 193 lbs/yr of TSS would need to be captured within this Drainage Network.

	Existing Conditions Network 3	**Base Loading**	**Existing Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	180.6	0	0%	180.6	**0.75**	**n/a**
	TSS (lb/yr)	83,080	0	0%	83,080	**347**	**46,262**
	Volume (acre-feet/yr)	128.08	0	0%	128.08	**0.53**	**n/a**
	Number of BMP's	None noted					
	BMP Size/Description	No Treatment Practices have been identified within the network					

Subcatchment 6 East

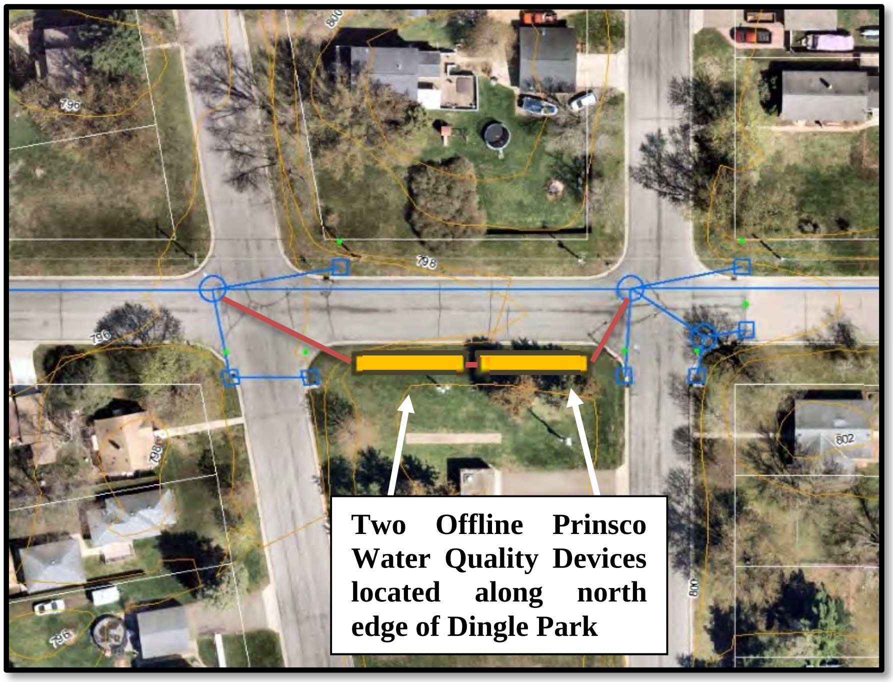


Map 20: Network 6 Subcatchment 6 East

Dingle Park Underground Sediment Units (6E-PWQ1)

Drainage Area – 40.38 acres
Location – North Side Dingle Park along 11th Avenue
Property Ownership – Public

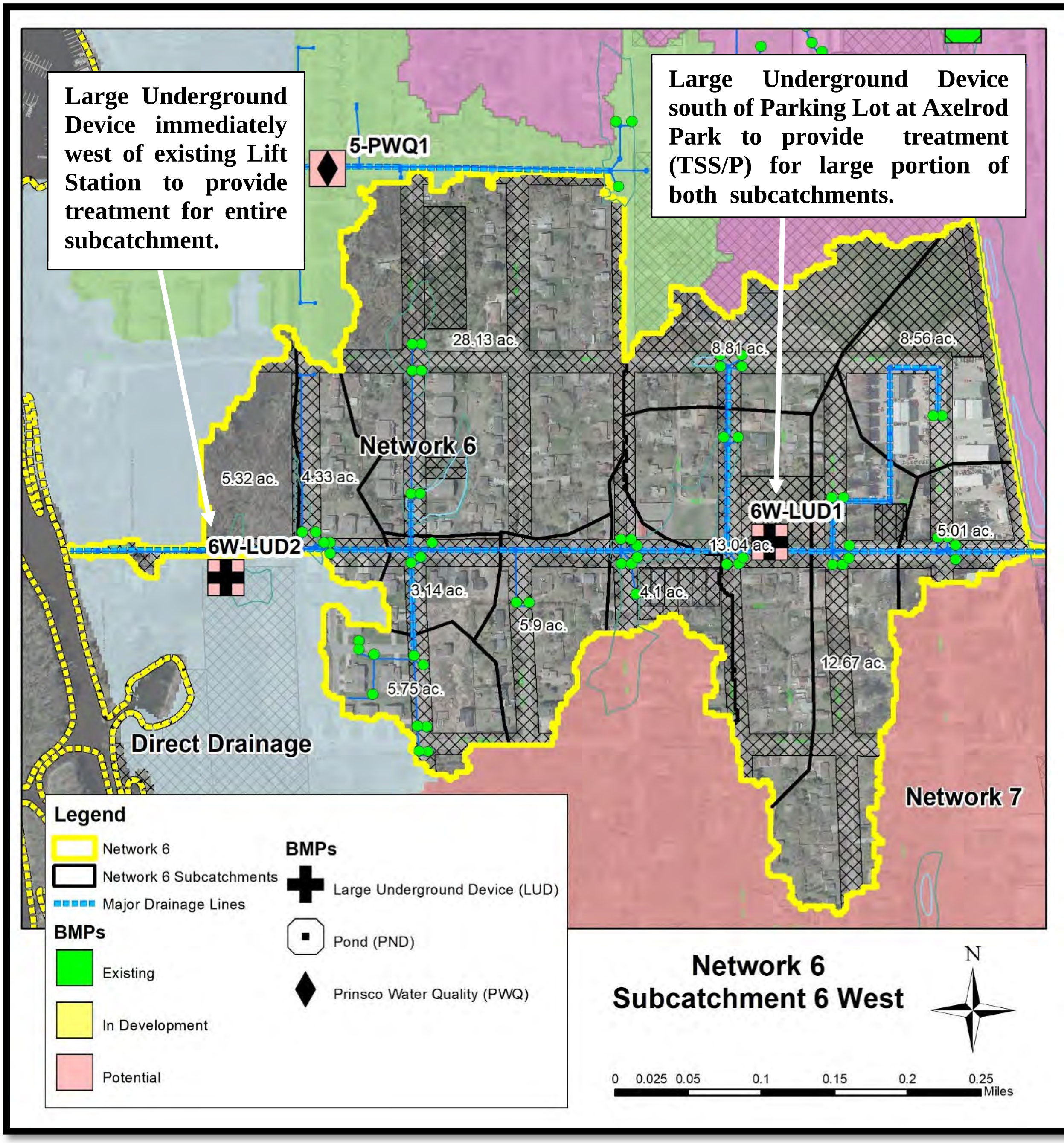
TSS Rank
8 of 22



The PRINSCO WQ6040 is a 40 foot long, 60 inch underground treatment device with internal baffles that trap sediment and floatables. Each unit has a sediment storage capacity area of 375.9 Cubic Feet. Storage is effective to 20% of fill capacity, so each unit is assumed to have an actual capacity of 75.9 cubic feet of effective storage before requiring cleanout. Product reporting indicates TSS removal efficiency rates exceeding 80% in all events below 1.2 cfs. Two units could be installed at the north end of Dingle Park, each capturing the full 75.9 cubic feet of sediment on an annual basis. The storage capacity of 151.80 cubic feet of sediment for the combined units, assuming cleanout on an annual basis is estimated at 15,180 lbs/yr, exceeding the 14,904 lbs modeled. Assuming 80% efficiency, the unit would capture 12,144 lbs/yr assuming regular losses per event. This unit would not target dissolved phosphorus, but the BWSR Pollution Reduction Estimator for Phosphorous associated with 121.44 cubic feet over 5 years produced an estimated reduction of 0.79 lbs/yr of total phosphorous.

	BMP BENEFIT / COST ESTIMATE 6E-PWQ1 - BMP Network 6 East Subcatchment 6 East	*6E-PWQ1*			
		Subcatchment 6 East			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	36.61	31.45	5.16	**14%**
	TSS (lb/yr)	14,904	0	12,144	**80%**
	Volume (acre-feet/yr)	19.5	19.5	0	**0%**
	Number of BMP's	2 combined devices			
	BMP Size/Description	Two Prinsco WQ6040 devices inline along the north edge of Dingle Park			
Cost	**Design/Engineering**	$25,000			
	Probable Project Cost	$120,000			
	Annual O&M	$1,200			
	20-yr Cost/lb-TP/yr	$1,638			
	20-yr Cost/2,000lb-TSS/yr	$1,392			

Subcatchment 6 West



Map 21: Network 6 Subcatchment 6 West

TSS Rank
3 of 12

Axelrod Park Large Underground Device (6W-LUD1)

Drainage Area – 165.31 acres
Location – South Side of Axelrod Park along Pullman Avenue
Property Ownership – Public

6W-LUD1 is proposed as an underground BMP that provides sediment capture. Vortechs underground treatment chamber is a typical type device. The unit is modeled to provide 80% treatment of TSS. This device in the middle reach of Network 6 could provide substantial benefit to any additional treatment systems located downstream as TSS reduction would reduce loads on subsequent devices.

	BMP BENEFIT / COST ESTIMATE 6W-LUD1 - BMP Network 6 West	*6W-LUD1*			
		Network 6 West			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	168.4	134.72	33.68	**20%**
	TSS (lb/yr)	69,559	13,912	55,647	**80%**
	Volume (acre-feet/yr)	105.51	105.51	0	**0**
	Number of BMP's	1 Biodynamic Separator			
	BMP Size/Description	Vortechs Sediment Capture underground BMP or similar			
Cost	Design/Engineering	$35,000			
	Probable Project Cost	$350,000			
	Annual O&M	$1,200			
	20-yr Cost/lb-TP/yr	$607			
	20-yr Cost/2,000lb-TSS/yr	$735			

Axelrod Park Large Underground Device – Enhance P Alternative (6W-LUD1)

Drainage Area – 160.82 acres
Location – South Side of Axelrod Park along Pullman Avenue
Property Ownership – Public

TSS Rank
9 of 12

An alternative treatment system at 6W-LUD1 would include a Bio Clean Kraken filter system combined with Dual Stage Hydrodynamic Separator or similar - device. The unit will provide 85% treatment of TSS with an additional 70% treatment of soluble P using filtration.

	BMP BENEFIT / COST ESTIMATE 6W-LUD1 – BMP – Enhanced P Network 6 West	***6W-LUD1 – BMP – Enhanced P Alt*** **Network 6 West**			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	168.4	25.3	143.1	**70**
	TSS (lb/yr)	69,559	10,434	59,125	**85**
	Volume (acre-feet/yr)	105.51	105.51	0	**0**
	Number of BMP's	2 combined devices			
	BMP Size/Description	Bio Clean DSBB and Kraken filters in combination provide TSS removal and protection for Kraken filters which provide FP and TP capture			
Cost	**Design/Engineering**	$35,000			
	Probable Project Cost	$550,000			
	Annual O&M	$12,000			
	20-yr Cost/lb-TP/yr	$288			
	20-yr Cost/2,000lb-TSS/yr	$1,395			

Pullman and Main Street Large Underground Device (6W-LUD2)

Drainage Area – 240 acres
Location – Southwest of intersection of Pullman Avenue and Main Steet
Property Ownership – Public

TSS Rank 2 of 12

6W-LUD2 is proposed as an underground BMP that provides sediment capture from the main stormsewer network along Pullman Avenue. Vortechs underground treatment chamber is a typical type device. The unit is modeled to provide 80% treatment of TSS. This device would be located to capture and treat TSS near the outlet to the Mississippi River. Sizing would depend on whether a device at Axelrod Park is installed or is a likely to be installed. A feature of this site is that it has the potential to be located within an existing low area, and could potentially require less excavation than the same device placed on flat ground. The device would require burial, but could be placed adjacent to the road and ground built up to meet site elevations.

	BMP BENEFIT / COST ESTIMATE 6W-LUD2 - BMP Network 6 West	***6W-LUD2***			
		Network 6 West			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	180.6	144.5	36.1	**20**
	TSS (lb/yr)	83,079	16,616	66,463	**80**
	Volume (acre-feet/yr)	126.3	126.3	0	**0**
	Number of BMP's	1 Biodynamic Separator			
	BMP Size/Description	Vortechs Sediment Capture underground BMP or similar			
Cost	**Design/Engineering**	$30,000			
	Probable Project Cost	$320,000			
	Annual O&M	$1,200			
	20-yr Cost/lb-TP/yr	$555			
	20-yr Cost/2,000lb-TSS/yr	$672			

Pullman and Main Large Underground Device - Enhance P Alternative (6W-LUD2)

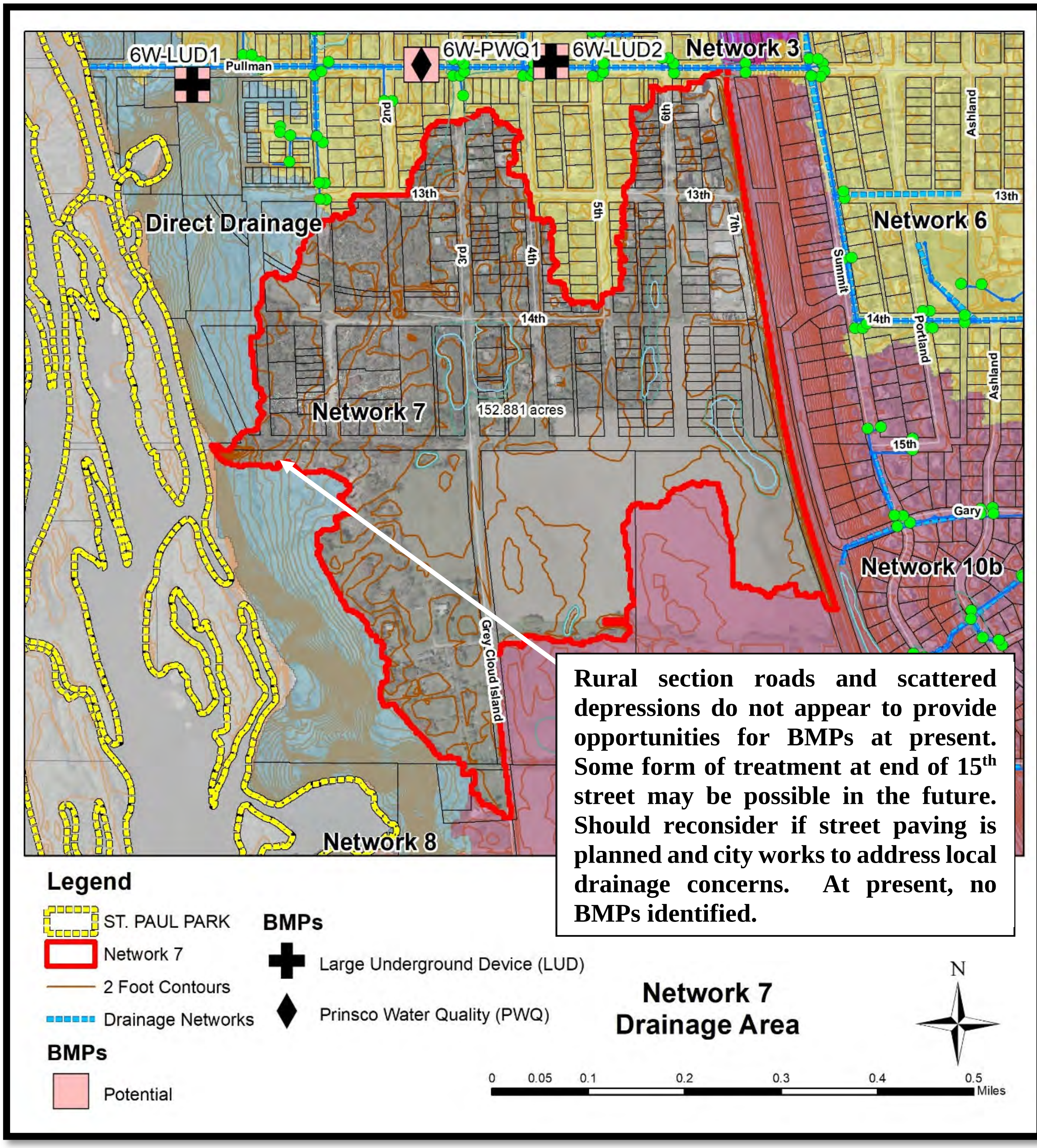
Drainage Area – 240 acres
Location – South Side of Axelrod Park along Pullman Avenue
Property Ownership – Public

TSS Rank
5 of 12

An alternative treatment system at 6W-LUD2 would include a Bio Clean Kraken filter system combined with Dual Stage Hydrodynamic Separator or similar device. The unit will provide 85% - treatment of TSS with an additional 70% treatment of soluble P using filtration.

	BMP BENEFIT / COST ESTIMATE 6W-LUD2 – BMP – Enhanced P Alt Network 6 West	***3C-LUD2 – Enhanced P Alt***			
		Network 6 West			
		Existing Loading to BMP Loc.	**With BMP**	**New treatment**	**Net %**
Treatment	**TP (lb/yr)**	180.6	54.2	126.4	**70**
	TSS (lb/yr)	83,079	12,462	70,617	**85**
	Volume (acre-feet/yr)	126.3	126.3	0	**0**
	Number of BMP's	2 combined devices			
	BMP Size/Description	Bio Clean DSBB and Kraken filters in combination provide TSS removal and protection for Kraken filters which provide FP and TP capture			
Cost	**Design/Engineering**	$35,000			
	Probable Project Cost	$600,000			
	Annual O&M	$12,000			
	20-yr Cost/lb-TP/yr	$346			
	20-yr Cost/2,000lb-TSS/yr	$1,239			

Catchment Drainage Network 7



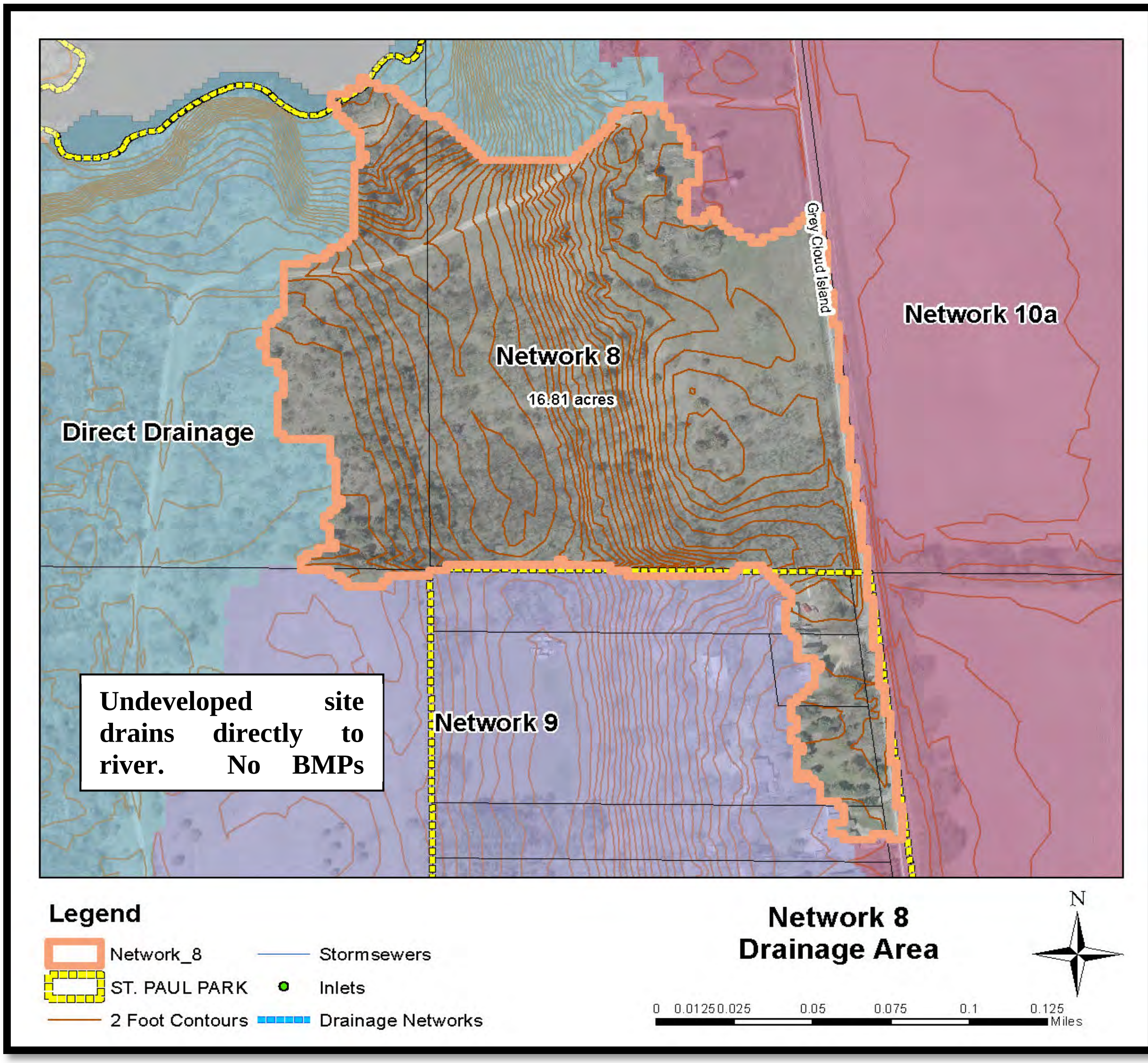
Map 22: Network 7

CATCHMENT DRAINAGE NETWORK 7 DESCRIPTION

Catchment drainage network 7 is 153 acres. Landcover within the network is a mix of single family residential with rural section, mostly gravel roads, tilled agriculture fields and woodlots. Automobile salvage yards dominate the areas within the woodlots in the western half of the Network. There is no stormwater infrastructure within the Network. Lots within the residential areas generally drain to back yards and infiltrate into well or excessively drained soils. As modeled, TSS loading in the network is 74 above the TMDL TSS goal. As development continues, with paved road infrastructure, opportunities to capture and treat stormwater will be instituted through the planning and permitting process. Drainage within the network is concentrated into a single outlet at the west end of 15th Avenue which should provide Network wide opportunities for treatment at the time of development. Identifying those opportunities at the time of development and design is ideal and reduces cost.

	Existing Conditions	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	81.42	0	0%	81.42	**0.53**	**n/a**
	TSS (lb/yr)	35,098	0	0%	35,098	**228**	**11,396**
	Volume (acre-feet/yr)	60.93	0	0%	60.93	**0.4**	**n/a**
	Number of BMP's	None Identified					
	BMP Size/Description	None Proposed at Present, Monitor New Development					

Catchment Drainage Network 8



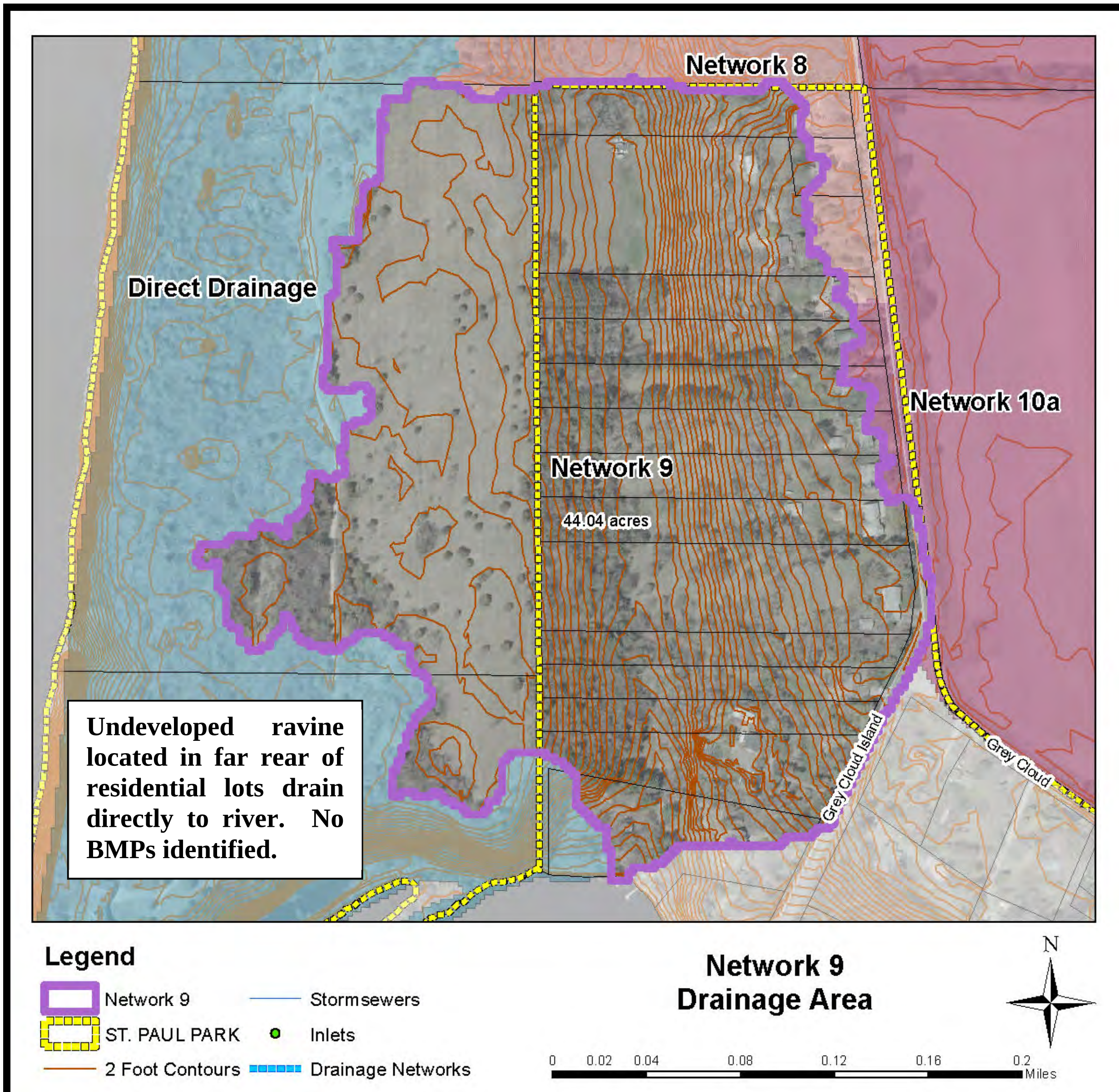
Map 23: Network 8

CATCHMENT DRAINAGE NETWORK 8 DESCRIPTION

Catchment drainage network 8 is 17 acres of largely undeveloped wooded and grassland setting. Excessively drained soils and predominance of perennial vegetation throughout the watershed do not warrant BMPs at this time. As modelled, the Network is well below the TMDL TSS target for loading to the Mississippi River.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading	Avg Loading per acre	Network Treatment needed to reach resource goal
Treatment	TP (lb/yr)	5.23	0	0%	5.23	**0.31**	**n/a**
	TSS (lb/yr)	2013	0	0%	2013	**120**	**-572**
	Volume (acre-feet/yr)	3.2	0	0%	3.2	**0.3**	**n/a**
	Number of BMP's	None Identified					
	BMP Size/Description	None Proposed					

Catchment Drainage Network 9



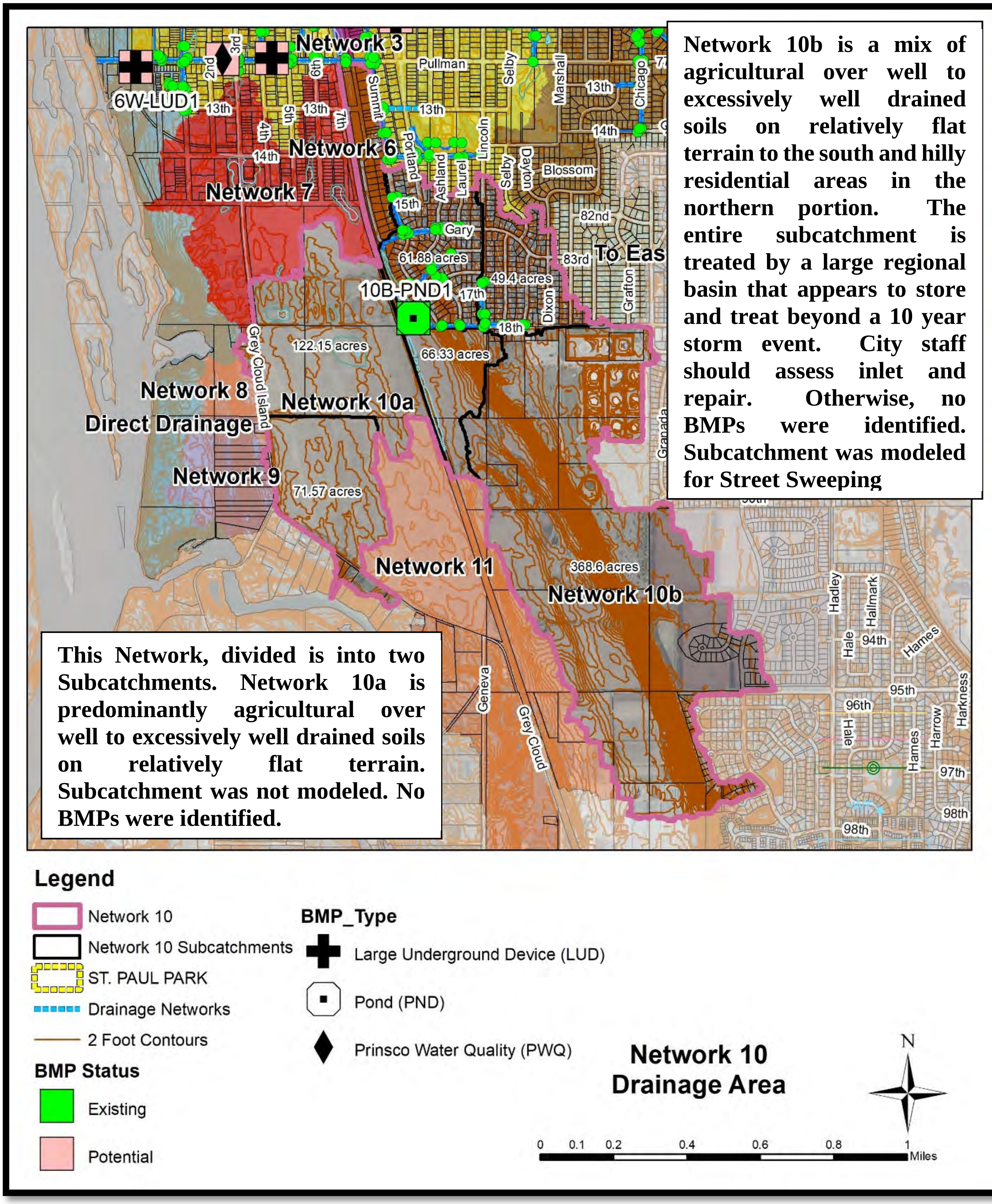
Map 24: Network 9

CATCHMENT DRAINAGE NETWORK 9 DESCRIPTION

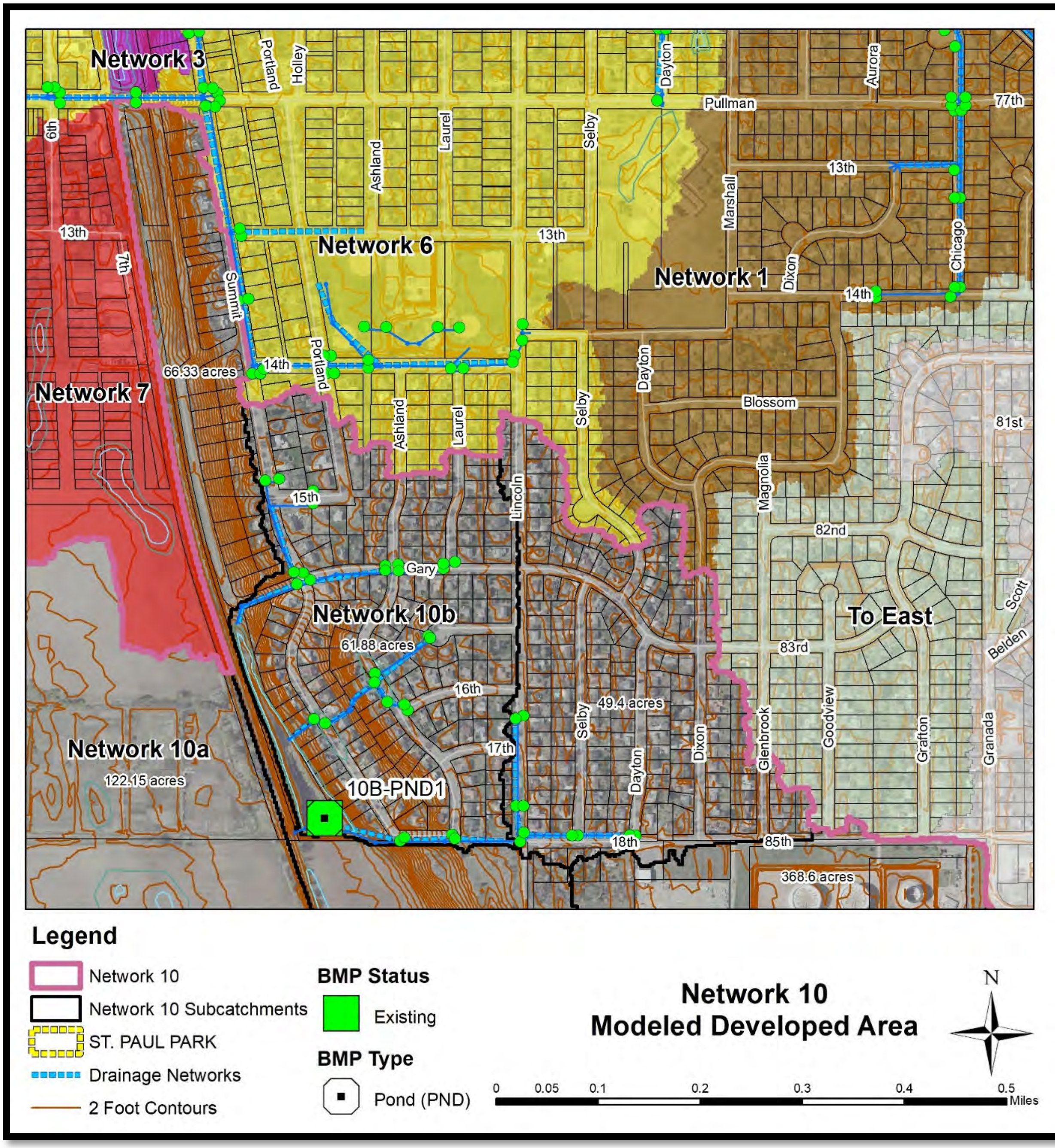
Catchment drainage network 9 is 44 acres of largely undeveloped wooded and grassland setting located within the back long linear lots. Given that the developed portions of the Network are located along Grey Cloud Island Drive, the excessively drained soils and predominance of perennial vegetation throughout the drainageways do not warrant additional BMPs at this time. As modelled, the Network is well below the TMDL TSS target for loading to the Mississippi River.

	Existing Conditions	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	13.7	0	0%	13.7	**0.31**	**n/a**
	TSS (lb/yr)	5273	0	0%	5273	**120**	**-572**
	Volume (acre-feet/yr)	8.35	0	0%	8.35	**0.19**	**n/a**
	Number of BMP's	None Identified					
	BMP Size/Description	None Proposed					

Catchment Drainage Network 10



Map 25: Network 10



Map 26: Network 10 Modeled Development Area

CATCHMENT DRAINAGE NETWORK 10 DESCRIPTION

Catchment drainage network 5 is 29.8 acres comprised of five subcatchments, three located east of the BNSF railroad, and two located west of the tracks. The three subcatchments east of the railroad drain to a single large stormwater pond (Stephens Pond) located at the end of 18th Avenue along the tracks. Approximately 350 of those acres are in tilled agriculture or woodlot and are largely disconnected from the pond. An industrial site, dominated by oil tank facilities is located at the top of the watershed, largely disconnected by undeveloped areas from the stormwater network. 110 acres of the site, dominated by single family residential, is treated by the Stephens Pond. As modeled, the TSS loading in from the residential area, combined with treatment provided by the existing pond is well below the Mississippi TMDL TSS goal. The pond appears to be sized appropriately, and downstream contributions are minimal at best. Pond cleanout has been recommended by the city engineer and costs associated with a cleanout were taken from engineer's recommendations.

Below the outlet on the west side of the railroad tracks, the land is entirely undeveloped and TSS loading is modeled well below the Mississippi TMDL target.

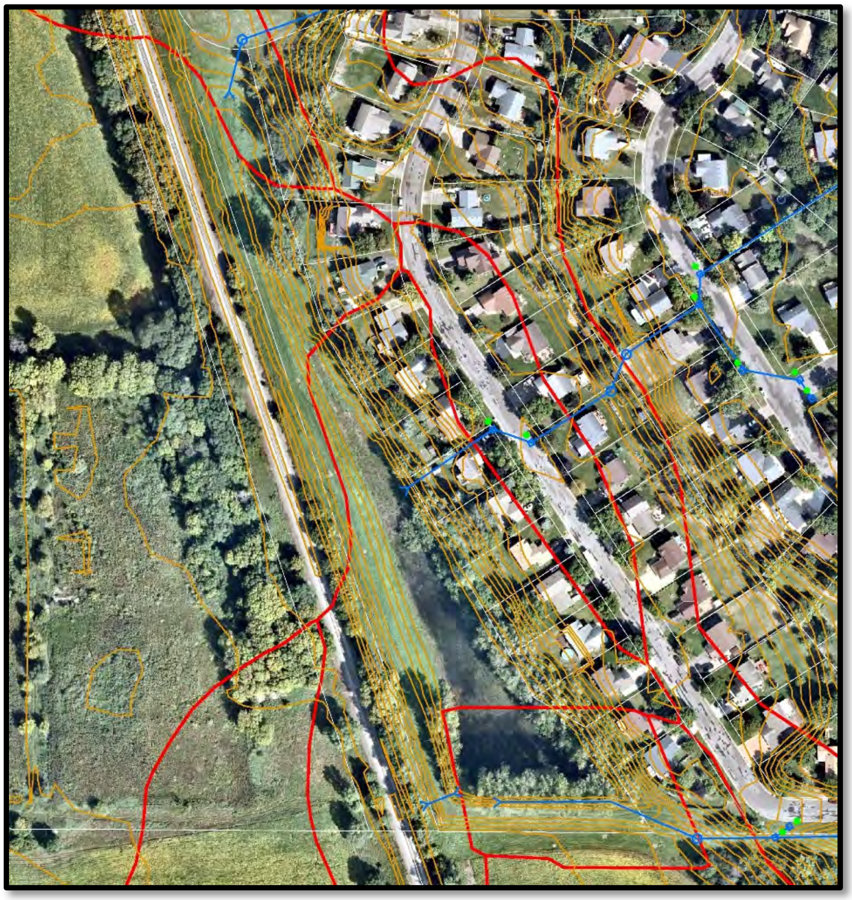
	Existing Conditions Neighborhood above Stephens pond	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	93.01	0	0%	32.82	**0.3**	**n/a**
	TSS (lb/yr)	34,908	0	0%	13,201	**119**	**-3,885**
	Volume (acre-feet/yr)	53.7	0	0%	48.5	**2.3**	**n/a**
	Number of BMP's	Large Detention Pond					
	BMP Size/Description	2.5 acre pond with approximately 6 feet of freeboard. Requires cleanout to ensure long term effectiveness.					

	Existing Conditions Undeveloped Lands below Pond	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	195.5	0	0%	195.5	**0.31**	**n/a**
	TSS (lb/yr)	75,269	0	0%	75,269	**120**	**-21,352**
	Volume (acre feet/yr)	120.8	0	0%	120.8	**0.2**	**n/a**
	Number of BMP's	None Identified					
	BMP Size/Description	None Proposed					

Pond Cleanout (10B-PND1)

Drainage Area – 111 acres
Location – East side of BNSF Railroad at the end of 18th Avenue
Property Ownership – Washington County Community Development Corp. (Public)

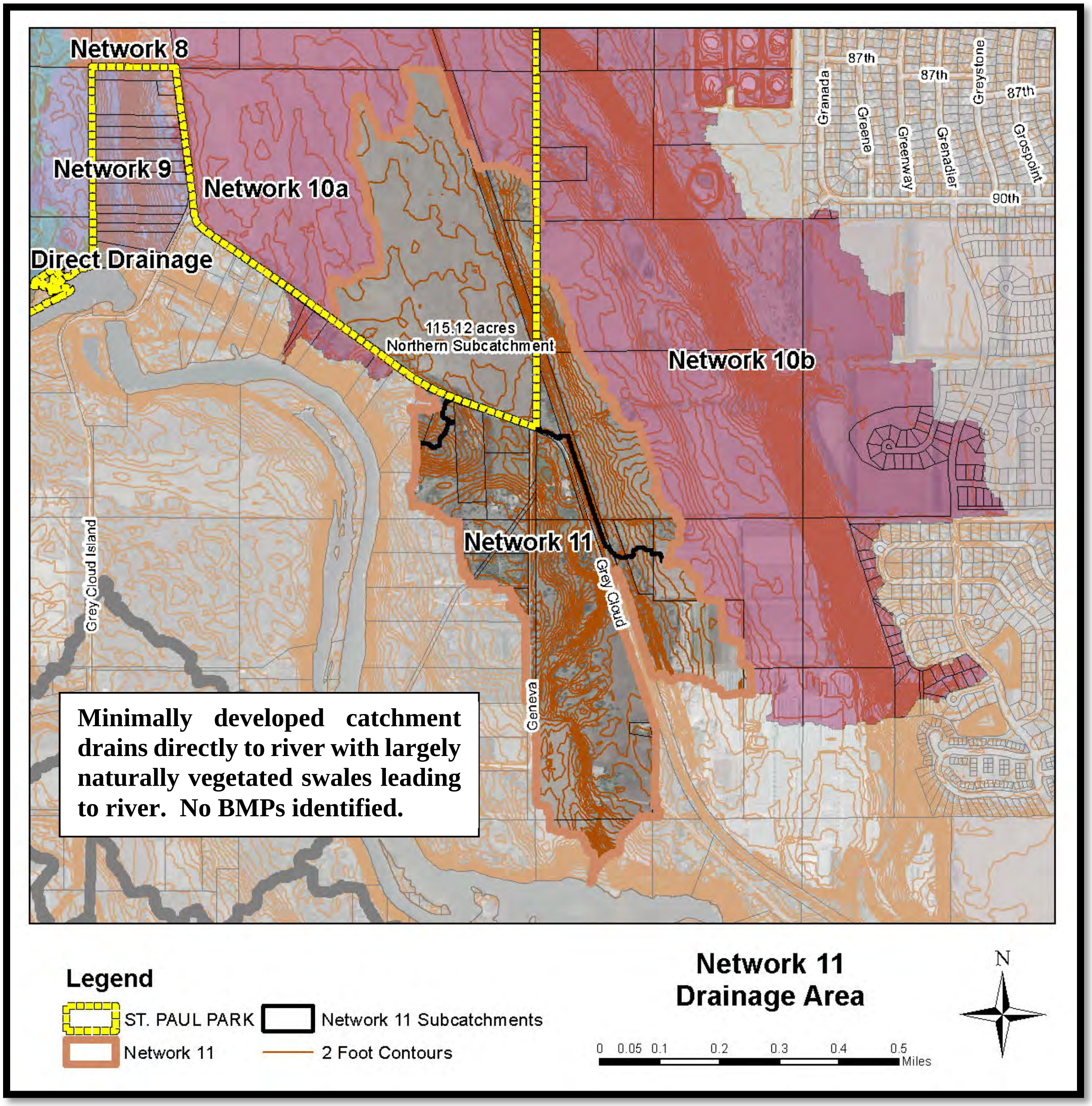
TSS Rank
22 of 22



Stephens pond is a decades old basin created to treat stormwater from the adjacent developments. As modeled, the pond is effective at capturing TSS and TP. Given the size of the basin, despite heavy sedimentation, and some erosion at the southern inlet, the pond remains effective at pollutant reductions and storage. The City Engineer has recommended a pond cleanout which would extend the effective life of the pond and provide a reset on treatment. Given the effectiveness of the the existing pond, the practice ranks low but would provide stability and treatment longevity to the existing practice.

	BMP BENEFIT / COST ESTIMATE 10B – PND1 - BMP Network 10 Subcatchment 10B	10B-PND Network 10B Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	32.82	31.83	0.99	1%
	TSS (lb/yr)	13,201	12,780	421	3%
	Volume (acre-feet/yr)	48.5	46.8	1.7	1%
	Number of BMP's	Large Detention Pond			
	BMP Size/Description	Clean out sediment in existing pond and repair inlets as needed. Will ensure long term effectiveness.			
	Design/Engineering	$4,000			
Cost	Probable Project Cost	$108,000			
	Annual O&M	$250			
	20-yr Cost/lb-TP/yr	$5,909			
	20-yr Cost/2,000lb-TSS/yr	$27,790			

Catchment Drainage Network 11



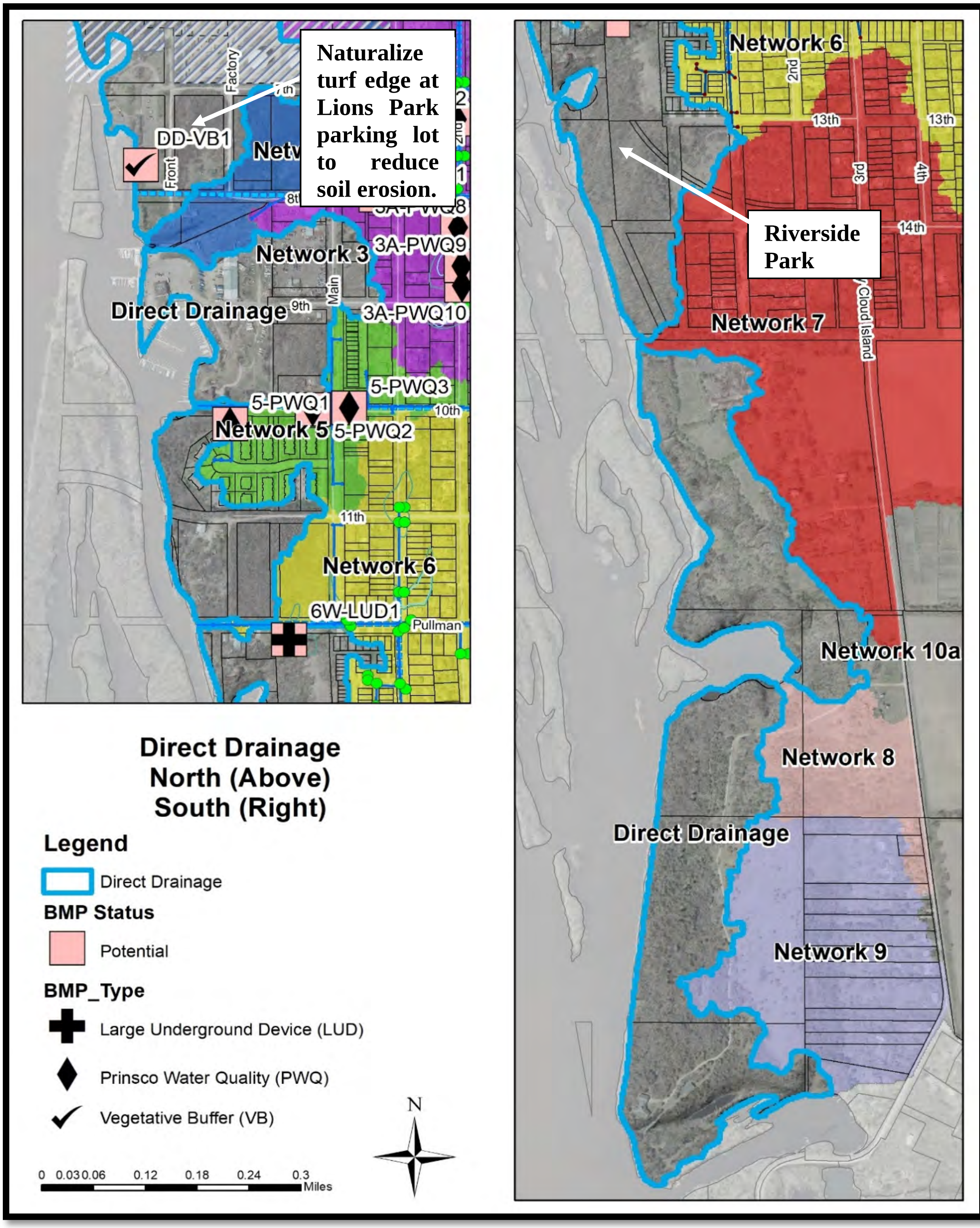
Map 27: Network 11

CATCHMENT DRAINAGE NETWORK 11 DESCRIPTION

The St. Paul Park portion of catchment drainage network 11 is 115 acres comprised entirely of tilled agriculture. Below the St. Paul Park portion, the subcatchment is comprised of low desnsity lots with the drainageway dominated by perennial grasses and scattered trees. There are no stormwater ponds or any other water treatment practices located within the network. As modeled, the TSS loading in the network is below the Mississippi TMDL TSS goal. Given the nature of the disconnected portion of the subcatchment, no BMPs are needed at this time.

	Existing Conditions	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**	**Avg Loading per acre**	**Network Treatment needed to reach resource goal**
Treatment	**TP (lb/yr)**	35.81	0	0%	35.81	**0.31**	**n/a**
	TSS (lb/yr)	13,783	0	0%	13,783	**120**	**-8,251**
	Volume (acre-feet/yr)	22.1	0	0%	22.1	**0.2**	**n/a**
	Number of BMP's	None Identified					
	BMP Size/Description	None Proposed					

Direct Drainage Areas



Map 28: Direct Drainage Areas

DIRECT DRAINAGE AREAS DESCRIPTION

Direct drainage areas are small catchments that directly drain to the Mississippi River with little to no pipe infrastructure – i.e. all overland flow. A single proposed BMP for this area is to work with city parks staff to replace turf grass with tall, deep rooted vegetation adjacent to the parking area at Lions Park. This would have direct benefits in this location but also promote the use of native vegetation along the Mississippi River corridor. Native vegetation will also help provide much needed habitat for pollinators in this area.

Additional opportunities may be present in the Riverside Park area where work has been ongoing to reduce the prevalence of common buckthorn. This species creates an understory monotype in wooded areas, often causing a complete loss of ground layer herbaceous vegetation leading to bare soils. Buckthorn removal and revegetation with dense ground layer grasses and flowers has the potential to provide soil holding capacity where diminished by buckthorn dominance. The SWWD, working with other partners are working to develop models to quantify the benefits of this type of conversion, but at present no established modelling is available.

Lions Park Turf to Native Cover Conversion (DD-VB1)

Drainage Area – 1 acres
Location – West Edge of Parking Lot at Lions Park
Property Ownership – Public

TSS Rank
18 of 12

An opportunity exists along the western edge of the parking lot at Lions Park to convert turf grass to a mix of prairie and savanna species. Once established, the vegetation would add roughness to ground surface and deep roots to hold soils in place. The combination of these factors would slow and trap sediment as well as create deep rooted pathways for water to infiltrate into the soils and be used by planted edge. The combination of beautification, education, habitat and water quality benefits could substantially improve the park experience.

	BMP BENEFIT / COST ESTIMATE *DD-VB1 – BMP* *Direct Drainage*	*DD-VB1* Direct Drainage			
		Existing Loading to BMP Loc.	With BMP	New treatment	Net %
Treatment	TP (lb/yr)	0.9	0.8	0.1	**10%**
	TSS (lb/yr)	372	107	265	**71%**
	Volume (acre-feet/yr)	0.1	0.08	0.02	**20%**
	Number of BMP's	1 conversion from turf to tall native herbaceous species			
	BMP Size/Description	Convert turf grass edge to tall native grasses on west and south side of existing parking lot.			
Cost	Design/Engineering	$750			
	Probable Project Cost	$6,000			
	Annual O&M	$480			
	20-yr Cost/lb-TP/yr	$8,175			
	20-yr Cost/2,000lb-TSS/yr	$6,169			

APPENDIX 1

Ranking Tables

Table 3: Ranking Table: All Proposed Practices Ranked by Cost Per Ton of Total Suspended Sediment removed per year (over 20 years)

TSS Rank	Project ID	Network / Project Location	BMP Treatment Area (ac)	BMP Type	Model	Eng. / Design Cost	Project Install Cost	Annual O&M	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	20-yr Cost /Ton-TSS/Yr	TP Rank	TSS Rank
1	1D-SWL1	**1D / Swale South of City Hall**	2.4	Swale along field edges	WinSLAMM	$2,500	$10,000	$400	2.72	607	$311	3	**1**
2	6W-LUD2	**6W / Pullman Avenue west of Main Street at Existing Lift Station**	240	Large Underground Device	WinSLAMM	$30,000	$320,000	$1,200	126.40	70,617	$672	7	**2**
3	6W-LUD1	**6W / Pullman Avenue at Axelrod Park**	161	Large Underground Device	WinSLAMM	$35,000	$350,000	$1,200	**33.68**	55,647	$735	8	**3**
4	1D-CCRG1	**1D / Corner of Portland Avenue and Broadway Ave.**	1.7	Curb Cut Raingarden	WinSLAMM	$4,000	$15,000	$400	3.37	1,105	$746	4	**4**
5	6W-LUD2 (FP alt)	**6W / Pullman Avenue west of Main Street at Existing Lift Station**	240	Large Underground Device with FP filter	WinSLAMM	$35,000	$600,000	$12,000	36.10	66,463	$1,239	2	**5**
6	3A-PWQ1-4	**3A / Four Prinsco Underground units along 2nd Street and 8th Avenue**	134.8	Large Underground Device	WinSLAMM, Mfr. Lit.	$32,000	$300,000	$2,500	7.44	30,360	$1,258	12	**6**
7	3B-PWQ1	**3B / Prinsco Underground Unit South of Public Works Building along 5th Street ROW**	29.5	Large Underground Device	WinSLAMM, Mfr. Lit.	$20,000	$72,000	$500	3.23	7,950	$1,283	13	**7**
8	6E-PWQ1	**6E / 11th Avenue North end of Dingle Park**	40.4	Large Underground Device	WinSLAMM	$25,000	$120,000	$1,200	**5.16**	12,144	$1,392	15	**8**
9	6W-LUD1 (FP alt)	**6W / Pullman Avenue at Axelrod Park**	161	Large Underground Device with FP filter	WinSLAMM	$35,000	$550,000	$12,000	**143.10**	59,125	$1,395	1	**9**
10	M	**3A / Catchbasin Insert in Public Works Parking Lot**	1.73	Catchbasin Insert	WinSLAMM, Mfr. Lit.	$200	$600	$300	0.51	436	$1,560	9	**10**
11	5-PWQ1	**Prinsco Water Quality 6040 unit east of Broadway and 10th Ave**	**15.1**	Large Underground Device	WinSLAMM, Mfr. Lit.	$20,000	$75,000	$600	**3.23**	6,795	$1,968	16	**11**
12	3C-LUD1	**3C / South of 9th Street at Nuevas Fronteras (in place)**	83.2	Large Underground Device with FP filter	WinSLAMM, Mfr. Lit., engineer's report (HR Green)	$25,000	$400,000	$12,000	20.70	28,274	$2,352	14	**12**
13	1E-PND1	**1E / Hastings Avenue Pond Retrofit and Expansion**	172.1	Pond Retrofit and Expansion	WinSLAMM	$40,000	$400,000	$1,500	42.50	14,238	$3,301	6	**13**
14	5-PWQ3	**Prinsco Water Quality 4820 unit at west end of Broadway**	**6.1**	Large Underground Device	WinSLAMM, Mfr. Lit.	$12,000	$65,000	$500	**1.01**	2,386	$4,254	18	**14**
15	1D-IESF1	**1D / North of City Water Tower along CP Rail Line**	12.9	Iron Enhanced Sand Filter at Pipe Outlet	WinSLAMM, BWSR SW Manual	$30,000	$180,000	$1,880	25.86	5,377	$4,605	5	**15**
16	5-PWQ2	**Prinsco Water Quality 4820 unit west of Broadway and 10th Ave**	**6.6**	Large Underground Device	WinSLAMM, Mfr. Lit.	$12,000	$65,000	$500	**1.01**	2,325	$4,677	19	**16**
17	1E-LUD1	**1E / Abdella Park South Side of Park along Hastings Ave.**	40.4	Large Underground Device	WinSLAMM, Mfr. Lit.	$25,000	$250,000	$3,000	4.70	7,040	$4,759	17	**17**
18	DD-VB1	**DD / Lions Park Parking Lot Edge**	1	Vegetation Restoration	MIDS Calculator	$500	$5,000	$600	0.10	265	$6,169	22	**18**
19	3B-LUD1 (FP alt)	**3B / South of Public Works Building along 5th Street ROW**	29.5	Large Underground Device with FP filter	WinSLAMM	$25,000	$400,000	$10,000	21.68	8,342	$7,492	11	**19**
20	3A-IPR1	**3A / Inlet Protection at Public Works Yard**	2.73	Swale Improvements and Inlet Protection	MIDS Calculator	$3,000	$6,000	$600	**0.93**	330	$8,502	10	**20**
21	1B-PND1	**1B / North of Broadway along BNSF Rail Line**	22.30	Pond Expansion	WinSLAMM	$6,000	$90,000	$500	0.67	386	$27,461	21	**21**
22	10B-PND1	**10B / Along BNSF Railroad**		Pond Cleaning	City Engineer's Report (WSB)	$4,000	$108,000	$250	**0.99**	421	$27,790	20	**22**

Table 4: Ranking Table: All Proposed Practices Ranked by Cost Per LB of Total Phosphorus (TP) removed per year (over 20 years)

TP Rank	Project ID	Network / Project Location	BMP Treatment Area (ac)	BMP Type	Model	Eng. / Design Cost	Project Install Cost	Annual O&M	TP Reduction (lb/yr)	20-yr Cost / lb-TP/Yr	TSS Rank	TP Rank
1	6W-LUD1 (FP alt)	**6W / Pullman Avenue at Axelrod Park**	161	Large Underground Device with FP filter	WinSLAMM	$35,000	$550,000	$12,000	**143.10**	$288	9	**1**
2	6W-LUD2 (FP alt)	**6W / Pullman Avenue west of Main Street at Existing Lift Station**	240	Large Underground Device with FP filter	WinSLAMM	$35,000	$600,000	$12,000	36.10	$346	5	**2**
3	1D-SWL1	**1D / Swale South of City Hall**	2.4	Swale along field edges	WinSLAMM	$2,500	$10,000	$400	2.72	$377	1	**3**
4	1D-CCRG1	**1D / Corner of Portland Avenue and Broadway Ave.**	1.7	Curb Cut Raingarden	WinSLAMM	$4,000	$15,000	$400	3.37	$401	4	**4**
5	1D-IESF1	**1D / North of City Water Tower along CP Rail Line**	12.9	Iron Enhanced Sand Filter at Pipe Outlet	WinSLAMM, BWSR SW Manual	$30,000	$180,000	$1,880	25.86	$479	15	**5**
6	1E-PND1	**1E / Hastings Avenue Pond Retrofit and Expansion**	172.1	Pond Retrofit and Expansion	WinSLAMM	$40,000	$400,000	$1,500	42.50	$553	13	**6**
7	6W-LUD2	**6W / Pullman Avenue west of Main Street at Existing Lift Station**	240	Large Underground Device	WinSLAMM	$30,000	$320,000	$1,200	126.40	$555	2	**7**
8	6W-LUD1	**6W / Pullman Avenue at Axelrod Park**	161	Large Underground Device	WinSLAMM	$35,000	$350,000	$1,200	**33.68**	$607	3	**8**
9	M	**3A / Catchbasin Insert in Public Works Parking Lot**	1.73	Catchbasin Insert	WinSLAMM, Mfr. Lit.	$200	$600	$300	0.51	$667	10	**9**
10	3A-IPR1	**3A / Inlet Protection at Public Works Yard**	2.73	Swale Improvements and Inlet Protection	MIDS Calculator	$3,000	$6,000	$600	**0.93**	$1,129	20	**10**
11	3B-LUD1 (FP alt)	**3B / South of Public Works Building along 5th Street ROW**	29.5	Large Underground Device with FP filter	WinSLAMM	$25,000	$400,000	$10,000	21.68	$1,441	19	**11**
12	3A-PWQ1-4	**3A / Four Prinsco Underground units along 2nd Street and 8th Avenue**	134.8	Large Underground Device	WinSLAMM, Mfr. Lit.	$32,000	$300,000	$2,500	7.44	$1,478	6	**12**
13	3B-PWQ1	**3B / Prinsco Underground Unit South of Public Works Building along 5th Street ROW**	29.5	Large Underground Device	WinSLAMM, Mfr. Lit.	$20,000	$72,000	$500	3.23	$1,579	7	**13**
14	3C-LUD1	**3C / South of 9th Street at Nuevas Fronteras (in place)**	83.2	Large Underground Device with FP filter	WinSLAMM, Mfr. Lit., engineer's report (HR Green)	$25,000	$400,000	$12,000	20.70	$1,606	12	**14**
15	6E-PWQ1	**6E / 11th Avenue North end of Dingle Park**	40.4	Large Underground Device	WinSLAMM	$25,000	$120,000	$1,200	**5.16**	$1,638	8	**15**
16	5-PWQ1	**Prinsco Water Quality 6040 unit east of Broadway and 10th Ave**	**15.1**	Large Underground Device	WinSLAMM, Mfr. Lit.	$20,000	$75,000	$600	**3.23**	$2,316	11	**16**
17	1E-LUD1	**1E / Abdella Park South Side of Park along Hastings Ave.**	40.4	Large Underground Device	WinSLAMM, Mfr. Lit.	$25,000	$250,000	$3,000	4.70	$3,564	17	**17**
18	5-PWQ3	**Prinsco Water Quality 4820 unit at west end of Broadway**	**6.1**	Large Underground Device	WinSLAMM, Mfr. Lit.	$12,000	$65,000	$500	**1.01**	$5,000	14	**18**
19	5-PWQ2	**Prinsco Water Quality 4820 unit west of Broadway and 10th Ave**	**6.6**	Large Underground Device	WinSLAMM, Mfr. Lit.	$12,000	$65,000	$500	**1.01**	$5,506	16	**19**
20	10B-PND1	**10B / Along BNSF Railroad**		Pond Cleaning	City Engineer's Report (WSB)	$4,000	$108,000	$250	**0.99**	$5,909	22	**20**
21	1B-PND1	**1B / North of Broadway along BNSF Rail Line**	22.30	Pond Expansion	WinSLAMM	$6,000	$90,000	$500	0.67	$7,910	21	**21**
22	DD-VB1	**DD / Lions Park Parking Lot Edge**	1	Vegetation Restoration	MIDS Calculator	$500	$5,000	$600	0.10	$8,175	18	**22**