

Hastings Water Quality Improvement Planning

Prepared for City of Hastings

May 2023







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Certification

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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May 5, 2023

Date

Hastings Water Quality Improvement Planning

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Abbreviations

- BMP Best management practice
- CIP Capital Improvement Plan
- HDS Hydrodyanmic separator
- TSS Total suspended solids
- TP Total phosphorus

Introduction

The purpose of this study was to identify locations for water quality improvement projects within the Vermillion River drainage area and complete planning-level evaluations for reductions in total suspended solids (TSS) and total phosphorus (TP). In order to accomplish this task Barr reviewed a wide range of data sets, discussed further in Section 2.1, to identify potential locations for best management practices (BMPs). The analysis resulted in identification of 34 potential BMP locations throughout the portion of the City of Hastings (City) that is tributary to the Vermillion River. Eight BMPs were selected for further evaluation based on coordination with City staff. Planning-level evaluations were completed for five filtration basins and three hydrodynamic separators (HDS). The following sections describe the methodology and results from the evaluation.

2 Identification of Potential Locations for Best Management Practices

2.1 Data Review

To evaluate potential BMP locations, a variety of data sources were compiled and reviewed. To help identify priority BMP implementation areas the following data sets were used and can be seen in Figure A-1:

- Future street projects (Caven 2023)
- Future capital projects (Caven 2023)
- Public parcels (Dakota County 2022)
- Trails (Caven 2023)
- Zoning (Caven 2023)
- Prior water quality projects (Caven 2023), (City of Hastings Watershed Management Plan 2009)

In addition, a qualitative screening for feasible locations was completed using the following criteria

- Treated and untreated areas, defined as discharging to an existing BMP
- Proximity and accessibility of storm sewer (Caven 2023)
- Adjacent to planned project in the City's CIP (Caven 2023)
- Publicly owned parcel (Dakota County 2022)
- Elevation and topography (Fugro Horizons Inc. 2011)
- Ease of construction access

One of the primary data sets used for the qualitative screen process was mapping of treated and untreated areas in the Vermillion River drainage area (Figure A-2). The treated and untreated dataset was developed by using subwatersheds from prior P8 and XPSWMM modeling (City of Hastings Watershed Management Plan 2009), locations of BMPs throughout the City (Caven 2023), (City of Hastings Watershed Management Plan 2009), and storm sewer network (Caven 2023). Subwatersheds were defined as treated if routed to a BMP modeled in P8 or a BMP installed throughout the City since 1998 (Caven 2023), (City of Hastings Watershed Management Plan 2009).

An important consideration for BMP implementation is potential soil constraints. Low soil permeability areas (National Cooperative Soil Survey 2019), karst areas (6), and wellhead protection zones (7) are shown on Figure A-3. A majority of soils within the study area are either unidentified or hydrologic group A or B. While hydrologic group A and B soils are suitable for infiltration practices, Figure A-3 shows that a majority of the Vermillion River study area is mapped within potential karst and/or wellhead protection areas. Due to the extents of potential karst, final selection of basin type (infiltration or filtration) would require a site investigation to determine if the proposed BMP is in a karst area and confirm soil permeability assumptions.

2.2 Identification of BMP Implementation Areas

To identify potential BMP implementation areas, a desktop analysis was completed. Potential BMPs were given qualitative rankings from low to very high. The qualitative ranking was based on potential treatment (size of drainage area), public parcel ownership, treated or untreated area, proximity to opportunity areas (planned road reconstruction areas, etc.), site factors such as tree loss, and constructability considerations. The desktop analysis resulted in 34 locations being identified throughout the City. In January, Barr met with the City to review the 34 BMP opportunity locations and determine which should be evaluated further. Figure A-4 shows the 34 BMPs reviewed with the City and one additional BMP opportunity identified by the Dakota County Soil and Water Conservation District. Figure A-4 also includes City review comments and highlights the eight BMPs selected for further evaluation.

3 Best Management Practice Planning-Level Evaluation

Planning-level evaluation for the eight BMP opportunities identified through coordination with the City (see opportunities highlighted in Figure A-4) was completed. Appendix B provides a planning level summary for each BMP evaluated, including summary of the following:

- BMP locations and description
- Approximate BMP drainage area
- BMP dimensions
- Pollutant loading summary
- Pollutant reduction summary
- Opinion of probable cost (OPC)
- Key design notes and considerations

The following subsections provide a summary of water quality modeling and cost estimating methodology.

3.1 Water Quality Modeling Methodology

The follow subsections provide an overview of water quality modeling methodology used to design and evaluate performance of the eight identified BMP opportunities. The 5 proposed filtration BMPs were evaluated using the water quality modeling program P8 Version 3.5 (P8), and the three HDS systems were evaluated using SHSAM Version 6.71.

3.1.1 Hydrology

Sizing and design of water quality BMPs is dependent on the drainage area and land use characteristics tributary to the BMP. The drainage area to each BMP was determined based on site topography, BMP siting, and assumed connections to City infrastructure (e.g., storm sewer connections, assumed curb cut locations, etc.). The City's XPSWMM model subwatersheds were referenced during this analysis. The assumed drainage area to each BMP is highlighted in Appendix B. Utilizing developed subwatershed divides, a GIS analysis was performed to generate hydrologic inputs required for water quality modeling (i.e., total area, average slope, tributary total and directly connected impervious area, and soil infiltration parameters).

3.1.2 BMP Sizing

Filtration BMPs (Figure B-1 through Figure B-5) were sized using design guidance outlined in the Minnesota Stormwater Manual (Design Criteria for Filtration n.d.). BMP water quality volume (live surface storage volume) was sized to treat 1.1 inches of runoff from tributary directly connected impervious surface area, and BMP depth was designed to allow for complete drawdown within 48-hours. Due to site constraints limiting the footprint size of the 15th Street Basin, two alternative sizing strategies were evaluated: (1) based on assumed bypass of 75% of the 15th St E storm sewer trunkline, and (2) based on

assumed bypass of 50% of the 15th St E storm sewer trunkline (Figure B-4 and Figure B-5, respectively). Rather than explicitly modeling the bypass, the BMPs were sized to provide treatment of 50% and 25% of the tributary directly connected impervious surface area, respectively.

Sizing evaluation of proposed HDS systems (Figure B-6 through Figure B-8) was performed using iterative modeling in SHSAM Version 6.71. Specifically, the SHSAM program simulates performance of multiple models of the selected HDS technology simultaneously and presents results for each. The user then reviews results to select the model size which is most-appropriately sized for the input drainage areas (i.e., the system that optimizes performance considering parameters such as TSS removal, cleanouts required per year, and system dimensions). Based on the large tributary area to the proposed HDS system on Walnut Street (160.8 acres, Figure B-8), sizing and performance of this HDS assumes installation of a bypass system to bypass 75% of flow from the Walnut Street trunkline.

3.1.3 Model Results

Performance of the proposed filtration BMPs (Figure B-1 through Figure B-5) was evaluated using P8 Version 3.5. Performance of each filtration BMP was evaluated using both (a) standard filtration media and (b) iron-enhance sand filtration media. Iron-enhanced sand provides additional removal of dissolved pollutant constituents including phosphate but is more expensive than traditional filtration media. Filtration efficiency values for standard and iron-enhances sand media were assumed based on filtration efficiency values cited in the Minnesota Stormwater Manual (Design Criteria for Iron Enhanced Sand Filter n.d.). TSS and TP loading and reductions results determined through modeling in P8 are summarized in Appendix B.

Performance of the proposed HDS systems (Figure B-6 through Figure B-8) was evaluated using SHSAM Version 6.71. Several HDS technologies were evaluated in SHSAM, including CDS, Downstream Defender, SciClone, and SAFL. Rather than providing results for many HDS technologies and model sizes, based on review of composite results at each of the proposed HDS location, it was determined that an annual TSS load reduction value of 35% was attainable at each location. A TSS load reduction of 35% was selected as a representative, average removal efficiency for the multiple HDS technologies. As noted in Section 3.1.2, the planned bypass at the Walnut Street HDS location (Figure B-8) results in TSS reduction from the total drainage area of 8.8% (35% TSS reduction of the non-bypass load). Because SHSAM does not report TP loading and removal, a P8 modeling analysis was performed to determine equivalent TP loading and reduction at each HDS site. This analysis was used to estimate TP loading to each site and an assumed HDS TP annual reduction efficiency of 10.3%.

Each BMP opportunity, drainage area, pollutant loading, and pollutant removal is summarized in Appendix B. Table 1 summarizes annualized pollutant loading and pollutant reduction evaluated of the eight proposed BMP locations. The proposed BMP locations are hypothetical and exact siting of the BMP may be impacted by unique site constraints, land acquisition and coordination, and utility conflicts.

Table 1Total Suspended Solids and Total Phosphorus Performance of Modeled Best
Management Practices

BMP Description	Annual TSS Load to BMP (lb/year)	Annual TSS Removed (lb/year)	% TSS removed	TP Load to BMP (lb/year)	Annual TP Removed ¹ (Ib/year)	% TP removed ¹			
18 th Street Infiltration Basin	761	721	95%	2.5	2.2	91%			
18 th Street Filtration Basin (Iron Enhanced ²)	761	657	86%	2.5	1.4 (1.7)	56% (71%)			
Westwood Park Infiltration Basin	852	792	93%	2.8	2.4	88%			
Westwood Park Filtration Basin (Iron Enhanced ²)	852	723	85%	2.8	1.5 (1.9)	54% (69%)			
10 th Street Infiltration Basin	2,363	2,303	97%	7.7	7.2	94%			
10th Street Filtration Basin (Iron Enhanced ²)	2,363	2,096	89%	7.7	4.4 (5.6)	58% (73%)			
15 th Street Infiltration Basin, treating 25% directly connected impervious	9,553	6,820	71%	31.1	16.6	53%			
15 th Street Filtration Basin, treating 25% directly connected impervious (Iron Enhanced ²)	9,553	6,411	67%	31.1	11.2 (13.5)	36% (43%)			
15 th Street Infiltration Basin, treating 50% directly connected impervious	9,553	8,270	87%	31.1	23.5	76%			
15 th Street Filtration Basin, treating 50% directly connected impervious (Iron Enhanced ²)	9,553	7,624	80%	31.1	15.2 (18.7)	49% (60%)			
HDS on Pine Street ³	et ³ 5,080 1,7		35%	25.6	2.7	10.3%			
HDS on Ashland Street ³	2,824	988	35%	14.0	1.4	10.3%			
HDS on Walnut Street (*includes 75% bypass) ³	19,161	1,677	8.8%	98.8	2.6	2.6%			

(1) Values are for standard filtration basin. Values in parentheses are for iron enhanced sand filtration

Assumes media is 5-8% iron, in accordance with stormwater manual (Design Criteria for Iron Enhanced Sand Filter n.d.)
 HDS performance was evaluated for four systems (CDS, Downstream Defender, SciClone, and SAFL) in SHSAM. Using the

results from SHSAM, a representative TSS reduction of 35% was selected and used to estimate HDS performance. Using results from P8, a representative TP reduction of 10.3% of selected.

3.2 Cost Estimate

Planning-level estimates of cost for each of the eight proposed BMPs evaluated is provided in Table 2 Following further definition of the scope of the water quality BMPs and completion of detailed design, the final cost may be lower or higher than the planning-level opinions of cost included in Table 2. These costs are intended to provide a planning-level estimate for the potential water quality BMPs described in previous sections.

These opinions of cost, project reserves, contingency, documentation, and discussion are intended to provide background information for planning-level budget planning. The cost of time escalation is not included in the opinions of probable cost. All costs are presented in 2022 US dollars.

Unit costs are based on recent bid prices, published construction cost-index resources, and similar projects. Costs associated with base planning engineering and design (PED), construction management (CM), permitting, and land acquisition are not included in the overall estimate for construction costs.

The opinions of cost also do not include engineering and design, permitting, land acquisition costs, and other tasks following construction, such as operations and maintenance or monitoring.

Contingency used in these opinions of probable cost is intended to help identify an estimated construction cost amount for items included in the current Project scope that have not yet been accurately quantified at the current level of design. Stated another way, contingency is the resultant of the pluses and minuses that cannot be estimated at the level of project definition that exists. The contingency also includes the cost of ancillary items not currently itemized in the quantity summaries but commonly identified in more detailed design and required for completeness of the work. A 30% contingency is applied to the estimated construction cost to account for the costs of these items.

Industry resources for cost estimating (10), (11) provide guidance on cost uncertainty, depending on the level of project design developed. The opinion of probable cost for the water quality BMPs evaluated generally corresponds to a Class 4 estimate characterized by completion of limited engineering. As the level of design detail increases, the level of uncertainty is reduced. Figure 1 provides a graphic representation of how uncertainty (or accuracy) of cost estimates can be expected to improve as more detailed design is developed.



Figure 1 Relationship between Cost Accuracy and Degree of Project Definition

At this early stage of planning, the range of uncertainty of total project cost is high. Due to the early stage of the project, it is standard practice to place a broad accuracy range around the point cost estimate.

The accuracy range is based on professional judgment considering the level of design completed, the complexity of the project, and the uncertainties in the project scope; the accuracy range does not include costs for future scope changes that are not part of the project as currently defined or risk contingency. The estimated accuracy range for this point estimate is -25% to +50%.

The opinion of probable construction cost is made based on Barr's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. It is acknowledged that additional investigations and additional site-specific information that becomes available in the next stage of design may result in changes to the proposed configuration, cost, and functioning of project features. This opinion is based on project-related information available to Barr at this time and includes a planning-level design of the project. In addition, because we have no control over the eventual cost of labor, materials, equipment, or services furnished by others, or over the contractor's

methods of determining prices, or over competitive bidding or market conditions, Barr cannot and does not guarantee that proposals, bids, or actual costs will not vary from the opinion of probable cost presented.

Table 2 summarizes construction opinion of probable cost and cost based on annual TSS and TP removal. Appendix C contains the full opinion of probable cost and quantities for all BMPs.

 Table 2
 Opinion of Probable Construction Cost for Best Management Practices

BMP Description	ВМР Туре	Opinion of Probable Cost ^(1,2)	Cost Per Pound of TSS Removed Annually ^(1,2)	Cost Per Pound of TP Removed Annually (1,2)				
18 th Street Infiltration Basin	Infiltration Basin	\$54,800 - \$109,500	\$80 - \$150	\$24,000 - \$49,000				
18 th Street Filtration Basin	Filtration Basin	\$77,300 - \$154,500	\$120 - \$240	\$55,000 - \$110,000				
18 th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	\$91,500 - \$183,000	\$140 - \$280	\$54,000 - \$108,000				
Westwood Park Infiltration Basin	Infiltration Basin	\$39,800 – \$79,500	\$50 - \$100	\$16,000 - \$32,000				
Westwood Park Filtration Basin	Filtration Basin	\$63,000 - \$126,000	\$90 - \$170	\$42,000 - \$84,000				
Westwood Park Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	\$78,000 - \$156,000	\$110 - \$220	\$41,000 - \$82,000				
10 th Street Infiltration Basin	Infiltration Basin	\$97,500 - \$195,000	\$40 - \$80	\$14,000 - \$27,000				
10th Street Filtration Basin	Filtration Basin	\$134,300 - \$268,500	\$60 - \$130	\$31,000 - \$61,000				
10th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	\$180,000 - \$360,000	\$90 - \$170	\$40,000 - \$80,000				
15 th Street Infiltration Basin, treating 25% directly connected impervious	Infiltration Basin	\$90,000 - \$180,000	\$10 - \$30	\$5,000 - \$11,000				
15 th Street Filtration Basin, treating 25% directly connected impervious	Filtration Basin	\$126,800 - \$252,000	\$20 - \$40	\$11,000 - \$23,000				
15 th Street Iron Enhanced Filtration Basin, treating 25% directly connected impervious	Iron Enhanced Filtration Basin	\$170,300 - \$340,500	\$30 - \$50	\$13,000 - \$25,000				
15 th Street Infiltration Basin, treating 50% directly connected impervious	Infiltration Basin	\$135,000 - \$270,000	\$20 to \$30	\$6,000 - \$11,000				
15 th Street Filtration Basin, treating 50% directly connected impervious	Filtration Basin	\$205,500 - \$411,000	\$30 - \$50	\$14,000 - \$27,000				
15 th Street Iron Enhanced Filtration Basin, treating 50% directly connected impervious	Iron Enhanced Filtration Basin	\$294,800 - \$589,500	\$40 - \$80	\$16,000 - \$32,000				
HDS on Pine Street	HDS	\$78,000 - \$156,000	\$40 - \$90	\$29,000 - \$58,000				
HDS on Ashland Street	HDS	\$78,000 - \$156,000	\$80 - \$160	\$56,000 - \$111,000				
HDS on Walnut Street (*includes 75% bypass)	HDS	\$105,500 - \$270,000	\$60 - \$120	\$39,000 - \$77,000				

(1) Opinion of probable cost is only for construction and does not include acquisition, design, construction observation, maintenance, or other costs

(2) Represents -25% to +50% range of probable cost

4 Conclusions

Using available data sources, 34 locations were identified in the City that could improve water quality before stormwater is discharged to the Vermillion River. From the 34 locations, eight were selected for further evaluation of water quality BMPs. The performance of BMP was evaluated using water quality modeling as described in Section 3, and varied based on location, BMP dimension, and BMP type. Planning-level estimates of water quality performance and cost are summarized in Table 3.

Summary of Best Management Practices Sorted by Cost Effectiveness (1) Table 3

BMP Description	ВМР Туре	Cost Per Pound of TSS Removed Annually ^(1,2)	Cost Per Pound of TP Removed Annually ^(1,2)	Annual TSS Removed (lb/year)	Annual TP Removed (lb/year)	
15th Street Infiltration Basin, treating 25% directly connected impervious	Infiltration Basin	\$10 - \$30	\$5,000 - \$11,000	6,820	16.6	
15th Street Filtration Basin, treating 25% directly connected impervious	Filtration Basin	\$20 - \$40	\$11,000 - \$23,000	6,411	11.2	
15th Street Iron Enhanced Filtration Basin, treating 25% directly connected impervious	Iron Enhanced Filtration Basin	\$30 - \$50	\$13,000 - \$25,000	6,411	13.5	
15th Street Infiltration Basin, treating 50% directly connected impervious	Infiltration Basin	\$20 to \$30	\$6,000 - \$11,000	8,270	23.5	
15th Street Filtration Basin, treating 50% directly connected impervious	Filtration Basin	\$30 - \$50	\$14,000 - \$27,000	7,624	15.2	
15th Street Iron Enhanced Filtration Basin, treating 50% directly connected impervious	Iron Enhanced Filtration Basin	\$40 - \$80	\$16,000 - \$32,000	7,624	18.7	
10th Street Infiltration Basin	Infiltration Basin	\$40 - \$80	\$14,000 - \$27,000	2,303	7.2	
10th Street Filtration Basin	Filtration Basin	\$60 - \$130	\$31,000 - \$61,000	2,096	4.4	
10th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	\$90 - \$170	\$40,000 - \$80,000	2,096	4.5	
HDS on Pine Street	HDS	\$40 - \$90	\$29,000 - \$58,000	1,778	2.7	
Westwood Park Infiltration Basin	Infiltration Basin	\$50 - \$100	\$16,000 - \$32,000	792	2.4	
Westwood Park Filtration Basin	Filtration Basin	\$90 - \$170	\$42,000 - \$84,000	723	1.5	
Westwood Park Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	\$110 - \$220	\$41,000 - \$82,000	723	1.9	
HDS on Walnut Street (*includes 75% bypass)	HDS	\$60 - \$120	\$39,000 - \$77,000	1,677	2.6	
18th Street Infiltration Basin	Infiltration Basin	\$80 - \$150	\$24,000 - \$49,000	721	2.2	
18th Street Filtration Basin	Filtration Basin	\$120 - \$240	\$55,000 - \$110,000	657	1.4	
18th Street Iron Enhanced Filtration Basin	Iron Enhanced Filtration Basin	\$140 - \$280	\$54,000 - \$108,000	657	1.7	
HDS on Ashland Street	HDS	\$80 - \$160	\$56,000 - \$111,000	988	1.4	

Table is sorted by annual TSS removal
 Represents -25% to +50% range of probable cost

5 References

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Appendix A

Identification of Potential Best Management Practices Figures





removal, could retain high flow bypass) mmmmmm

BMP Type: Surface BMP (filtration basin, wet pond) **Opportunity:** Divert Vermillion St / trunkline to proposed surface BMP Qualitative Ranking: Rank: Low (public, small drainage area, significant tree loss)

BMP Type: Surface BMP (filtration basin, wet pond). Opportunity: Curb cut from intersection(s) to proposed BMP Qualitative Ranking: Rank: Med-Low (public, storm diversion difficult limiting WQ benefit)

4th StW

BMP Type: Surface BMP (filtration basin) **Opportunity:** Divert 19th St E / trunkline to proposed surface BMP or curb cut directly to BMP. Qualitative Ranking: Rank: Medium (public, curb cut could treat medium sized drainage area).

BMP Type: Underground (HDS) **Opportunity:** Install HDS during 2024 road reconstruction Qualitative Ranking: Rank: Medium (large

untreated areas, medium WQ benefit).

and a stand and

BMP Type: Underground (HDS) Opportunity: Install HDS during 2024 road reconstruction Qualitative Ranking: Rank: Medium (large

untreated areas, medium WQ benefit).

Opportunity: Stormsewer diversion to proposed surface BMP off of Bohlken Dr. **Qualitative Ranking:** Rank: NA (associated with proposed surface BMP off Bohlken).

BMP Type: Diversion (diversion to proposed BMP)

BMP Type: Underground (HDS)

2024 road reconstruction

Opportunity: Install HDS during tentative

(large untreated areas, medium WQ benefit).

Qualitative Ranking: Rank: Medium

5th St E

6th St E

7th St E

alley

BMP Type: Surface BMP (filtration basin, wet pond) **Opportunity:** Divert Bohlken Dr trunkline and potentially Hackberry Dr trunkline to surface BMP.

Qualitative Ranking: Rank: Medium to High (public, requires diversion from Hackberry Dr to increase drainage 🜉 area to feature).

City Comments: Road currently not in reconstruction plan, but if grant funding is secured that timeline could move up. City and county are planning a repair / upgrade 🚺 to the Greenway Trail in this area. Proximity to Vermillion diversion area could pose challenges / require additional hydraulic analysis. Residents may be opposed to BMP implementation in back lot area.

61

Kendall Dr

Tiffany Dr

37th StW

BMP Type: Underground (HDS) **Opportunity:** Install HDS in 2022 road recon area. Qualitative Ranking: Rank: Low (small drainage area, recently reconstructed).

South Oaks Dr

-

BMP Type: Underground (HDS) **Opportunity:** Install HDS in 2022 road recon area. **Qualitative Ranking:** Rank: Low (small drainage area, recently reconstructed).

BMP Type: Underground (HDS, regional UG filtration) **Opportunity:** Install HDS or regional underground filtration BMP under school lot.

Qualitative Ranking: Rank: Low (potential for high NQ benefit, but low cost-benefit).

> **BMP Type:** Surface BMP (wet pond) **Opportunity:** Expand storage area to create new wet pond feature. Qualitative Ranking: Rank: Med-Low (high

WQ benefit, but significant tree loss and difficult access)

BMP Type: Surface BMP (filtration basin) **Opportunity:** Divert 18th St E / trunkline to proposed surface BMP or curb cut directly to BMP. Qualitative Ranking: Rank: Med-Low (public, storm diversion difficult limiting WQ benefit) **Cty Comments:** Fairly new street, so options at this time may be limited to curb cuts. Consider re-evaluating in 5-10yrs when next road reconstruction effort is being planned

BMP Type: Underground BMP (HDS) **Opportunity:** Install large HDS system during tentative 2026 road reconstruction Qualitative Ranking: Rank: Medium (large untreated areas, medium WQ benefit, portion of drainage area is County owned).

BMP Type: Underground BMP (HDS) **Opportunity:** Install large HDS system during tentative 2026 road reconstruction Qualitative Ranking: Rank: Medium arge untreated areas, medium WQ benefit, portion of drainage area is County owned).

BMP Type: Surface BMP (filtration basin) **Opportunity:** Convert ditch to filtration swale ^r sand filter.

Qualitative Ranking: Rank: High (private but portion with RoW, large untreated drainage area) **City Comments:** Pond and BMPs constructed in the area recently associated with road reconstruction project.

> **BMP Type:** Surface BMP (filtration basin) Opportunity: Convert ditch to filtration swale or sand filter. **Qualitative Ranking:** Rank: High (public, large untreated lrainage area) **City Comments:** Pond and BMPs constructed in the area ecently associated with road reconstruction project.

BMP Type: Surface BMP (filtration basin, wet pond) **Opportunity:** Divert 10 St E / trunkline to proposed surface BMP.

Qualitative Ranking: Rank: Medium (public, high WQ benefit, complex diversion) City Comments: Bedrock could be a challenge here. Opportunity associated with plant project. Some trail projects in this area as well (potential future opportunities in ~2024-2026)

BMP Type: Underground (HDS) **31st Star Official Opportunity:** Install HDS during 2027 road reconstruction Qualitative Ranking: Rank: Medium (large untreated areas, medium WQ benefit, some DS treatment).

Treated Areas → Storm Sewer Vermillion River Drainage Area in Hastings

160th STE

Best Management

Opportunity Selected

Best Management

Practice Opportunity

for Modeling Analysis

Hastings Municipal Boundary

Qualitative ranking was determined based on treatment potential, parcel ownership, and various site factors.

BEST MANAGEMENT PRACTICE OPPORTUNITIES WQM BMP Planning City of Hastings, MN FIGURE 4

Appendix B

Best Management Practice Description and Evaluation Summaries

18th Street Basin

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.

Water quality modeling results:

Dimensions

- 2.4 feet deep, 2,600 square feet
- 4,300 cubic feet storage

Drainage Area

- Total drainage area: 3.4 acres
- Total impervious area: 1.5 acres
- TSS loading: 761 lb/year
- TP Loading: 2.5 lb/year

Pollutant Reduction

- Infiltration basin: 721 lb/year TSS (95%), 2.2 lb/year TP (91%)
- Filtration basin: 657 lb/year TSS (86%), 1.4 lb/year TP (56%)
- Iron enhanced basin: 657 lb/year TSS (86%), 1.7 lb/year TP (71%)

Install 2x curb cut or designed inlet to direct local drainage

Opinion of Probable Cost:

Infiltration: \$54,800 to \$109,500 Filtration: \$77,300 to \$154,500 Iron Enhanced: \$91,500 to \$183,000

Figure B-2 Westwood Park Basin

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.

basins

Water quality modeling results:

Dimensions

- 2.4 feet deep, 2,500 square feet ٠
- 4,600 cubic feet storage .

Drainage Area

- Total drainage area: 5.1 acres •
- Total impervious area: 1.7 acres •
- TSS loading: 852 lb/year •
- TP Loading: 2.8 lb/year ٠

Pollutant Reduction

- Infiltration basin: 792 lb/year TSS (93%), 2.4 lb/year TP (88%) •
- Filtration basin: 723 lb/year TSS (85%), 1.5 lb/year TP (54%) •
- Iron enhanced basin: 723 lb/year TSS (85%), 1.9 lb/year TP (69%)

Opinion of Probable Cost:

Infiltration: \$39,800 to \$79,500 Filtration: \$63,000 to \$126,000 Iron Enhanced: \$78,000 to \$156,000

10th Street Basin

BMP opportunity description:

Filtration basin was sized to treat 1.1 inches of runoff from the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.

Water quality modeling results:

Dimensions

- 2.4 feet deep, 5,700 square feet
- 13,600 cubic feet storage

Drainage Area

- Total drainage area: 5.45 acres
- Total impervious area: 3.92 acres
- TSS loading: 2363 lb/year
- TP Loading: 7.7 lb/year

Pollutant Reduction

- Infiltration basin: 2,303 lb/year TSS (97%), 7.2 lb/year TP (94%)
- Filtration basin: 2,096 lb/year TSS (89%), 4.4 lb/year TP (58%)
- Iron enhanced basin: 2,096 lb/year TSS (89%), 5.6 lb/year TP (73%)

Install curb cut or designed inlet to direct local drainage

Opinion of Probable Cost:

Infiltration: \$97,500 to \$195,000 Filtration: \$134,300 to \$268,500 Iron Enhanced: \$180,000 to \$360,000

15th Street Basin, treating 25% directly connected impervious

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the 25% of the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.

Water quality modeling results:

Dimensions

- 2.4 feet deep, 5,400 square feet
- 13,000 cubic feet storage

Drainage Area

- Total drainage area: 43.4 acres
- Total impervious area: 18.7 acres
- TSS loading: 9,553 lb/year
- TP Loading: 31.1 lb/year

Pollutant Reduction

- Infiltration basin: 6,820 lb/year TSS (71%), 16.6 lb/year TP (53%)
- Filtration basin: 6,411 lb/year TSS (67%), 11.2 lb/year TP (36%)
- Iron enhanced basin: 6,411 lb/year TSS (67%), 13.5 lb/year TP (43%)

Drainage area to feature may be impacted by final BMP location (assumed that drainage area to NW will bypass BMP)

Opinion of Probable Cost:

Infiltration: \$90,000 to \$180,000 Filtration: \$126,000 to \$252,000 Iron Enhanced: \$170,300 to \$340,500

15th Street Basin, treating 50% directly connected impervious

BMP opportunity description:

Basin was sized to treat 1.1 inches of runoff from the 50% of the directly connected impervious. Filtration basin could be iron enhanced to increase phosphorus removal. An infiltration basin could be used if soils allow, would increase total suspended solids and phosphorus removal.

Water quality modeling results:

Dimensions

- 2.4 feet deep, 11,000 square feet
- 26,000 cubic feet storage

Drainage Area

- Total drainage area: 43.4 acres
- Total impervious area: 18.7 acres
- TSS loading: 9,553 lb/year
- TP Loading: 31.1 lb/year

Pollutant Reduction

- Infiltration basin: 8,270 lb/year TSS (87%), 23.5 lb/year TP (76%)
- Filtration basin: 7,624 lb/year TSS (80%), 15.2 lb/year TP (49%)
- Iron enhanced basin: 7,624 lb/year TSS (80%), 18.7 lb/year TP (60%)

Drainage area to feature may be impacted by final BMP location (assumed that drainage area to NW will bypass BMP)

Budget \$325,000

Opinion of Probable Cost:

Infiltration: \$135,000 to \$270,000 Filtration: \$205,500 to \$411,000

Iron Enhanced: \$294,500 to \$589,000

HDS on Pine Street

BMP opportunity description:

HDS system can be installed during the next road construction project.

Water quality modeling results:

Dimensions

- Size is approximately 8 feet tall and 7 feet in diameter (SciClone) Drainage Area
- Total drainage area: 36.5 acres
- Total impervious area: 15.8 acres
- TSS loading: 5,080 lb/year
- TP Loading: 25.6 lb/year

Pollutant Reduction

- 1,778 lb/year TSS (35%), assumed 35% based on ~average of four types of HDS (Downstream defender, CDS, SciClone, and SAFL)
- 2.7 lb/year TP (10.3%), modeled pond with equivalent % TSS removal to find % TP removal

Approximate HDS dimension: 8 ft height, 7 ft diameter

Opinion of Probable Cost: \$78,000-\$156,000

HDS on Ashland Street

BMP opportunity description:

HDS system can be installed during the next road construction project.

Water quality modeling results:

Dimensions

- Size is approximately 8 feet tall and 7 feet in diameter (SciClone) Drainage Area
- Total drainage area: 21 acres
- Total impervious area: 8.5 acres
- TSS loading: 2,284 lb/year
- TP Loading: 14 lb/year

Pollutant Reduction

- 988 lb/year TSS (35%), assumed 35% based on average of four types of HDS (Downstream defender, CDS, SciClone, and SAFL)
- 1.4 lb/year TP (10.3%)

Approximate HDS dimension: 8 ft height, 7 ft diameter

Opinion of Probable Cost:

\$78,000-\$156,000

HDS on Walnut Street

BMP opportunity description:

HDS system can be installed during the next road construction project. HDS will include a bypass to only treat 25% of the drainage area

Water quality modeling results:

Dimensions

- Size is approximately 8 feet tall and 7 feet in diameter (SciClone) Drainage Area
- Total drainage area: 160.8 acres
- Total impervious area: 62.7 acres
- TSS loading: 19,161 lb/year
- TP Loading: 98.8 lb/year

Pollutant Reduction

- 1,677 lb/year TSS (8.8%), assuming 75% is bypasses
- 2.6 lb/year TP (2.6%) , assuming 75% is bypasses

Approximate HDS dimension: 8 ft height, 7 ft diameter

Opinion of Probable Cost: \$100,500-\$201,000

Appendix C

Opinion of Probable Costs

Hastings Water Quality Improvement Planning Project Best Management Practices Alternatives Engineer's Opinion of Probable Cost (OPC) Construction Cost Estimate (ASTM E2516-11, Class 4) Barr Engineering #23-19-0703.00

			i i		1	i i	1	1	1	1		i i i i i i i i i i i i i i i i i i i	1							1	1	1				
												15th Street	t				15th Str	eet								
					18th Stre	et		Westwood Park		15t	h Street Filtration	Filtration Bas	sin,	15th Street	15th S	treet Filtration	Filtration I	Basin,	15th Street		10th Street					
	18th Street				Filtration Ba	asin, 18th Street	Westwood Park	Filtration Basin,	West	wood Park Ba	sin, 25% drainage	25% drainag	ge Inf	iltration Basin,	Basin,	50% drainage	50% drainag	ge area	nfiltration Basin	, 10th Street	Filtration Basin,	10	th Street	HDS on Pine	HDS on Ashland	HDS on Walnut
Construction Costs	-		F	iltration Basin	with iro	n Infiltration Basin	Filtration Basin	with iron	Infiltr	ation Basin	area	area with irc	on 25%	% drainage area		area	with ir	on 50	0% drainage are	a Filtration Basin	with iron	Infiltr	ation Basin	Street	Street	Street
Category	Item Description	Unit	Unit Price Qty	y Extension	Qty Extens	sion Qty Extension	Qty Extension	Qty Extension	Qty I	Extension Qty	Extension	Qty Extensio	on Qty	Extension	Qty	Extension	Qty Exte	nsion Q	ty Extension	Qty Extension	Qty Extension	Qty	Extension	Qty Extension	Qty Extension	Qty Extension
General/Restoration	Mobilization/Demobilization	LS	10% Construction Cost	1 \$ 7,200	0 1 \$ 8	3,500 1 \$ 5,100	1 \$ 5,900	1 \$ 7,300	1	\$ 3,700	1 \$ 11,700	1 \$ 15,9	900	1 \$ 8,400	1	\$ 19,200	1 \$	27,500	1 \$ 12,600	1 \$ 12,500	1 \$ 16,800	1	\$ 9,100	1 \$ 7,300	\$ 7,300	1 \$ 9,400
	Erosion Control	LS	2% Construction Cost	1 \$ 1,500	0 1 \$ 1	L,700 1 \$ 1,100) 1 \$ 1,200	1 \$ 1,500	1	\$ 800	1 \$ 2,300	1 \$ 3,2	200	1 \$ 1,700	1	\$ 3,800	1 \$	5,400	1 \$ 2,500	1 \$ 2,500) 1 \$ 3,300	1	\$ 1,800	1 \$ 1,500	1 \$ 1,500	1 \$ 1,900
	Restoration	SY	\$ 11.50 2	280 \$ 3,300	280 \$ 3	3,300 280 \$ 3,300	310 \$ 3,600	310 \$ 3,600	310	\$ 3,600 11	00 \$ 12,700	1100 \$ 12,7	700 11	12,700	2200	\$ 25,300	2200 \$	25,300	2200 \$ 25,300	0 1000 \$ 11,500	1000 \$ 11,500	1000	\$ 11,500	1 \$ 1,400	1 \$ 1,400	1 \$ 1,800
Best Management Practice Costs	Excavation	CY	\$ 40 1	170 \$ 6,800	0 170 \$ 6	5,800 170 \$ 6,800) 190 \$ 7,600	190 \$ 7,600	190	\$ 7,600 7	30 \$ 29,200	730 \$ 29,2	200 7	730 \$ 29,200	1450	\$ 58,000	1450 \$	58,000	1450 \$ 58,000	560 \$ 22,400	560 \$ 22,400	560	\$ 22,400	0\$-	0\$-	0\$-
	Sand Filtration Media	TON	\$ 40 1	130 \$ 5,200	0 \$	- 0\$-	140 \$ 5,600	0\$-	0	\$ - 4	10 \$ 16,400	0\$	-	0\$-	810	\$ 32,400	0\$	-	0\$-	420 \$ 16,800	0\$-	0	\$ -	0\$-	0\$-	0\$-
	Iron Enhanced Sand Filtration Media	TON	\$ 140	0\$-	130 \$ 18	3,200 0 \$ -	0\$-	140 \$ 19,600	0	\$ -	0\$-	410 \$ 57,4	400	0\$-		\$-	810 \$ 1	13,400	0\$-	0\$-	420 \$ 58,800	0	\$ -	0\$-	0\$-	0\$-
	Perforated Draintile	SF	\$ 3 17	/00 \$ 5,100	0 1700 \$ 5	5,100 0 \$ -	1900 \$ 5,700	1900 \$ 5,700	0	\$ - 54	00 \$ 16,200	5400 \$ 16,2	200	0\$-	10800	\$ 32,400	10800 \$	32,400	0\$-	5700 \$ 17,100	5700 \$ 17,100	0	\$ -	0\$-	0\$-	0\$-
	Riser Outlet and Connection	LS	\$ 10,000	1 \$ 10,000	1 \$ 10	0,000 0 \$ -	1 \$ 10,000	1 \$ 10,000	0	\$ -	0\$-	0\$	-	0\$-	0	\$-	0\$	-	0\$-	1 \$ 10,000	1 \$ 10,000	1	\$ 10,000	0\$-	0\$-	0\$-
	Complex outlet structure and connection	LS	\$ 15,000	0\$-	0\$	- 0\$-	0\$-	0\$-	0	\$ -	1 \$ 15,000	1 \$ 15,0	000	1 \$ 15,000	1	\$ 15,000	1\$	15,000	1 \$ 15,000	0 \$ -	0\$-	0	\$-	0\$-	0\$-	0\$-
	Removal / Disposal of Manhole	EA	\$ 5,000	0\$-	0\$	- 0\$-	0\$-	0\$-	0	\$ -	1 \$ 5,000	1 \$ 5,0	000	1 \$ 5,000	1	\$ 5,000	1\$	5,000	1 \$ 5,000	1 \$ 5,000	1 \$ 5,000	1	\$ 5,000	1 \$ 5,000	1 \$ 5,000	1 \$ 5,000
	Catch Basin Removal	EA	\$ 5,000	4 \$ 20,000	0 4 \$ 20	0,000 4 \$ 20,000	4 \$ 20,000	4 \$ 20,000	4	\$ 20,000	0\$-	0\$	-	0\$-	0	\$-	0\$	-	0\$-	0\$-	0\$-	0	\$ -	0\$-	0\$-	0\$-
	Curb Cut / Designed Inlet	LS	\$ 10,000	2 \$ 20,000	2 \$ 20	0,000 2 \$ 20,000	0 \$ -	0\$-	0	\$ -	0\$-	0\$	-	0\$-	0	\$-	0\$	-	0\$-	2 \$ 20,000	2 \$ 20,000	2	\$ 20,000	\$ -	\$-	\$ -
	Curb Cut	LS	\$ 5,000	0\$-	0\$	- \$-	1 \$ 5,000	1 \$ 5,000	1	\$ 5,000	0\$-	0\$	-	\$ -	0	\$-	0\$	-	0\$-	\$ -	\$ -		\$ -	\$ -	\$-	\$ -
	HDS and Bypass Structures ²	LS	\$ 65,000	0\$-	0\$	- 0\$-	0\$-	0\$-	0	\$ -	0\$-	0\$	-	0\$-	0	\$-	0\$	-	0\$-	0\$-	0\$-	0	\$-	1 \$ 65,000	1 \$ 65,000	1 \$ 65,000
	Bypass Structure	LS	\$ 20,000	0\$-	0\$	- 0\$-	0\$-	0\$-	0	\$ -	1 \$ 20,000	1 \$ 20,0	000	1 \$ 20,000	1	\$ 20,000	1\$	20,000	1 \$ 20,000	1 \$ 20,000	1 \$ 20,000	1	\$ 20,000	0\$-	0\$-	1 \$ 20,000
	SUBTOTAL			\$ 79,100) \$ 93	3,600 \$ 56,300	\$ 64,600	\$ 80,300		\$ 40,700	\$ 128,500	\$ 174,6	600	\$ 92,000		\$ 211,100	\$ 3	02,000	\$ 138,400	\$ 137,800	\$ 184,900		\$ 99,800	\$ 80,200	\$ 80,200	\$ 103,100
CONTINGENCY	30)%		\$ 24,000) \$ 28	3,000 \$ 17,000	\$ 19,000	\$ 24,000		\$ 12,000	\$ 39,000	\$ 52,0	000	\$ 28,000		\$ 63,000	\$	91,000	\$ 42,000	\$ 41,000	\$ 55,000		\$ 30,000	\$ 24,000	\$ 24,000	\$ 31,000
SUBTOTAL W/CONTINGENCY				\$ 103,000) \$ 122	2,000 \$ 73,000	\$ 84,000	\$ 104,000		\$ 53,000	\$ 168,000	\$ 227,0	000	\$ 120,000		\$ 274,000	\$ 3	93,000	\$ 180,000	\$ 179,000	\$ 240,000		\$ 130,000	\$ 104,000	\$ 104,000	\$ 134,000
ESTIMATED TOTAL OPINION OF PROBABLE COST	•			\$ 103,000) \$ 122	2,000 \$ 73,000	\$ 84,000	\$ 104,000		\$ 53,000	\$ 168,000	\$ 227,0	000	\$ 120,000		\$ 274,000	\$ 3	93,000	\$ 180,000	\$ 179,000	\$ 240,000		\$ 130,000	\$ 104,000	\$ 104,000	\$ 134,000
	-								-																	
TOTAL OPION OF COST				\$ 103,000) \$122	2,000 \$ 73,000	\$ 84,000	\$ 104,000		\$ 53,000	\$ 168,000	\$ 227,0	000	\$ 120,000		\$ 274,000	\$ 3	93,000	\$ 180,000	\$ 179,000	\$ 240,000		\$ 130,000	\$ 104,000	\$ 104,000	\$ 134,000
Anticipated Accuracy Range	High	50%		\$ 154,500) \$ 183	3,000 \$ 109,500	\$ 126,000	\$ 156,000		\$ 79,500	\$ 252,000	\$ 340,5	500	\$ 180,000		\$ 411,000	\$ 5	39,500	\$ 270,000	\$ 268,500	\$ 360,000		\$ 195,000	\$ 156,000	\$ 156,000	\$ 201,000
	Low	-25%	i	\$ 77,300) \$91	L,500 \$ 54,800	\$ 63,000	\$ 78,000		\$ 39,800	\$ 126,000	\$ 170,3	300	\$ 90,000		\$ 205,500	\$ 2	94,800	\$ 135,000	\$ 134,300	\$ 180,000		\$ 97,500	\$ 78,000	\$ 78,000	\$ 100,500

Notes: ¹ - Assumed restoration cost 1% of construction cost for HDS installation. ¹ - HDS structure assumed based on tributary drainage area. Cost may vary based on technology selected.

Use \$325,000 -