Wilkinson Lake Water Quality Improvement Feasibility Report

Wilkinson Lake Water Quality Improvement Study

Vadnais Lake Area Water Management Organization (VLAWMO)

VADLA 153927 | September 2020

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October 9, 2020

RE: Wilkinson Lake Water Quality Improvement Feasibility Report
Vadnais Lake Area Water Management Organization (VLAWMO)
SEH No. VADLA 153927 4.00

Mr. Phil Belfiori, Administrator
Vadnais Lake Area Water Management Organization (VLAWMO)
800 East Co. Rd. E
Vadnais Heights, Minnesota 55127

Dear Mr. Belfiori:

Attached is the Wilkinson Lake Water Quality Improvement Feasibility Study. This report is intended to provide a summary of the Wilkinson Lake background, existing conditions, stakeholder involvement and study completed to determine potential priority areas within the watershed. SEH evaluated three selected priority areas for water quality improvement projects, including:

- East Wilkinson Lake Watershed Enhancements,
- Ash Street Regional Treatment Approach, and
- Ash Street Linear Treatment Approach.

Conceptual figures or layouts and cost estimates were prepared for each selected priority area. Please feel free to contact me if you have any questions or require additional information.

Sincerely,

Emily Jennings

Emily Jennings, PE
Water Resources Engineer/Project Manager
(Lic. MN)

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Wilkinson Lake Water Quality Improvement Feasibility Report

Wilkinson Lake Water Quality Improvement Study

Prepared for Vadnais Lake Area Water Management Organization (VLAWMO)

1 Introduction

The Vadnais Lakes area watershed contains the City of North Oaks, and portions of the Cities of White Bear Lake, Gem Lake, Vadnais Heights, Lino Lakes, and White Bear Township, and includes 17 lakes, 1 creek, and over 1000 wetlands. The watershed is managed by the Vadnais Lake Area Water Management Organization, commonly referred to as VLAWMO.

VLAWMO is pursuing a feasibility study to identify potential locations for new or enhanced best management practices (BMPs) that can be implemented to capture nutrients before entering Wilkinson Lake.

2 Project Location

Wilkinson Lake is located just west of Wilkinson Lake Boulevard in North Oaks, Minnesota. Wilkinson Lake is near the headwaters of the Vadnais Lakes Watershed. The Lake itself resides in the Minnesota Land Trust with a sub-watershed comprised of multi-family residential, commercial, industrial, and protected open spaces totaling just over 1,100 acres. Wilkinson Lake is surrounded by a large wetland, creating a significant setback from the adjacent roadways.

Figure 1 shows Wilkinson Lake relative to the VLAWMO Watershed.

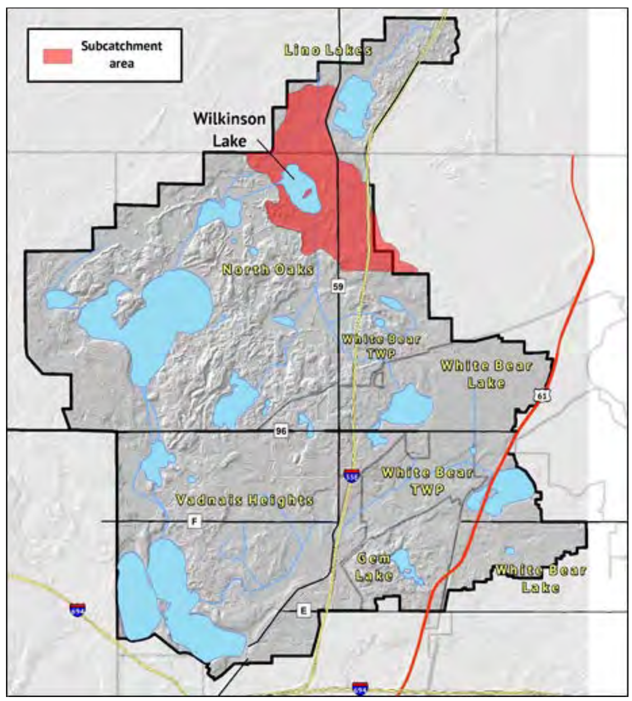


Figure 1: Wilkinson Lake Watershed Location Map Prepared by VLAWMO

3 Background

Wilkinson Lake is a shallow waterbody, with an average depth of 2 feet and a surface area of over 90 acres. The lake is impaired for excess nutrients and was listed as an impaired water on the MPCA's Impaired Waters List (303(d)) in 2010. The Vadnais Lake Area WMO TMDL (TMDL) was prepared for Wilkinson Lake and other impaired water bodies within the watershed in 2013.

The TMDL modelled watershed loading using P8 software and internal loading was modelled using measured periods of anoxia with literature values for phosphorus release to directly calculate internal phosphorus release rates. The TMDL indicated that the large majority of phosphorus loading to Wilkinson Lake is coming from the Wilkinson Lake watershed and not internally.

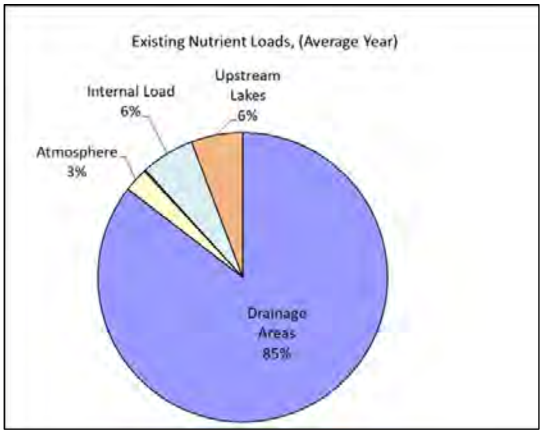


Figure 2: TMDL Lake Model Summary for Wilkinson Lake

It should be noted that there are some data gaps and limitations within the TMDL, as the P8 watershed modeling from the TMDL study did not simulate the natural ponds and wetlands in the Wilkinson Lake watershed. This may have led to overestimated phosphorus loadings for the watershed. Natural ponds and wetlands are present in the Wilkinson Lake Watershed and include several natural connections from the direct watershed to the Lake itself.

Figure 2 shows the lake modelling results for nutrient loading to Wilkinson Lake, prepared as part of the TMDL Study.

Excess nutrients can come from residential lawn care or landscaping, agricultural activities, pet waste and litter, and other municipal activities or private business, for example. In addition to general best practices for the aforementioned activities, other ways to effectively remove excess nutrients include volume management and filtering techniques that can include enhanced medias that target specific nutrients.

In addition to the TMDL, SEH staff reviewed several other pertinent items, including:

- Gilfillan Tamarack Wilkinson Subwatershed Urban Stormwater Retrofit Analysis (2012, Ramsey Conservation District)
- East Goose, West Goose and Wilkinson Lakes Feasibility Study (2017, Barr Engineering Company)
- Wilkinson Lake Fish Survey (2017), Depth Survey (2017) and Macrophyte Survey (2017)
- Wilkinson Lake Monitoring Data

3.1 Retrofit Analysis and Feasibility Study

Potential nutrient reduction BMPs in the Wilkinson Lake watershed were previously studied in 2012 as part of a Gilfillan Tamarack Wilkinson Subwatershed Urban Stormwater Retrofit Analysis (2012, Ramsey Conservation District) and in 2017 as part of the East Goose, West Goose and Wilkinson Lakes Feasibility Study (2017, Barr Engineering Company). These reports and studies are hereby incorporated into this report by reference.

The 2012 retrofit analysis identified three priority source areas:

- A residential area in the southeast corner of the Wilkinson direct watershed
- A residential area northeast of Birch Lake that discharges to the Wilkinson inflow ditch
- A commercial area northeast of Birch Lake that discharges to the Wilkinson inflow ditch

Priority areas were chosen based on the lack of existing treatment. The retrofit report recommended two clusters of 14 total bio-retention retrofits within the residential areas and two small sections of pervious asphalt to replace impervious areas within the commercial area. These retrofits were estimated to provide a 2.3% reduction from the estimated base load at a cost of approximately $68,000. Similar overall reductions were calculated for all 23 retrofit opportunities identified throughout the Gilfillan, Tamarack and Wilkinson watersheds within the report, demonstrating the difficulty in identifying a retrofit opportunity within the study areas to return a significant base load reduction. It should be noted that the methodology to estimate the base load is described within the report as a conservative approach, not including any regional treatment facilities upstream, natural or manmade.

The 2017 feasibility study identified two priority source areas:

- The area north of Wilkinson Lake, between the Amelia Lake outlet and the Ash St. monitoring station
- The area south of Wilkinson Lake upstream of the North Oaks Farms monitoring station, but downstream of Birch Lake, Black Lake and the Centerville monitoring station

Priority areas were chosen based on sampling data. Potential sources of the loading in these areas were identified as possible release from ponds/wetlands during the summer months. The study recommended VLAWMO conduct additional monitoring throughout the priority areas and identify the presence of rough fish during the next Wilkinson fish survey. The study did not include estimated nutrient reductions or associated costs.

3.2 Wilkinson Lake Surveys

3.2.1 Fish Survey

In September 2017, VLAWMO contracted with Blue Water Science for a fish survey with the primary objective to characterize the fish community in Wilkinson Lake. A rough fish population may result in the re-suspension of sediment, leading to increased internal loading.

A total of 13 fish species were sampled in Wilkinson Lake, including:

- Black Bullhead
- Black Crappies
- Bluegills
- Golden Shiner
- Sunfish (Green, Hybrid, Pumpkinseed)
- Largemouth Bass
- Yellow Perch
- Minnow (Fathead, Mud, Shiner, Stickleback)

Black bullheads were the most abundant in the survey, followed by green and pumpkinseed sunfish. The presence of these fish indicate that winterkills are likely to occur in Wilkinson Lake with fish re-introductions from the downstream Deep and Pleasant Lakes. The best management recommendations following the fish survey was to continue to allow Wilkinson to let the natural conditions impact the fish community.

3.2.2 Depth Survey

In April of 2017, Ramsey Conservation District conducted a depth survey on Wilkinson Lake for VLAWMO. Using BioBase technologies, it was recorded that the deepest parts of the Lake are approximately 5.6 feet deep with the majority being much shallower, however it was reported that dense vegetation on the bottom of the lake made measuring difficult. Additionally, due to the overall shallowness of the Lake, the technology was unable to collect data points evenly so the interpolation of data was used to project overall results.

3.2.3 Macrophyte and Bio-Volume Survey

In August of 2017, VLAWMO conducted a macrophyte and bio-volume survey on Wilkinson Lake. Native macrophytes, or aquatic plants, drive the health of shallow lakes. Species such as Curly Leaf Pondweed can cause very specific problems by changing the dynamics of internal phosphorus loading. Samples were collected at sixty locations with Wilkinson Lake to assess the aquatic macrophyte community of Wilkinson Lake, with macrophytes found at all 60 locations, including (and in order of most common):

- Canada Waterweed
- White Water Lily
- Flat-Stem Pondweed
- Filamentous Algae
- (Fewer than 15% of survey locations) Coontail, Curly Leaf Pondweed, Greater Duckweed, Sago Pondweed, Yellow Water Lily, Slender Waternymph, Muskgrass, and Stonewart

The bio-volume survey used BioBase technologies to collect submerged aquatic vegetation bio-volume data. The results indicated that the majority of the lake covered with 100% bio-volume.

3.3 Wilkinson Lake Monitoring Data

VLAWMO staff collects samples from 12 water bodies annually, including Wilkinson Lake. The data received from the monitoring is used by the Minnesota Pollution Control Agency (MPCA) to determine the health of the state's waters. In 2019, the average total phosphorus of Wilkinson was measured at 81 micrograms per liter (µ/L). Although this is below the historical average (1998-2019) of 117 µ/L, this is still above the state standard of 60 µ/L.

In addition to the annual sampling conducted at Wilkinson Lake, additional sampling of the Ash Street crossing (north of Wilkinson, from Amelia Lake), and the Wilkinson Inlet (south of Wilkinson, from Black, Fish, and Birch Lakes) was conducted in 2017/2018. Sampling occurred between the months of June and August and data indicated an average total phosphorus concentration of approximately 330 µ/L from the Ash Street Crossing (north of Wilkinson Lake) and approximately 450 µ/L from the Wilkinson Inlet (south of Wilkinson Lake). This coincides with the information presented in the East Goose, West Goose and Wilkinson Lakes Feasibility Study (2017, Barr Engineering Company).

4 Existing Conditions

The Vadnais Lakes Watershed covers 24.2 square miles or nearly 15,500 acres in the northeast metro area. **Figure 3** shows the VLAWMO Watershed.

Nearly 5,000 acres discharges towards Wilkinson Lake collected via several upstream lakes, including Birch, Tamarack, Black, and Gilfillan, located south of Wilkinson Lake, and Amelia, located north of Wilkinson Lake. The entire system makes up the most upstream portion of the Vadnais Lakes Watershed.

Birch, Tamarack, Black, and Gilfillan Lakes discharge towards Wilkinson Lake via drainage ditches. The most direct connection from Amelia to Wilkinson is via the west Amelia outlet, which goes through a series of wetlands, before entering a pond just north of the Ash Street Crossing, discharging south to Wilkinson Lake. However, the complete connection between Amelia and Wilkinson Lakes is only made during very wet weather conditions, last witnessed in approximately 2016/2017. During normal conditions, this connection is mostly stagnant.

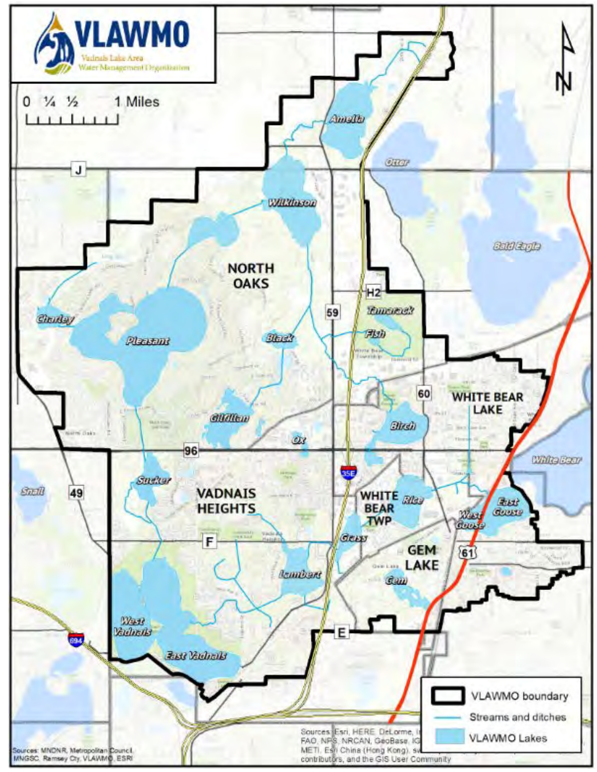


Figure 3: Vadnais Lake Area Watershed Prepared by VLAWMO

Wilkinson Lake discharges to Deep Lake, through an outlet channel located in the southwest portion of the Lake. There is also a connection from Amelia Lake to Deep Lake, through an abandoned, non-operational, Saint Paul Regional Water Service (SPRWS) system. Any flow that may run through that system is likely nominal shallow groundwater flow. This is not represented within the TMDL data.

The purpose of this study is to identify possible best management practices (BMPs) that can be implemented to capture nutrients before entering Wilkinson Lake, as Wilkinson Lake is impaired for excess nutrients. It is important to note that in addition to Wilkinson Lake's impairment, Gilfillan and Tamarack Lakes are also impaired for excess nutrients. Gilfillan is predominantly landlocked and in the event of discharge, discharges towards a wetland complex and eventually Black Lake prior to entering Wilkinson Lake while Tamarack discharges towards Fish Lake and a large wetland complex prior to entering Wilkinson Lake. The remainder of upstream lakes and ditches are not classified as impaired. To keep with the intent of the study, priority is given to potential BMP areas within the direct Wilkinson Watershed, i.e. those areas that do not discharge to Wilkinson Lake via upstream lakes.

As indicated in the TMDL and observed in sampling data, the large majority of phosphorus loading to Wilkinson Lake is coming from the Wilkinson Lake approximately 1,100 acre direct watershed. The Wilkinson direct watershed is a moderately developed watershed with areas of multi-family residential, commercial, industrial, and protected open space. There is proposed development within the watershed, which could include multi-family senior housing and additional commercial properties.

Wiki-Watershed's "Model My Watershed" tool was used to get a high level understanding of what the different land uses were contributing to the lake in terms of total phosphorus. Through this analysis, four land use types were identified as the highest contributors of TP to the lake:

- Cropland
- Hay/Pasture
- Developed Areas, Medium-Density Mixed
- Developed Areas, High-Density Mixed

It is important to note that of these areas, all exist in some form adjacent to Wilkinson Lake, the Ash Street Crossing and the Wilkinson Inlet, and the respective contributing areas to the point sources.

5 Potential BMP(s) Site Identification

In order to evaluate the best option for potential project sites, SEH identified a set of criteria to guide selection. The criteria was not comprehensive but rather open to sites that meet portions of the criteria in order to display a wide range of options. The primary selection criteria included:

- Areas within the direct Wilkinson Watershed
- Areas previously identified by past studies
- Areas with any known proposed development or redevelopment public projects
- Areas corresponding to high phosphorus contributing land uses

Using these criteria, 40 sites were identified as potential BMP project sites. To further describe the data set, a set of 9 viability measures were applied to each site to provide a 'rating' for each site, in order to distinguish between low, moderate, and high viability. Some measures were weighted more heavily than others; for example, if a site met a certain measure it was 'good' but if it did not meet that measure it was 'bad'. In other instances, if a site didn't meet a certain criteria, a 'bad' rating was not applied, but rather a null measure was used as to not affect the overall rating. This variability allowed for a more inclusive look at potential viability.

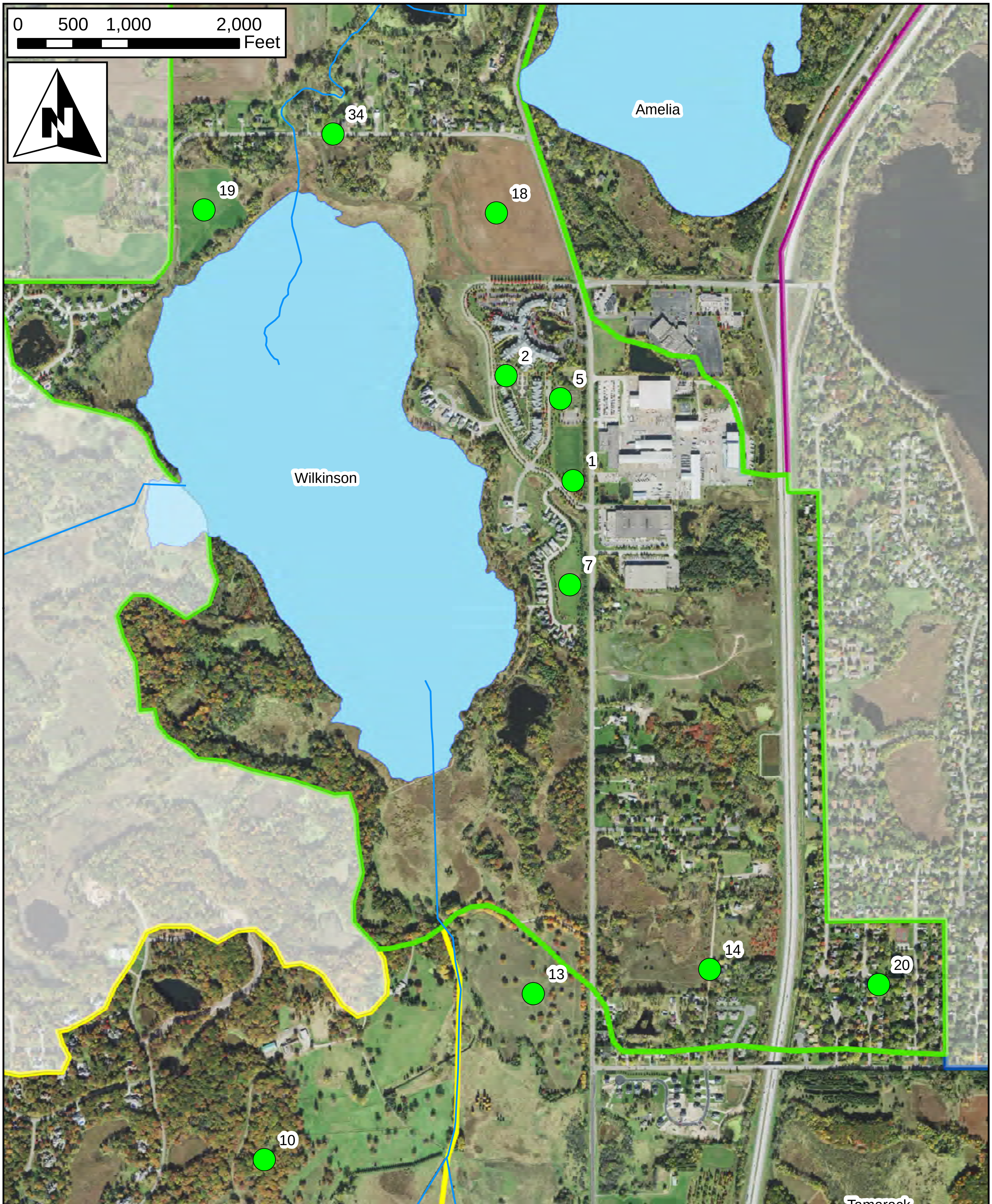
Each site and respective viability measures, including assumptions made in determining criteria, are summarized with the interim submittal made to VLAWMO following the site identification in **Appendix A**. The overall conditional analysis yielded 11 potential sites with a high viability rating, summarized in **Table 1**. It should be noted that although some priority sites focused on a specific location, others refer to more general potential with the approximate area.

Table 1: High Viability Sites

Site	Description
1	General Area: Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA Park Area, Potential BMP Enhancements
2	General Area: Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA Park Area, Potential BMP Enhancements
5	General Area: Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA Park Area, Potential BMP Enhancements
7	General Area: Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA Park Area, Potential BMP Enhancements
10	Future Red Forest Way South Development, North Oaks Company Property
13	Future Gatehill Development, North Oaks Company
14	Peterson Road, White Bear Township
18	Future Development northeast of Wilkinson Lake, North Oaks Company
19	Future Development, northwest of Wilkinson Lake, North Oaks Company
20	Residential area in the southeast corner of the Wilkinson direct watershed, previously identified in the 2012 retrofit analysis
34	Ash Street Crossing, North Oaks Company, Lino Lakes, Ramsey County, Anoka County

Figure 4 shows a map of high viability sites. Stakeholder input was vital to the decision of choosing priority sites, as all high priority sites would require stakeholder collaboration.

It should be noted that a ‘low viability’ rating does not intend to imply that a particular site should be eliminated from consideration but rather additional site analysis and investigation should occur to verify viability.



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Print Date: 5/8/2020

Map by: mchristenson
Projection: NAD 1983 UTM Zone 15N
Source: MnGeo, SEH, VLAWMO

Wilkinson Lake Feasibility Study
High Viability Site Map
Figure 4

This map is neither a legally recorded map nor a survey map and is not intended to be used as one. This map is a compilation of records, information, and data gathered from various sources listed on this map and is to be used for reference purposes only. SEH does not warrant that the Geographic Information System (GIS) Data used to prepare this map are error free, and SEH does not represent that the GIS Data can be used for navigational, tracking, or any other purpose requiring exacting measurement of distance or direction or precision in the depiction of geographic features. The user of this map acknowledges that SEH shall not be liable for any damages which arise out of the user's access or use of data provided.

6 Stakeholder Involvement

VLAWMO utilizes partnerships frequently to reach their goals within the watershed. During the early stages of evaluating potential BMP(s) sites, several stakeholders conversations were initiated to solicit information on any planned infrastructure improvement or new development sites where potential collaboration could occur within the Wilkinson Lake Watershed, including:

- North Oaks
- White Bear Township
- White Bear Lake
- Ramsey County
- Anoka County

Several stakeholders were also engaged following the potential site and priority area determinations to begin collaborative discussions to determine stakeholder willingness and any future design and construction timelines that should be considered in conceptual design.

6.1 North Oaks

The North Oaks Company is a key stakeholder in this project, as Wilkinson Lake and much of the surrounding area lie within the City limits and intercept drainage from the City. The North Oaks Company is a leader in development within the City of North Oaks. The City of North Oaks Company met with VLAWMO and SEH staff on March 26th, 2020 to discuss the concept level plans the City has and how they may be able to collaborate the efforts for the Wilkinson nutrient reduction efforts. There were a total of 5 concept plans, including:

- The Nord Development, a future housing development located northwest of Deep Lake, however this future development area is located downstream of Wilkinson Lake and thus would have no impact on the runoff going to Wilkinson Lake.
- The Anderson Wood Development, a future single-family housing development located just southeast of Wilkinson Lake. The concept design for this development indicates a low density residential development with several adjacent wetlands.
- The Gate Hill Development, a future single-family housing development located south of Wilkinson Lake. The concept design for this development indicates a medium density residential development, existing between agricultural easements.
- The Island Field Development, a future housing development located south of Wilkinson Lake and northeast of Black Lake. The concept design for this development indicates condominiums, a large parking lot, and an access road, surrounded by green space.
- Red Forest Way South Development, a future single-family housing development located south of Wilkinson Lake. The concept design for this development indicates a low density residential development with adjacent forested and agricultural areas.

In addition to the concept plans reviewed, it is recognized that the North Oaks Company has other development plans throughout the City, some of which are located in areas identified during the potential site reviews. Similarly, the North Oaks Company also owns properties that are not ideal for development and did express willingness to collaborate with the Watershed in these areas.

The North Oaks Home Owners' Association (NOHOA) is a private association responsible for roads, parks and recreation, and other administrative duties within the City of North Oaks. All home owners within the City of North Oaks are members of the Association. NOHOA owns property within the City of North Oaks.

There are also association-maintained neighborhoods with the City of North Oaks, including the Villas of Wilkinson Lake. The Villas of Wilkinson Lake neighborhood is located on the northeast shore of Wilkinson Lake, and several locations within or adjacent to the neighborhood were identified in the potential sites review.

6.2 White Bear Township

The northwestern limits of White Bear Township discharge to the Wilkinson Lake Watershed, both directly and upstream through Tamarack and Black Lakes. The Township undertakes annual roadway projects. For the 2020 year, the Township shared their plans to improve Peterson Road. Peterson Road is an existing gravel roadway, located in the direct Wilkinson Watershed. The Township and their Engineer, met with VLAWMO and SEH staff on July 7th, 2020 and again on July 24th, 2020 and intermittingly thereafter, to discuss the Peterson Road improvements concept level plans. The Peterson Road project will include a stormwater treatment BMP facility for the redeveloped roadway.

Initially, discussions with the Township were pursued on behalf of potential partnership opportunities centered on the Peterson Road project, however due to the timing of construction and design and final space constraints, this opportunity was shifted towards a retrofit based opportunity. In addition to plans for the redevelopment or Peterson Road, the Township also shared plans for development at Tamarack Nature Center. Tamarack and Black Lakes are located in the Tamarack Nature Center, a 320-acre preserve which includes education buildings, hiking & cross-country skiing trails and other outdoor recreation areas. There are plans to further develop Tamarack Nature Center, however any future development will be treated locally with future construction dates dependent on securing funds for development.

6.3 White Bear Lake

The Wilkinson Lake direct watershed is not located within the limits of White Bear Lake, however portions of White Bear Lake drain to Birch Lake, which is located approximately 2.5 miles upstream of Wilkinson Lake. Birch Lake is not an impaired water body.

The City of White Bear Lake did share their plans for future capital improvements in the Birch Lake Area. The plans consisted of very few projects in the area, as the majority of the existing roadways appear to have acceptable pavement condition, constructed to current standards. Of the roadways planned for future improvements in the area, they are slated for 2025 construction, subject to change.

6.4 Ramsey County

Ramsey County is another key stakeholder in the project. The Ramsey County Soil and Water Conservation District has supported portions of the feasibility study efforts and collaborated with VLAWMO during the site analysis process. In addition to municipal stakeholders, Ramsey County was also solicited for information on future projects within the Wilkinson Watershed area, particularly, the County Road that exists just north of Wilkinson Lake, herein known as Ash Street. The Ash Street Crossing (north of Wilkinson Lake) has been identified previously as an area of high loading to Wilkinson Lake. Ash Street is unique in that parts of it either exist on the County Line, and other portions exist wholly within Anoka County.

During an Ash Street informational meeting that occurred on July 13th, 2020 with SEH, VLAWMO, and representatives of both Ramsey and Anoka Counties indicated that the portion of Ash Street that exists west of Centerville Road (CSAH 32) would be led by Anoka County, while the those portions east of Centerville Road would be led by Ramsey County (County Road J East). Ramsey County has current plans to reconstruct the eastern portion of Ash Street in 2024, pending secured funds. This reconstruction may include a round-a-bout or other intersection reconstruction.

6.5 Anoka County

Amelia Lake and the ditch system that conveys flows from the Lake to Wilkinson Lake is located within Anoka County. Anoka County coordinated with SEH, VLAWMO and Ramsey County during the Ash Street informational meeting that occurred on July 13th, 2020 and indicated that the reconstruction of this area is not currently being planned for, but the County does anticipate that the project will occurring sometime in the next 10 years.

7 Priority Project Areas

Following a review of the 40 potential BMP project sites and their respective viability rating, and several conversations with Stakeholders, three priority project areas that were chosen for further analysis and conceptual design of a best management practice(s), including:

- East Wilkinson Lake Watershed Enhancements (High Viability Sites 1, 2, 5, 7, and 14),
- Ash Street (Regional Treatment) (High Viability Site 34), and
- Ash Street (Linear Treatment) (High Viability Site 34).

The goal of the conceptual designs is nutrient removal, which is reported in terms of total phosphorus (TP) removal. TP is comprised of particulate phosphorus (PP, assumed at 55% of TP) and dissolved phosphorus (DP, assumed at 45% of TP).

For the purpose of this study, phosphorus loading rates for the priority project areas studied were taken from the Minimal Impact Design Standards (MIDS) calculator or approximated from the TMDL Lake Model. Refined loading and removal rates should be evaluated during any final design efforts.

7.1 East Wilkinson Lake Watershed Enhancements

A large portion of the Wilkinson Lake direct watershed is located to the east of Wilkinson Lake. This area is also the most heavily developed within the watershed, including various density residential properties, industrial areas, and roadways. There are several existing ponds and wetlands in this area. Several of the existing ponds were installed with adjacent development, some of which may be designed for superseded standards (ex. “NURP Ponds”). Despite the existing stormwater facilities, the eastern Wilkinson Lake Watershed was identified as a priority project area based on the suspected loading within the Watershed and the ability to enhance existing stormwater treatment facilities with modern and innovative design approaches.

There were two main areas identified within the eastern watershed, including,

- The Peterson Road Project (Site 14), and
- Several existing wet ponds located just east of Wilkinson Lake (Sites 1, 2, 5, 7).

The Peterson Road project is a 2020 roadway development project led by White Bear Township. The various wet pond locations identified as part of this study are all located within the City of North Oaks, although ownership varies between the North Oaks Company and the Villas of Wilkinson Lake Association. NOHOA properties are nearby.

7.1.1 Peterson Road

Peterson Road is an existing gravel roadway, located in the direct Wilkinson Watershed approximately 3,500 feet southeast of Wilkinson Lake. The roadway currently is a rural section, draining to the north end of the dead end road to a wetland complex adjacent to the existing road. This wetland joins with the ditch system from Black, Fish, and Birch Lakes, prior to entering Wilkinson Lake via the Wilkinson Inlet. This is a small portion of a larger area that is known as a large contributing point source of phosphorus to Wilkinson Lake, as indicated by the sampling and monitoring data collected by VLAWMO.

The roadway is an existing gravel roadway, as shown in **Figure 5**, which is planned for reconstruction. The reconstruction will include paving of the roadway and transitioning the road from a rural to urban section, with curb, gutter, and storm sewer. The project is planned for construction starting in fall 2020, with substantial completion by summer 2021. Based on the nature of the construction, the project itself is required to treat the reconstructed impervious surfaces to the Township Standards, however the project allows for a unique scenario to enhance the Township's design and treat stormwater to the maximum extent practicable. An infiltration basin is proposed as part of the Township's project. Due to the timing of construction, a retrofit based opportunity was pursued within this study.

Although not included with the current project, there is a future potential project to extend the Peterson Road reconstruction further north, to the end of the roadway.

Figure 5: Peterson Road

7.1.1.1 Contributing Area

The contributing area to the future Peterson Road stormwater basin is approximately 9 acres, with 0.8 of those being directly connected impervious surfaces from the new, urban section roadway. The future expansion could include approximately 2-4 acres of total drainage depending on design, with approximately 0.6 acres of directly connected impervious surfaces.

Outside of the roadway surfaces, the drainage area includes various density residential properties and open spaces that will ultimately discharge towards Peterson Road via surface flow. The Township's design is based on the directly connected impervious surfaces, therefore this information is tabulated separately and was used within conceptual design. Approximate phosphorus loading of the contributing area and roadway only, including the future expansion area in both scenarios, is summarized in **Table 2**.

Table 2: Peterson Road Annual TP Load in pounds per year (lb/yr)

Source	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
Peterson Road (Total Drainage Area)	2.36	1.92	**4.28**
Peterson Road (Roadway Only)	1.47	1.20	**2.67**

Source: Minimal Impact Design (MIDS) Calculator

7.1.1.2 Conceptual Treatment Approach

Based on the Township requirements, the project must treat 0.75 inches over the redeveloped impervious surfaces. The Township may redevelop the northern segment of the road in the future, and therefore included this future area in the stormwater design. The proposed enhancements will also plan for this additional area to maintain the regional vision of the basin. The Peterson Road redevelopment project is planned to be treated via an infiltration basin, utilizing native soils, with a Hydrologic Soil Group 'B' designation. The soils are assumed to infiltrate at a rate of 0.4 inches/hour. The Peterson Road basin water quality modelling summary and plan and profile information as submitted by the Township's engineer is included in **Appendix B**. As shown in the information in **Appendix B**, the pond is designed to include 0.6 feet of depth, based on the 0.75 inch water quality volume.

The suggested treatment approach for enhancements to the Peterson Road infiltration basin is a retrofit design, including:

- Increasing the water quality volume by 1,800 cubic feet to treat up to the 1.1 inch event over the redeveloped impervious surfaces
- Media enhancements of the native soils to improve surface drawdown and promote longer-standing infiltration integrity
- Outlet modifications (raising outlet approximately 0.2') will be necessary to accommodate the additional treatment volume
- Vegetation re-establishment will be necessary throughout the basin following media replacement. An upgraded seed mix designed or selected to include a diverse selection of native wetland plants and shrubs to increase pollutant removal and support pollinators is recommended.

Additional treatment approaches could include:

- Expanding the basin footprint to the north, adding approximately 3,000 cubic feet of storage to be used for additional treatment, resiliency, or specific vegetation areas
- Installing additional media enhancements (such as iron enhanced sand) to increase treatment for those events exceeding the water quality volume but still recognized as polluted runoff (up to 2.5")

Modelling within final design will be required to verify the appropriate outlet configuration. A concept sketch of the proposed retrofit treatment is shown in **Figure 6**.

7.1.1.3 Pollutant Reduction Potential

Based on the Township's preliminary modelling, the proposed basin will remove 76.5% of total phosphorus from the 0.75 inch design water quality volume over the redeveloped roadway surface, summarized in **Table 3**. The 'No Treatment' scenario below represents the directly connected impervious surfaces only.

Table 3: Peterson Road Discharge Loading and Proposed Removals (lb/yr)

Scenario	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
Peterson Road Pre-Redevelopment (No Treatment)	1.47	1.20	**2.67**
Peterson Road Post-Redevelopment	0.35	0.28	**0.63**
		Removal Percentage	**76.5%**

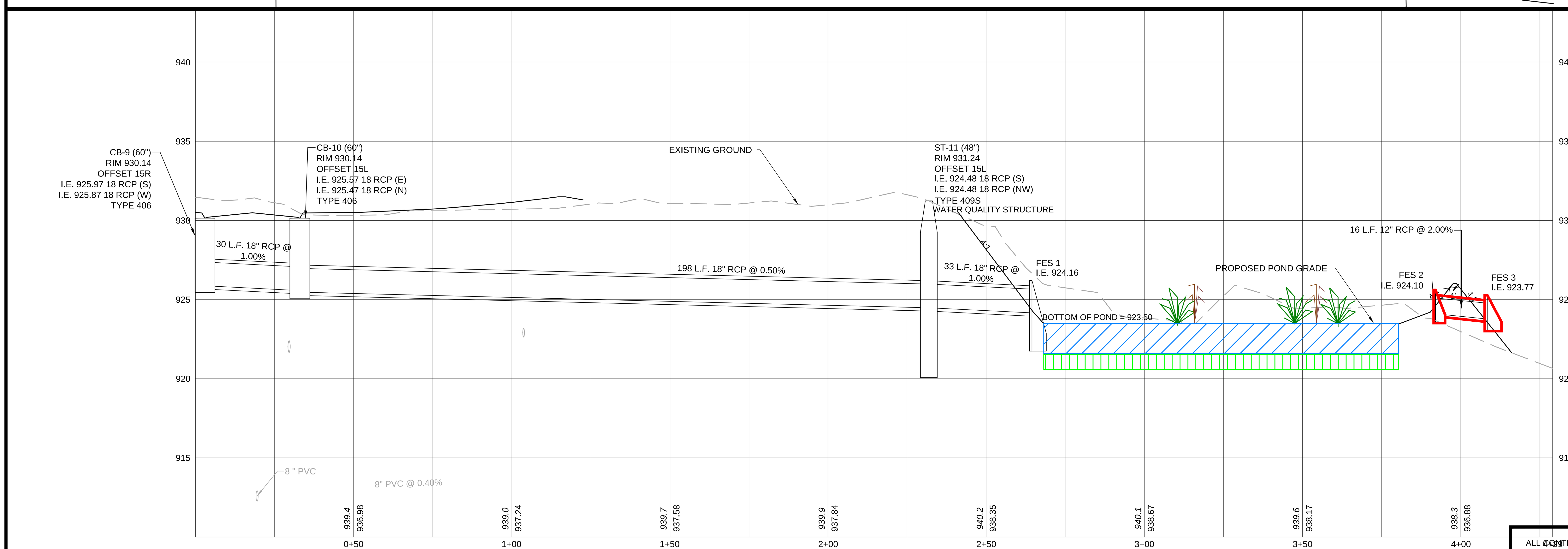
Source: Minimal Impact Design (MIDS) Calculator

The proposed enhancements will increase the removal potential of the proposed basin to 97% of TP for the water quality volume over the redeveloped roadway, summarized in **Table 4.**

Table 4: Peterson Road Discharge Loading and Enhanced Basin Removals (lb/yr)

Scenario	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
Peterson Road Pre-Redevelopment (No Treatment)	1.47	1.20	**2.67**
Peterson Road Enhanced Basin	0.04	0.05	**0.09**
		Removal Percentage	**97.0%**

Source: Minimal Impact Design (MIDS) Calculator



INFILTRATION POND NOTES:

1. CONTRACTOR SHALL COORDINATE 2 DOUBLE RING INFILTROMETER TESTS ON THE POND BOTTOM PRIOR TO TURF RESTORATION. INFILTRATION RATE IS ASSUMED TO BE 0.4IN/HR. CONTRACTOR TO NOTIFY ENGINEER IF TESTED RATE IS BELOW 0.8IN/HR.
2. CONTRACTOR SHALL WORK TO MINIMIZE COMPACTION OF THE POND BOTTOM. INFILTRATION POND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MPCA NPDES PERMIT STANDARDS.

LEGEND

- Outlet and Storm Sewer Modifications
- Media Enhancements
- Subsoil Preparation
- Vegetation Enhancements

PRELIMINARY
NOT FOR
CONSTRUCTION

ALL CONTRACTORS AND SUBCONTRACTORS SHALL VERIFY ALL DIMENSIONS BY MEASUREMENT AT THE BUILDING AND/OR SITE

0 1
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS DRAWING ADJUST SCALES ACCORDINGLY.

NO.	DATE	BY	DESCRIPTION OF REVISIONS
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DESIGNED AMK
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CHECKED JES

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

SIGNATURE:________________ DATE: ---

NAME: JAMES E. STUDENSKI LIC. NO.: 23757

TKDA
444 Cedar Street, Suite 1500
Saint Paul, MN 55101
651.292.4400
tkda.com

PETERSON ROAD
IMPROVEMENTS

Wilkinson Lake Feasibility Study
Peterson Road Enhancements
Figure 6

PLOT DATE: Aug 13, 2020 - 5:06pm
FILENAME: \\tkdcsrv01.tkda.com\projects\n-z\WhiteBearTwp\17727002\04_Production\01_CAD\02_Sheets\C104 STREET AND STORM SEWER PLAN & PROFILE.dwg

7.1.2 East Wilkinson Lake Ponding Areas

Development just east of Wilkinson Lakes includes several residential neighborhoods, parks and green space, and industrial areas within the City of North Oaks. This area is the most heavily developed within the watershed and therefore is suspected as an area of higher loading to Wilkinson Lake. The majority of developments appear to have onsite stormwater treatment through existing wet ponds. Wet ponds can remove nutrients if designed properly, however typically have lower removal rates than infiltration or filtration treatment facilities. Due to the nature of the area soils and suspected groundwater, these areas are not conducive for infiltration, however do offer an opportunity for enhanced media filtration practices to be retrofit along pond banks.

For the purposes of this study, those ponds that exist in the residential area were the area of focus. It should be noted that these ponds exist on private property as owned by either Presbyterian Homes, North Oaks Company, or the Wilkinson Lake Homeowner's Association. A site visit to several existing ponds was conducted on August 26th, 2020 and included:

- Presbyterian Homes Undeveloped Area
    - This ponding area is located just northeast of Wilkinson Lake and although it is surrounded by undeveloped area, it was reported that this pond is the discharge point for the Presbyterian Homes development to the east of Wilkinson Lake Boulevard. Dense vegetation exists along the pond banks so no further information was identified during the site visit.
- Phoebe Lane Residential Area
    - This ponding area is located adjacent to Phoebe Lane and Wilkinson Lake Boulevard. The east pond bank is steep as it ties into the Boulevard. However the west side has flatter slopes that may support the installation of a filtration bench. Further information on storm sewer routing is needed for a more detailed analysis of this area. The Phoebe Lane residential area pond is shown in **Figure 7**.
- Kestrel Court Residential Area
    - This ponding area is located south of the Kestrel Court neighborhood and intercepts drainage from a large swale located between the Kestrel Court neighborhood and Osprey Court neighborhood that drains from east to west. The swale area is shown in **Figure 8**. The existing swale is wide and could potentially include linear treatment enhancements, prior to discharge to the pond. Dense vegetation exists along the pond banks so no further information was identified during the site visit.
- Osprey Court Residential Area (2)
    - The Osprey Court residential area pond is a longer linear pond, which exists between residential homes and the conservation trail. The east side of the pond, neighboring the residential homes, is steeper with retaining wall structures. The west side of the pond is flatter with areas that may support the installation of a

filtration bench. Further information on storm sewer routing is needed for a more detailed analysis of this area. The Phoebe Lane residential area pond is shown in **Figure 9**.

- A second pond located south of the Osprey Court residential area was visited during the site visit. This pond is relatively new and includes two cells; one wet pond cell and an infiltration cell. Due to the nature of this pond, enhancements are not suggested as volume management is already being achieved onsite.

- There were some additional smaller ponding areas identified during the site visit in the Osprey Court residential area, although it is recognized that these ponding areas could be wetlands or serve a different purpose than stormwater treatment. Further investigation is suggested for these areas to determine if there are any other potential treatment areas.

Figure 7: Phoebe Lane Residential Area Pond

Figure 8: Kestrel Court Swale to Pond

Figure 9: Osprey Court Residential Area Pond

7.1.2.1 Contributing Area

As the stormwater ponds were constructed as part of the residential developments, it is assumed that they are designed to capture drainage from the neighborhood roadways and homes. The contributing areas do vary amongst the ponds, however due to the density of development and for purposes of this study, it is assumed that the impervious percentage of the drainage area is approximately 30% at full build out, with the majority of the remaining area being comprised of lawn or other manicured green space.

The approximate phosphorus loading of a general residential drainage area, 3 acres in size with 30% impervious coverage, is summarized in **Table 5**. The data in **Table 5** could be scalable based on watershed size and impervious coverage.

Table 5: General Residential Area Watershed Annual TP Load in pounds per year (lb/yr)

Source	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
General Residential Drainage Area (No Treatment)	1.47	1.20	**2.67**

Source: Minimal Impact Design (MIDS) Calculator

7.1.2.2 Conceptual Treatment Approach

The suggested treatment approach for the east Wilkinson Lake ponding areas include installing an enhanced media filtration bench that would function with the existing stormwater infrastructure to create a 'treatment train' system for up to the water quality event.

Standard filtration practices are known to filter pollutants from runoff. However, filtration practices are limited in their abilities to capture dissolved phosphorus. Utilizing iron filings within a filtration media allow for the sorption of dissolved phosphorus, yielding higher total phosphorus removal rates.

The proposed bench would be designed to maintain the existing pond normal water level, intercepting drainage upon a bounce in the ponds live storage following a rainfall event. The pond would provide pre-treatment for the bench. Stormwater up to the water quality event would filter through the enhanced media bench prior to discharge towards Wilkinson Lake. See **Figure 10** for an Iron Enhanced Sand Filter Bench schematic.

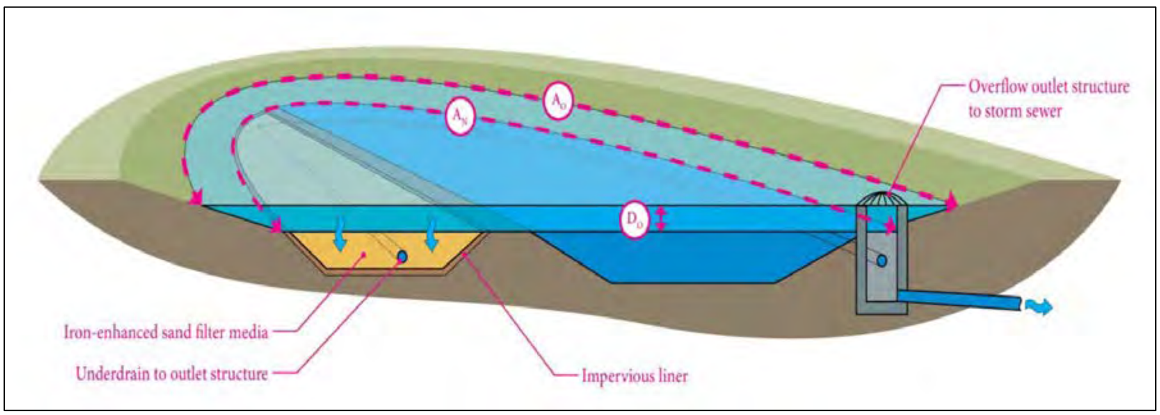


Figure 10: Iron Enhanced Sand Filter Bench in Wet Pond (Source: MIDS Work Group)

A concept sketch of the potential treatment locations for the Phoebe Lane residential area, Kestrel Court Swale, and Osprey Court residential area are shown in **Figures 11-13**.

7.1.2.3 Pollutant Reduction Potential

It is assumed that the existing stormwater ponds are providing a level of treatment consistent with a Design Level 1 Pond (MIDS), therefore removing 0% dissolved phosphorus and 62%

particulate phosphorus, for a total of 34% total phosphorus. **Table 6** summarizes potential removal rates from a general residential drainage area with a stormwater pond.

Table 6: General Residential Area Discharge Loading and Proposed Removals (lb/yr)

Scenario	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
General Residential Drainage Area (No Treatment)	1.47	1.20	**2.67**
General Residential Area with Stormwater Pond	0.56	1.20	**1.76**
		Removal Percentage	**34.0%**

Source: Minimal Impact Design (MIDS) Calculator

Iron-enhanced sand media has accepted removal rates of up to 65% of total phosphorus for the filtrated volume, including 40% of dissolved phosphorus and 85% of particulate phosphorus (MIDS Calculator). The proposed enhancements will increase the removal potential of the proposed system from 34% to approximately 55-75%, based on the contributing area and final design. For the purposes of this study, the additional removal potential was applied to the general drainage area, yielding an increase of removal of approximately 38% of total phosphorus for the water quality volume, summarized in **Table 7**.

Table 7: General Residential Area Discharge Loading and Enhanced Stormwater Pond Removals (lb/yr)

Scenario	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
General Residential Drainage Area (No Treatment)	1.47	1.20	**2.67**
General Residential Area with Enhanced Stormwater Pond	0.08	0.66	**0.74**
		Removal Percentage	**72.3%**

Source: Minimal Impact Design (MIDS) Calculator

7.1.3 Opinion of Probable Cost

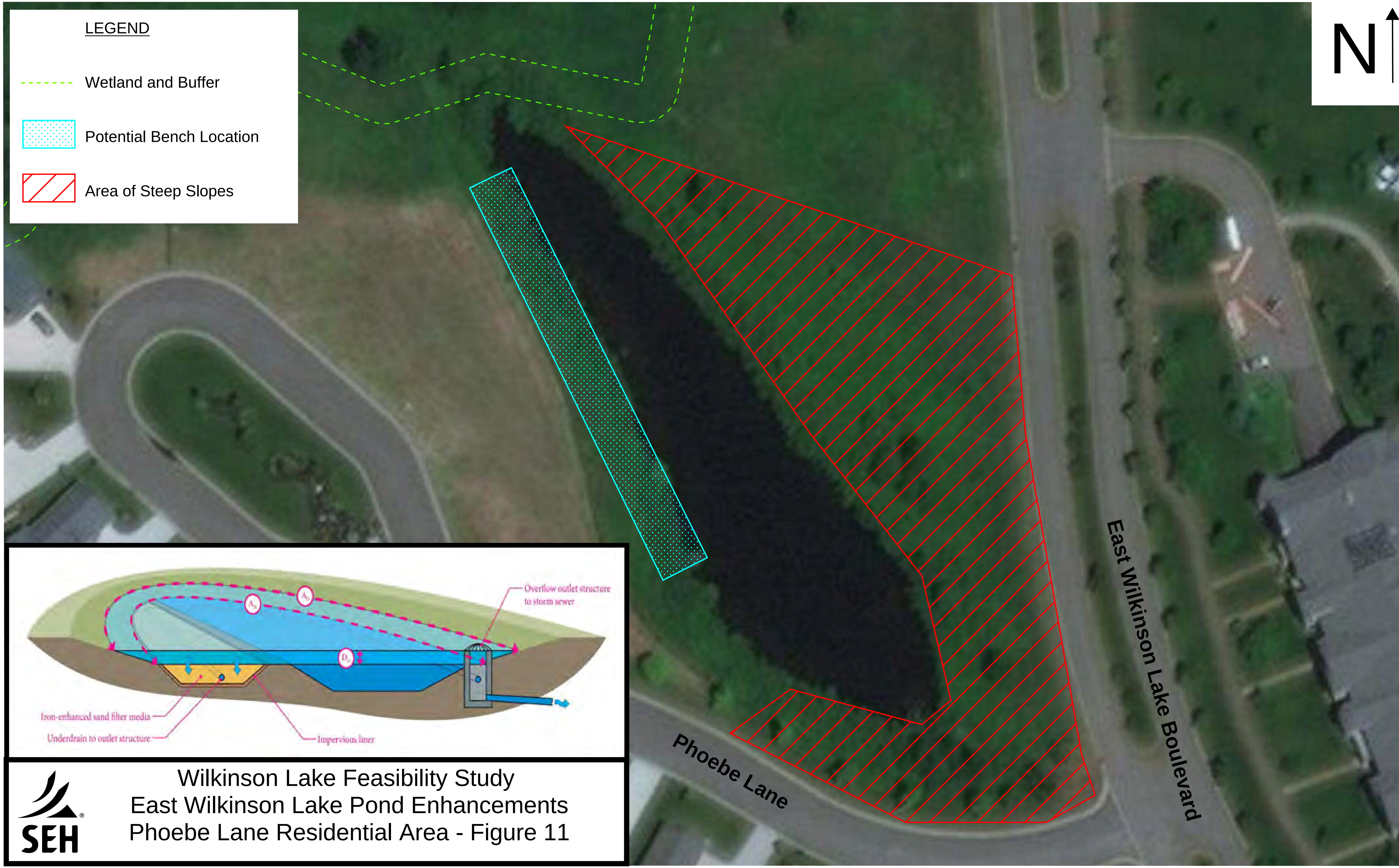
SEH has prepared a preliminary cost estimate for the construction and engineering fees for the East Wilkinson Lake Watershed Enhancements. Unit costs were chosen using MnDOT average bid prices and information from recent stormwater treatment projects. Detailed cost estimates are in **Appendix C** and a summary of cost estimation is shown in **Table 8**.

It is important to note that the estimated total cost for the East Wilkinson Lake Enhanced Ponding Area assumes 100 lineal feet of bench area. This cost is intended to be scaled to an actual design length.

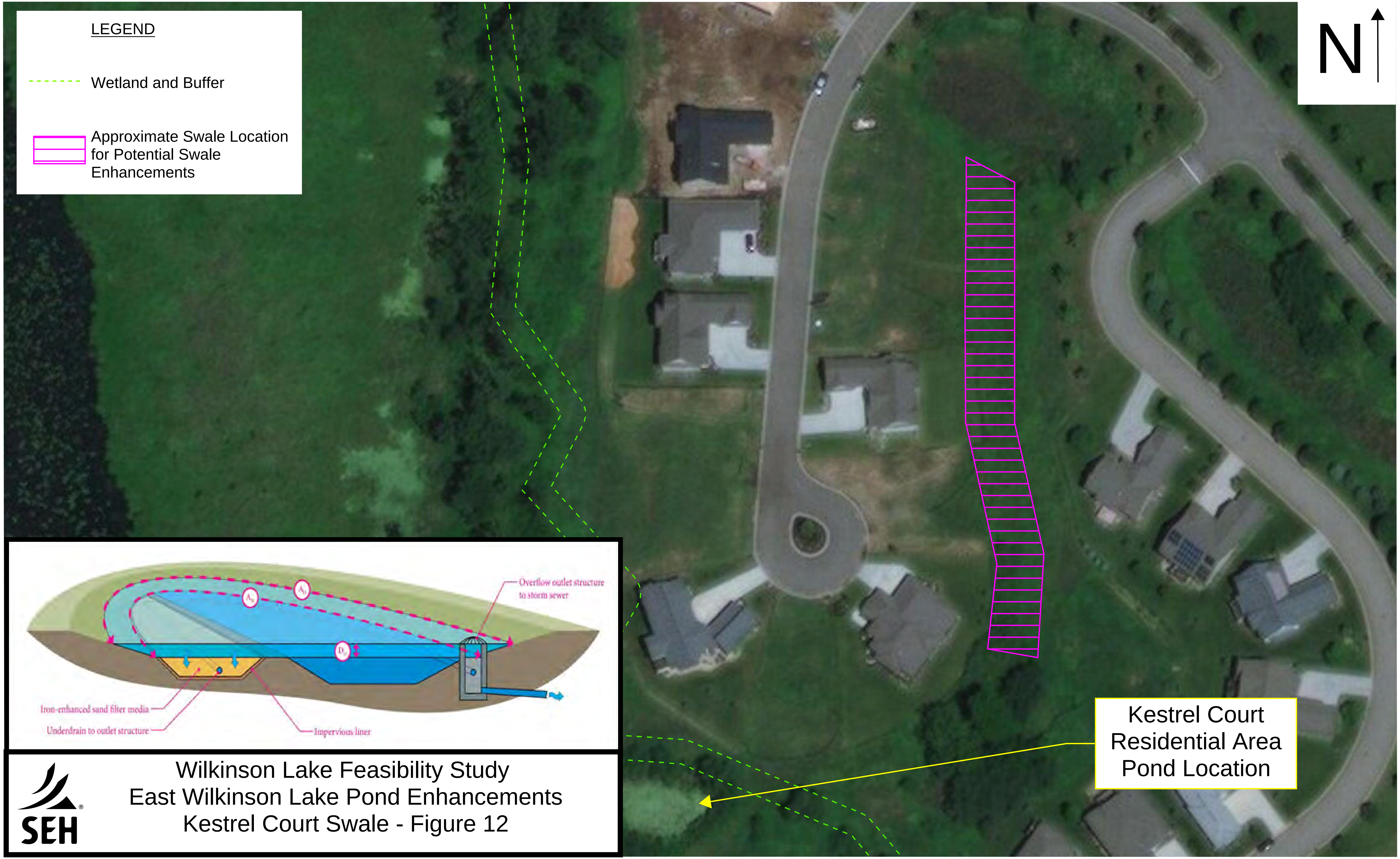
Table 8: East Wilkinson Lake Watershed Enhancements Cost Estimated Summary

Scenario	Estimated Total Cost
Peterson Road Enhanced Basin	**$146,000**
East Wilkinson Lake Enhanced Ponding Area	**$61,500 (per 100 LF)**

It should be noted that the above costs do not include fees associated with wetland mitigation that may be required due to the project work.



Wilkinson Lake Feasibility Study
East Wilkinson Lake Pond Enhancements
Phoebe Lane Residential Area - Figure 11



SEH

Wilkinson Lake Feasibility Study
East Wilkinson Lake Pond Enhancements
Kestrel Court Swale - Figure 12

Wilkinson Lake Feasibility Study
East Wilkinson Lake Pond Enhancements
Osprey Court Residential Area - Figure 13

7.2 Ash Street

Ash Street runs along the Ramsey County and Anoka County line and is staggered on either side of Centerville Road. As indicated by the Counties, Ash Street to the west of Centerville Road (CSAH 32) is led by Anoka County while Ash Street to the east of Centerville Road (County Road J East) is led by Ramsey County. Ramsey County has plans to reconstruct the eastern segment of Ash Street in 2024, however Anoka County does not yet have a date in mind for the reconstruction of the western portion of Ash Street. Although reconstruction of these areas is slated for several years from now, this area was identified as a priority project area based on the suspected loading within the watershed to the crossing and the proximity to Wilkinson Lake.

Two treatment approaches were investigated for Ash Street, including:

- Regional Treatment downstream of the Ash Street Crossing, and
- Linear Treatment along both east and western portions of Ash Street.

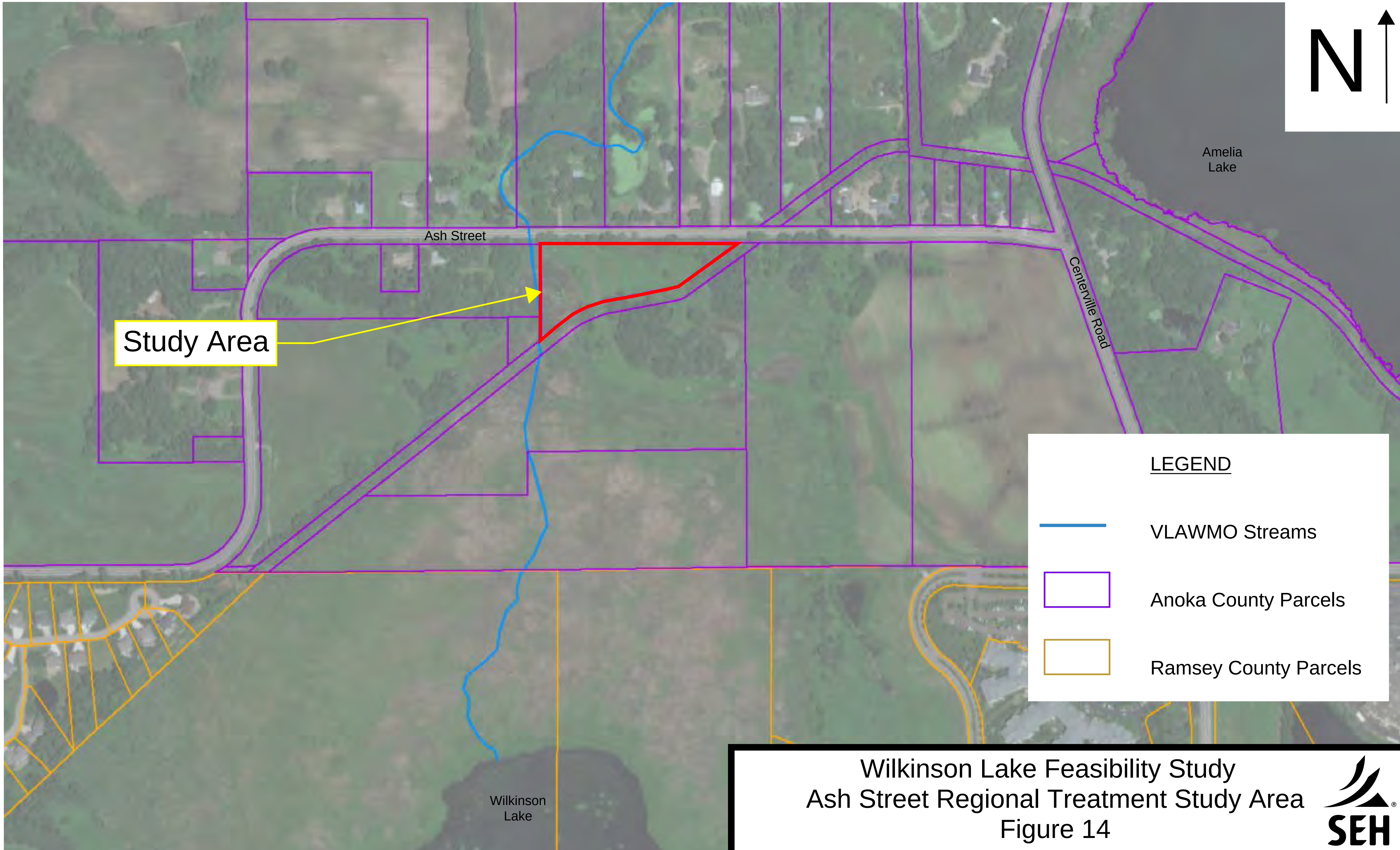
7.2.1 Ash Street (Regional Treatment)

As indicated by the sampling and monitoring data collected by VLAWMO, the Ash Street crossing ditch system is known as a large contributing point source of phosphorus to Wilkinson Lake. Just downstream and adjacent to the Ash Street crossing, there is a property owned by North Oaks Farms (Property ID 34-31-22-44-0006), within Anoka County, as shown in **Figure 14**. North Oaks has expressed willingness to let VLAWMO investigate the use of this property for stormwater treatment. This collaboration offers an opportunity to pursue a larger, regional treatment system.

7.2.1.1 Contributing Area

The ditch system which crosses beneath Ash Street and discharges to Wilkinson Lake conveys flow from Amelia Lake and the northern Wilkinson Lake direct watershed, therefore conveying discharge from a large drainage area of nearly 1,000 acres, comprised of open space, agricultural land, and residential properties. Of the nearly 1,000 acres of drainage, approximately 200 acres is part of the Wilkinson direct watershed, while the remaining is part of the Amelia Lake direct watershed. As aforementioned, the complete connection between Amelia and Wilkinson Lakes is only made during very wet weather conditions. During normal conditions, this connection is mostly stagnant.

As part of the TMDL Lake Model, annual phosphorus loading from Lake Amelia was calculated. Additionally, annual phosphorus loading from the Wilkinson direct watershed was also calculated. For the purposes of this study, the loading from the direct Wilkinson watershed which discharges through the Ash Street crossing was proportionally assumed based on area. It is important to note that the TMDL Lake Model has the direct watershed area tabulated at 12 square kilometers, or nearly 3,000 acres, which is larger than was anticipated. This may result in higher loading values represented within the TMDL however lower loading values represented in this report. Approximate phosphorus loading of the drainage area to the Ash Street crossing is summarized in **Table 9**.



Wilkinson Lake Feasibility Study
Ash Street Regional Treatment Study Area
Figure 14

SEH

Table 9: Ash Street Crossing Annual TP Load in pounds per year (lb/yr)

Source	Particulate Phosphorus (PP) (lb/yr)	Dissolved Phosphorus (DP) (lb/yr)	Total Phosphorus (TP) (lb/yr)
Lake Amelia	7.0	8.6	**15.6**
Direct Watershed to Ash Street	27.5	22.5	**50.0**

Source: TMDL Lake Model

Annual loading to Ash Street crossing may need further analysis within final design to determine accurate removal potentials.

7.2.1.2 Regional Treatment Approach

The property being investigated for the regional treatment is somewhat linear in shape extending east, away from the Ash Street crossing, therefore ditching or crossing realignment would be necessary to utilize the entire property. The property is bound by wetland areas from Wilkinson Lake on the south and west and the roadside ditch to the north, inadvertently decreasing the space available for stormwater treatment. Additionally, the Ash Street Crossing does not have much vertical separation from the adjacent wetlands, making an infiltration or filtration system difficult. Due to the nature of the surrounding area and site constraints, the following treatment types were considered for regional treatment:

- Constructed Wetland, and
- Stormwater Pond.

Constructed wetlands, also known as stormwater wetlands, are similar in design to stormwater ponds, but differ in their variety of water depths and vegetative habitat. There are different kinds of constructed wetlands. For the purposes of this report, a shallow wetland was investigated. This type of constructed wetland is appropriate for the property given vertical elevation constraints. A shallow wetland is mostly shallow with approximately 1 to 1.5 feet depth of water with some deeper marsh areas, including a sediment forebay. As in any wetland complex, maintainable hydrology is imperative to the wetland health. The proximity to groundwater in this location is beneficial sustenance of hydrology.

A concept layout of a constructed wetland and stormater pond downstream of the Ash Street crossing are shown in **Figures 15-16**. Additionally, typical plan and profiles for a constructed wetland and stormwater pond as available on the Minnesota Stormwater Manual are included in **Appendix D**.

7.2.1.3 Pollutant Reduction Potential

Phosphorus removals from constructed wetlands and stormwater ponds are summarized in **Table 10**. Both treatment types do not provide any dissolved phosphorus removal but do provide a reduction in particulate phosphorus. Additionally, both treatment types also provide other beneficial uses, such as aquatic habitat or floodwater retention, for example. A Design Level 1 is assumed for a stormwater pond at this site. Any stormwater pond constructed on this site would interact with groundwater, making it ineligible for Design Level 2.

Table 10: Constructed Wetland and Stormwater Pond Phosphorus Removal Rates

Treatment Type	Particulate Phosphorus Removal (%)	Dissolved Phosphorus Removal (%)	Total Phosphorus Removal (%)
Constructed Wetland	55	0	**30**
Stormwater Pond (Design Level 1)	62	0	**34**

Source: Minnesota Stormwater Manual

It is important to note that the reported removal rates represent removal for a water quality event, effectively captured by each type of treatment. As shown in **Table 10**, both treatment types offer comparable removal potentials, however differing volumes are achievable onsite, yielding the ability to capture differing water quality volumes.

Preliminary grading was completed for both treatment options. It was assumed that the wetland area would have 6:1 side slopes and tie into existing wetland areas adjacent to the site, intercepting drainage from the adjacent wetland and Wilkinson Lake. Further micro-grading of the interior wetland area should be evaluated during final design.

Preliminary grading for the stormwater pond included both dead and live storage areas. Dead storage areas must be at least 3 feet in depth but cannot exceed 10 feet and must provide1800 cubic feet of storage for each acre draining to the pond. The live storage area was maximized as the discharge rate must not exceed 5.66 cubic feet per second per acre of surface area of the pond.

Available space and the corresponding water quality volume is summarized in **Table 11**. The treatment volume for the constructed wetland is tabulated as shallow ponding areas while the treatment volume available for the stormwater pond is the live storage area.

Table 11: Constructed Wetland and Stormwater Pond Treatment Area Potential

Treatment Type	Treatment Volume (ac-ft)	Water Quality Event (in)	Treatment Area (ac)
Constructed Wetland	1.3	1.1	**14**
Stormwater Pond (Design Level 1)	1.2	1.1	**13**

Using the design criteria and treatment area available as summarized in **Table 10** and **Table 11**, respectively, potential phosphorus removals were estimated as shown in **Table 12**. For this analysis, the loading from the direct Wilkinson watershed which discharges through the Ash Street crossing was proportionally assumed based on treatment area, using the estimation from **Table 9**. As noted above, the values represented in the TMDL Lake Model for direct watershed area and loading should be verified.

Table 12: Constructed Wetland and Stormwater Pond Treatment Area Potential Removals (lb/yr)

Treatment Type	Treatment Area (ac)	Approximate Total Phosphorus Loading (TP) (lb/yr)	Approximate TP Removal (lb/yr)
Constructed Wetland	14	3.5	1.05
Stormwater Pond (Design Level 1)	13	3.3	1.12

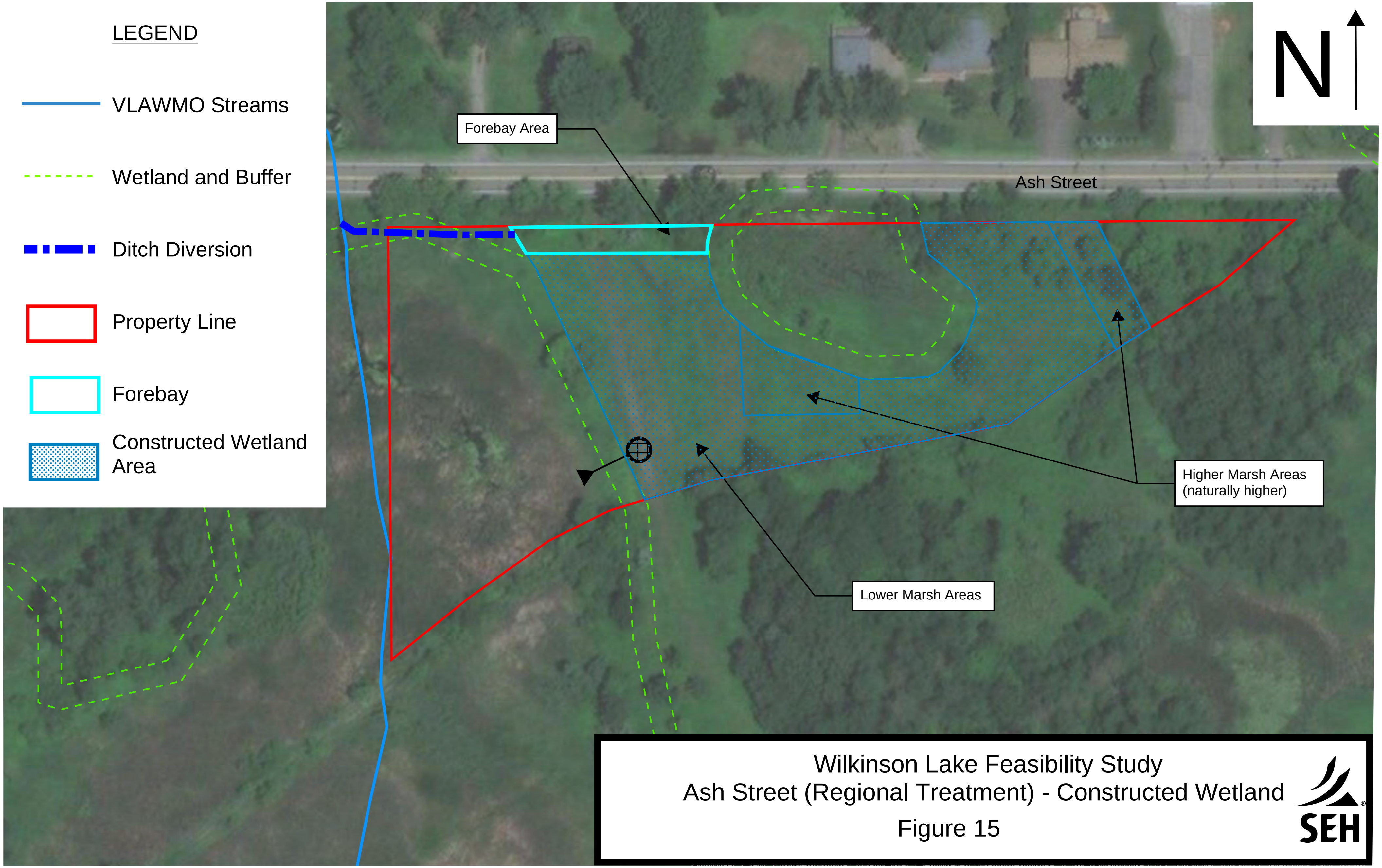
7.2.1.4 Opinion of Probable Cost

SEH has prepared a preliminary cost estimate for the construction and engineering fees for regional treatment just downstream of the Ash Street Crossing. Unit costs were chosen using MnDOT average bid prices and information from recent stormwater treatment projects. Detailed cost estimates are in Appendix C and a summary of cost estimation is shown in **Table 13**.

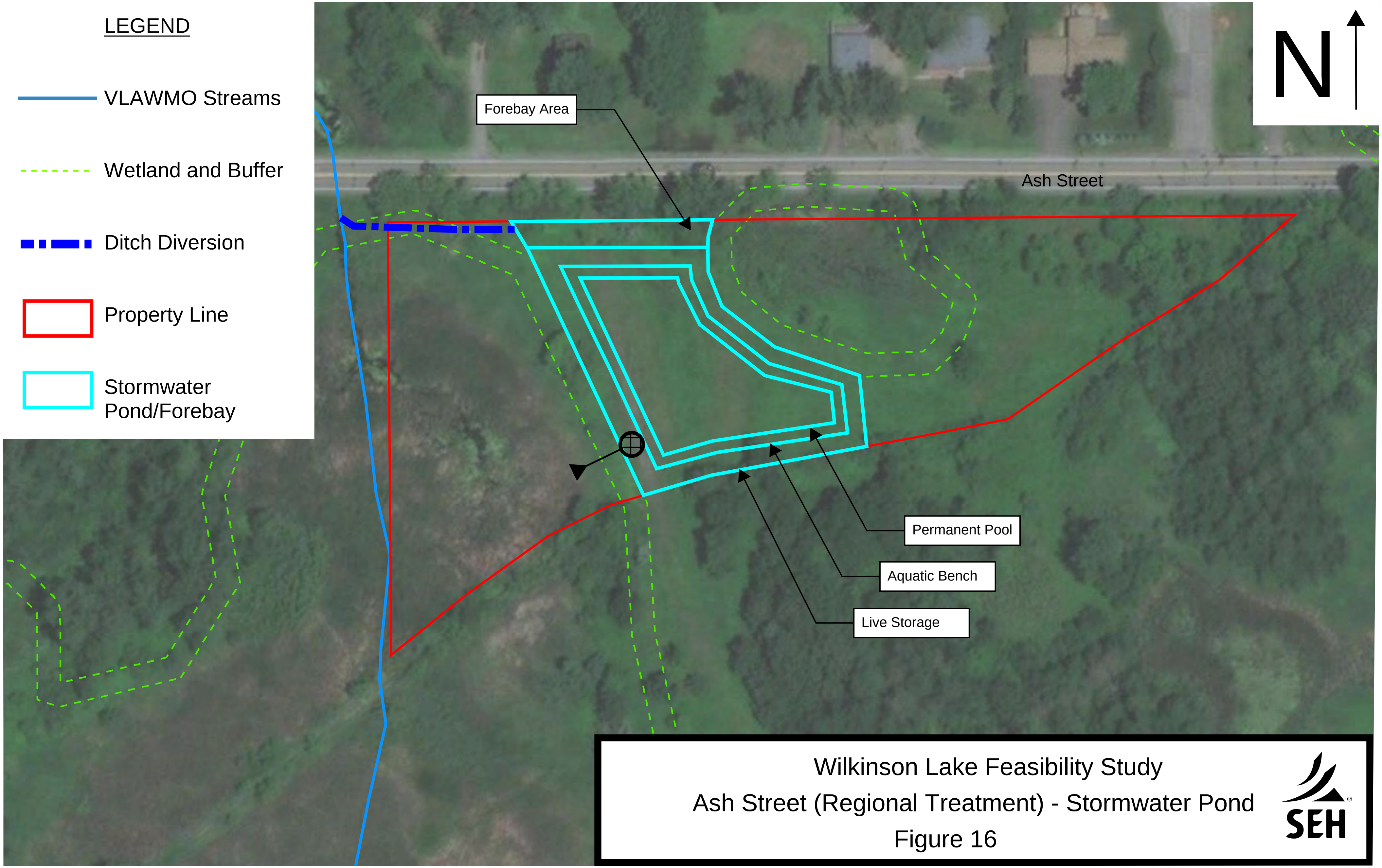
Table 13: Ash Street Regional Treatment Cost Estimated Summary

Scenario	Estimated Total Cost
Ash Street Regional Constructed Wetland	**$389,500**
Ash Street Regional Stormwater Pond (Design Level 1)	**$302,500**

It should be noted that the above costs do not include fees associated with wetland mitigation that may be required due to the project work.



Wilkinson Lake Feasibility Study
Ash Street (Regional Treatment) - Constructed Wetland
Figure 15



Wilkinson Lake Feasibility Study

Ash Street (Regional Treatment) - Stormwater Pond

Figure 16

7.2.2 Ash Street (Linear Treatment)

It is recognized that regional treatment efforts are cost prohibitive and require adequate space and routing, therefore an additional approach to treatment within the Ash Street area was examined due to the proximity to Wilkinson Lake and past sampling and monitoring data.

Linear stormwater treatment facilities are designed to fit throughout a linear corridor. These treatment facilities are often smaller sized facilities, placed in a treatment train style. There can be opportunities for larger practices within a linear corridor in intersection areas.

Ash Street is shown in **Figure 17**.

Figure 17: Ash Street (Anoka County)

7.2.2.1 Contributing Area

The contributing area to linear treatment facilities is usually direct runoff from the adjacent roadway, however there are some instances where offsite drainage is intercepted. For the western Ash Street area (Anoka County), it is assumed that the drainage areas would consist of both roadway and offsite drainage, comprised of mostly green spaces, agricultural areas or low density residential. For the eastern Ash Street area (Ramsey County), it is assumed that the drainage areas would consist of mostly roadway and with some offsite drainage, comprised of mostly landscaped areas with some impervious surfaces.

7.2.2.2 Conceptual Linear Treatment Approach

There are a variety of linear treatment best management practices, including but not limited to:

- Swale Side Slopes
- Bio-Swales
- Ditch Checks
- Infiltration Trenches
- Subsurface Systems
- Proprietary Devices and Filters

These methods can be designed for infiltration or filtration, depending on the site soils. Some of these methods provide volume management while others are ‘flow through’ devices. It is suggested that linear treatment facilities are investigated and chosen based on contributing drainage areas, constructability, and treatment type desired.

Details and typical plan and profiles for linear treatment best management practices as available on the Minnesota Stormwater Manual are included in **Appendix D**.

7.2.2.3 Pollutant Reduction Potential

The potential pollutant reductions for linear treatment facilities can vary greatly based on size, treatment type and contributing drainage areas. However, potential pollutant removals can be estimated based on general treatment type accepted removal values. It is important to note that these removal potentials are based on the treatment type, sized adequately for the desired water quality volume. Some general treatment type accepted removal values are:

- Infiltration – Up to 100% of total phosphorus for infiltrated volume
- Filtration – Approximately 50-55% of total phosphorus for filtrated volume
- Filtration with Enhanced Media – Approximately 65% of total phosphorus for filtrated volume
- Detention – Approximately 35% of total phosphorus for detained volume

7.2.2.4 Opinion of Probable Cost

SEH has summarized preliminary unit cost estimates for construction and engineering fees for the linear treatment facilities as shown in **Table 14**. Unit costs were chosen using MnDOT average bid prices and information from recent stormwater treatment projects. These costs are intended to be scalable to linear treatment space or quantity available and should be used for planning purposes only.

Table 14: Linear Treatment Facility Unit Cost Estimation Summary

Linear Treatment	Estimated Total Unit Cost
Swale Side Slopes	$30/LF
Bio-Swales	$130/LF
Ditch Checks	$2,200/Each
Infiltration Trenches	$50/LF
Subsurface Systems	$400/LF
Proprietary Devices and Filters	$5,000-$25,000/Each

It should be noted that the above cost do not include fees associated with wetland mitigation that may be required due to the project work.

7.3 Additional Treatment Opportunities

In the analysis of the various site options, there were two residential neighborhood sites that had been identified in the 2012 Retrofit and Feasibility Study performed by Ramsey Conservation District. The 2012 study recommended bio-retention retrofits throughout the residential area. These areas, referred to as sites 20 and 22 within this study, received a high and moderate viability rating, respectively. This rating assumes that the entire neighborhood could be captured and treated in some BMP or network of BMPs. These sites may be an opportunity for VLAWMO to utilize their cost share programs to encourage individual landowners to install rain gardens or undertake other water quality practices within their properties.

Additionally, VLAWMO's cost share programs at both Level 1 and Level 2 may be able to support ventures as listed in this report, and provide additional treatment opportunity throughout the Wilkinson Watershed.

8 Recommendations

The potential treatment locations and their respective removal potentials as described in this report is a high level analysis to assist VLAWMO in determining the overall feasibility of individual projects throughout the Wilkinson Lake Watershed. It is recommended that VLAWMO pursue the following actions should any of these projects continue towards final design:

- Continue discussions with stakeholders to collaborate on development and redevelopment project locations, timelines, and goals
- Initiate stakeholder discussions early in the design process to maintain involvement and open communication
- Prior to initiating a final design, complete additional structure and topographic surveys, soil investigations, and any additional monitoring needed to provide further detail necessary for the East Wilkinson Lake Pond Enhancement Areas and Ash Street Regional Treatment Area
- Continue watershed sampling throughout the Wilkinson watershed to identify areas of high loading
- Continue to utilize the VLAWMO cost share program throughout the watershed

Appendix A

Potential BMP(s) Site Identification Assumptions and Interim Submittal

Appendix A
Table A-1

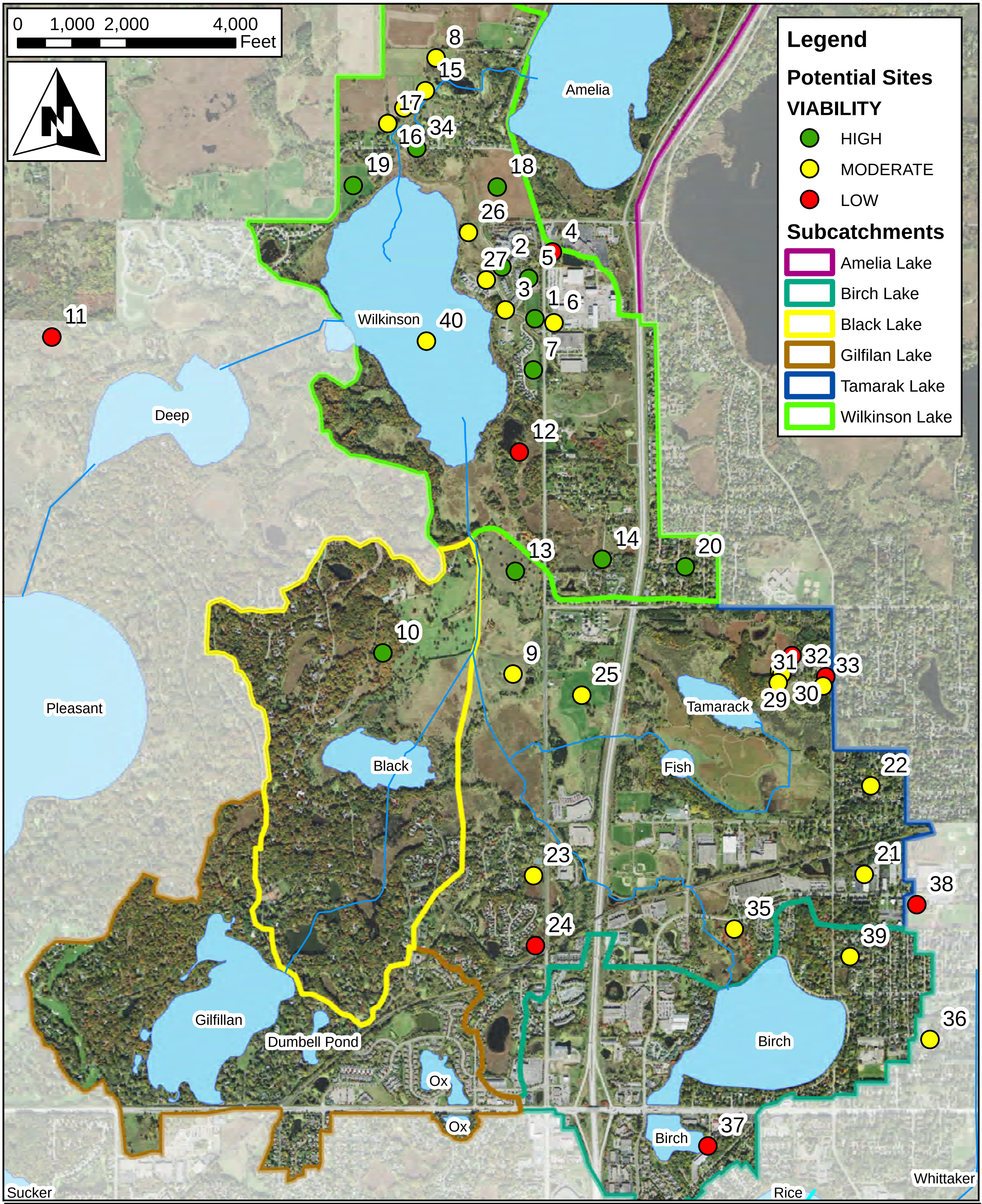
Site	Description
1	North Oaks Home Owners' Association (NOHOA) Park Area
2	Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA, Potential BMP Enhancements
3	Villas of Gem Lake, NOHOA, Potential BMP Enhancements
4	Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA, Potential BMP Enhancements
5	North Oaks Home Owners' Association Park Area
6	Schwing America Inc, Potential BMP Enhancements
7	North Oaks Home Owners' Association Park Area
8	Privately owned land north of Wilkinson, agricultural drainage
9	Island Field Development, North Oaks Company
10	Future Red Forest Way South Development, North Oaks Company
11	Nord Development, North Oaks (Downstream of Wilkinson Lake)
12	Anderson Woods Development, North Oaks Company
13	Gatehill Development, North Oaks Company
14	Peterson Road, White Bear Township
15	Privately owned land north of Wilkinson, agricultural drainage
16	Privately owned land north of Wilkinson, agricultural drainage
17	Privately owned land north of Wilkinson, agricultural drainage
18	Future Development northeast of Wilkinson Lake, North Oaks Company
19	Future Development, northwest of Wilkinson Lake, North Oaks Company
20	Residential area in the southeast corner of the Wilkinson direct watershed, previously identified in the 2012 retrofit analysis
21	T O Properties Co, previously identified in the 2012 retrofit analysis
22	Residential area in the far southeast corner of the Wilkinson direct watershed, previously identified in the 2012 retrofit analysis
23	NOHOA Open Space
24	Pine of North Oaks Home Owners' Association Open Space
25	North Oaks Farms Property
26	Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA
27	Presbyterian Homes Waverly Garden Campus, Villas of Gem Lake, NOHOA
28	Tamarack Nature Center, Potential BMP Enhancements
29	Proposed BMP for Tamarack Nature Center, White Bear Township
30	Proposed BMP for Tamarack Nature Center, White Bear Township
31	Proposed BMP for Tamarack Nature Center, White Bear Township
32	Tamarack Nature Center, Potential BMP Enhancements
33	Proposed BMP for Tamarack Nature Center, White Bear Township
34	Ash Street Crossing, North Oaks Company, Lino Lakes, Ramsey County, Anoka County
35	White Bear Lake proposed 2020 project, parking lot mill and overlay
36	White Bear Lake proposed 2022 project, Birch Lake Avenue mill and overlay
37	White Bear Lake proposed 2022 project, Sports Center Drive mill and overlay
38	White Bear Lake proposed 2020 project, parking lot mill and overlay
39	White Bear Lake proposed 2025 project, 5th Street full reconstruction
40	Wilkinson Lake

Table A-2

Site	Local Stakeholder Owners'hip	Planned Development or Redevelopment	Anticipated Land Use Loading Rate	Infiltration Feasibility	Direct Wilkinson Watershed	Buffer Lake	Contributing Drainage Area (ac)	Current BMP Onsite	Wetland Area	Overall Viability
1	Yes	No	Moderate	Yes	Yes	No	0.49	No	No	H
2	Yes	No	Moderate	Yes	Yes	No	1.83	No	No	H
3	Yes	No	Moderate	No	Yes	No	0.57	No	No	M
4	No	No	Moderate	Yes	Yes	No	3.80	Yes	No	L
5	Yes	No	Moderate	Yes	Yes	No	0.43	No	No	H
6	No	No	Moderate	Yes	Yes	No	7.59	Yes	No	M
7	Yes	No	Moderate	Yes	Yes	No	5.57	No	No	H
8	No	No	High	No	Yes	No	11.88	No	No	M
9	Yes	Yes	Moderate	No	No	No	6.20	No	Yes	M
10	Yes	Yes	Low	Yes	No	No	90.98	No	No	H
11	n/a	n/a	n/a	n/a	n/a	n/a	52.40	n/a	Yes	L
12	Yes	Yes	Low	No	Yes	No	3.29	No	Yes	L
13	Yes	Yes	Moderate	Yes	No	No	29.67	No	No	H
14	Yes	Yes	Moderate	Yes	Yes	No	12.14	No	No	H
15	No	No	High	No	Yes	No	4.59	No	No	M
16	No	No	High	No	Yes	No	4.98	No	No	M
17	No	No	High	No	Yes	No	6.21	No	No	M
18	Yes	No	High	No	Yes	No	29.26	No	No	H
19	Yes	No	High	Yes	Yes	No	9.58	No	No	H
20	No	No	Moderate	Yes	Yes	No	33.36	No	No	H
21	No	No	Moderate	No	No	No	10.54	No	No	M
22	No	No	Moderate	Yes	No	No	40.38	No	No	M
23	Yes	No	Moderate	No	No	No	15.14	No	Yes	M
24	Yes	No	Moderate	Yes	No	No	7.35	Yes	Yes	L
25	Yes	No	Moderate	Yes	No	No	24.49	No	Yes	M
26	Yes	No	Moderate	No	Yes	No	23.34	Yes	Yes	M
27	Yes	No	Moderate	No	Yes	No	17.15	Yes	Yes	M
28	Yes	Yes	Low	Yes	No	No	1.69	Yes	No	L
29	Yes	Yes	Low	Yes	No	No	0.50	No	No	M
30	Yes	Yes	Low	Yes	No	No	0.50	No	No	M
31	Yes	Yes	Low	Yes	No	No	0.24	No	No	M
32	Yes	Yes	Low	Yes	No	No	0.81	Yes	No	L
33	Yes	Yes	Low	Yes	No	No	0.37	No	No	M
34	Yes	Yes	Moderate	No	Yes	No	3.70	No	No	H
35	Yes	Yes	Moderate	No	No	No	0.84	No	Yes	M
36	Yes	Yes	Moderate	No	No	Yes	10.18	No	No	M
37	Yes	Yes	Moderate	Yes	No	Yes	4.18	No	No	L
38	Yes	Yes	Moderate	No	No	Yes	3.51	No	No	L
39	Yes	Yes	Moderate	No	No	Yes	5.35	No	No	M
40	Yes	No	Moderate	No	Yes	No	1112.00	No	Yes	M

Table A-3

Criteria	Assumptions
Local Stakeholder Owners'hip	If the registered property owner associated with North Oaks Company LLC or public, then 'Yes', then 'No'?
Planned Development or Redevelopment	If there is any known development or redevelopment planned at the site (in the near future), then 'Yes', if not, then 'No'?
Anticipated Land Use Loading Rate	Relative based on Wiki Watershed assessment (high, medium, low). If a known project is planned at the site the proposed land use was including in the assessment. • High: Cropland • Moderate: Hay/pasture, High/Med density developed • Low: All others
Infiltration Feasibility	Based on Web Soil Survey. If single HSG rating A or B, then 'Yes' as infiltration is assumed feasible. If dual type A/D and B/D or other, then 'No' as area assumed to have high water table and thus infiltration is not feasible unless demonstrated otherwise.
Direct Wilkinson Watershed	If the proposed site within the direct Wilkinson Watershed, then 'Yes', if not, then 'No'.
Buffer Lake	If there a non-impaired lake between the proposed site and Wilkinson? (i.e. Black Lake), then 'Yes', if not 'No'.
Contributing Drainage Area	Based on a rough delineation from limited data sources (surface drainage and limited storm sewer).
Current BMP Onsite	If the potential site has an existing BMP onsite or adjacent to site as identified on aerial photography then 'Yes', if not, then 'No'.
Wetland Area	If NWI Wetlands are present on a significant portion of the site, then 'Yes', if not 'No'.
Good Viability	Increased Viability Rating
Moderate Viability	Negligible on Viability Rating
Low Viability	Decreased Viability Rating, Unless 'No' in yellow, then negligible



Path: C:\Projects\Wilkinson Lake\GIS\MXD\Figure_2.mxd

SEH

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Project: VADLA-153927
Print Date: 5/8/2020

Map by: mchristenson
Projection: NAD 1983 UTM Zone 15N
Source: MnGeo, SEH, VLAWMO

Potential Sites Map
Wilkinson Lake Feasibility Study
Ramsey and Anoka County, MN

Figure 2

This map is neither a legally recorded map nor a survey map and is not intended to be used as one. This map is a compilation of records, information, and data gathered from various sources listed on this map and is to be used for reference purposes only. SEH does not warrant that the Geographic Information System (GIS) Data used to prepare this map are error free, and SEH does not represent that the GIS Data can be used for navigational, tracking, or any other purpose requiring exacting measurement of distance or direction or precision in the depiction of geographic features. The user of this map acknowledges that SEH shall not be liable for any damages which arise out of the user's access or use of data provided.

Building a Better World for All of Us®

MEMORANDUM

TO: Dawn Tanner
VLAWMO

FROM: Mark Chirstenson, EIT
Emily Jennings, PE
SEH

DATE: May 7, 2020

RE: Wilkinson Feasibility Study High Priority Sites
SEH No. VADLA-153927 14.00

INTRODUCTION & BACKGROUND

This memo represents the completion of Task 2 of the Wilkinson Lake Feasibility Study. Accompanying this high priority site analysis is a copy of the raw data for all 40 identified sites as well as a map of the site locations and GIS shapefiles.

DISCUSSION OF PRIORITY SITES

In analyzing the existing conditions of the Wilkinson Lake watershed, SEH initially identified 40 potential sites to locate water quality BMPs that would treat for total phosphorus (TP). In working through the analysis a set of criteria were identified to analyze each site by to assess the viability of each site. "Viability" in this sense is a combination of how likely a project could be constructed at a site as well as how effective a BMP at this location might be at reducing the overall load of TP to Wilkinson Lake. A list of the Criteria used and the assumptions made with each criteria are provided in ***Table 1***. The analysis yielded 11 of the initially identified 40 sites as having a "HIGH" viability rating and a discussion of each of these sites follows.

Site #1

Priority Site #1 is located within "The Villas of Wilkinson Lake" housing development. The pros and cons of the site are summarized in the table below.

Pros	Cons
• Parcel owned by North Oaks Homeowners Association • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands nearby • Would serve area with moderate TP loading rate	• Small contributing drainage area (0.5 acres)*

*Drainage delineation based on limited and/or incomplete data

DRAFT

As is noted in the table, the one con of this site are that it has a fairly small drainage area. This could be refined with more site data, and there may be some potential to tie into the existing storm sewer to serve a larger area. This however, would drastically increase the cost of this option.

Potential BMPs for this site could include:

- Infiltration Basin
- Biofiltration Basin
- Iron-enhanced Sand Filter

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #2

Priority Site #2 is also located within "The Villas of Wilkinson Lake" housing development. The pros and cons of the site are summarized in the table below and similar to those of Site #1.

Pros	Cons
• Parcel owned by North Oaks Homeowners Association • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands nearby • Would serve area with moderate TP loading rate	• Relatively small contributing drainage area (1.8 acres)*

*Drainage delineation based on limited and/or incomplete data

As is noted in the table, the one con of this site are that it has a relatively small drainage area (though is larger than that of Site #1). This could be refined with more site data, and there may be some potential to tie into the existing storm sewer to serve a larger area. This however, would drastically increase the cost of this option.

Potential BMPs for this site could include:

- Infiltration Basin
- Biofiltration Basin
- Iron-enhanced Sand Filter

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #5

Priority Site #5 is located within "The Villas of Wilkinson Lake" housing development. The pros and cons of the site are summarized in the table below.

Pros	Cons
• Parcel owned by North Oaks Homeowners Association • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands on-site • Would serve area with moderate TP loading rate	• Small contributing drainage area (0.5 acres)*

* Drainage delineation based on limited and/or incomplete data

DRAFT

As is noted in the table, the one major con of this site are that it has a fairly small drainage area. This could be refined with more site data, and there may be some potential to tie into the existing storm sewer to serve a larger area. There is also a wetland nearby that would need to be

Potential BMPs for this site could include:

- Infiltration Basin
- Biofiltration Basin
- Iron-enhanced Sand Filter

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #7

Priority Site #5 is located within "The Villas of Wilkinson Lake" housing development. The site in question is a large open area west of Centerville drive that may be slated for future home developments, though has yet to be subdivided into individual parcels. The pros and cons of the site are summarized in the table below.

Pros	Cons
• Parcel owned by North Oaks Homeowners Association • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands on-site • Would serve area with moderate TP loading rate	• May be saved for future home parcels

As is noted in the table, there do not appear to be any major cons with this site, based on the criteria identified. However, based on the surrounding housing development it appears that this area may be saved for the development of more homes or other community buildings or amenities. Further communication with the North Oaks Company on this site is recommended to assess this site's full potential.

Potential BMPs for this site could include:

- Infiltration Basin
- Biofiltration Basin
- Iron-enhanced Sand Filter

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #10

Site #10 is the location of the proposed Red Forest Way South development as part of the North Oaks Company proposed development agreement (PDA). The Red Forest Way south development is a future single-family housing development located south of Wilkinson Lake. A summary of the pros and cons of the site are listed in the table below.

Pros	Cons
• Parcel owned by North Oaks Company • A current project is planned for the site • Soils are favorable for infiltration • NWI wetlands on-site are limited	• The existing land use is predominantly forest and will be converted to low density mixed development (both low TP contributors) • The site is not located within the direct Wilkinson Watershed, though drains to the ditch just upstream of Wilkinson Lake

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As is indicated in the table above the impacts of extended treatment here may still be limited due to the existing and proposed land uses having relatively low TP loading rates. That being said, much of the area is currently forested and is planned to go to low-density development, so an effort to maintain tree cover as the site is developed would help limit the increase in loading rate. Additionally, the land use on the eastern portion of the project is listed as “Hay/pasture” in the 2016 NLCD dataset which is considered to have a moderate TP loading rate. Efforts to improve on the loading rate in this section of the development could have a larger impact than other areas of the development.

Potential BMPs for this site could include:

- Regional BMPs
  - Infiltration Basin
  - Biofiltration basin
  - Iron-enhanced Sand Filter
- Individual Parcel practices
  - Rain Gardens
  - Maintain tree canopy to maximum extent practicable
  - Limit fertilizer use
  - Ensure leaves and grass clippings stay out of street and storm sewer
  - Encourage “Lawns to Legumes” project adoption

Table 2 summarizes the listed regional BMPs and identifies pros and cons of each.

Site #13

Site #13 is the location of the proposed Gate Hill housing development as part of the North Oaks Company proposed development agreement (PDA). The Gate Hill Development is a future single-family housing development located south of Wilkinson Lake. A summary of the pros and cons of the site are listed in the table below.

Pros	Cons
• Parcel owned by North Oaks Company • A current project is planned for the site • Soils are favorable for infiltration • No NWI wetlands on-site • Serves an area with moderate TP loading rate • Treats a large drainage area	• The site is not located within the direct Wilkinson Watershed, though drains to the ditch just upstream of Wilkinson Lake

This potential site is not located within the immediate Wilkinson Lake watershed but just upstream in the Tamarack Lake watershed. The site will technically drain to the drainage ditch that splits the Black Lake and Tamarack Lake watersheds, and flows directly into Wilkinson Lake. This site is also located in one of the priority areas identified in the 2017 study performed by Barr Engineering. One key attribute to note is that this site is listed as Hay/pasture (according to 2016 NLCD) and will be developed to what might be considered med-density developed land. This, like Site #10, would benefit from individual landowner practices in addition to regional BMPs.

Potential BMPs for this site could include:

- Regional BMPs
  - Infiltration Basin

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- Biofiltration basin
  - Iron-enhanced Sand Filter
- Individual Parcel practices
  - Rain Gardens
  - Maintain tree canopy to maximum extent practicable
  - Limit fertilizer use
  - Ensure leaves and grass clippings stay out of street and storm sewer
  - Encourage “Lawns to Legumes” project adoption

Table 2 summarizes the listed regional BMPs and identifies pros and cons of each.

Site #14

Site #14 is the location of the Peterson Road project in White Bear Township. The project site is located southeast of Wilkinson Lake. A summary of the pros and cons of the site are listed in the table below.

Pros	Cons
• Site within road right-of-way • A known project is proposed • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands on-site • Would serve area with moderate TP loading rate	

This site was chosen because there is a known project occurring here. This site has many attributes in its favor, as is demonstrated in the table above. However, this is a road project and the number of BMPs that will fit within the road right of way or limited and may be unlikely to significant benefit. There do appear to be several parcels adjacent to the road that are owned by the North Oaks Company however and a larger BMP may be possible with collaboration.

Potential BMPs for this site could include:

- Infiltration Basin
- Ditch checks (infiltration)
- Biofiltration Basin
- Iron-enhanced Sand Filter

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #18

Site #18 is located just northeast of Wilkinson Lake. The pros and cons of the site are summarized in the table below.

Pros	Cons
• Parcel owned by North Oaks Company (within Lino Lakes) • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands onsite • Would serve area with High TP loading rate	

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The site is an agriculture field located directly adjacent to Wilkinson Lake. One of the major benefits of this site is that the current land use is for crop land, which is considered a High TP load contributor. That coupled with there being a significant amount of land to work with, this makes this a location that could be rather versatile and a range of treatment options could be explored.

Potential BMPs for this site could include:

- Infiltration Basin
- Biofiltration Basin
- Iron-enhanced Sand filter (spent lime filter)
- Vegetated buffer zone
- Cover crops
- Reduced tillage
- Targeted fertilizer application

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #19

Site #19 is located just northwest of Wilkinson Lake. The pros and cons of the site are summarized in the table below.

Pros	Cons
• Parcel owned by North Oaks Company (within Lino Lakes) • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands onsite • Would serve area with High TP loading rate	

The site is an agriculture field located directly adjacent to Wilkinson Lake. This site is similar to Site #18 with the added complication that there is a utility easement that runs between the site and Wilkinson Lake. This utility easement may prevent the placement of an outlet pipe from a treatment BMP to the lake itself.

Potential BMPs for this site could include:

- Infiltration Basin
- Biofiltration Basin
- Iron-enhanced Sand filter (spent lime filter)
- Vegetated buffer zone
- Cover crops
- Reduced tillage
- Targeted fertilizer application

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

Site #20

Site #20 is one of the previously identified priority areas from the 2012 Retrofit and Feasibility Study. While this site was given a “HIGH” rating. This rating assumes that the entire neighborhood could be captured and treated in some BMP or network of BMPs which could prove challenging and expensive given that the areas are already fully developed and privately owned. Because of this, it may be advisable to shift the rating of this site down to “Moderate” due to the difficulty in designing a system to treat the entire site. However, this area and other neighborhood areas investigated herein and within the 2012 Retrofit and Feasibility Study may present a separate opportunity for VLAWMO to undertake a campaign or continue campaigns to encourage individual landowners to install rain gardens or undertake other water quality practices such as BWSR's "Lawns to Legumes" program. Based on "Google Streetview" it appears that the roads in these neighborhoods are actually rural sections, making the installation of raingardens easier and cheaper than if curb cuts would need to be installed.

Potential BMPs for this site could include:

- Individual Parcel practices
  - Rain Gardens
  - Maintain tree canopy to maximum extent practicable
  - Limit fertilizer use
  - Ensure leaves and grass clippings stay out of street and storm sewer
  - Encourage "Lawns to Legumes" project adoption

Table 2 summarizes the listed regional BMPs and identifies pros and cons of each.

Site #34

Site #34 is the location of the 2024 Ash Street reconstruction project. Like with Site #14 this is a road project which normally might be limited to the right-of-way for treatment options, however there are several parcels directly adjacent to the road that are owned by the North Oaks Company, expanding the options available here if collaboration occurs.

A summary of the pros and cons of the site are listed in the table below.

Pros	Cons
• Site within road right-of-way • A known project is proposed • Soils are favorable for infiltration • Site is within the direct Wilkinson watershed • No NWI wetlands on-site • Would serve area with moderate TP loading rate	• Relatively small drainage area served (3.7 acres)

Potential BMPs for this site could include:

- Infiltration Basin
- Ditch checks (infiltration)
- Biofiltration Basin
- Iron-enhanced Sand Filter

Table 2 summarizes the listed BMPs and lists the pros and cons of each.

DRAFT

TABLES

Table 1: Analysis Criteria and Assumptions

Criteria	Assumptions
Owned by North Oaks Company or Public Entity?	Is the registered property owner associated with North Oaks Company LLC or public?
Project Planned?	Is there a known project planned at the site in the near future?
Land use TP loading rate	Relative based on Wiki Watershed assessment (high, medium, low). If a known project is planned at the site the proposed land use was assessed. High • Cropland Moderate • Hay/pasture • High/Med density developed Low • All others
Infiltration feasible?	Single HSG rating A or B. Dual type A/D and B/D assumed to have high water table and thus not feasible unless demonstrated otherwise.
Within the direct Wilkinson Lake watershed?	Is the proposed site within the direct Wilkinson Watershed?
Buffer Lake?	Is there a non-impaired lake between the proposed site and Wilkinson? (i.e. Black Lake)
Contributing Drainage Area	Rough delineation based off of limited data sources (surface drainage and limited storm sewer)

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Current BMP on site?	Is the proposed site an existing BMP or right next to one? May mean to look at existing BMP or retrofit with some sort of additional treatment.
Wetlands	NWI Wetlands are present on a significant portion of the site

DRAFT

Table 2: Best Management Practice (BMP) Pros and Cons

BMP	Pros	Cons	Additional notes
Infiltration Basin	• Volume reduction • Good phosphorus removal (initially) • Don't necessarily need additional infrastructure (though probably want it to ensure long-term functionality) • Attractive (if planted and maintained well), removes other pollutants.	• Require frequent maintenance (plant care knowledge), • Relatively high rate of failure (capped underdrain can ensure functionality but adds to cost, and negates volume reduction), • Can become a source for phosphorus over time	Smaller scale infiltration basins (Rain Gardens, ditch checks) are a good option for individual residents or road projects. If creating a large scale Infiltration Basin, a good practice is to design with a capped underdrain or knife valve that can be opened in the event of failure.
Bio-filtration basin	• Good to Moderate phosphorus removal, • Attractive, • High likelihood of success,	• Require frequent maintenance (plant care knowledge), • Requires storm sewer infrastructure (underdrain), • Can become a source for phosphorus over time	
Iron-enhanced/Spent Lime sand filter (IESF)	• Binds up dissolved phosphorus well. • Effective when functioning properly. • Can be fairly versatile (basin, bench along existing pond or lake) • Can be used in a treatment sequence, a stand-alone BMP, or a retrofit to an existing BMP.	• Expensive. • Require frequent maintenance. • Need to ensure conditions in the filter do not become anoxic (no oxygen), will release all of the bound of phosphorus if they do. • Have to be "recharged" periodically. • Not attractive (large basins are particularly conspicuous, perhaps better as a bench).	Need to ensure that the bed remains aerated, the sand itself can for a crust that must be broken up to prevent the filter from becoming anoxic. Vegetation cannot be allowed to grow or accumulate as decomposition of this material can cause low oxygen conditions. IESFs are best suited to conditions with minimal groundwater intrusion or tailwater effects.
Stormwater Wet Pond	• High likelihood of success • Widely applicable.	• Limited TP removal • Maintenance is infrequent but expensive (dredging and disposal of sediment due to pollutants)	
In-Lake Alum treatment	• Immediate gratification (lake clears shortly after treatment). Relatively cheap	• TMDL did not identify significant internal loading • Will have to continually dose the lake to maintain results. • Can have toxicity issues to wildlife if not performed properly	Ultimately Alum is a quick way to clear the lake by binding up dissolved phosphorus, however if the problem is high TP loading from the watershed this will not address the problem. TP loads need to be reduced going to the lake.

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Appendix B

Water Quality Calculations for Peterson Road Improvements

SAINT PAUL, MINNESOTA
August 14, 2020

Storm Water Calculations
for
Peterson Road Improvements

White Bear Township,
Ramsey County, Minnesota

CERTIFICATION

I hereby certify that the attached report and calculations for the subject project was prepared by me or under my direct supervision; and I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

Amanda M. Kieffer
Lic. No. 56216 Date: August 14, 2020

Project Description
White Bear Township is reconstructing Peterson Road. Peterson road is currently a gravel road with a rural section and will be converted to an urban bituminous roadway with curb and gutter and storm sewer. The project also includes new water and sanitary sewer services along Peterson Road and rehabilitation of Otter Ridge Cul-de-sac. Peterson Road currently drains to the existing wetlands to the west of the roadway. Peterson Road storm sewer will drain north to a new infiltration pond which will outlet to the existing wetland to the North-west of the project. The proposed pond will be sized for a future addition of Peterson Road of 0.58acres. See attached plans for a project location map. The project is not within a flood plain.

Storm Water Requirements
The reconstructed roadway will be required to meet the requirements of White Bear Township Storm water Management Ordinance and the NPDES construction storm water permit. The project will be reviewed by the Vadnais Lake Area Water management Organization.

Water Quality and Volume Reduction
White Bear Township Storm water Management Ordinance requires 0.75in over all new or reconstructed impervious areas will be infiltrated for linear projects. The bottom of the pond is 3.5ft above the normal water level of the adjacent wetland. A summary of the required infiltration volume and provided is below. Pre-treatment will be provided with a water quality sediment structure. The 40% TSS reduction is achieved with the infiltration as seen in Exhibit A. A 20ft buffer is provided from the construction limits to adjacent wetlands.

	New Impervious Area	Water Treatment Volume Required	Water Treatment Volume Provided
	AC	CF	CF
Current Project	0.81	2204	
Future Project	0.58	1588	
Total	1.39	3792	4144

Runoff Rate Control
Meeting the requirements of White Bear Township Storm water Management Ordinance the peak run off rate for the 2 and 10 year 24 hour proposed storm event shall be less than existing. The 100 year 24 hour storm event shall be safely passed through the system. The storm sewer was designed for a 10 year storm. The pond outlet is a culvert with a flared end and rip rap for energy dissipation. Calculations were performed with Autodesk Storm and Sanitary Analysis software using TR-55. A summary of the existing and proposed rates are below and the calculations are found in Exhibit B.

	2 Year Storm (cfs)	10 Year Storm (cfs)	100 Year Storm (cfs)
Existing Conditions	2.38	5.12	13.62
Proposed Conditions	0.38	1.69	4.45

Exhibit A: Water Quality Calculations

Minnesota MIDS Calculator -- Version 3: January 2017

Notes:
1) Make sure macros are enabled. If not, click Microsoft Office Button in upper left hand corner.
Click "Excel Options". Click "Trust Center", click "Trust Center Settings" and then click "Macro Settings". Set Macro Settings to "Enable All Macros" and restart Excel.

2) Enter Site Information in blue cells below

3) Go to MIDS BMP Calculator tab and follow instruction on top of that page

Project Name:	Peterson Road Improvements
User Name / Company Name:	TKDA
Date:	8-3-2020
Project Description:	
Are you using the calculator to determine compliance with a Construction Stormwater permit? (Yes/No)	Yes

Legend
- **User input cells**
- **Calculation cells**
- **Constant values**
- **Value obtained from another sheet**

Site Information

Retention Requirment (inches):	0.75	This value has been changed from the recommended value of 1.1 ins
Site's Zip code:	55127	
Annual Rainfall (inches):	31.8	
Phosphorus EMC (mg/L):	0.3	
TSS EMC (mg/L):	54.5	
Fraction of annual rainfall events that produce runoff:	0.9	

Total Watershed Area

Land Cover (acres)	**A soils**	**B Soils**	**C Soils**	**D Soils**	**Totals (acres)**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land					0
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed		0.25			0.25
Impervious Cover (acres)					1.39
				Total:	1.64

Watershed Area Routed to BMPs (Summary of "MIDS BMP Calculator" Tab)

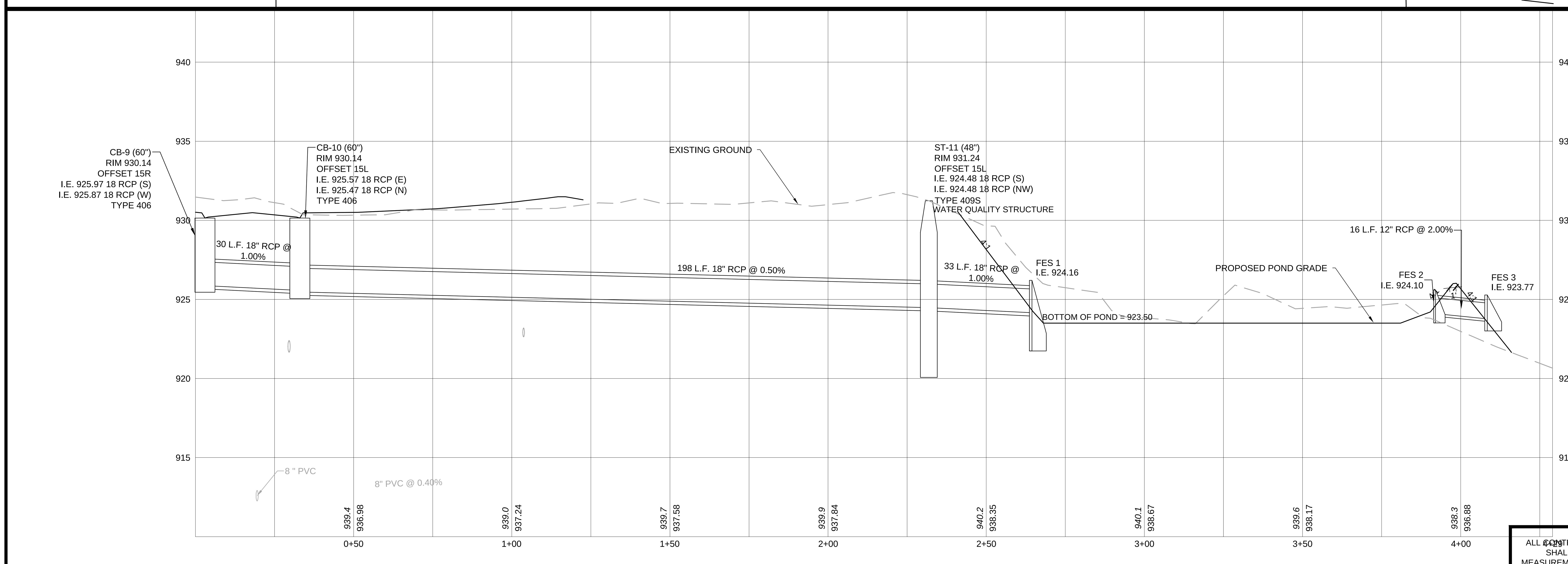
Land Cover (acres)	**A soils**	**B Soils**	**C Soils**	**D Soils**	**Totals (acres)**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land					0
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed					0
Impervious Cover (acres)					1.24
				Total:	1.24

Summary Information

Total impervious cover (acres)	1.39
Total watershed area (acres)	1.64
Site runoff coefficient, Rv	0.84
% Impervious	85%
Development volume retention requirement (cubic feet)	**3,784**
Volume removed by BMPs (cubic feet)	3,376
Additional volume removal needed to meet requirement (cubic feet	408
Percent volume removed	89.21%
Post-developoment annual volume (acre-ft)	3.27
Annual volume removed by BMPs (acre-ft)	2.50
Percent annual volume removed	76.46%
Post-development annual Particulate P load (lb/yr	1.47
Annual Particulate load removed by BMPs (lb/yr	1.12
Post-development annual Dissolved P load (lb/yr	1.20
Annual Dissolved P load removed by BMPs (lb/yr	0.92
Percent annual TP removed	76.46%
Post-development annual TSS load (lb/yr)	485
Annual TSS load removed by BMPs (lb/yr)	370
Percent annual TSS removed	76.46%

Note:
Green cells will fill in when MIDS BMP Calculator tab is complete

Grey Cells are calculated using Site Information entered above



INFILTRATION POND NOTES:

1. CONTRACTOR SHALL COORDINATE 2 DOUBLE RING INFILTROMETER TESTS ON THE POND BOTTOM PRIOR TO TURF RESTORATION. INFILTRATION RATE IS ASSUMED TO BE 0.4IN/HR. CONTRACTOR TO NOTIFY ENGINEER IF TESTED RATE IS BELOW 0.8IN/HR.
2. CONTRACTOR SHALL WORK TO MINIMIZE COMPACTION OF THE POND BOTTOM. INFILTRATION POND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MPCA NPDES PERMIT STANDARDS.

PRELIMINARY
NOT FOR
CONSTRUCTION

ALL CONTRACTORS AND SUBCONTRACTORS SHALL VERIFY ALL DIMENSIONS BY MEASUREMENT AT THE BUILDING AND/OR SITE

0 1
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS DRAWING ADJUST SCALES ACCORDINGLY.

NO.	DATE	BY	DESCRIPTION OF REVISIONS
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DESIGNED AMK
DRAWN AMK
CHECKED JES

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

SIGNATURE:______ DATE: ---
NAME: JAMES E. STUDENSKI LIC. NO.: 23757

TKDA
444 Cedar Street, Suite 1500
Saint Paul, MN 55101
651.292.4400
tkda.com

PETERSON ROAD IMPROVEMENTS

STREET AND STORM SEWER PLAN & PROFILE

PROJ. NO. 17727.002
DRAWING NO. C104

PLOT DATE: Aug 13, 2020 - 5:06pm
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Appendix C

Opinions of Probable Cost

East Wilkinson Lake Watershed Enhancements
Peterson Road Enhanced Basin

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
1	Mobilization	LS	1	$ 7,900.00	$ 7,900.00
2	Clearing and Grubbing	LS	1	$ 1,000.00	$ 1,000.00
3	Common Excavation	CY	535	$ 20.00	$ 10,700.00
4	Minor Grading	LF	550	$ 5.00	$ 2,750.00
5	Enhanced Media	CY	535	$ 50.00	$ 26,750.00
6	Mulch Material Type 6	CY	135	$ 35.00	$ 4,725.00
7	Deciduous Shrub	EA	250	$ 40.00	$ 10,000.00
8	Outlet Control Structure	EA	1	$ 10,000.00	$ 10,000.00
9	Construction Entrance	EA	1	$ 2,500.00	$ 2,500.00
10	Sediment Control Log	LF	600	$ 3.00	$ 1,800.00
11	Geotextile Type 3	SY	100	$ 3.50	$ 350.00
12	Riprap Cl. II	CY	30	$ 47.00	$ 1,410.00
13	Topsoil Borrow	CY	85	$ 20.00	$ 1,700.00
14	Seeding (Seed Mixture MNDOT 36-211)	LB	8	$ 300.00	$ 2,400.00
15	Erosion Control Blanket Cat. 3N	SY	815	$ 3.00	$ 2,445.00
CONTINGENCY @ 30%					**$ 25,929.00**
SUBTOTAL					**$ 112,359.00**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 33,707.70**

TOTAL	**$ 146,066.70**

East Wilkinson Lake Watershed Enhancements
East Wilkinson Lake Ponding Areas

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
1	Mobilization	LS	1	$ 3,300.00	$ 3,300.00
2	Clearing and Grubbing	LS	1	$ 1,000.00	$ 1,000.00
3	Common Excavation	CY	150	$ 25.00	$ 3,750.00
4	Minor Grading	LF	100	$ 5.00	$ 500.00
5	Plastic Liner	SY	111	$ 20.00	$ 2,220.00
6	4" PVC Pipe Drain	LF	200	$ 30.00	$ 6,000.00
7	4" PVC Pipe Drain Cleanout	EA	4	$ 280.00	$ 1,120.00
8	Iron Enhanced Sand Media	CY	75	$ 50.00	$ 3,750.00
9	Outlet Control Structure	EA	1	$ 10,000.00	$ 10,000.00
10	Construction Entrance	EA	1	$ 2,500.00	$ 2,500.00
11	Sediment Control Log	LF	200	$ 3.00	$ 600.00
12	Geotextile Type 3	SY	50	$ 3.50	$ 175.00
13	Riprap Cl. II	CY	10	$ 47.00	$ 470.00
14	Topsoil Borrow	CY	20	$ 20.00	$ 400.00
15	Seeding (Seed Mixture MNDOT 36-211)	LB	1.5	$ 30.00	$ 45.00
16	Erosion Control Blanket Cat. 3N Type Straw 2S	SY	170	$ 3.00	$ 510.00
CONTINGENCY @ 30%					**$ 10,902.00**
SUBTOTAL					**$ 47,242.00**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 14,172.60**

TOTAL	**$ 61,414.60**

Ash Street Regional Treatment
Constructed Wetland

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
1	Mobilization	LS	1	$ 18,700.00	$ 18,700.00
2	Clearing	AC	2.5	$ 5,000.00	$ 12,500.00
3	Grubbing	AC	2.5	$ 5,000.00	$ 12,500.00
4	Traffic Control	LS	1	$ 3,000.00	$ 3,000.00
5	Common Excavation	CY	2100	$ 30.00	$ 63,000.00
6	Minor Grading	LF	500	$ 50.00	$ 25,000.00
7	Construction Entrance	EA	1	$ 2,500.00	$ 2,500.00
8	Sediment Control Log	LF	1,400	$ 3.00	$ 4,200.00
9	Topsoil Borrow	CY	540	$ 20.00	$ 10,800.00
10	Wetland Seeding Mixture	LB	90	$ 30.00	$ 2,700.00
11	Erosion Control Blanket Cat. 3N Type Straw 2S	SY	4840	$ 3.00	$ 14,520.00
12	Shrub and/or Tree Plantings	EA	1000	$ 40.00	$ 40,000.00
13	Earthen Berm	LF	700	$ 30.00	$ 21,000.00
CONTINGENCY @ 30%					**$ 69,126.00**
SUBTOTAL					**$ 299,546.00**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 89,863.80**

TOTAL	**$ 389,409.80**

Ash Street Regional Treatment
Stormwater Pond

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
1	Mobilization	LS	1	$ 14,000.00	$ 14,000.00
2	Clearing	AC	2.5	$ 5,000.00	$ 12,500.00
3	Grubbing	AC	2.5	$ 5,000.00	$ 12,500.00
4	Traffic Control	LS	1	$ 3,000.00	$ 3,000.00
5	Common Excavation	CY	1940	$ 30.00	$ 58,200.00
6	Minor Grading	LF	500	$ 50.00	$ 25,000.00
7	Construction Entrance	EA	1	$ 2,500.00	$ 2,500.00
8	Sediment Control Log	LF	1,400	$ 3.00	$ 4,200.00
9	Topsoil Borrow	CY	270	$ 20.00	$ 5,400.00
10	Wetland Seeding Mixture	LB	45	$ 30.00	$ 1,350.00
11	Erosion Control Blanket Cat. 3N Type Straw 2S	SY	2420	$ 3.00	$ 7,260.00
12	Shrub and/or Tree Plantings	EA	300	$ 40.00	$ 12,000.00
13	Earthen Berm	LF	700	$ 30.00	$ 21,000.00
CONTINGENCY @ 30%					**$ 53,673.00**
SUBTOTAL					**$ 232,583.00**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 69,774.90**

TOTAL	**$ 302,357.90**

Ash Street Linear Treatment
Swale Side Slope

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
	Mobilization	LS	1	$ 200.00	$ 200.00
	Minor Grading	LF	100	$ 5.00	$ 500.00
	Topsoil Borrow	CY	10	$ 20.00	$ 200.00
	Seeding (Seed Mixture MNDOT 36-211)	LB	0.1	$ 300.00	$ 30.00
	Erosion Control Blanket Cat. 3N	SY	100	$ 3.00	$ 300.00
	Erosion and Sed Control	LF	100	$ 5.00	$ 500.00
CONTINGENCY @ 30%					**$ 519.00**
SUBTOTAL					**$ 2,249.00**
ENGINEERING, ADMIN AND LEGAL FEES @ 30%					**$ 674.70**
TOTAL					**$ 2,923.70**
				PER LF	**$ 29.24**

Ash Street Linear Treatment
Ditch Checks

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
	Mobilization	LS	1	$ 100.00	$ 100.00
	Minor Grading	LF	25	$ 5.00	$ 125.00
	Filter Material	CY	10	$ 50.00	$ 500.00
	Seeding (Seed Mixture MNDOT 36-211)	LB	0.1	$ 300.00	$ 30.00
	Erosion Control Blanket Cat. 3N	SY	15	$ 3.00	$ 45.00
	Erosion and Sed Control	LF	100	$ 5.00	$ 500.00
CONTINGENCY @ 30%					**$ 390.00**
SUBTOTAL					**$ 1,690.00**
ENGINEERING, ADMIN AND LEGAL FEES @ 30%					**$ 507.00**
TOTAL					**$ 2,197.00**

Ash Street Linear Treatment
BioSwale

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
	Mobilization	LS	1	$ 700.00	$ 700.00
	Minor Grading	LF	100	$ 5.00	$ 500.00
	Media Material	CY	25	$ 50.00	$ 1,250.00
	Drain Tile and Clean Outs	LF	100	$ 30.00	$ 3,000.00
	Seeding (Seed Mixture MNDOT 36-211)	LB	0.1	$ 300.00	$ 30.00
	Erosion Control Blanket Cat. 3N	SY	225	$ 3.00	$ 675.00
	Filter Material	CY	10	$ 50.00	$ 500.00
	Planting	EA	16	$ 40.00	$ 640.00
	Erosion and Sed Control	LF	100	$ 5.00	$ 500.00
CONTINGENCY @ 30%					**$ 2,188.50**
SUBTOTAL					**$ 9,983.50**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 2,995.05**

TOTAL		**$ 12,978.55**
	PER LF	**$ 129.79**

Ash Street Linear Treatment
Infiltration Trench

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
	Mobilization	LS	1	$ 200.00	$ 200.00
	Minor Grading	LF	100	$ 5.00	$ 500.00
	Seeding (Seed Mixture MNDOT 36-211)	LB	0.1	$ 300.00	$ 30.00
	Erosion Control Blanket Cat. 3N	SY	225	$ 3.00	$ 675.00
	Filter Material	CY	10	$ 50.00	$ 500.00
	Planting	EA	16	$ 40.00	$ 640.00
	Erosion and Sed Control	LF	100	$ 5.00	$ 500.00
CONTINGENCY @ 30%					**$ 763.50**
SUBTOTAL					**$ 3,808.50**
ENGINEERING, ADMIN AND LEGAL FEES @ 30%					**$ 1,142.55**
TOTAL					**$ 4,951.05**
				PER LF	**$ 49.51**

Ash Street Linear Treatment
Subsurface Gallery

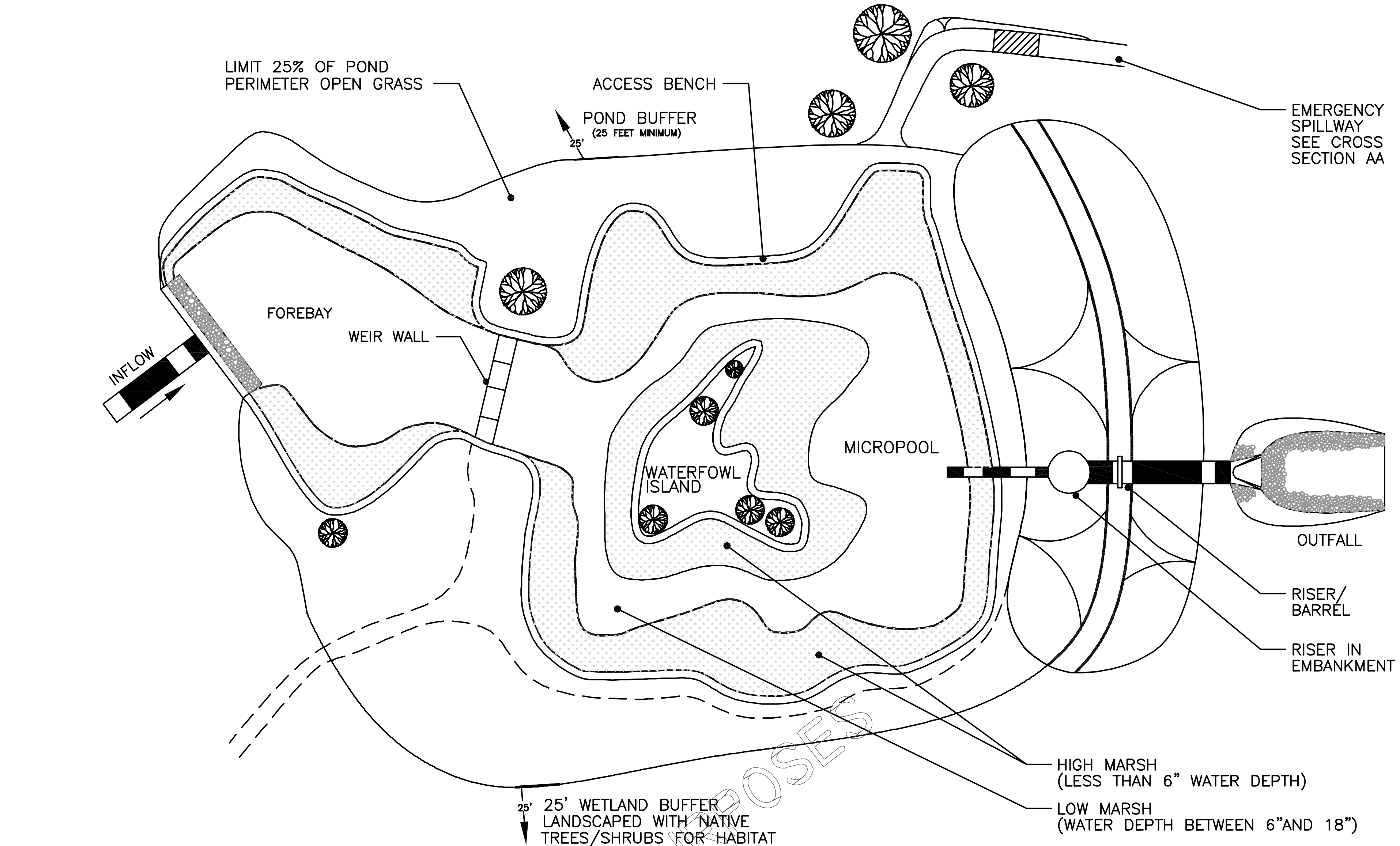
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
	Mobilization	LS	1	$ 1,800.00	$ 1,800.00
	Excavation	CY	120	$ 30.00	$ 3,600.00
	Minor Grading	LF	100	$ 5.00	$ 500.00
	Bedding	CY	20	$ 40.00	$ 800.00
	Pipe Material	LF	200	$ 50.00	$ 10,000.00
	Drainage Structure	EA	4	$ 1,500.00	$ 6,000.00
	Seeding (Seed Mixture MNDOT 36-211)	LB	0.1	$ 300.00	$ 30.00
	Erosion Control Blanket Cat. 3N	SY	225	$ 3.00	$ 675.00
	Erosion and Sed Control	LF	100	$ 5.00	$ 500.00
CONTINGENCY @ 30%					**$ 7,171.50**
SUBTOTAL					**$ 31,076.50**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 9,322.95**

TOTAL		**$ 40,399.45**
	PER LF	**$ 403.99**

Appendix D

Typicals



PLAN VIEW
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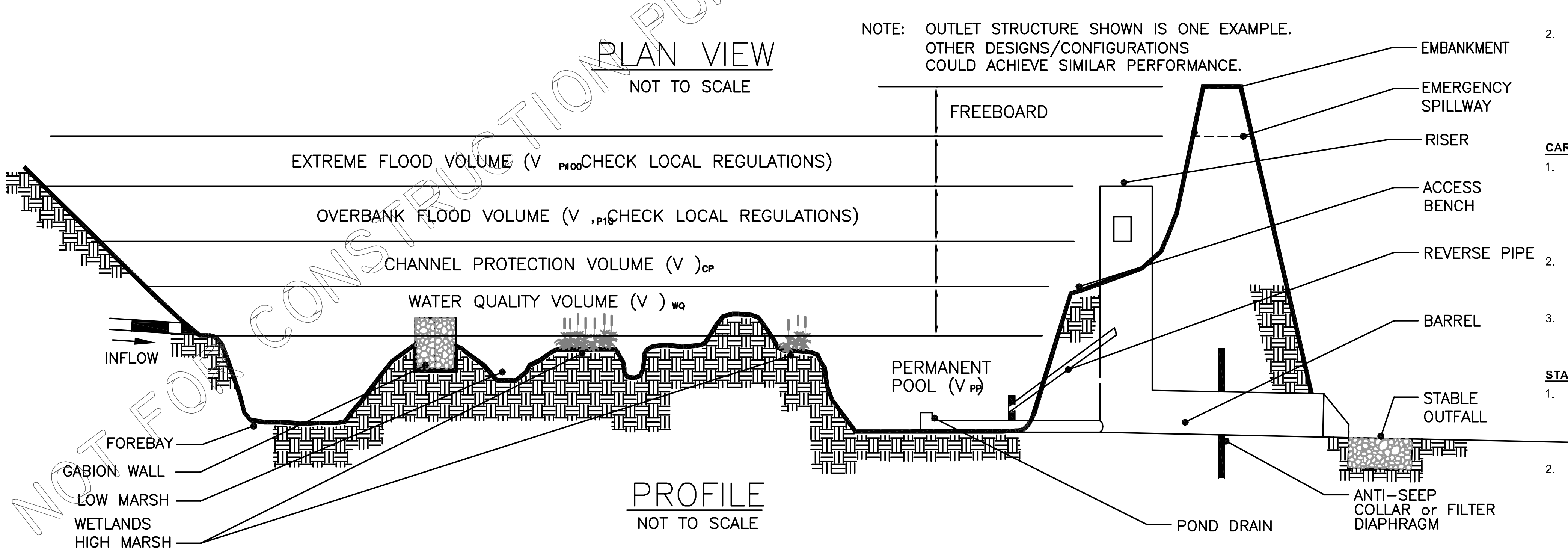


PROFILE
NOT TO SCALE

NOT FOR CONSTRUCTION PURPOSES

CONSTRUCTION STANDARDS AND SPECIFICATIONS

(ADAPTED FROM STORMWATER MANAGER'S RESOURCE CENTER, WWW.STORMWATERCENTER.NET <http://www.stormwatercenter.net> WITH SOME ADDITIONS)

SITE PREPARATION

1. TEMPORARY EROSION CONTROL MEASURES IN ACCORDANCE WITH MNDOT GENERAL CONDITIONS 2573 SHALL BE INSTALLED PRIOR TO THE START OF ANY CONSTRUCTION OPERATION THAT MAY CAUSE ANY SEDIMENTATION OR SILTATION AT THE SITE.
2. AREAS DESIGNATED FOR BORROW AREAS, EMBANKMENT, AND STRUCTURAL WORKS SHALL BE CLEARED, GRUBBED AND STRIPPED OF TOPSOIL.
3. VEGETATION AND OTHER MATERIAL SHALL BE CLEARED FROM POND AREA.
4. TOPSOIL SHALL BE STOCKPILED FOR FUTURE USE AS SPECIFIED.

EARTH FILL

1. FILL MATERIAL SHALL BE TAKEN FROM APPROVED BORROW AREAS AND SHALL BE FREE OF ROOTS, STUMPS, WOOD, RUBBISH, STONES GREATER THAN 6", FROZEN MATERIAL, AND OTHER OBJECTIONABLE MATERIALS.
2. FILL MATERIAL FOR CENTER OF EMBANKMENT SHALL CONFORM TO UNIFIED SOIL CLASSIFICATION GC, SC, CH, OR CL AND MUST HAVE AT LEAST 30% PASSING THE #200 SIEVE. CONSIDERATION MAY BE GIVEN TO THE USE OF OTHER MATERIALS IN THE EMBANKMENT IF DESIGNED BY A GEOTECHNICAL ENGINEER.
3. MATERIALS USED IN THE OUTER SHELL OF THE EMBANKMENT MUST HAVE THE CAPABILITY TO SUPPORT VEGETATION OF THE QUALITY REQUIRED TO PREVENT EROSION OF THE EMBANKMENT.
4. AREAS ON WHICH FILL IS TO BE PLACED SHALL BE SCARIFIED PRIOR TO PLACEMENT OF FILL. FILL MATERIALS SHALL BE PLACED IN MAXIMUM 8 INCH THICK (BEFORE COMPACTION) LAYERS WHICH ARE TO BE CONTINUOUS OVER THE ENTIRE LENGTH OF THE FILL. THE MOST PERMEABLE BORROW MATERIAL SHALL BE PLACED IN THE DOWNSTREAM PORTIONS OF THE EMBANKMENT. THE PRINCIPAL SPILLWAY MUST BE INSTALLED CONCURRENTLY WITH FILL PLACEMENT AND NOT EXCAVATED INTO THE EMBANKMENT.
5. WHEN REQUIRED BY THE REVIEWING AGENCY THE MINIMUM REQUIRED DENSITY SHALL NOT BE LESS THAN 95% OF MAXIMUM DRY DENSITY WITH A MOISTURE CONTENT WITHIN 2% OF THE OPTIMUM. EACH LAYER OF FILL SHALL BE COMPACTED AS NECESSARY TO OBTAIN THAT DENSITY, AND IS TO BE CERTIFIED BY THE ENGINEER AT THE TIME OF CONSTRUCTION. ALL COMPACTION IS TO BE DETERMINED BY AASHTO METHOD T-99 (STANDARD PROCTOR).
6. THE CORE OF THE EMBANKMENT SHALL BE PARALLEL TO THE CENTERLINE OF THE EMBANKMENT. THE TOP WIDTH OF THE CORE SHALL BE A MINIMUM OF FOUR FEET. THE HEIGHT SHALL EXTEND UP TO AT LEAST THE 10 YEAR WATER ELEVATION OR AS SHOWN ON THE PLANS. THE SIDE SLOPES SHALL BE 1 TO 1 OR FLATTER. THE CORE SHALL BE COMPACTED WITH CONSTRUCTION EQUIPMENT, ROLLERS, OR HAND TAMPERS TO ASSURE MAXIMUM DENSITY AND MINIMUM PERMEABILITY. IN ADDITION, THE CORE SHALL BE PLACED CONCURRENTLY WITH THE OUTER SHELL OF THE EMBANKMENT.

STRUCTURE BACKFILL

1. BACKFILL ADJACENT TO PIPES OR STRUCTURES SHALL BE OF THE TYPE AND QUALITY CONFORMING TO THAT SPECIFIED FOR THE ADJOINING FILL MATERIAL. THE FILL SHALL BE PLACED IN HORIZONTAL LAYERS NOT TO EXCEED FOUR INCHES IN THICKNESS AND COMPACTED BY HAND TAMPERS OR OTHER MANUALLY DIRECTED COMPACTION EQUIPMENT. THE MATERIAL NEEDS TO FILL COMPLETELY ALL SPACES UNDER AND ADJACENT TO THE PIPE.
2. AT NO TIME DURING THE BACKFILLING OPERATION SHALL DRIVEN EQUIPMENT BE ALLOWED TO OPERATE CLOSER THAN FOUR FEET, MEASURED HORIZONTALLY, TO ANY PART OF A STRUCTURE. UNDER NO CIRCUMSTANCES SHALL EQUIPMENT BE DRIVEN OVER ANY PART OF A CONCRETE STRUCTURE OR PIPE, UNLESS THERE IS A COMPACTED FILL OF 24" OR GREATER OVER THE STRUCTURE OR PIPE.

CARE OF WATER DURING CONSTRUCTION

1. ALL WORK ON PERMANENT STRUCTURES SHALL BE CARRIED OUT IN AREAS FREE FROM WATER. TEMPORARY DIKES, LEVEES, COFFERDAMS, DRAINAGE CHANNELS, AND STREAM DIVERSIONS NECESSARY TO PROTECT THE AREAS TO BE OCCUPIED BY THE PERMANENT WORKS SHALL BE INSTALLED, AS WELL AS PUMPING AND OTHER EQUIPMENT REQUIRED FOR REMOVAL OF WATER FROM VARIOUS PARTS OF THE WORK.
2. AFTER HAVING SERVED THEIR PURPOSE, ALL TEMPORARY PROTECTIVE WORKS SHALL BE REMOVED OR LEVELED AND GRADED TO THE EXTENT REQUIRED TO PREVENT OBSTRUCTION OF THE FLOW OF WATER TO THE SPILLWAY OR OUTLET WORKS.
3. STREAM DIVERSIONS SHALL BE MAINTAINED UNTIL THE FULL FLOW CAN BE PASSED THROUGH THE PERMANENT WORKS.

STABILIZATION AND EROSION CONTROL

1. ALL EXPOSED SURFACES OF THE EMBANKMENT, SPILLWAY, SPOIL AND BORROW AREAS, AND BERMS SHALL BE STABILIZED BY SEEDING, LIMING, FERTILIZING AND MULCHING IN ACCORDANCE WITH LOCAL NATURAL RESOURCES CONSERVATION SERVICE STANDARDS AND SPECIFICATIONS. A 4-INCH LAYER OF TOPSOIL SHALL BE PLACED ON THESE AREAS TO SUPPORT STABILIZING VEGETATION
2. FILTER FABRIC PLACED BENEATH THE RIP-RAP SHALL MEET STATE OR LOCAL DEPARTMENT OF TRANSPORTATION REQUIREMENTS FOR A CLASS "C" FILTER FABRIC.

NO.	REVISION DESCRIPTION	DATE	BY

I hereby certify that this plan 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

Print Name:
Sign Name:
Date ______ License No. ______

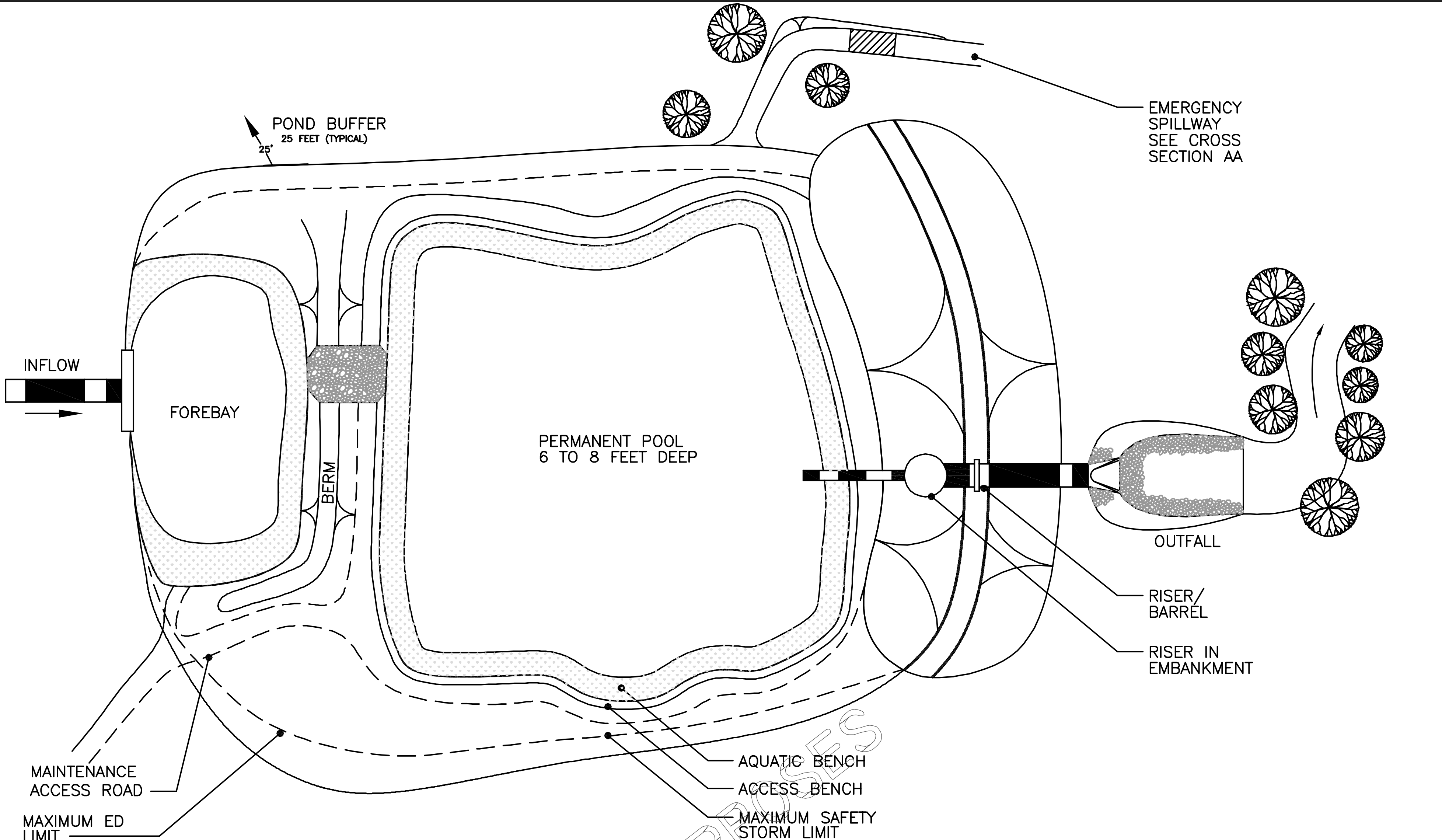
Date
Designed By
Drawn By

Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194
Phone: (651)-296-6300
TTY: (651)-282-5332
WEBSITE:www.pca.state.mn.us/

2005 MINNESOTA STORMWATER MANUAL

SHALLOW WETLAND PLAN AND PROFILE

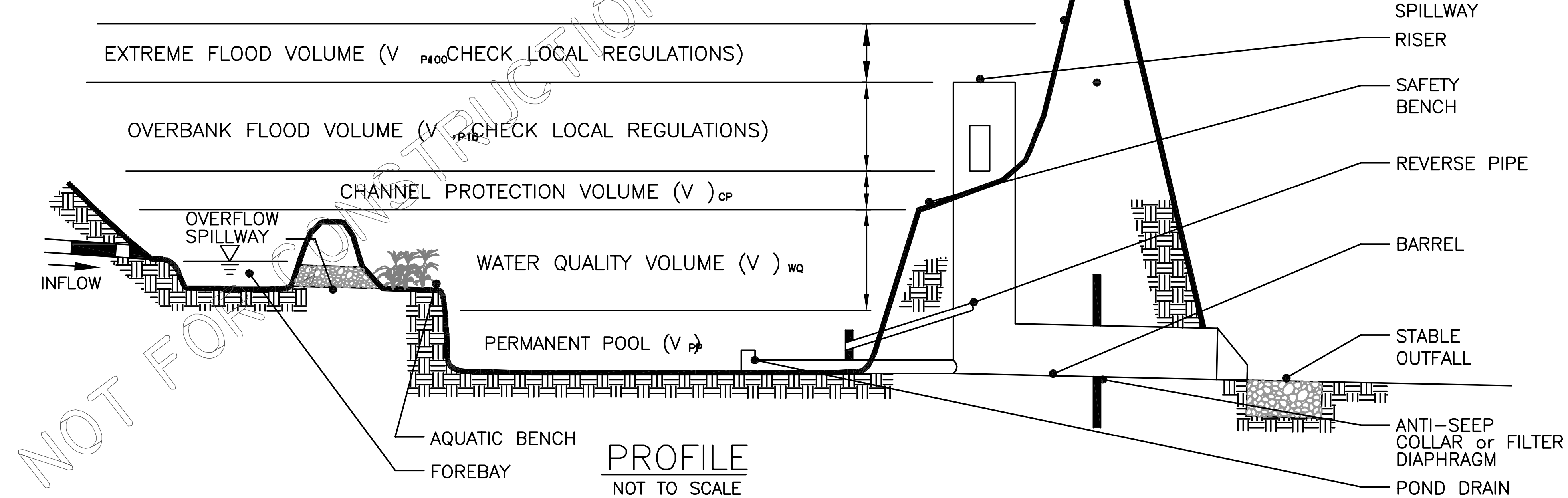
Sheet No. of Sheets



NOTE: OUTLET STRUCTURE SHOWN IS ONE EXAMPLE. OTHER DESIGNS/CONFIGURATIONS COULD ACHIEVE SIMILAR PERFORMANCE.

PLAN VIEW

NOT TO SCALE



PROFILE

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CARE OF WATER DURING CONSTRUCTION

1. ALL WORK ON PERMANENT STRUCTURES SHALL BE CARRIED OUT IN AREAS FREE FROM WATER. TEMPORARY DIKES, LEVEES, COFFERDAMS, DRAINAGE CHANNELS, AND STREAM DIVERSIONS NECESSARY TO PROTECT THE AREAS TO BE OCCUPIED BY THE PERMANENT WORKS SHALL BE INSTALLED, AS WELL AS PUMPING AND OTHER EQUIPMENT REQUIRED FOR REMOVAL OF WATER FROM VARIOUS PARTS OF THE WORK.
2. AFTER HAVING SERVED THEIR PURPOSE, ALL TEMPORARY PROTECTIVE WORKS SHALL BE REMOVED OR LEVELED AND GRADED TO THE EXTENT REQUIRED TO PREVENT OBSTRUCTION OF THE FLOW OF WATER TO THE SPILLWAY OR OUTLET WORKS.
3. STREAM DIVERSIONS SHALL BE MAINTAINED UNTIL THE FULL FLOW CAN BE PASSED THROUGH THE PERMANENT WORKS.

STABILIZATION AND EROSION CONTROL

1. ALL EXPOSED SURFACES OF THE EMBANKMENT, SPILLWAY, SPOIL AND BORROW AREAS, AND BERMS SHALL BE STABILIZED BY SEEDING, LIMING, FERTILIZING AND MULCHING IN ACCORDANCE WITH LOCAL NATURAL RESOURCES CONSERVATION SERVICE STANDARDS AND SPECIFICATIONS. A 4-INCH LAYER OF TOPSOIL SHALL BE PLACED ON THESE AREAS TO SUPPORT STABILIZING VEGETATION
2. FILTER FABRIC PLACED BENEATH THE RIP-RAP SHALL MEET STATE OR LOCAL DEPARTMENT OF TRANSPORTATION REQUIREMENTS FOR A CLASS "C" FILTER FABRIC.

NO.	REVISION DESCRIPTION	DATE	BY

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Date

Designed By

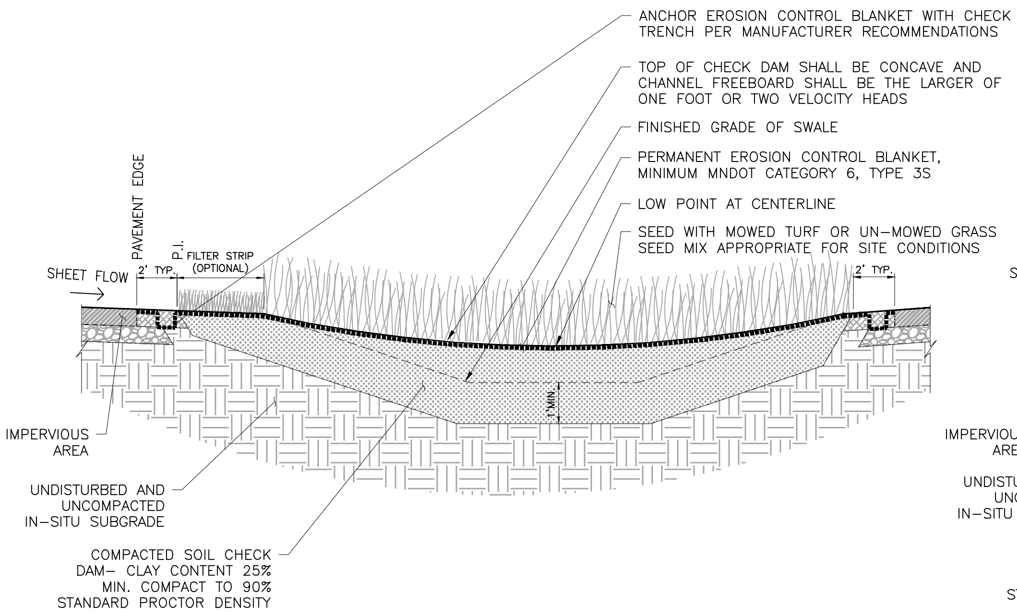
Drawn By

Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194
Phone: (651)-296-6300
TTY: (651)-282-5332
WEBSITE:www.pca.state.mn.us/

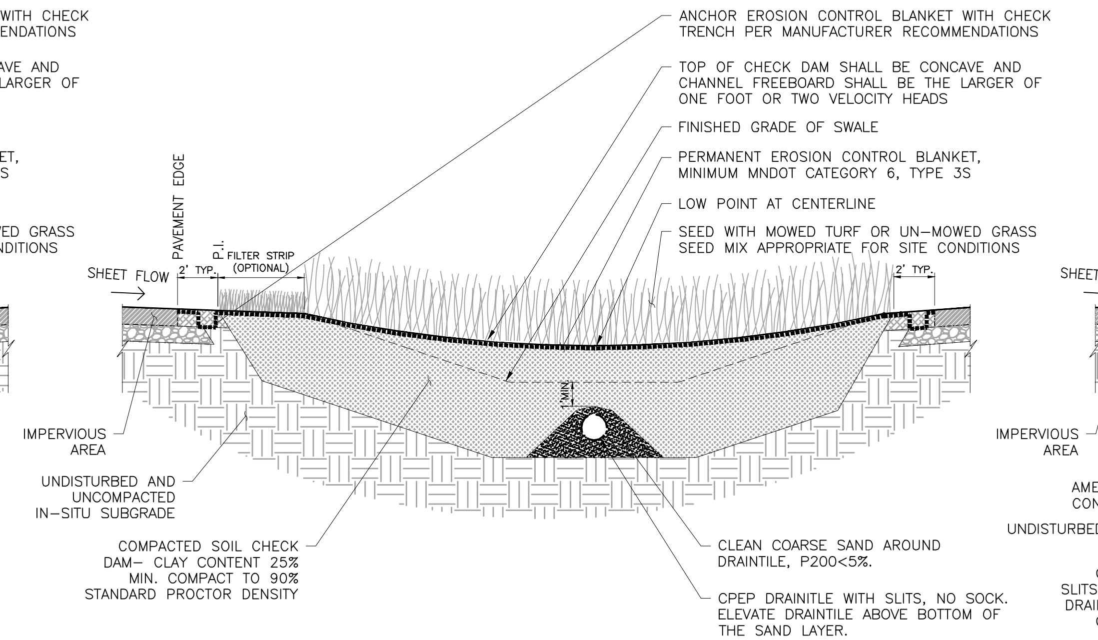
2005 MINNESOTA STORMWATER MANUAL

TYPICAL POND PLAN AND PROFILE

Sheet No. of Sheets



1/2 TYPICAL DRY SWALE CHECK DAM CROSS SECTION
NOT TO SCALE



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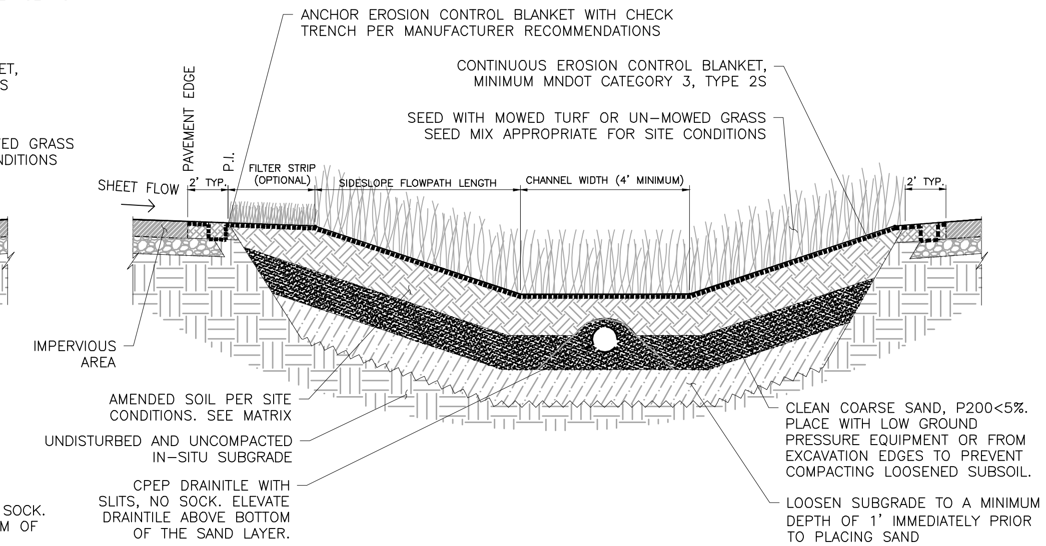
NOT TO SCALE



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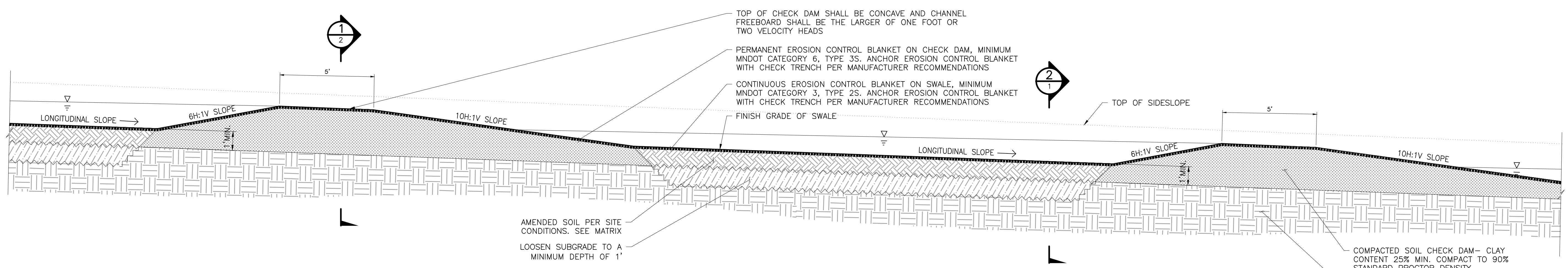
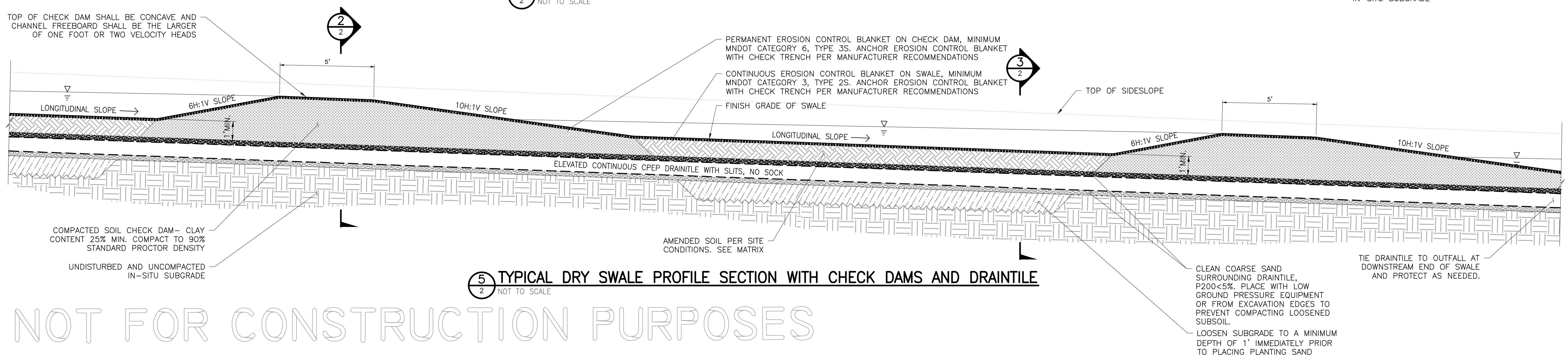
NOT TO SCALE



4/2 TYPICAL DRY SWALE PROFILE SECTION WITH CHECK DAMS
NOT TO SCALE



5/2 TYPICAL DRY SWALE PROFILE SECTION WITH CHECK DAMS AND DRAINTILE
NOT TO SCALE

NOT FOR CONSTRUCTION PURPOSES

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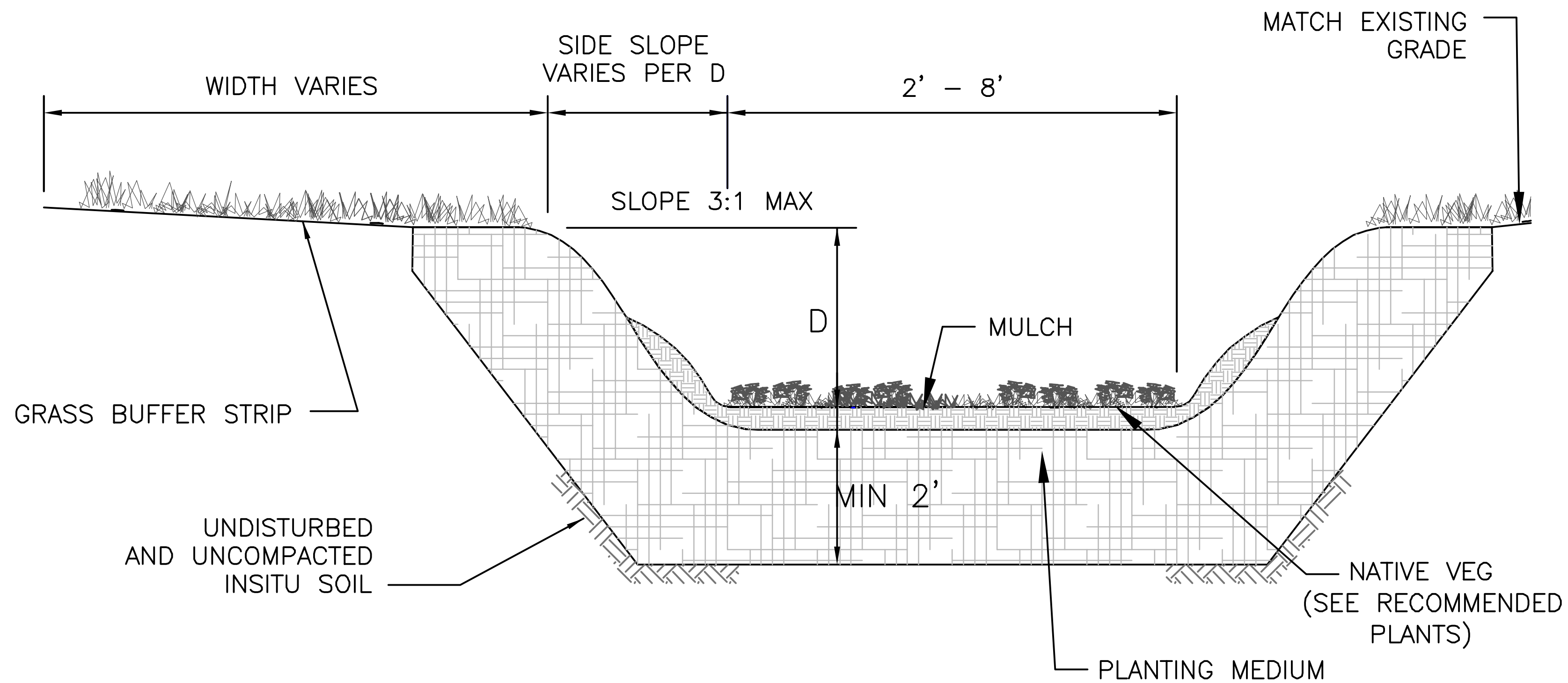
TYPICAL DRY SWALE WITH CHECKDAM AND DRAINTILE

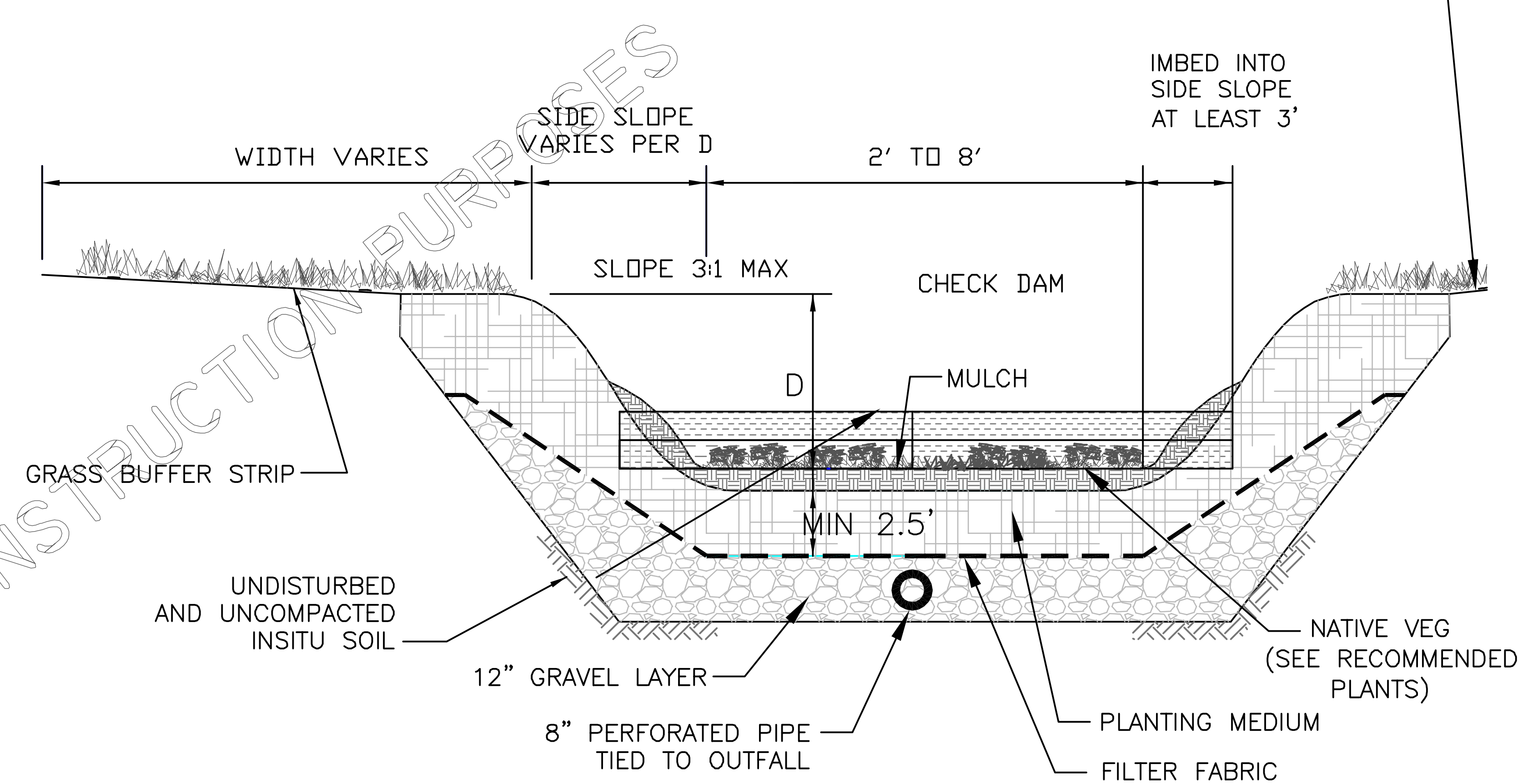
Sheet No. 2 of 2 Sheets

CADD USER: Candice M. Kantor FILE: P:\MPLS\23 MN\62\23621050 MIDS\WORKFILES\PHASE2\PHASE 2 (DRY SWALES TASK 2.2)\DRAWINGS\CAD\MIDS DRY SWALE SECTIONS.DWG PLOT SCALE: 1:2 PLOT DATE: 6/28/2013 3:40 PM



TYPICAL WET SWALE CROSS-SECTION

NOT TO SCALE



NOT FOR CONSTRUCTION PURPOSES

TYPICAL DRY SWALE CROSS-SECTION (WITH CHECKDAM)

NOT TO SCALE

CONSTRUCTION SEQUENCING:

1. PERFORM CONTINUOUS INSPECTIONS OF EROSION CONTROL PRACTICES.
2. INSTALL SILT FENCE ALONG THE PERIMETER OF THE SITE TO PREVENT SEDIMENT FROM LEAVING THE SITE DURING THE CONSTRUCTION PROCESS.
3. ALL DOWNGRADIENT PERIMETER SEDIMENT-CONTROL BMPS MUST BE IN PLACE BEFORE ANY UP GRADIENT LAND-DISTURBING ACTIVITY BEGINS.
4. REMOVE TOPSOIL FROM THE SITE AND PLACE IN TEMPORARY STOCKPILE LOCATION. TEMPORARY SEED THE STOCKPILE.
5. INSTALL UNDERGROUND UTILITIES (WATER, SANITARY SEWER, ELECTRIC AND PHONES) TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
7. SEED AND MULCH DISTURBED AREAS ON SITE.
8. CONSTRUCT THE ROADS TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
9. PERFORM ALL OTHER SITE IMPROVEMENTS TAKING THE LOCATION AND FUNCTION OF THE STORM WATER BMPS INTO CONSIDERATION.
10. FINAL GRADE THE SITE.
11. STABILIZE THE SITE BY IMPLEMENTING THE NATIVE SEEDING AND PLANTING PORTION OF THE LANDSCAPING PLAN.
12. INSTALL THE EROSION CONTROL BLANKET AND COIR ROLL/CHECK DAMS.
13. REMOVE THE SILT FENCE AFTER THE SITE IS STABILIZED PER PROJECT ENGINEER APPROVAL.

GENERAL NOTES:

1. INSTALL ALL TEMPORARY EROSION CONTROL MEASURES (IN ACCORDANCE WITH MnDOT GENERAL CONDITIONS 2573) PRIOR TO THE START OF ANY CONSTRUCTION OPERATION THAT MAY CAUSE ANY SEDIMENTATION OR SILTATION AT THE SITE.
2. INSTALL STORM DRAIN INLET PROTECTION TO PREVENT CLOGGING OF THE STORM SEWER AND SEDIMENT LOADS TO DOWNSTREAM STORM WATER FACILITIES OR WATERBODIES.
4. GRADING OF THE SWALE SHALL BE ACCOMPLISHED USING LOW-IMPACT EARTH-MOVING EQUIPMENT TO PREVENT COMPACTION OF THE UNDERLYING SOILS. SMALL TRACKED DOZERS AND BOBCATS WITH RUNNER TRACKS ARE RECOMMENDED.
5. EXCAVATE THE SWALE TO THE SPECIFIED DEPTH (ELEVATION). IT IS RECOMMENDED THAT ALL SUB MATERIAL BELOW THE SPECIFIED ELEVATION SHALL BE LEFT UNDISTURBED, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
6. GRADE TO THE DEPTH (ELEVATION) SPECIFIED IN THE CONSTRUCTION DOCUMENTS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. IN THE EVENT THAT SEDIMENT IS INTRODUCED INTO THE BMP DURING OR IMMEDIATELY FOLLOWING EXCAVATION, THIS MATERIAL WILL NEED TO BE REMOVED FROM THE SWALE PRIOR TO INITIATING THE NEXT STEP IN THE CONSTRUCTION PROCESS. THIS IS ESPECIALLY IMPORTANT IF THE SWALE HAS BEEN DESIGNED TO INFILTRATE STORM WATER: SEDIMENT THAT HAS BEEN WASHED INTO THE SWALE DURING THE EXCAVATION PROCESS CAN SEAL THE PERMEABLE MATERIAL, SIGNIFICANTLY REDUCING THE INFILTRATION CAPACITY OF THE SOILS.
8. MATERIAL EXCAVATED FROM THE SWALE(S) SHALL BE DISPOSED OF ON-SITE AT LOCATIONS (STOCKPILE AREAS) DESIGNATED BY ENGINEER.
9. **NON-STANDARD COMPONENT:** CLEAN, WASHED 1.5 TO 3.5-INCH GRAVEL SHALL BE PLACED IN THE BOTTOM OF THE SWALE TO THE DEPTH SPECIFIED IN THE CONSTRUCTION DOCUMENTS. GRAVEL SHOULD BE PLACED IN LIFTS AND LIGHTLY COMPACTED WITH PLATE COMPACTORS.
10. **NON-STANDARD COMPONENT:** THE PERFORATED PIPE (UNDERDRAIN) SHALL BE LAID DIRECTLY ON THE GRAVEL BED. GRADE AND ALIGNMENT SHALL NOT VARY FROM THE PRESCRIBED GRADE BY MORE THAN 0.03 FEET (9 MM) AT ANY POINT. THE JOINTS BETWEEN SECTIONS OF PIPE SHALL BE CONNECTED IN A FASHION ACCEPTABLE TO ENGINEER. ONCE THE PIPE IS IN PLACE, IT SHALL BE COVERED IMMEDIATELY WITH GRANULAR MATERIAL AS SPECIFIED IN THE CONSTRUCTION DOCUMENTS. THE GRANULAR MATERIAL SHALL BE OF UNIFORM DEPTH ON BOTH SIDES OF THE PIPE. SPECIAL INLETS AND SPECIAL DEVICES AT THE OUTLET END OF THE PIPE SHALL BE CONSTRUCTED AS SHOWN IN THE PLANS.
12. PORTIONS OF SWALE TO BE PLANTED SHALL RECEIVE 3" OF WOODCHIP MULCH (MnDOT TYPE 6).
13. PORTIONS OF SWALE TO BE SEEDED SHALL BE MULCHED WITH CLEAN GRAIN STRAW (MnDOT TYPE 3) AT A RATE OF 2 TONS PER ACRE.
14. SEEDING AND INSTALLATION OF EROSION CONTROL BLANKET SHALL BE COMPLETED WITHIN 48 HOURS OF FINAL GRADING.

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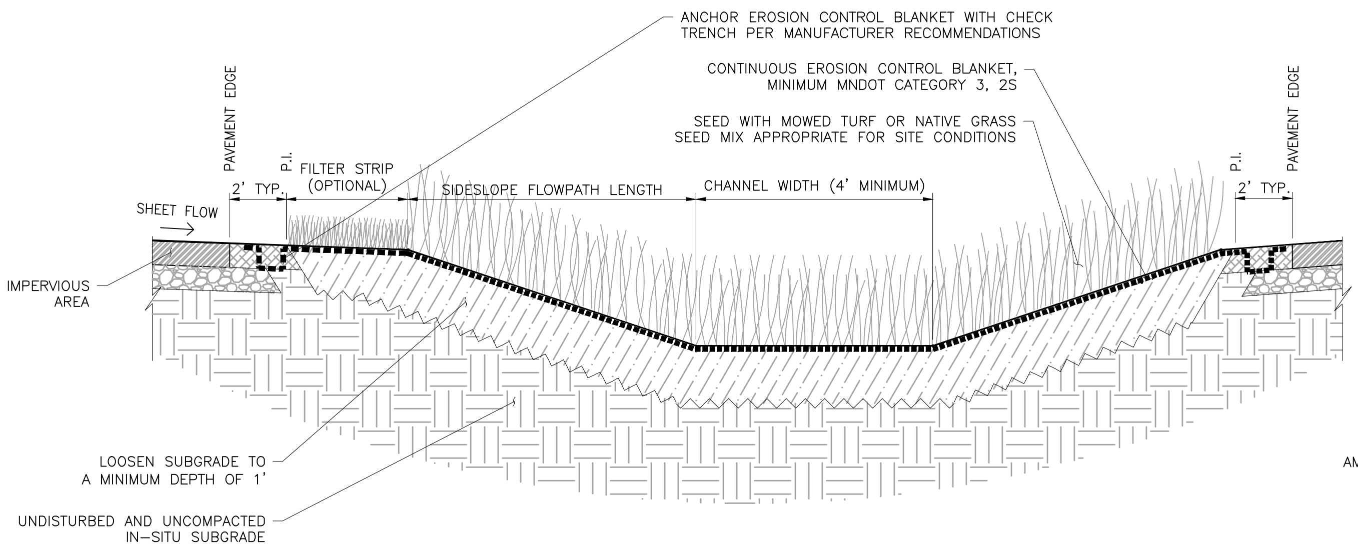
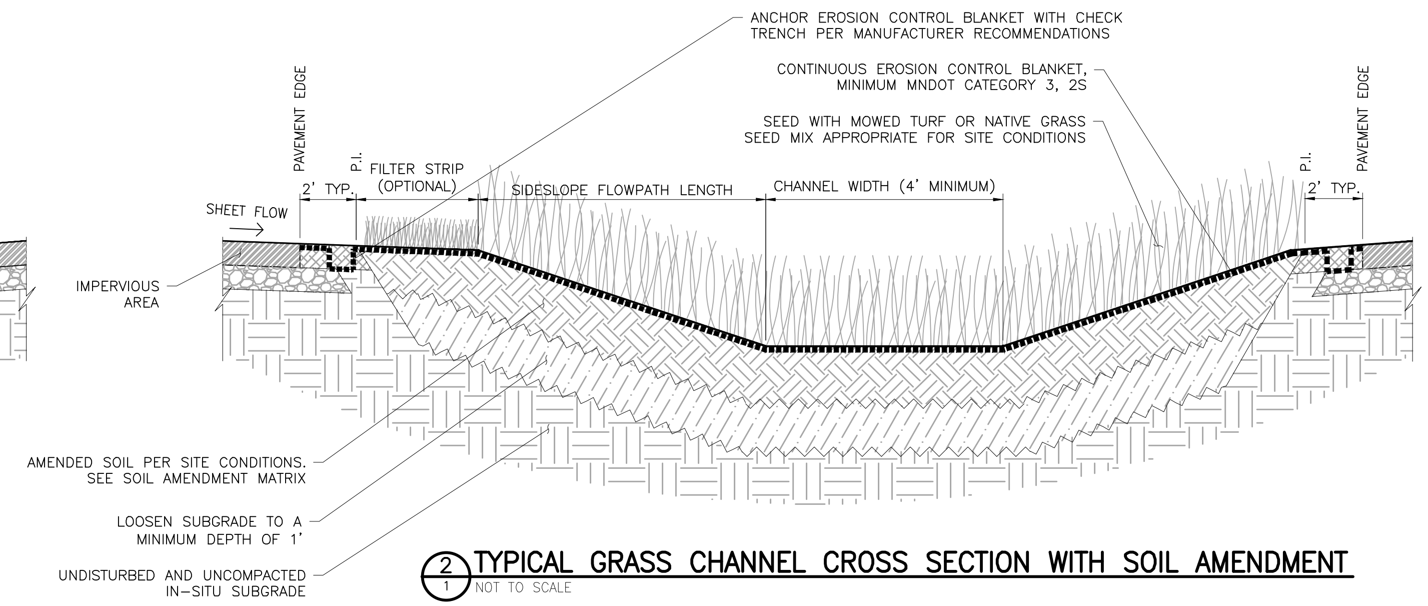
2005 MINNESOTA STORMWATER MANUAL

WET AND DRY SWALES

Sheet No. of Sheets



1/1 TYPICAL GRASS CHANNEL CROSS SECTION WITHOUT SOIL AMENDMENT
NOT TO SCALE



2/1 TYPICAL GRASS CHANNEL CROSS SECTION WITH SOIL AMENDMENT
NOT TO SCALE

TABLE 1: MIDS GRASS CHANNEL SOIL AMENDMENT MATRIX

Vegetation Type	In-Situ Soil Type			
	A	B	C	D
MOWED TURF SWALE OR NATIVE GRASS SWALE	Place 6" Imported topsoil**. Mix topsoil into subsoil by loosening subsoil to a minimum depth of 12"	Loosen subsoil to a minimum depth of 12"	Place 6" imported filtration soil* on top of subgrade and mix into subsoil by loosening subsoil to a minimum depth of 12"	Place 6" imported filtration soil* on top of subgrade and mix into subsoil by loosening subsoil to a minimum depth of 12"

* Filtration soil is defined as 80% clean sand mixed with 20% organic compost by volume

** Topsoil shall be sandy loam, loamy sand, or loam texture per USDA textural triangle with less than 5% clay content

GENERAL NOTES - GRASS CHANNELS AND DRY SWALES:

1. INSTALL ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES IN ACCORDANCE WITH THE SWPPP, PROJECT PLANS, AND SPECIFICATIONS IN ORDER TO EFFECTIVELY REDUCE THE VOLUME AND VELOCITY OF RUNOFF AND REDUCE EROSION OF SURFACE SOILS AND TO CONTROL SEDIMENT TRANSPORT OFF SITE DURING THE CONSTRUCTION PERIOD.
2. INSPECT AND MAINTAIN ALL EROSION AND SEDIMENT CONTROL MEASURES DURING THE DURATION OF THE PROJECT.
3. SEED MIX SHALL BE SELECTED BASED ON SITE CONDITIONS INCLUDING SOIL TYPE, MOISTURE CONDITIONS, FLOW CONDITIONS, SUN VS. SHADE CONDITIONS, AESTHETICS, AND MAINTENANCE REQUIREMENTS. MNDOT SPECIFICATION 3876 PROVIDES USEFUL CRITERIA FOR SELECTING APPROPRIATE SEED MIXTURES.
4. EROSION CONTROL BLANKET SHALL BE SELECTED IN ACCORDANCE WITH MNDOT SPECIFICATION 3885 FOR THE SPECIFIC SITE CONDITIONS. THE MINIMUM RECOMMENDED EROSION CONTROL BLANKET IS CATEGORY 3, 2S. MORE PERMANENT EROSION CONTROL BLANKET MAY BE REQUIRED BASED ON SWALE GRADIENT, FLOW VELOCITY, AND FLOW DEPTH.
5. EROSION CONTROL BLANKETS INSTALLATION SHALL BE IN ACCORDANCE WITH MNDOT SPECIFICATION 3885 AND MANUFACTURERS RECOMMENDATIONS FOR ANCHORING, CHECK TRENCHES, AND EDGE AND END OVERLAPS.
6. AVOID COMPACTION OF ALL IN-SITU SOILS AND IMPORTED SOILS UNLESS DIRECTED OTHERWISE. DO NOT LOOSEN SUBSOIL UNDER CHECK DAMS.
7. IF POSSIBLE, RESTRICT FLOW OR DIVERT FLOW FROM SWALE UNTIL VEGETATION IS ESTABLISHED.

NOT FOR CONSTRUCTION PURPOSES

TYPICAL CONSTRUCTION SEQUENCING-GRASS CHANNEL:

1. EXCAVATE CHANNEL TO SUBGRADE ELEVATIONS PER THE PLAN.
2. CONSTRUCTION SEQUENCE VARIES DEPENDING ON IN-SITU SOIL TYPE. SEE TABLE 1 FOR PROPER SEQUENCE FOR LOOSENING SUBSOILS AND ADDING SOIL AMENDMENTS.
3. LOOSEN SOIL IN A MANNER THAT AVOIDS RECOMPACTION OF THE SOIL BY CONSTRUCTION TRAFFIC.
4. AFTER SOIL LOOSENING AND ADDITION OF SOIL AMENDMENTS THE SURFACE OF THE SWALE WILL BE ROUGH.
5. IF POSSIBLE, STABILIZE ALL UPSTREAM TRIBUTARY AREAS BEFORE COMPLETING FINISH GRADING OF SWALES. THIS WILL MINIMIZE THE DEPOSITION OF SEDIMENT IN THE FINISHED SWALE.
6. IN THE EVENT THAT SEDIMENT IS INTRODUCED INTO THE BMP DURING OR IMMEDIATELY FOLLOWING EXCAVATION, THIS MATERIAL WILL NEED TO BE REMOVED FROM THE SWALE PRIOR TO INITIATING THE NEXT STEP IN THE CONSTRUCTION PROCESS. THIS IS ESPECIALLY IMPORTANT IF THE SWALE HAS BEEN DESIGNED TO INFILTRATE STORMWATER: SEDIMENT THAT HAS BEEN WASHED INTO THE SWALE DURING THE EXCAVATION PROCESS CAN SEAL THE PERMEABLE MATERIAL, SIGNIFICANTLY REDUCING THE INFILTRATION CAPACITY OF THE SOILS.
7. FINISH GRADE THE SWALE USING METHODS THAT AVOID RECOMPACTION OF LOOSENED SOIL. ACCEPTABLE METHODS INCLUDE HAND RAKING, SMOOTHING WITH A BACKHOE BUCKET FROM OUTSIDE THE LIMITS OF THE SWALE, AND/OR PULLING A DRAG BEHIND LOW GROUND PRESSURE EQUIPMENT LIKE AN ATV.
8. SOW SEED AND PLACE EROSION CONTROL BLANKET AFTER FINISH GRADING AND BEFORE THE FIRST RAINFALL EVENT (WITHIN 24 HOURS IS PREFERRED). DEPOSITION OF SEDIMENT ON TOP OF THE EROSION CONTROL BLANKET MAY KILL SEED AND BECOME A SOURCE OF SEDIMENT WASHING OFF SITE. SEDIMENT ON TOP OF THE EROSION CONTROL BLANKET SHALL BE REMOVED TO A DEPTH LESS THAN ONE INCH.
9. IF STEP 6 IS NOT COMPLETED BEFORE THE FIRST RAINFALL EVENT, REPAIR RESULTING EROSION AND REMOVE ALL ACCUMULATED SEDIMENT FROM THE SWALE BEFORE SOWING SEED AND PLACING EROSION CONTROL BLANKET. EROSION REPAIR AND SEDIMENT REMOVAL SHALL BE COMPLETED WITHOUT COMPACTING THE SOIL (SEE STEP 5).

TYPICAL CONSTRUCTION SEQUENCING-DRY SWALES (SEE SHEET 2):

1. EXCAVATE CHANNEL TO SUBGRADE ELEVATIONS PER THE PLAN.
2. CONSTRUCT CHECK DAMS AT THE LOCATIONS AND TO THE ELVATIONS SHOWN ON THE PLANS.
3. CONSTRUCTION SEQUENCE VARIES DEPENDING ON IN-SITU SOIL TYPE. SEE TABLE 1 FOR PROPER SEQUENCE FOR LOOSENING SUBSOILS AND ADDING SOIL AMENDMENTS.
4. LOOSEN SOIL IN A MANNER THAT AVOIDS RECOMPACTION OF THE SOIL BY CONSTRUCTION TRAFFIC. DO NOT LOOSEN SOILS UNDER CHECK DAMS.
5. INSTALL UNDERDRAIN (IF SPECIFIED) AFTER LOOSENING SUBGRADE SOILS. CAREFULLY COVER UNDERDRAIN WITH SAND TO AVOID COMPACTION AND DAMAGE TO THE PIPE. MARK THE LOCATION OF UNDERDRAIN AS NECESSARY TO AVOID DAMAGING THE PIPE DURING SUBSEQUENT CONSTRUCTION ACTIVITIES.
6. STABILIZE ALL UPSTREAM TRIBUTARY AREAS BEFORE COMPLETING FINISH GRADING OF SWALES. THIS WILL MINIMIZE THE DEPOSITION OF SEDIMENT IN THE FINISHED SWALE.
7. FINISH GRADE THE SWALE USING METHODS THAT AVOID RECOMPACTION OF LOOSENED SOIL. ACCEPTABLE METHODS INCLUDE HAND RAKING, SMOOTHING WITH A BACKHOE BUCKET FROM OUTSIDE THE LIMITS OF THE SWALE, AND/OR PULLING A DRAG BEHIND LOW GROUND PRESSURE EQUIPMENT LIKE AN ATV.
8. SOW SEED AND PLACE EROSION CONTROL BLANKET AFTER FINISH GRADING AND BEFORE THE FIRST RAINFALL EVENT (WITHIN 24 HOURS IS PREFERRED). DEPOSITION OF SEDIMENT ON TOP OF THE EROSION CONTROL BLANKET MAY KILL SEED AND BECOME A SOURCE OF SEDIMENT WASHING OFF SITE. SEDIMENT ON TOP OF THE EROSION CONTROL BLANKET SHALL BE REMOVED TO A DEPTH LESS THAN ONE INCH.
9. IF STEP 6 IS NOT COMPLETED BEFORE THE FIRST RAINFALL EVENT, REPAIR RESULTING EROSION AND REMOVE ALL ACCUMULATED SEDIMENT FROM THE SWALE BEFORE SOWING SEED AND PLACING EROSION CONTROL BLANKET. EROSION REPAIR AND SEDIMENT REMOVAL SHALL BE COMPLETED WITHOUT COMPACTING THE SOIL (SEE STEP 5).

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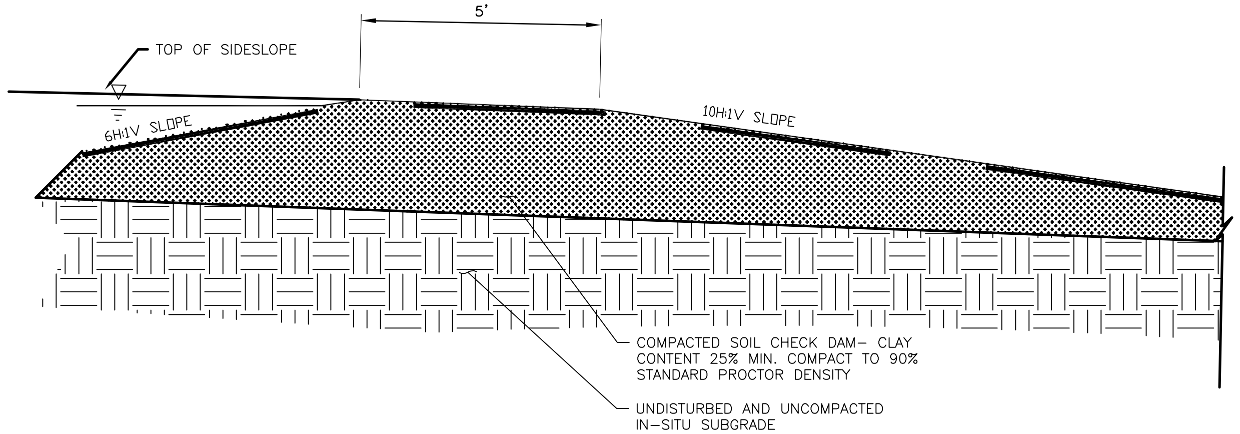
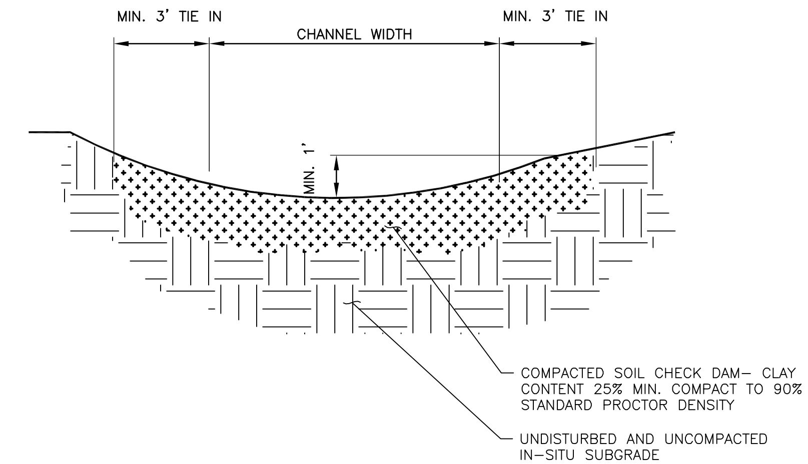
TYPICAL GRASS CHANNEL SECTIONS AND DESIGN MATRIX

Sheet No. 1 of 2 Sheets

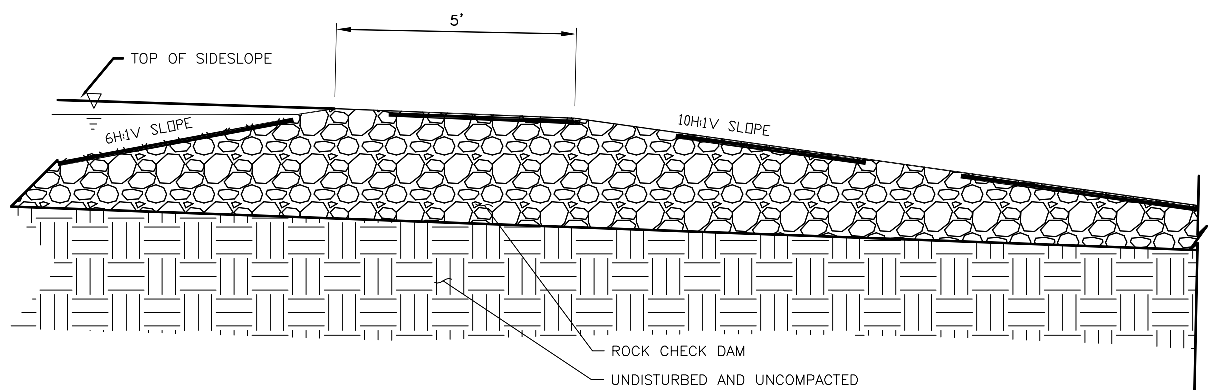
CADD USER: Candice M. Kantor FILE: P:\MPLS\23 MN\62\23621050 MIDS\WORKFILES\PHASE2\PHASE 2 (DRY SWALES TASK 2.2)\DRAWINGS\CAD\MIDS DRY SWALE SECTIONS.DWG PLOT SCALE: 1:2 PLOT DATE: 6/28/2013 3:32 PM



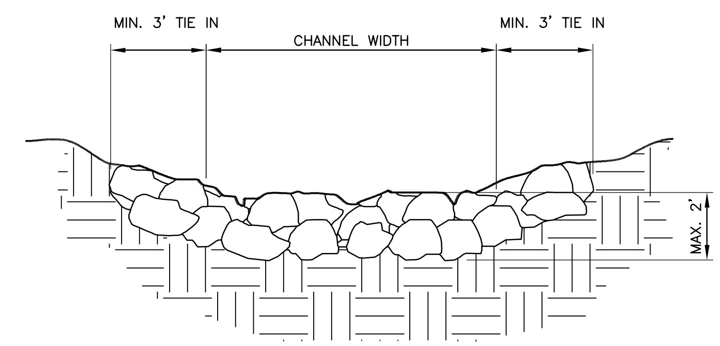
1 TYPICAL EARTHEN CHECK DAM PROFILE
1 NOT TO SCALE



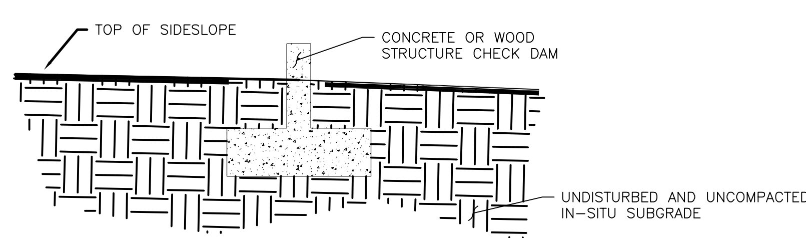
2 TYPICAL EARTHEN CHECK DAM CROSS SECTION
1 NOT TO SCALE



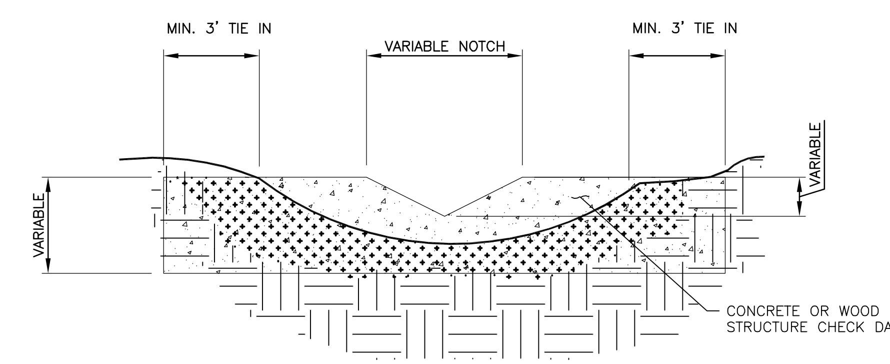
3 TYPICAL ROCK CHECK DAM PROFILE
1 NOT TO SCALE



4 TYPICAL ROCK CHECK DAM CROSS SECTION
1 NOT TO SCALE



5 TYPICAL STRUCTURAL CHECK DAM PROFILE
1 NOT TO SCALE



6 TYPICAL STRUCTURAL CHECK DAM CROSS SECTION
1 NOT TO SCALE

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Drawn By

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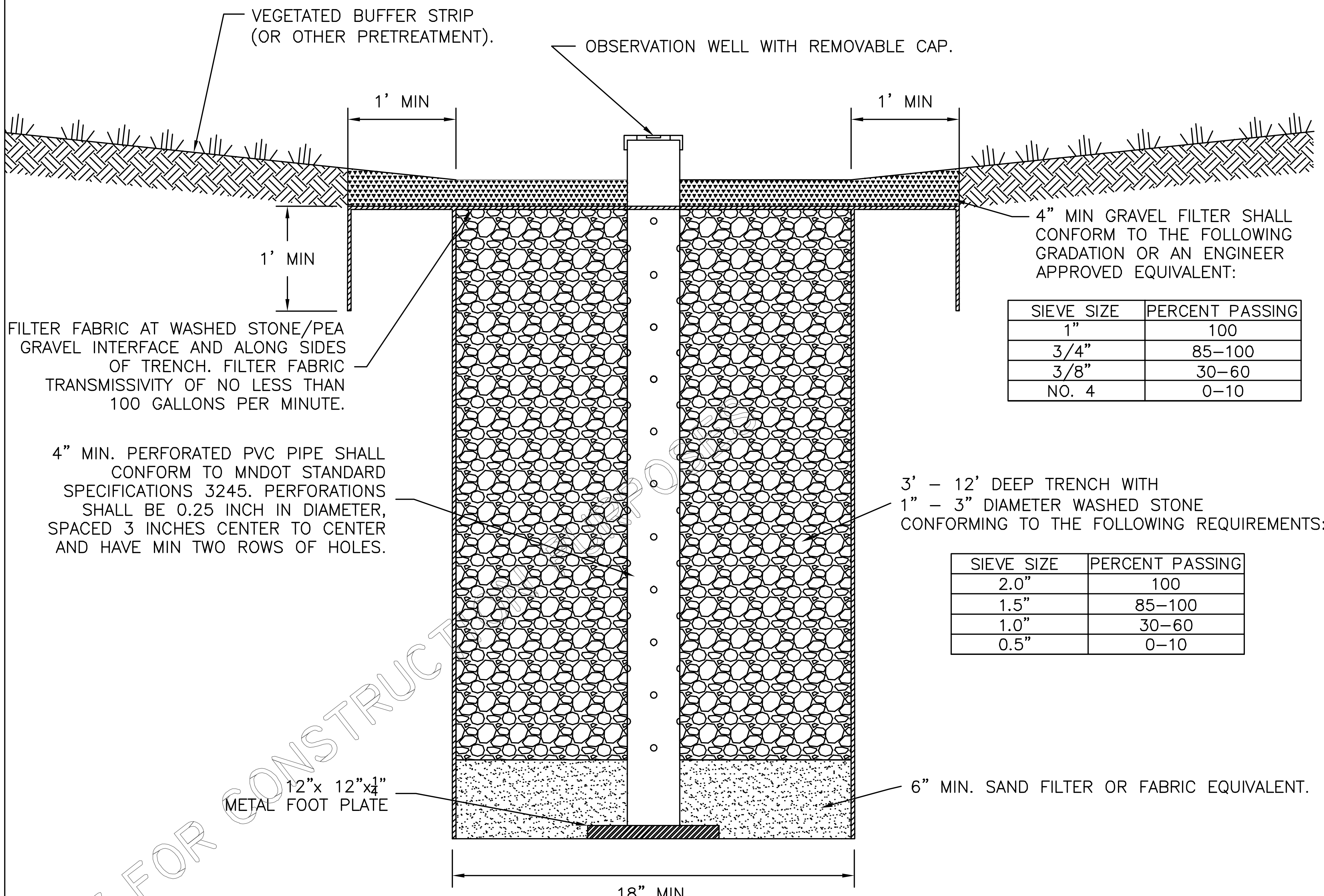
Sheet No.

of

Sheets



SIEVE SIZE	PERCENT PASSING
1"	100
3/4"	85–100
3/8"	30–60
NO. 4	0–10

SIEVE SIZE	PERCENT PASSING
2.0"	100
1.5"	85–100
1.0"	30–60
0.5"	0–10

TYPICAL INFILTRATION TRENCH CROSS–SECTION

NOT TO SCALE

CONSTRUCTION SEQUENCING:

1. PERFORM CONTINUOUS INSPECTION OF EROSION CONTROL PRACTICES.
2. INSTALL SILT FENCE ALONG THE PERIMETER OF THE SITE TO PREVENT SEDIMENT FROM LEAVING THE SITE DURING THE CONSTRUCTION PROCESS.
3. ALL DOWNGRADIENT PERIMETER SEDIMENT-CONTROL BMPS MUST BE IN PLACE BEFORE ANY UP GRADIENT LAND-DISTURBING ACTIVITY BEGINS.
4. REMOVE TOPSOIL FROM THE SITE AND PLACE IN TEMPORARY STOCKPILE LOCATION. TEMPORARY SEED THE STOCKPILE.
5. INSTALL UNDERGROUND UTILITIES (WATER, SANITARY SEWER, ELECTRIC AND PHONES) TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
6. ROUGH GRADE THE SITE. IF THE INFILTRATION TRENCH IS GOING TO BE USED FOR TEMPORARY SEDIMENT CONTROL, GRADE THE INFILTRATION TRENCH TO WITHIN THREE (3) FEET OF FINAL GRADE TO PREVENT CLOGGING OF INSITU SOIL.
7. SEED AND MULCH DISTURBED AREAS ON SITE.
8. CONSTRUCT THE ROADS TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
9. PERFORM ALL OTHER SITE IMPROVEMENTS TAKING THE LOCATION AND FUNCTION OF THE STORM WATER BMPS INTO CONSIDERATION.
10. FINAL GRADE THE SITE.
11. STABILIZE THE SITE BY IMPLEMENTING THE NATIVE SEEDING AND PLANTING PORTION OF THE LANDSCAPING PLAN.
12. REMOVE THE SILT FENCE AFTER THE SITE IS STABILIZED PER PROJECT ENGINEER APPROVAL.

GENERAL NOTES:

1. INSTALL ALL TEMPORARY EROSION CONTROL MEASURES (IN ACCORDANCE WITH MnDOT GENERAL CONDITIONS 2573) PRIOR TO SITE DISTURBANCE.
2. INSTALL STORM DRAIN INLET PROTECTION TO PREVENT CLOGGING OF THE STORM SEWER AND SEDIMENT LOADS TO DOWNSTREAM STORM WATER FACILITIES OR WATERBODIES.
3. IF THE STORM WATER BMP IS BEING DESIGNED TO SERVE AS A TEMPORARY SEDIMENT BASIN, GRADE THE BMP TO WITHIN THREE (3) FEET OF FINAL GRADE TO PREVENT CLOGGING OF INSITU SOIL. ONCE CONSTRUCTION IN THE CONTRIBUTING DRAINAGE AREA HAS BEEN COMPLETED AND THE SITE IS STABILIZED, EXCAVATE THE INFILTRATION TRENCH TO FINAL GRADE AND COMPLETE CONSTRUCTION OF THE INFILTRATION TRENCH.
4. GRADING OF THE INFILTRATION TRENCH SHALL BE ACCOMPLISHED USING LOW-IMPACT EARTH-MOVING EQUIPMENT TO PREVENT COMPACTION OF THE UNDERLYING SOILS. WIDE TRACKED VEHICLES SUCH AS BACK HOES, SMALL DOZERS AND BOBCATS ARE RECOMMENDED.
5. EXCAVATE THE INFILTRATION TRENCH TO THE SPECIFIED DEPTH (ELEVATION). ALL SUB MATERIAL BELOW THE SPECIFIED ELEVATION SHALL BE LEFT UNDISTURBED, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
6. GRADE TO THE DEPTH (ELEVATION) SPECIFIED IN THE CONSTRUCTION DOCUMENTS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. IN THE EVENT THAT SEDIMENT IS INTRODUCED INTO THE BMP DURING OR IMMEDIATELY FOLLOWING EXCAVATION, THE SEDIMENT WILL NEED TO BE REMOVED FROM THE INFILTRATION TRENCH PRIOR TO INITIATING THE NEXT STEP IN THE INFILTRATION TRENCH CONSTRUCTION PROCESS.
8. MATERIAL EXCAVATED FROM THE INFILTRATION TRENCH SHALL BE DISPOSED OF ON-SITE AT LOCATIONS (TEMPORARY STOCKPILE AREAS) DESIGNATED BY ENGINEER.
9. CLEAN, WASHED 1 TO 3-INCH GRAVEL SHALL BE PLACED IN THE BOTTOM OF THE INFILTRATION TRENCH TO THE DEPTH SPECIFIED IN THE CONSTRUCTION DOCUMENTS. GRAVEL SHOULD BE PLACED IN LIFTS AND LIGHTLY COMPACTED WITH PLATE COMPACTORS.

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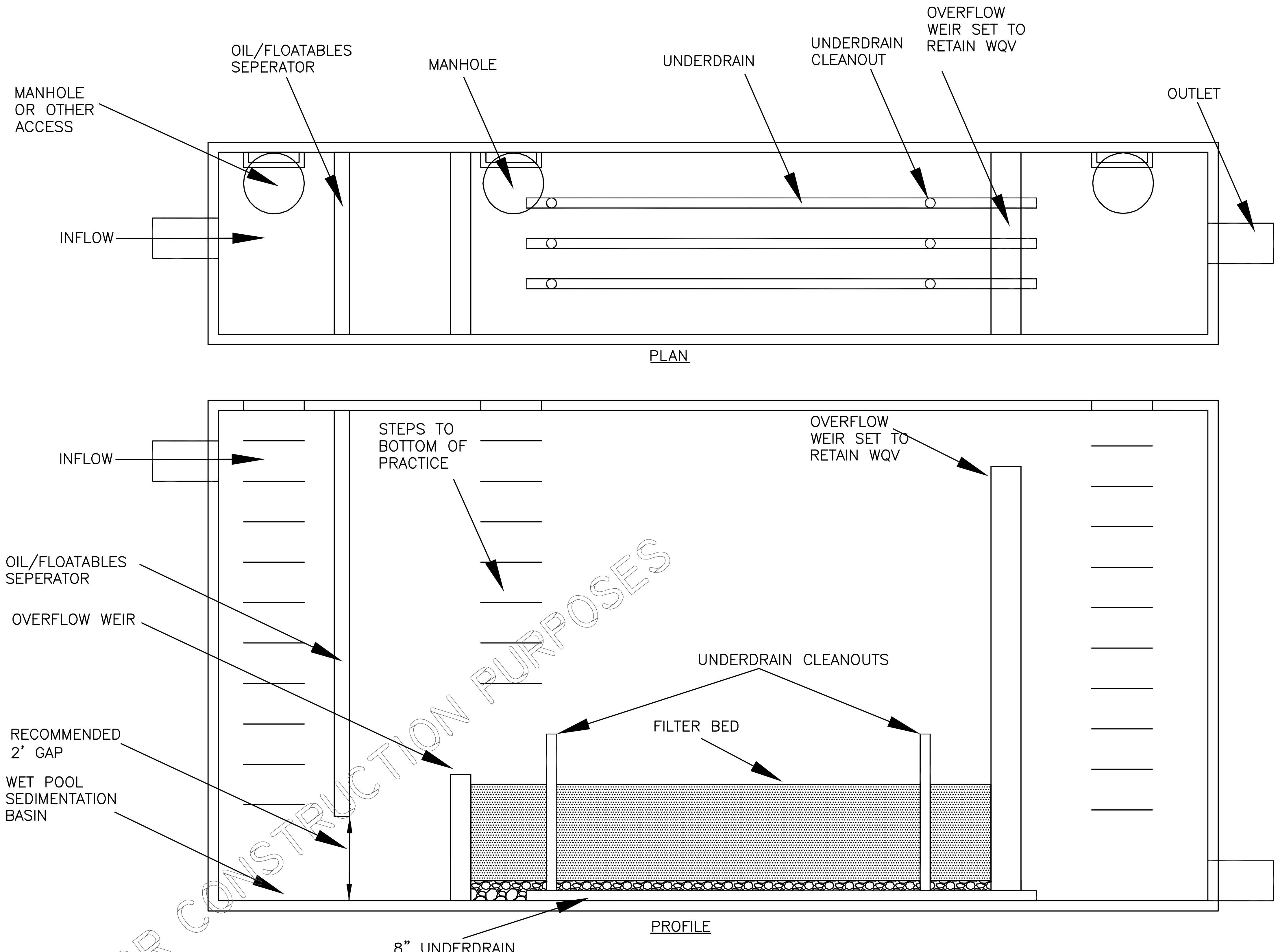
2005 MINNESOTA STORMWATER MANUAL

TYPICAL INFILTRATION TRENCH CROSS–SECTION

Sheet No. of Sheets



NOT FOR CONSTRUCTION PURPOSES

UNDERGROUND SAND FILTER

NOT TO SCALE

CONSTRUCTION SEQUENCING:

1. PERFORM CONTINUOUS INSPECTIONS OF EROSION CONTROL PRACTICES.
2. INSTALL SILT FENCE ALONG THE PERIMETER OF THE SITE TO PREVENT SEDIMENT FROM LEAVING THE SITE DURING THE CONSTRUCTION PROCESS.
3. ALL DOWNGRADIENT PERIMETER SEDIMENT-CONTROL BMPS MUST BE IN PLACE BEFORE ANY UP GRADIENT LAND-DISTURBING ACTIVITY BEGINS.
4. REMOVE TOPSOIL FROM THE SITE AND PLACE IN TEMPORARY STOCKPILE LOCATION. TEMPORARY SEED THE STOCKPILE.
5. INSTALL UNDERGROUND UTILITIES (WATER, SANITARY SEWER, ELECTRIC AND PHONES) TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.

7. SEED AND MULCH DISTURBED AREAS ON SITE.
8. CONSTRUCT THE ROADS TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
9. PERFORM ALL OTHER SITE IMPROVEMENTS TAKING THE LOCATION AND FUNCTION OF THE STORM WATER BMPS INTO CONSIDERATION.
10. FINAL GRADE THE SITE.
11. STABILIZE THE SITE BY IMPLEMENTING THE NATIVE SEEDING AND PLANTING PORTION OF THE LANDSCAPING PLAN.
12. INSTALL THE EROSION CONTROL BLANKET
13. REMOVE THE SILT FENCE AFTER THE SITE IS STABILIZED PER PROJECT ENGINEER APPROVAL.

GENERAL NOTES:

1. INSTALL ALL TEMPORARY EROSION CONTROL MEASURES (IN ACCORDANCE WITH MnDOT GENERAL CONDITIONS 2573) PRIOR TO THE START OF ANY CONSTRUCTION OPERATION THAT MAY CAUSE ANY SEDIMENTATION OR SILTATION AT THE SITE.
2. INSTALL STORM DRAIN INLET PROTECTION TO PREVENT CLOGGING OF THE STORM SEWER AND SEDIMENT LOADS TO DOWNSTREAM STORM WATER FACILITIES OR WATERBODIES.
3. GRADE TO THE DEPTH (ELEVATION) SPECIFIED IN THE CONSTRUCTION DOCUMENTS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. IN THE EVENT THAT SEDIMENT IS INTRODUCED INTO THE BMP DURING OR IMMEDIATELY FOLLOWING CONSTRUCTION, THIS MATERIAL WILL NEED TO BE REMOVED FROM THE PRACTICE PRIOR TO INITIATING THE NEXT STEP IN THE CONSTRUCTION PROCESS. SEDIMENT THAT HAS BEEN WASHED INTO THE PRACTICE CAN SEAL THE PERMEABLE MATERIAL, SIGNIFICANTLY REDUCING THE FILTRATION CAPACITY OF THE SOILS.
5. CLEAN OUT SETTLING BASIN WHEN 1' OF SEDIMENT HAS ACCUMULATED.

NO.	REVISION DESCRIPTION	DATE	BY

I hereby certify that this plan 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

Print Name:

Sign Name:

Date ______ License No.

Date

Designed By

Drawn By

Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194
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WEBSITE:www.pca.state.mn.us/

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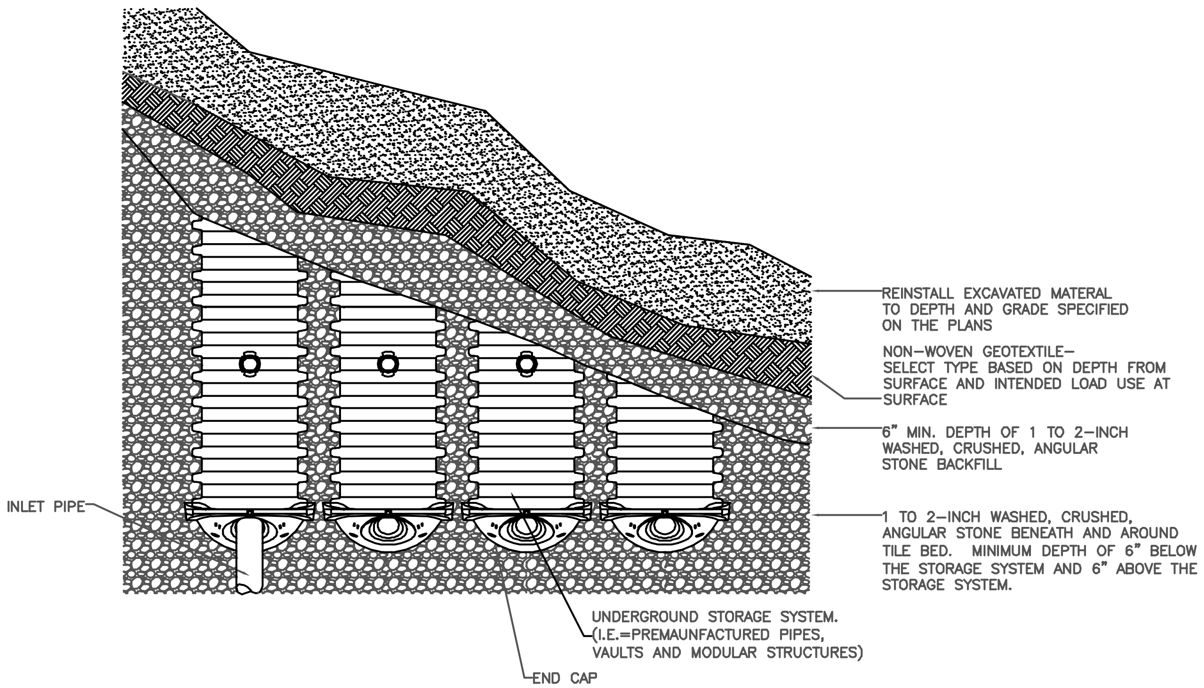
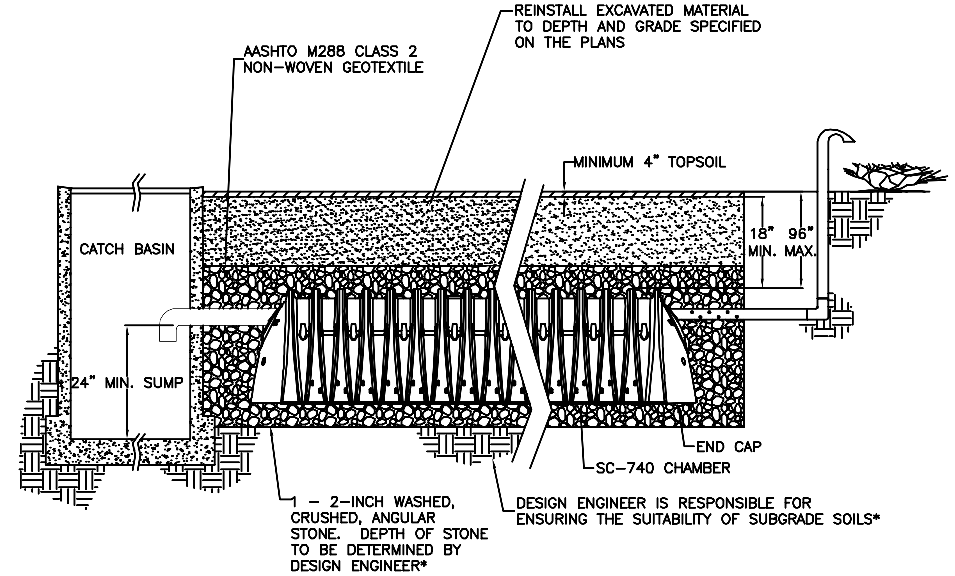
UNDERGROUND SAND FILTER DETAILS

Sheet No. of Sheets



UNDERGROUND INFILTRATION SYSTEM
PLAN VIEW DETAIL
NOT TO SCALE



UNDERGROUND INFILTRATION SYSTEM
VENT DETAIL
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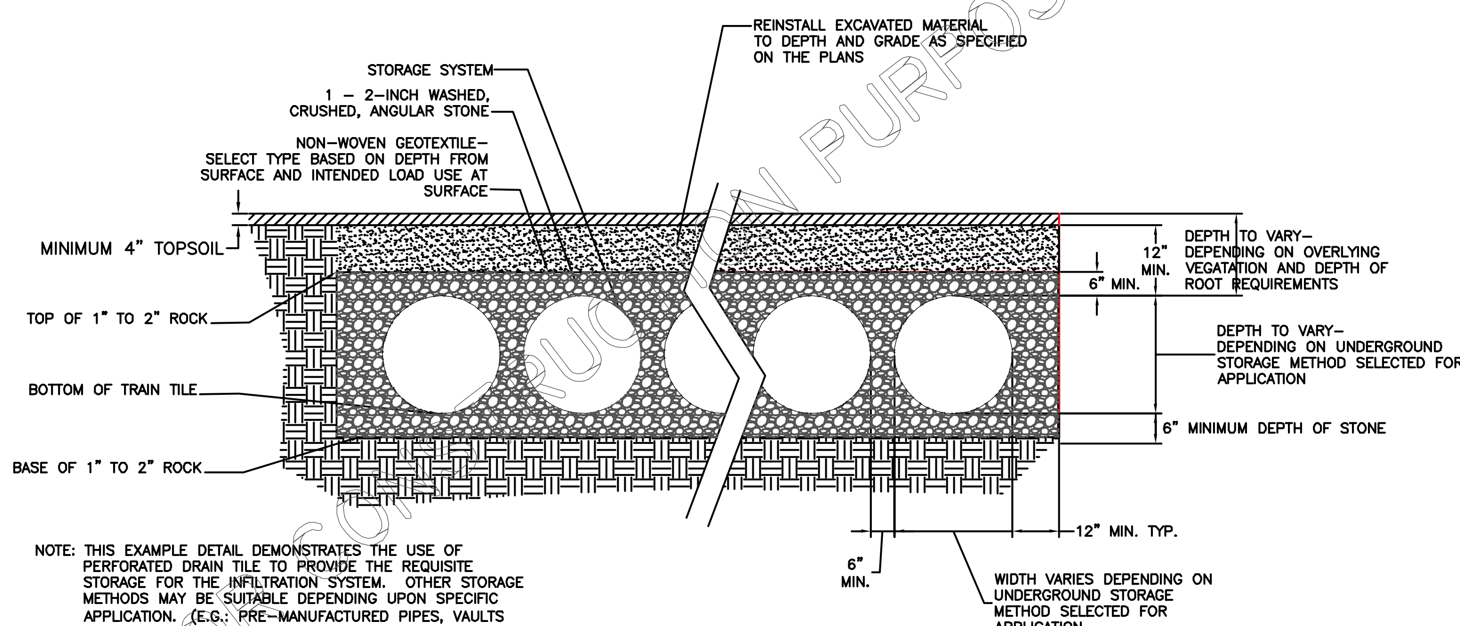

NOTE: THIS EXAMPLE DETAIL DEMONSTRATES THE USE OF PERFORATED DRAIN TILE TO PROVIDE THE REQUISITE STORAGE FOR THE INFILTRATION SYSTEM. OTHER STORAGE METHODS MAY BE SUITABLE DEPENDING UPON SPECIFIC APPLICATION. (E.G.: PRE-MANUFACTURED PIPES, VAULTS AND MODULE STRUCTURES)

UNDERGROUND INFILTRATION SYSTEM
TYPICAL CROSS SECTION DETAIL
NOT TO SCALE

NOT FOR CONSTRUCTION PURPOSES

INFILTRATION SUBSURFACE PLANS & PROFILE

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NO.	REVISION DESCRIPTION	DATE	BY

I hereby certify that this plan 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

Print Name:
Sign Name:
Date
License No.

Date
Designed By
Drawn By

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INFILTRATION SUBSURFACE PLANS AND SECTIONS

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