East Vadnais Lake Subwatershed

Water Quality/Flood Resilience Study

Report Version 3.0

Prepared for:

Vadnais Lake Area Watershed Management Organization (VLAWMO) and project partners:
- **City of Vadnais Heights**
- **Ramsey County**
- **Saint Paul Regional Water Services (SPRWS)**

Prepared by:

SRF

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Chapter 1 Introduction/Goals

1.1 Introduction

The East Vadnais Lake subwatershed provides essential resources to the residents of the Vadnais Lakes Area Watershed Management Organization, the City of Vadnais Heights, and Ramsey County, ranging from vital retail and commercial centers to residential areas, parks and recreation opportunities, to an important source of drinking water for the community. Vadnais Lake is used as the drinking water reservoir for approximately 450,000 customers in the St. Paul area. As the subwatershed is impacted by climate change and changing precipitation patterns, the need to identify Best Management Practices (BMPs) that will provide resiliency by enhancing the subwatershed's ability to withstand and recover from the impacts of a changing climate while maintaining hydrological functions and protecting the subwatershed's water resources and infrastructure is becoming ever more urgent.

The report includes text and tables within the body with figures found in the Appendices.

1.2 Partnership

This study is supported through a partnership with the following agencies.

- Lead agency – Vadnais Lake Area Water Management Organization (VLAWMO)
- City of Vadnais Heights
- Ramsey County
- Saint Paul Regional Water Services (SPRWS)

1.3 Study Location and Goals

The East Vadnais Lake Subwatershed encompasses roughly 280 acres of commercial, residential, and natural areas north and east of East Vadnais Lake (Figure 1.1).

During the kickoff meeting with the four partners, we discussed goals and objectives each had for this study. The overall theme is to reduce flooding while improving water quality to provide a more resilient stormwater management system. Each of the partners responses are found in Table 1.1. Other partner meeting notes are found in Appendix C.

Table 1.1 – Partner Goals

Vadnais Heights	- Understand how the upstream part of the subwatershed impacts the downstream. - E.g. understand how Berwood area to Arcade impacts the Centerville/ Edgerton intersection in terms of capacity and flooding. - Slow water down in the upstream parts of the watershed to get increased water quality benefits through infiltration or attenuation. - Understand what elements of the storm sewer network need to be updated to alleviate street flooding, without creating new issues.
Ramsey County	- Captured in the RFP, primarily focused on reducing localized flooding. - Does not have any other projects currently planned outside of pavement rehab.
SPRWS	- Focused on water quality improvement. East Vadnais Lake is a source of pride to SPRWS. - Improved water quality helps to reduce treatment costs. - East Vadnais Lake is a source of water for them. Pumps turn on based on lake levels, so in larger storm events a larger percent of their water is pulled from the watershed.
VLAWMO	- Expand upon the County's Edgerton Road flood project to further reduce the flood risk. - Improve water quality. - Provide multi-benefit BMPs. - Overall resiliency. - Working to buildable projects that solve problems.

Chapter 2 Data Sources

2.1 Sources

Information was collected from the following partners:

- City of Vadnais Heights
- VLAWMO
- Ramsey County
- SPRWS

Partners have also contributed to the study via several meetings. Meeting notes are found in Appendix C.

2.2 Data

Table 2.1 contains an exhaustive list of information received from the partners and collected in the field.

Table 2.1 Available Data

Data Description	Source
Edgerton Street/Centerville Road Flood Feasibility Study	Ramsey County
GIS Storm Sewer Data	Vadnais Heights
Storm Sewer/Utility As-Builts	Vadnais Heights
Rain Gauge Data	VLAWMO
HydroCAD Modeling	Ramsey County
Lake Level Data	SPRWS
GIS Impervious Cover	Ramsey County
Hydrologic Soil Groups	USDA Natural Resources Conservation Service (NRCS) Web Soil Survey
GIS Right Of Way/Parcel Lines	Ramsey County
Parcel Sketch	Ramsey County
Existing Storm Sewer Survey	SRF
Select Field Survey	SRF
Level 1 Wetland Delineations	SRF
West Vadnais Lake Subwatershed: Urban Stormwater Retrofit Analysis	VLAWMO

Chapter 3 Existing Conditions

3.1 Definitions

There are several features noted on the Figures (Appendix A) and in the following text that are named after their physical features but should be defined. Some are connected to the Edgerton Street/Centerville Road Flood Feasibility Study, completed by SRF in 2023 (SRF, 2023). In addition, other terms used have been defined, such as the study's definition of resiliency.

Resiliency – Climate-resilient infrastructure is planned, designed, built, and operated in a way that anticipates, prepares for, and adapts to changing climate conditions. For this study it is focused on drainage infrastructure that provides protection of structures, property and street flooding allowing provisions for emergency response vehicles during a large storm event.

Edgerton Street/Centerville Road Flood Feasibility Study (SRF, 2023) – This study included a hydrologic and hydraulic modeling effort to evaluate and design improvements to reduce/eliminate longstanding flooding on Edgerton Street near the railroad trestle. This model contains labeling and other information that is the foundation for the modeling done for this study.

The proposed improvements are scheduled to be constructed in 2024 so they have been included in the models as existing conditions.

Cigar Pond – Referred to as Cigar Pond in the Edgerton Study, it is the city-owned pond east of the railroad that receives all of Subdrainage Areas A, B and C. This study refers to it as Pond 3.

Big Hole – This is a depression along Edgerton Street that straddles the Big Woods Brewery property line. It has been delineated as a wetland and receives most of the runoff from entire subwatershed.

Deep Ravine – This ravine runs along the east side of Centerville Road and carries water from the drainage area east of the railroad (Subdrainage Area D) to the box culvert crossing Centerville Road.

Flow Splitter Structure – Also referred to as 'splitter', this large structure is located on the west side of Arcade Street near the entrance to the Walmart center. It consists of a large, cast in place concrete structure with three storm sewer inlets from the north, east, and south and a 24-inch storm sewer outlet that discharges to Pond 4. In storm events larger than a 1-inch event, water builds up inside the structure and exits the grate into the north wetland complex.

<u>North Wetland Complex</u> – The large natural area/open space south of City Hall and west of Arcade Street was farmed until the 1950's but is now presumed to be wetland. It is bound by the railroad to the west, City Hall to the north, Arcade Street to the east and residential land use to the south.

<u>Parcels and Structures</u> – In order to quantify inundation impacts and improvements, impacts to parcels and structures are referenced throughout the report. Parcel impacts are instances where private parcels, from Ramsey County parcel data, show some level of inundation in a given storm event based on the inundation mapping. Structure impacts are instances where the inundation extends up an insurable structure. Structures are a sub-set of the parcels.

3.2 Contributing Drainage Areas and Hydrology

Figure 1.1 shows the contributing drainage areas to the outfall to East Vadnais Lake. Approximately 280 acres drains through the system to East Vadnais Lake, ultimately discharging to the lake via two outlet pipes. For modeling purposes, the larger contributing area was broken into six subdrainage areas:

- Subdrainage Area A includes 39.4 acres that contribute to the flow splitter structure, Discharge Point 1, and include the Walmart complex, City Hall and fire station, and portions of Arcade Street. Soils in this area are generally classified as A soils.
- Subdrainage Area B includes 110.5 acres that drain to the Garceau Lane trunk sewer and is a mixture of natural and residential areas, including the North Wetland Complex. Soils in this area vary, including A, C, and A/D.
- Subdrainage area C includes 52.2 acres that drains to Pond 3 and includes primarily residential land uses. Soils are generally classified as C/D soils.
- Subdrainage Area D includes 16.1 acres of direct drainage south of Centerville Road and north of the railroad tracks. Soils are generally classified as A soils.
- Subdrainage Area E includes 49.4 acres of direct drainage from the residential area between Centerville Road and Edgerton Street. Soils are generally classified as either A or C soils.
- Subdrainage Area F includes 13 acres of residential drainage area that discharges to the low point that has experienced flooding north of the railroad tracks on Edgerton Street. Soils are generally classified as B soils.

3.3 Contributing Drainage Areas and Hydraulics

Figure 1.1 also shows the general drainage patterns for the upstream area. Drainage patterns observed have been summarized below:

- Subdrainage Area A is currently routed through a storm sewer system to the flow splitter structure that routes small storms to Pond 4 for treatment (1 inch storm or less) and overtops into the North Wetland Complex in larger storms. The overtopping elevation is 1 foot below the low point on Arcade Street. The overflow is undefined – it enters the North Wetland Complex and eventually flows south to the Pond 4 area. The modeling accounts for the known pressure conditions and provides an overflow to the south.
- Subdrainage Area B includes overland flow from the north into the Pond 4 area as well as residential areas that drain west to Pond 3 via storm sewer. The main trunk system runs east-west through backyards between Garceau Lane and Hiawatha Avenue.
- Subdrainage Area C is conveyed to Pond 3 via storm sewer from south of the Pond and includes a number of backyard drains. Pond 3 has a controlled outlet that ultimately discharges to the Deep Ravine through a 72" pipe underneath the railroad.
- Subdrainage Area D discharges to the Deep Ravine via overland conveyance and a shallow ditch along the north side of the railroad. The Deep Ravine outlets through a box culvert with headwalls to support the surrounding embankment. The box culvert is picked up via a drop inlet structure on the north side of Centerville Road, at the entrance of a planned future development (Big Woods Brewery), and routed to the Big Hole via a 36" RC Pipe.
- Runoff from subdrainage Area E drains to the Big Hole at the NE corner of Edgerton Street and Centerville Road via a swale/ditch system, ultimately discharging to East Vadnais Lake via a culvert under Edgerton Street.
- The conveyance system for Subdrainage Area F is being improved via the Edgerton Street/Centerville Road Construction project in 2024. A new pond and outfall to East Vadnais Lake will reduce flooding in this low point.

3.4 East Vadnais Lake Levels

East Vadnais Lake is part of the SPRWS water supply system, which receives water from the Mississippi River through a series of lakes and streams. SPRWS pumps between 38 MGD in the winter upwards to 68 MGD during peak summer months. The lake levels are managed to allow this pumping to occur at an average gage level of 12 (833.55 NAVD 88). The lake overflows at a gage level of 13.1 (884.65 NAVD 88).

3.5 General Soil Conditions

Based on the Ramsey County Web Soil Survey, soils in the area are generally A soils (fine sands) north of the railroad and C/D (silt loams) or B/D (fine sandy loam) south of the railroad. These have been used to develop hydrologic parameters (curve numbers) for the modeling effort.

3.6 Wetlands

A Level 1 wetland delineation was performed for the north wetland complex (Figure 1.1). This desktop delineation was field verified in February, 2024. While the delineation was done outside of the growing season, it is a good representation of the vegetative cover as the 2023/24 winter had very limited snow by that date, and the work was performed without snow on the ground. However, little is known about the groundwater or hydrology available to the site, and soils data is also limited. A level 2 field delineation will need to be completed during the growing season to better understand the wetland characteristics and extents. Piezometers will also be needed to understand potential impacts to water levels from any proposed grading changes.

The delineation figures and other documentation is found in Appendix E.

Chapter 4 Hydrologic and Hydraulic Modeling

4.1 Description

XP-SWMM hydrologic and hydraulic modeling software was used for the hydrologic and hydraulic evaluation of this subwatershed. This model can evaluate the entire system at each timestep and is a powerful tool to understand the interaction within complex urban systems.

4.2 Modeling Parameters

4.2.1 Hydrologic Modeling Parameters

The following parameters were used to generate runoff from the subwatersheds.

- Atlas 14 Rainfall with Regionalized IDF Storm Distribution
- The SCS Hydrograph Method using NRCS Curve Number (CN) and Time of Concentrations (Tc)
- Drainage areas were chosen to capture existing BMP's as well as potential BMP locations, various land uses, and low points.
- Impervious surfaces taken from Ramsey County GIS data with some modifications for recent developments in the Walmart area.
- Ramsey County land use data overlayed with soils data from the NRCS Web Soil Survey to develop CNs.
- LiDAR data was used to determine drainage areas, computing Tc's and the initial grading of proposed BMPs.
- Used Directly Connected Impervious Area (DCIA) multipliers to account for reduced runoff from areas where impervious areas are primarily disconnected. A reduction factor of 40% was used for primarily residential drainage areas. See 4.2.3 for more details.

4.2.2 Hydraulic Modeling Parameters

- Included larger private and public surface BMPs but generalized smaller private BMPs (rain gardens, underground facilities) that would likely not reduce flooding.
- Generally modeled surface overflows in the streets as natural channels. Generalized street overflows into 3 categories.
  - North portion of Arcade with 50' wide cross section
  - South portion of Arcade with 40' cross section
  - Residential streets with 30' cross section
- Allowed for ponding in select areas to capture attenuation.
  - E.g. Walmart's roof

- County Rd E is not included in the model as it generally does not drain to the storm sewer networks in this project. In larger storm events some water may bypass inlets along County Rd E and contribute to this subwatershed but would not likely impact the overall results.
- The storm sewer pipe network is based on City's GIS and as-built information. The most up to date information was used in cases where the information was inconsistent.
- Collected field survey for elevations at key overtopping points.
- Starting water levels for the modeling in East Vadnais Lake is at gage 12 (833.5 ft NAVD), the level maintained by SPRWS.

4.2.3 Validating the Results

The initial XP-SWMM modeling effort was constructed to mimic the physical conditions of the subwatershed, applying hydrologic parameters based on these characteristics. Numerous recent studies have indicated that the total impervious surface within a given land use overestimates runoff as it doesn't account for disconnected impervious, including roofs, sidewalks, patios, etc., that discharges to pervious surfaces.

Initial discussions on the modeling results with Vadnais Heights staff indicated flooding in locations where it has not been observed, particularly in residential areas. Hydrologic parameters were then modified to reduce curve numbers in these areas, with results more representative of observations. These DCIA modifications are identified in the hydrologic parameters above.

4.3 Existing Model Results

The 2, 10, and 100-year, and 10-inch storm events were evaluated for this study. The 10-inch event was modeled as a flood resiliency event and is discussed in more detail in section 6.3.2. Model results for key locations are found in Tables 4.1 and 4.2 below. Tables containing the XPSWMM modeling results for all nodes and links are found in Appendix B. Figure 4.1 shows the locations of the inlets and drainage areas. Flood inundation mapping for the 100-year event existing conditions, based on LiDAR data, are found in Figure 4.2. Mapping for the 10-inch event under existing conditions is provided in Figure 6.8.

Table 4.1 XP-SWMM Model Results – Existing Depths

Key Flood Locations	XPSWMM Node Identifier	Map Symbol	10-year/24 hour Depth (ft)	100-year/24 hour Depth (ft)	10-inch/24 hour Depth (ft)
Subdrainage Area A					
Walmart parking lot	StormInlet1406	A1	0.7	1.3	1.5
Walmart parking lot	StormInlet1390	A2	0.9	1.5	1.7
Arcade St near splitter	StormInlet217	A3	0.1	1.8	2.1
Subdrainage Area B					
Large wetland complex	Node1715	B1	-0.3	1.1	1.5
Pond 4	Node1701	B2	5.7	7.1	7.5
Wetland next to Pond 4	Node1700	B3	2.7	4.1	4.5
Garceau Ln	StormInlet42	B4	-2.2	1.2	2.9
Garceau Ln	StormInlet37	B5	-1.5	1.0	2.9
Garceau Ln	StormInlet36	B6	-0.6	0.7	1.0
Backwards between Garceau Ln and Hiawatha Ave	Node1692	B7	-2.3	1.7	3.5
Arcade St near Garceau Ln	StormInlet24	B8	-2.5	2.1	2.9
Arcade St near Garceau Ln	Node1689	B9	-4.9	-0.8	0.5
Backyards between Hiawatha Ave and Berwood Ave	StormInlet105	B10	0.3	2.3	2.8
Backyards between Hiawatha Ave and Berwood Ave	StormInlet116	B11	0.1	2.7	3.2
Berwood Ave	StormInlet104	B12	-1.1	0.3	0.7

Table 2.1 **XP-SWMM Model Results – Existing Depths (cont.)**

Key Flood Locations	XPSWMM Node Identifier	Map Symbol	10-year/24 hour HWL (ft)	100-year/24 hour HWL (ft)	10-inch/24 hour HWL (ft)
Subdrainage Area C					
Pond 3	1680	C1	3.0	6.8	7.5
Berwood Ave	StormInlet86	C2	0.2	1.2	2.2
Monn Ave	StormInlet135	C3	-3.9	2.3	3.3
Subdrainage Area F					
Edgerton Low Point	DA 4:Low Point	F1	-2.8	-1.7	1.3

Table 4.2 **XP-SWMM Model Results – Existing Flow Rates**

Key Flood Locations	XPSWMM Node Identifier	10-year/24 hour Q (cfs)	100-year/24 hour Q (cfs)	10-inch/24 hour Q (cfs)
Outlet pipe from splitter	SGM 1122	22.6	21.4	20.6
Weir overflow from splitter into wetland	Split to wetland	70.0	122.7	194.2
Weir overflow from Arcade into wetland	Road to wetland	0.0	34.4	72.2
Outlet from Pond 4	SGM 546	7.7	8.7	8.7
Overflow flow to Garceau from Pond 4/wetland	Weir1701	0.0	39.9	71.7
Eastern trunk line into Pond 3	SGM 521e	85.4	130.9	133.0
Southern trunk line into Pond 3	SGM 552d	25.3	57.6	70.9

4.4 Existing Model Observations

A review of the mapping, tables and model results yields the following observations.

- There is minor flooding (less than 6 inches of depth and fairly well contained) in a few back yards (B10 - between Hiawatha and Berwood) and streets in the 10-

year event due to limited capacity in the trunk storm sewer system. For the most part the systems appear to handle the 10-year design event. It should be noted that additional minor flooding is likely observed during this event due to inlet capacity and clogging, which is not accounted for in the modeling

- There is more significant flooding in the 100-year event in these areas (greater than 2 feet of depth).
- Based on LiDAR contours, this flooding extends to seven residential structures immediately south of Pond 4 along Garceau Lane, and an additional twenty structures further south, primarily between Hiawatha and Berwood. A total of 89 parcels have some inundation in the 100-year event.
- The outfall for Pond 4 (12-inch) is a significant restriction for this pond with the emergency overflow (EOF) engaging in the southwest corner of the west ponding area, flowing to Garceau Lane, for the 100-year event.
- The overflow from the splitter structure engages for all modeled storm events (2, 10, 100 and 10-inch). As such, water level depth is within 1-foot of the low point elevation in Arcade Street for all events, putting the system in pressure flow for all events. The 10-year storm and greater creates flooding on the roadway surface.
- There are parcels impacted by flooding in Subdrainage Area F. The inundated areas are several feet lower than all structures in a deep ravine, and as such, are not addressed in the mitigation efforts.

Chapter 5 BMP Alternatives

5.1 Introduction

Using the modeling results, nine alternative locations were identified that would provide a varied level of flood relief for flood prone areas as well as provide water quality benefits. These locations are shown in Figure 5.1 in the appendix and described below.

5.2 Considerations

The nine alternative locations were compared across the following considerations:

- Solve a Flooding Problem
- Water Quality Improvements
- Ecological Benefits
- Constructability
- Property Ownership
- Probable Construction Costs
- Utility Impacts
- Construction Detours/Road Shutdown
- Triggers Permitting Requirements

5.3 Potential Alternative Locations

While there are many types of BMP's that could be considered to accomplish water quality and flood reduction goals, some type of open system (wet ponds, dry ponds, bio infiltration or biofiltration) was assumed given the available space and ability to maximize flood control/attenuation in addition to water quality.

Underground systems could also be considered at each of these locations. However, given the relatively shallow nature of most of the sites and potential for high groundwater, depth may become a limiting factor. Cost of construction and long-term maintenance is also higher with underground systems, so they are typically used when space is not available.

5.3.1 Alternative 1 - Arcade South

Alternative #1 is located along Arcade Street. It provided some good opportunities to reduce flooding as well as improve water quality and quantity. It is a public parcel which can take in public water.

5.3.2 Alternative 2 - Arcade North (City Owned)

Alternative #2 is in proximity to the flooding on Arcade Street near the existing flow splitter structure. If it can hold back enough water, it could provide detention upstream of the pond north of Garceau Street. This location could be a filtration basin providing treatment for Arcade Street, or a wet pond that could provide treatment for a larger area.

5.3.3 Alternative 3 – Cigar Pond (City Owned)

Alternative #3 is a city owned pond that was initially considered for lowering the normal water level using active management strategies. One additional possibility to increase water quality performance is to route the outfall from Pond 4 (already treated water) around Pond 3 to the outfall, reducing the drainage area to Pond 3 to allow additional residence time for particle settling. This rerouting is further discussed in the Next Steps section of this report.

5.3.4 Alternative 4 - 1700/1701 Pond (City Owned Pond)

Alternative #4, and existing pond providing water quality for the Walmart and Arcade Street area, would take a similar approach to Alternative #3. Ideally the overflow water from the splitter box would be directed to the open water portion of this area (east side) and the west side reconfigured for better biofiltration or infiltration. This reconfiguration of the west side has a few complications – a small portion was a wetland mitigation site built in the 1990's and it is privately owned. The 12-inch pipe outfall from Pond 4 is a significant constriction for drainage from a large drainage area.

5.3.5 Alternative 5 - North Wetland Complex (City Owned)

Alternative #5 is a large natural area that potentially has Type 1, 2, 3/5 and 6 wetlands as well as wooded upland areas. This alternative has a lot of potential to hold back water within the wetland, create more diversity in the wetland complex while providing flood control and water quality benefits. Development of this alternative will involve significant wetland agency coordination.

As noted in chapter 3, this area was farmed until the 1950's.

5.3.6 Alternative 6 – Private North Parcel (3548 Edgerton St)

Alternative #6 has a significant drainage area coming to it and could provide quite a bit of water quality benefits but wouldn't provide much in terms of flood benefit given its location within the subwatershed.

5.3.7 Alternative 7 - County Lot (Centerville Rd)

Alternative #7 has a fairly small drainage area and is a fairly narrow site with quite a few ash trees. Similar to Alternative #6, it is downstream of most of the flooding and not able to provide much flood benefit.

5.3.8 Alternatives 8 and 9 - South Residential Area 1 (Villas on Edgerton) – South Residential Area 2 (630/644 Berwood Ave W)

Alternatives #8 and 9 were initially studied to address flooding near Monn Ave. The final modeling shows only minor flooding so these might be sites to keep in mind for future water quality projects.

5.4 Consumer Reports Comparison

Table 5.1 in Appendix B compares the alternatives based on the items above in a consumer report style decision matrix to better understand the nuances of each alternative. Table 5.2 in Appendix B includes a description of the criterion used in the comparison table. The project goals and project constraints have been summarized separately.

Chapter 6 Preferred Alternatives Comparison

6.1 Selected Alternative Locations for Further Study

The partners reviewed the 9 identified sites and selected the following alternatives for further study.

6.1.1 Combined Alternatives 2, 4 and 5

These three alternative locations are connected hydraulically and in discussions with the partners it was decided to combine them into a larger strategy (referred to as the Combined Alternative). Since this is a fairly significant alternative that could take on many forms, VLAWMO and the City of Vadnais Heights engaged the SRF team to lead a design charette to explore options. This process is described in the next section.

The Combined Alternative configuration includes excavation in the Alternative 5 area (North Wetland Complex), creating two large, restored wetland basins whose function will be dependent on wetland permitting. The restored wetland basins may qualify for wetland exemption since it involves excavation. The Combined Alternative also includes reconfiguring the outlet from Pond 4 to a multistage outlet with a larger outlet pipe. Figures 6.1 through 6.4 show the conceptual grading for this combined system. In addition, the Combined Alternative includes upsizing the storm sewer system from the low point on Arcade into the wetland restoration areas to address street flooding in that area. Due to the proximity of this low point to the fire station, the City requested that the storm sewer be upsized to allow for no street flooding in the 100-year event at A3.

6.1.2 Alternative Pond 3

Alternative 3 involves modifications to Pond 3 to investigate potential water quality improvements and flood resiliency improvements. Since the existing pond takes up the available public land, the main consideration for improvement involves potential active management of the pond. Active management removes water from the permanent pool in the pond prior to a storm event to provide additional flood and water quality storage for the event. Often the pump or actuated valve are controlled by a system that is connected to weather stations. The systems can be set up to remove as much water as desired.

6.1.3 Storm Sewer Improvements Alternative

The nine alternatives identified were selected to address both flooding and water quality. Another way to solve flooding and provide a more resilient system is to add capacity to the storm sewer system.

As shown in Figure 4.2, inundation occurs in the residential neighborhood south of the North Wetland Complex. While some residential street flooding may be acceptable in a large storm event, the street flooding is fairly extensive in the 100-year event. In addition, this inundation extends into nearly 30 structures throughout the neighborhood. The combined alternative discussed above helps to address inundation of structures immediately adjacent to Pond 4, but additional improvements will be needed to mitigate flooding in the rest of the neighborhood.

Three trunk storm sewer systems are identified that could be improved to reduce flooding.

- From the south end of Arcade Street, Key Inundation Area B8, to Pond 3. Includes Key Inundation Areas B4. B5, B6, B7 B8, B9.
- From Berwood Avenue, Key Inundation Area B12, to Pond 3. Includes Key Inundation Areas B10, B11, B12.
- From Monn Avenue, Key Inundation Area C3, to Pond 3. Includes Key Inundation Areas C2, C3.

These systems were included in the future condition modeling results and are discussed below.

6.2 Combined Alternative – Design Charrette

To better define the combined alternative a design charrette was held with the SRF design team, including water resource engineers and landscape architects, City of Vadnais Heights staff and VLAWMO staff. The group explored the use of the North Wetland Complex for flood control, wetland enhancements, and water quality improvements as well as incorporating passive park elements (trails, overlooks, etc.). Connectivity through the area for local residents was another key element.

Two concepts were developed (Figure 6.5 and 6.6). The concepts involve a 'string of pearls' with a channel connecting the deep-water wetland along Arcade Street to Pond 4. This channel would include ditch blocks to direct low flows into the 'pearls', creating wetland complexes that have varied hydrology from the existing condition.

Concept A was modified for the study to eliminate the channel and instead include a series of cascading bio infiltration/wetland basins with control structures at the trail sections. The basins would be excavated, with the trails at existing ground. Proposed grading for this option was developed and is included in Figures 6.1-6.4.

6.3 Flood Benefit/Resiliency Comparison

6.3.1 100-year Event

Figures 4.2. and 6.7 show the flooding extents for the 100-year storm event for the existing conditions and the future condition. The future condition combines the Combined Alternative BMP and the Storm Sewer Improvements Alternatives. Table 6.1 includes the existing and proposed flood depths at key locations for the existing and future condition.

Table 6.1 **100-year and 10-inch Storm Flood Depths**

Key Flood Locations	XPSWMM Node Identifier	Map Symbol	100-year/24 hour		10-inch/24 hour	
			Existing (ft)	Future (ft)	Existing (ft)	Future (ft)
Subdrainage Area A						
Walmart parking lot	StormInlet1406	A1	1.3	1.2	1.5	1.4
Walmart parking lot	StormInlet1390	A2	1.5	1.5	1.7	1.7
Arcade St near splitter	StormInlet217	A3	1.8	-0.4	2.1	1.2
Subdrainage Area B						
Large wetland complex	Node1715	B1	1.1	-0.6	1.5	0.5
Pond 4	Node1701	B2	7.1	4.9	7.5	6.5
Wetland next to Pond 4	Node1700	B3	4.1	1.9	4.5	3.4
Garceau Ln	StormInlet42	B4	1.2	0.1	2.9	1.0
Garceau Ln	StormInlet37	B5	1.0	0.2	2.9	0.5
Garceau Ln	StormInlet36	B6	0.7	-0.6	1.0	0.6
Backwards between Garceau Ln and Hiawatha Ave	Node1692	B7	1.7	-1.7	3.5	1.1
Arcade St near Garceau Ln	StormInlet24	B8	2.1	-0.7	2.9	2.1
Arcade St near Garceau Ln	Node1689	B9	-0.8	-3.4	0.5	-0.7
Backyards between Hiawatha Ave and Berwood Ave	StormInlet105	B10	2.3	1.0	2.8	2.3
Backyards between Hiawatha Ave and Berwood Ave	StormInlet116	B11	2.7	0.7	3.2	2.6
Berwood Ave	StormInlet104	B12	0.3	-0.5	0.7	0.4

Table 6.1 **100-year and 10-inch Storm Flood Levels (cont.)**

Key Flood Locations	XPSWMM Node Identifier	Map Symbol	100-year/24 hour		10-inch/24 hour	
			Existing (ft)	Future (ft)	Existing (ft)	Future (ft)
Subdrainage C						
Pond 3	1680	C1	6.8	6.8	7.5	8.0
Berwood Ave	StormInlet86	C2	1.2	-0.6	2.2	0.9
Monn Ave	StormInlet135	C3	2.3	0.0	3.3	2.3
Subdrainage Area F						
Edgerton Low Point	DA 4: Low Point	F1	-1.7	-1.3	1.3	3.9

As expected, the addition of flood storage with the Combined Alternative and the increased control of the outfall reduces the flood elevation of Pond 4, removing the seven adjoining residential parcels/structures from the 100-year flood boundary based on LiDAR contours. The added capacity of the Storm Sewer Improvements Alternative removes the remaining 20 structures from the flood boundary, and brings the total number of inundated parcels down from 89 to 7.

6.3.2 Test Storm Event for Flood Resiliency

The system was stress tested for resiliency using the 10-inch/24-hour storm event, which is slightly less than the 500-year event. Results are also shown on Figures 6.8 and 6.9 for the existing condition and with future condition respectively. There are discussions among agencies and experts as to what storm event to use to test a system's resiliency. The 10-inch/24-hour type II storm event, the 100-year/24-hour 90% confidence interval, and the 500-year/24-hour storm event were all considered. The three storm events had precipitation depths within a few tenths of an inch of each other based on the National Oceanic and Atmospheric Administration (NOAA)'s precipitation data, so the 10-inch storm was chosen as it was the median value.

6.3.3 Flood Resiliency Observations

Combined Alternative

The Combined Alternative adds 3.9 acre-feet of flood storage below elevation 909.0 ft in the North Wetland Complex, removing flooding on Arcade Street near the Walmart entrance and removing eight parcels/structures on Garceau Lane from the flood boundary. There may be some modifications that can occur to the Pond 4 outfall that would remove the remaining parcels/structures along Garceau Lane still in the flood boundary (four structures). Further refinement requires additional survey data and is discussed in the Next Steps section. The multistage outlet provides an emergency overflow to Garceau lane that is only utilized in the 10-inch event (See Figure 6.4).

In order to meet the goal of no street flooding at A3 in the 100-year event the capacity of the storm sewer was roughly doubled. These improvements reduce the extent of street flooding in the 10-inch event, but do not fully resolve it.

Pond 3

The model was used to evaluate flood benefits of lowering the pond's normal water level by 3 feet prior to the storm event using an adaptive management strategy. This resulted in lowering the smaller storms (2 and 10-year) HWL's and discharge rates but had little impact to the 100-year or 10-inch storm events.

Storm Sewer Improvements

After initial review of trunk storm sewer, it appears that the storm sewer at the furthest upstream Key Inundation Areas has relatively little cover and the downstream system has very limited opportunities to lower pipes and/or increase pipe sizes without replacing the entire trunk lines to Pond 3.

To determine if storm sewer could resolve flooding the capacity was doubled assuming a second trunk storm sewer was installed in their current locations and elevations.

- The impacted lines are called out as Future Storm Sewer on Figures 6.7 and 6.9
- Since the link from Key Flood Inundation Area C2 to the trunk line was rather small in existing conditions (18-inch), this link was upsized to a 24-inch pipe to further address flooding.

Increasing the capacity resulted in a significant improvement in flood depths in the affected flooding locations as summarized in Table 6.2 below and Figures 6.7 and 6.9. In the future condition, when both the combined alternative and storm sewer improvements are applied, all structures are located outside of the flood extents in the 100-year event and approximately 75% of them are outside of the 10-inch resiliency storm flood extents.

Table 6.2 100-year and 10-inch Inundated Parcels/Structures

	100-year/24 hour		10-inch/24 hour	
	Existing (ft)	Future (ft)	Existing (ft)	Future (ft)
Inundated Parcels	89	7	137	72
Inundated Structures	27	0	85	20

6.4 Water Quality Comparison

Water quality benefits have been quantified for the Combined Alternative using the MIDS calculator to better understand the potential benefits. The annual reduction of loading provides a comparison between the alternatives for total suspended solids (TSS) and Phosphorus (particulate, dissolved and total) reduction, as shown in Table 6-2. Reductions in Pollutant loading from any of the alternative locations would reduce the overall loading on East Vadnais Lake. For instance, the Combined Alternative reduces the annual loading from 39 acres (14% of the subwatershed) by 11,014 lbs of sediment and 38.9 lbs of TP. Both represent a significant improvement in pollutant load reduction to the lake.

Table 6.3 Estimated Annual Pollutant Removal – Combined Alternative

Pollutant	Existing Gross Pollutant Loading (lbs)	Proposed Gross Pollutant Removed Annually									
		Pretreatment /Wetland Restoration		Wetland A		Wetland B		Pond 4		Totals	
	Total	lbs	%	lbs	%	lbs	%	lbs	%	lbs	%
TSS	11,908	8,367	76	1,624	62	67	62	956	76	11,014	93
Particulate TP	36.1	25.3	76	3.9	50	2.1	50	3.6	76	34.9	97
Dissolved TP	29.5	2.0	7	0	0	0	0	2.0	7	4	14
Total TP	65.5	27.3	42	3.9	25	2.1	25	5.6	42	38.9	59

6.5 Probable Construction Costs

Table 6.4 provides a concept-level estimate of probable construction costs for each alternative. A 30% contingency has been added to each given the conceptual nature of the alternatives. A more detailed breakdown is available in Appendix D.

Table 6.4 Summary of Probable Construction Costs

Item	Future Condition Construction Costs	Pond 3 Estimated Construction Costs
Grading and Removals	$1,155,000	-
Weirs/outlet structures	$351,000	-
Storm sewer/pretreatment	$1,000,000	-
Pump Station/Adaptive Management System		$792,000
Boardwalk/bridge crossings	$216,000	-
Wetland Restoration/Engineered Soil/Erosion Control	$379,000	-
Miscellaneous Costs	$1,043,000	-
Storm Sewer Improvements from South Arcade Street	$1,036,000	-
Storm Sewer Improvements from Berwood Avenue	$484,000	-
Storm Sewer Improvements from Monn Avenue	$591,000	-
Estimated Total Construction Costs	$6,255,000	$792,000
Contingency	$1,877,000	$286,000
Estimated Total Costs Plus Contingency	$8,132,000	$1,237,000

6.6 Potential Permits Needed

The following permits may be required for the various alternatives considered.

- WCA will require a permit for the Combined Alternative and will generally allow excavation in Type 1/2 wetlands. Combined Alternative grading concepts will need to be refined based on Level 2 wetland delineation, groundwater and soils data, and studies on the influence of excavation on existing groundwater levels and the potential impact on remaining wetlands. Mitigation will be required if fill is needed.
- USACE 404 permit for wetland impacts if the North Wetland Complex is determined to be within the jurisdiction.
- An NPDES permit from the Minnesota Pollution Control Agency (MPCA)
- City of Vadnais Heights grading/erosion control permits (as needed)

Chapter 7 Grant Opportunities

The following grants present opportunities for funding for the various alternatives considered.

- Board of Water and Soil Resources (BWSR) Clean Water fund competitive Grant Program – Projects and Practices Grant
    - Drinking Water subgrant
- BWSR Watershed-based Implementation Funding Program
    - For water quality focused BMPs
- Minnesota Pollution Control Agency (MPCA) Implementation Grant for Stormwater Resilience
- MPCA Resilient Implementation Grant "Construction Grant"
    - This is a new program that may be coming soon, more investigation may be needed as information becomes available.

Chapter 8 Observations and Next Steps

8.1 Observations

The following observations are based on a review of the flood resilience, water quality, probable costs, and other elements.

- Pond 4 has a controlled outlet and minor water flowing through the system was observed in March 2024. Maintaining the NWL in the future condition is needed to maintain this groundwater hydrology.
- Combined Alternative grading concepts will need to be refined based on Level 2 wetland delineation, groundwater and soils data, and studies on the influence of excavation on existing groundwater levels and the potential impact on remaining wetlands.
- The additional flood storage and modified outlet in the Combined Alternative lowers the 100-year and 10-inch flood elevations below the existing 100-year flood elevation around Pond 4.
- In addition to the flood and water quality benefits, the Combined Alternative provides opportunities for passive recreation by including trails that connect residential areas with commercial and institutional land uses, as well as providing a means of connection between residents and wildlife. The wetland areas also provide a more diverse habitat for wildlife. The area was farmed until the 1950's will see some restoration to what may have been its pre-settlement conditions.
- Providing adaptive management at Pond 3 had limited impacts to the downstream network, presumably because it receives such larger volumes of water that the additional storage is quickly filled in a large event. It may be beneficial to add adaptive management to Pond 4 in addition to Pond 3 to provide additional flood storage to the system.
- Increasing capacity in the neighborhood storm sewer systems resulted in significant flood reductions. In some places, doubling the capacity of the existing system may be more than sufficient to achieve the flood depth reductions needed.
- The future condition was able to remove all structures from flood extents in the 100-year event, and reduce impacted structures by approximately 75% in the 10-inch event.
- With the reduced depths and extents of inundation the duration also decreases. In the 100-year event duration of inundation generally decreased at Key Flooding locations by 60%-100%. In the 10-inch event duration of inundation generally decreased by 40%-80%.
- Pond 4 water quality computations were completed assuming the pond is functioning as designed in 1994.

- The water quality computations show the Combined Alternative provides a significant amount of water quality benefit beyond the existing Pond 4 efficiency, which will also benefit East Vadnais Lake as the overall receiving water.

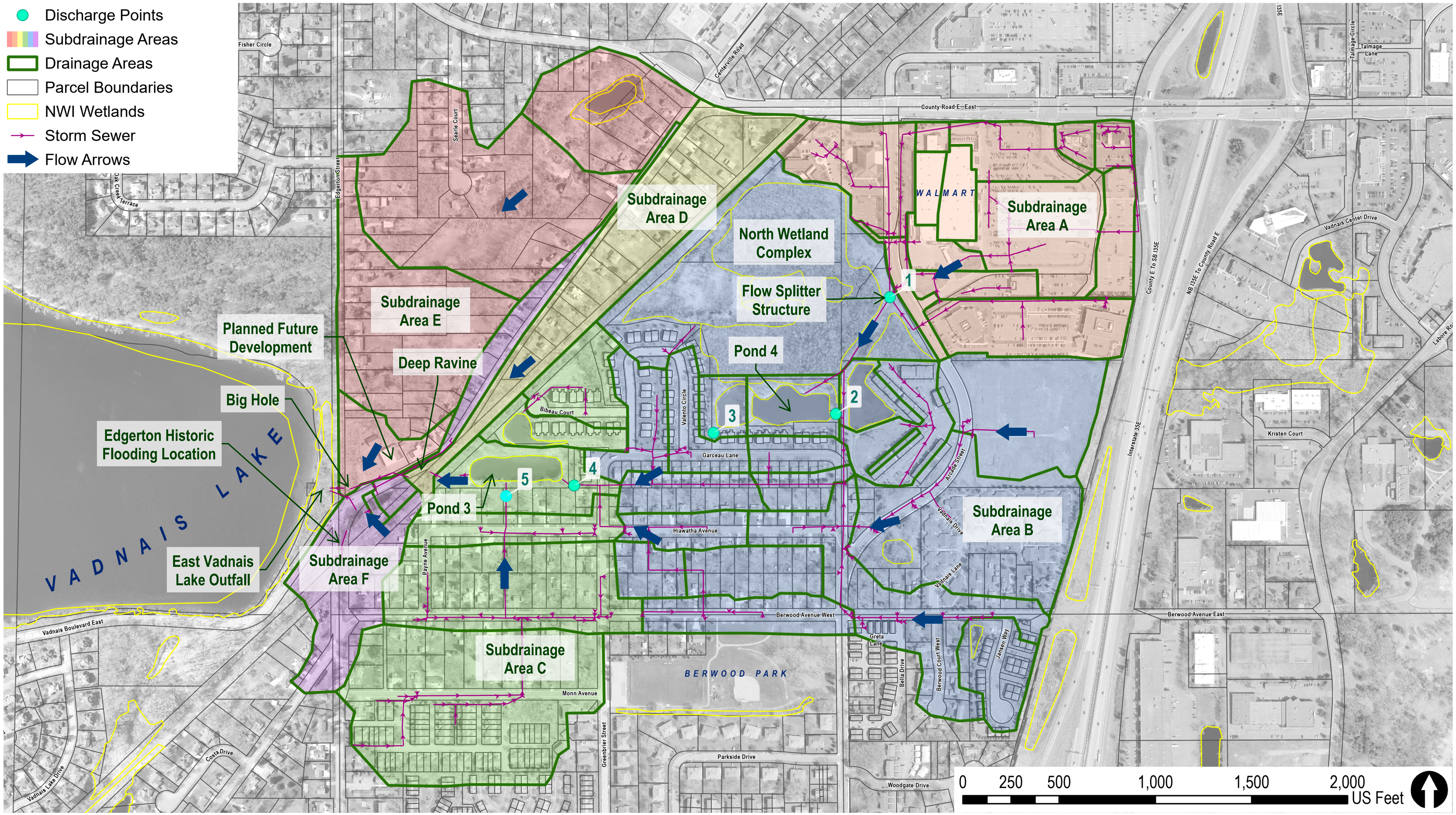
8.2 Next Steps

- Additional information is needed to vet the Combined Alternative, including soil borings, piezometers, level 2 wetland delineation, and a field survey prior to meeting with the wetland agencies to understand the permitting requirements or constraints.
- The low openings of structures adjacent to Pond 4 within the identified floodplain should be surveyed to set the design 100-year HWL for the system.
- The low openings of structures impacted in the rest of the neighborhood should be surveyed to determine the extent of storm sewer improvements needed.
- The Combined Alternative includes a new outfall structure and trunk storm sewer system within Garceau Lane. This system could be constructed when the road is reconstructed in 2025. Portions of the proposed Storm Sewer Improvements Alternative could also be constructed with this project.
- Water leaving Pond 4 is treated to a high degree with the Combined Alternative. Pond 3 may operate at a higher level if part of the Pond 4 outfall reconstruction routed water around Pond 3 rather than through it. This concept will require further study to determine how to route the water as the optimal location is within private property.
- The existing pond north of Pond 3 was not included in the analysis because it is privately held. There may be some benefit in reconfiguring it as a filtration basin taking water from Pond 3 if Pond 4 outlet water is bypassed around Pond 3.
- Adaptive management may be explored for Pond 4 if the new outfall is constructed and may be incorporated as a simpler system depending on the depth of the outfall pipe. This system would incorporate an actuated valve in the outfall structure and would not require pumping.
- Subdrainage Areas A-C contain a number of alternatives for BMPs. A P-8 model of the water quality benefits of the system may be helpful to evaluate cost benefits of the various improvements. MIDS was used in this initial study to describe the removals for a given alternative for comparison purposes, but P-8 would be better suited to provide a full picture of how the system as whole functions and how different alternatives would impact the discharge at the outfall to the lake.

- The Storm Sewer Improvements Alternative demonstrates that adding capacity to the trunk system can reduce flooding in streets and neighborhoods in the southern part of the subwatershed. Further field investigation is needed to better optimize pipe sizes and locations, as doubling capacity is likely not necessary in all locations. Future street reconstruction projects might provide opportunities to add capacity along existing or new alignments.
- Additional optimization would likely be able to reduce storm sewer infrastructure needed at A3, and its associated cost. For example, allowing limited street flooding in the 100-year event (e.g. setting a maximum allowable depth or inundation duration) and grading in an emergency overflow could significantly reduce the infrastructure needed.

Appendices

Appendix A Figures



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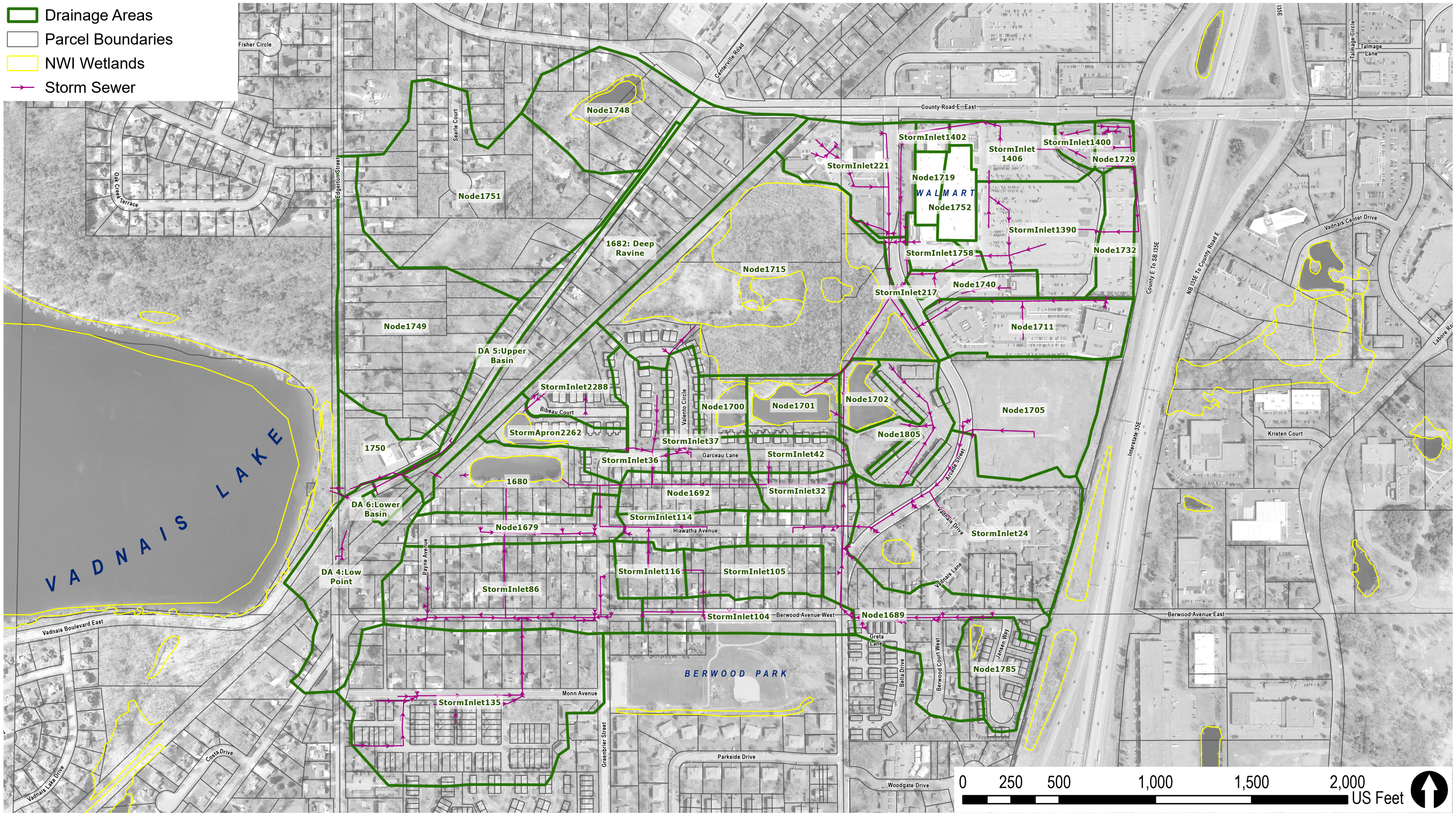
Location Map

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 1.1

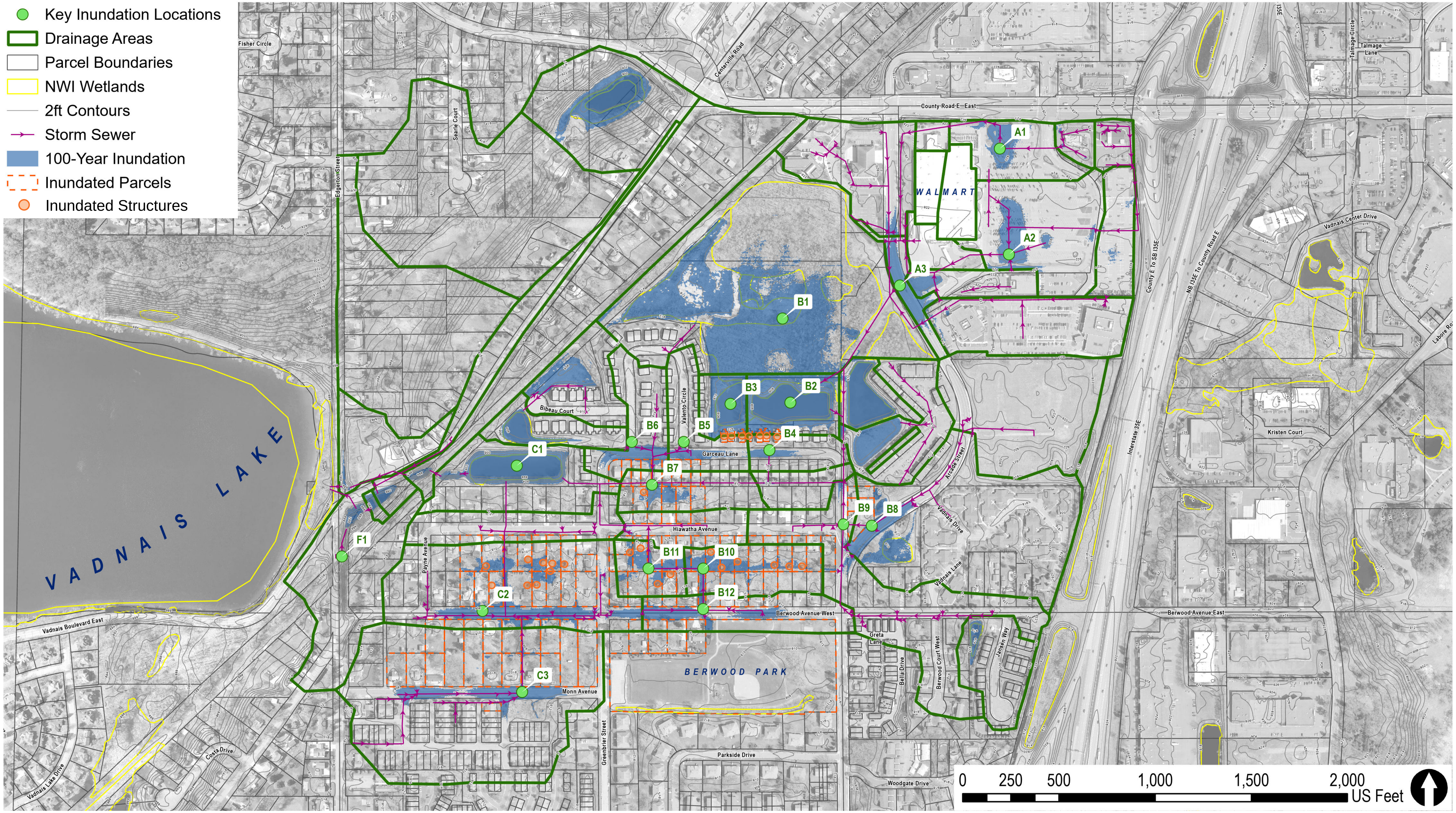


Subwatershed Map

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 4.1



100-Year Inundation Map - Existing Conditions

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

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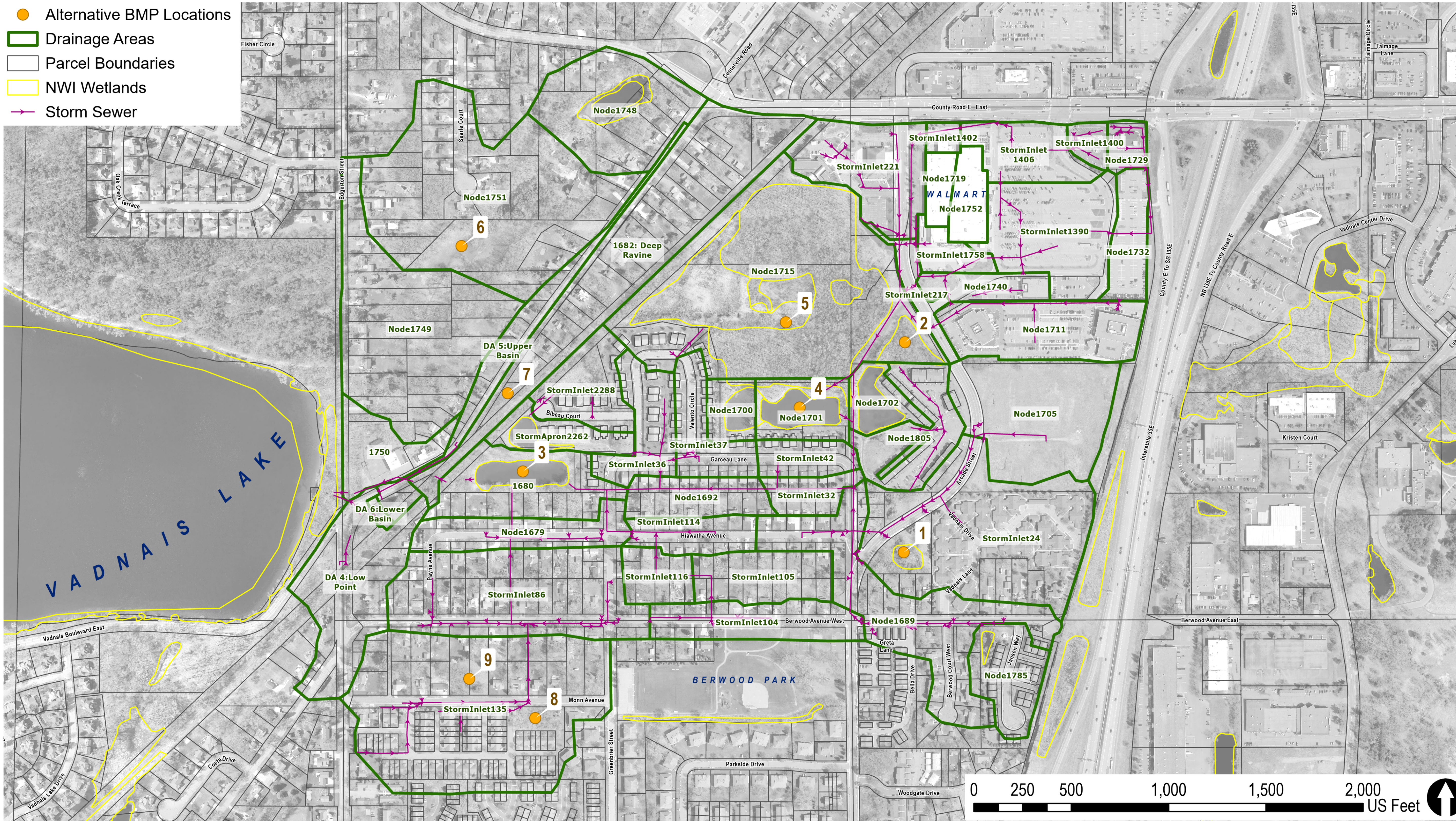
Figure 4.2



Alternative BMP Locations

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 5.1

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Combined Alternative Proposed Grading

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 6.1

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Combined Alternative Proposed Grading

East Vadnais Lake Subwatershed Resiliency Study
Vadnais Lake Area Watershed Management Organization

Figure 6.2

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Combined Alternative Proposed Grading

East Vadnais Lake Subwatershed Resiliency Study
Vadnais Lake Area Watershed Management Organization

Figure 6.3

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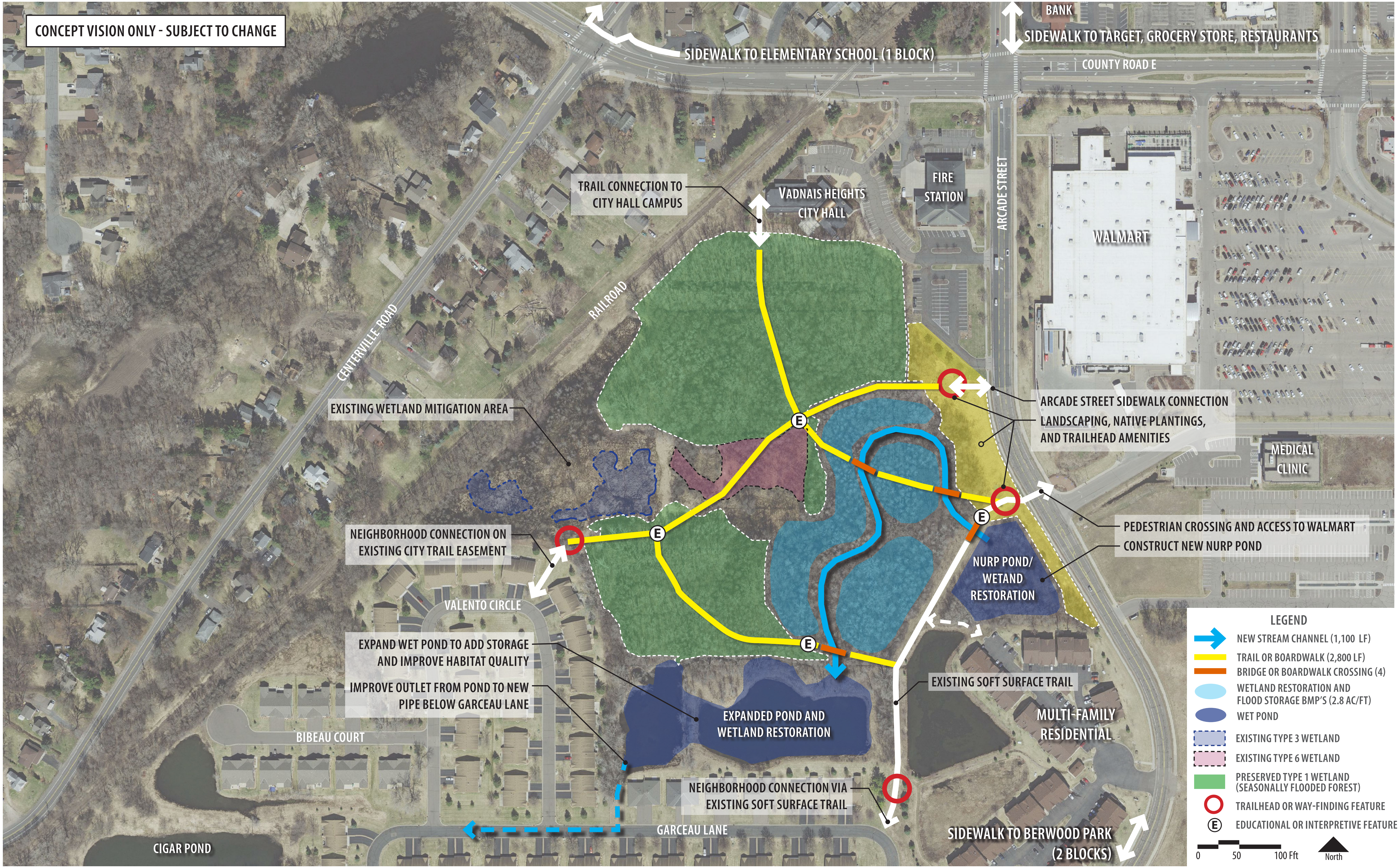
Combined Alternative Proposed Grading

East Vadnais Lake Subwatershed Resiliency Study
Vadnais Lake Area Watershed Management Organization

Figure 6.4

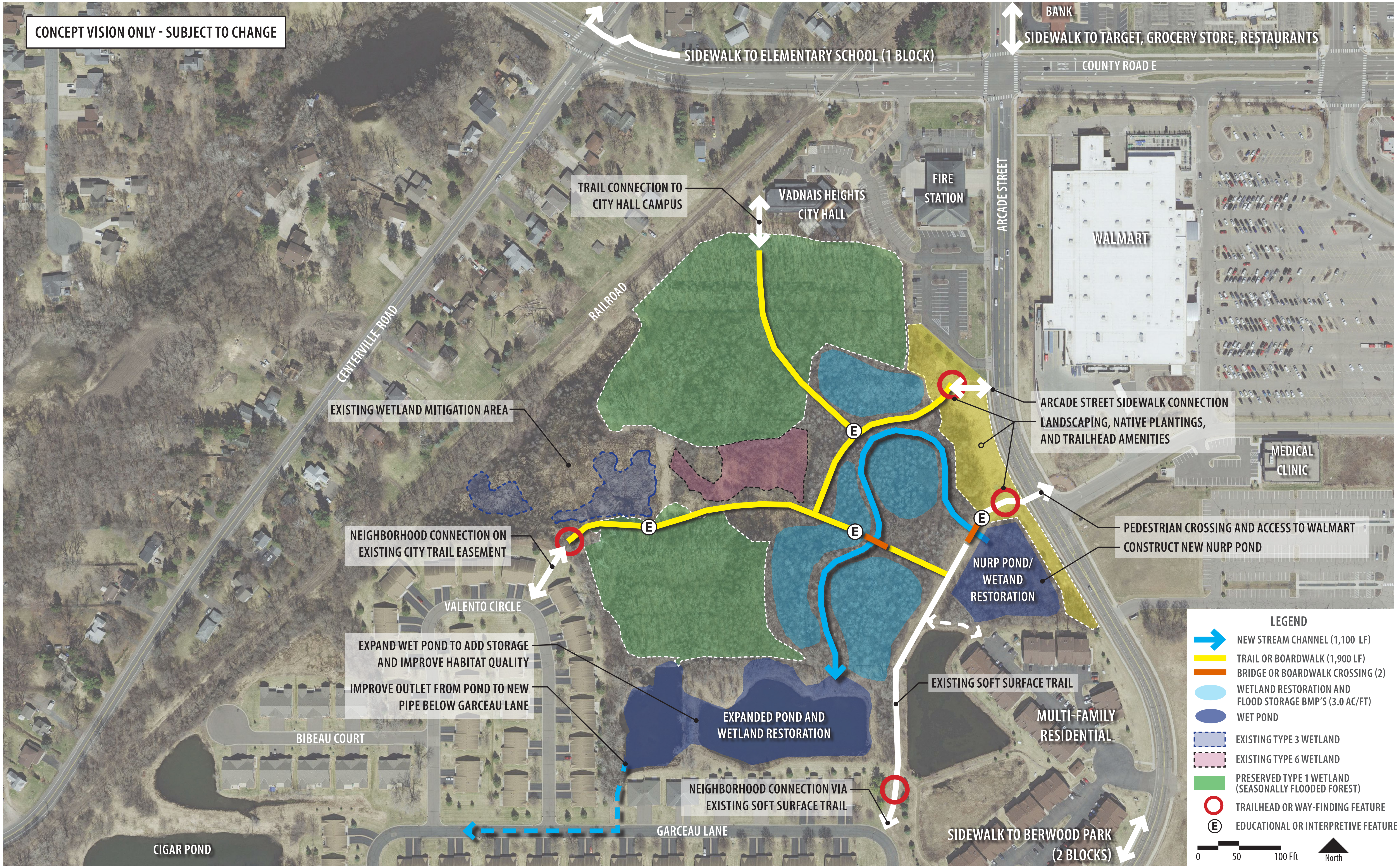


STORMWATER CONCEPT PLAN A

Vadnais Lake Area Watershed Management Organization (VLAWMO)

Figure 6.5

February 1, 2024

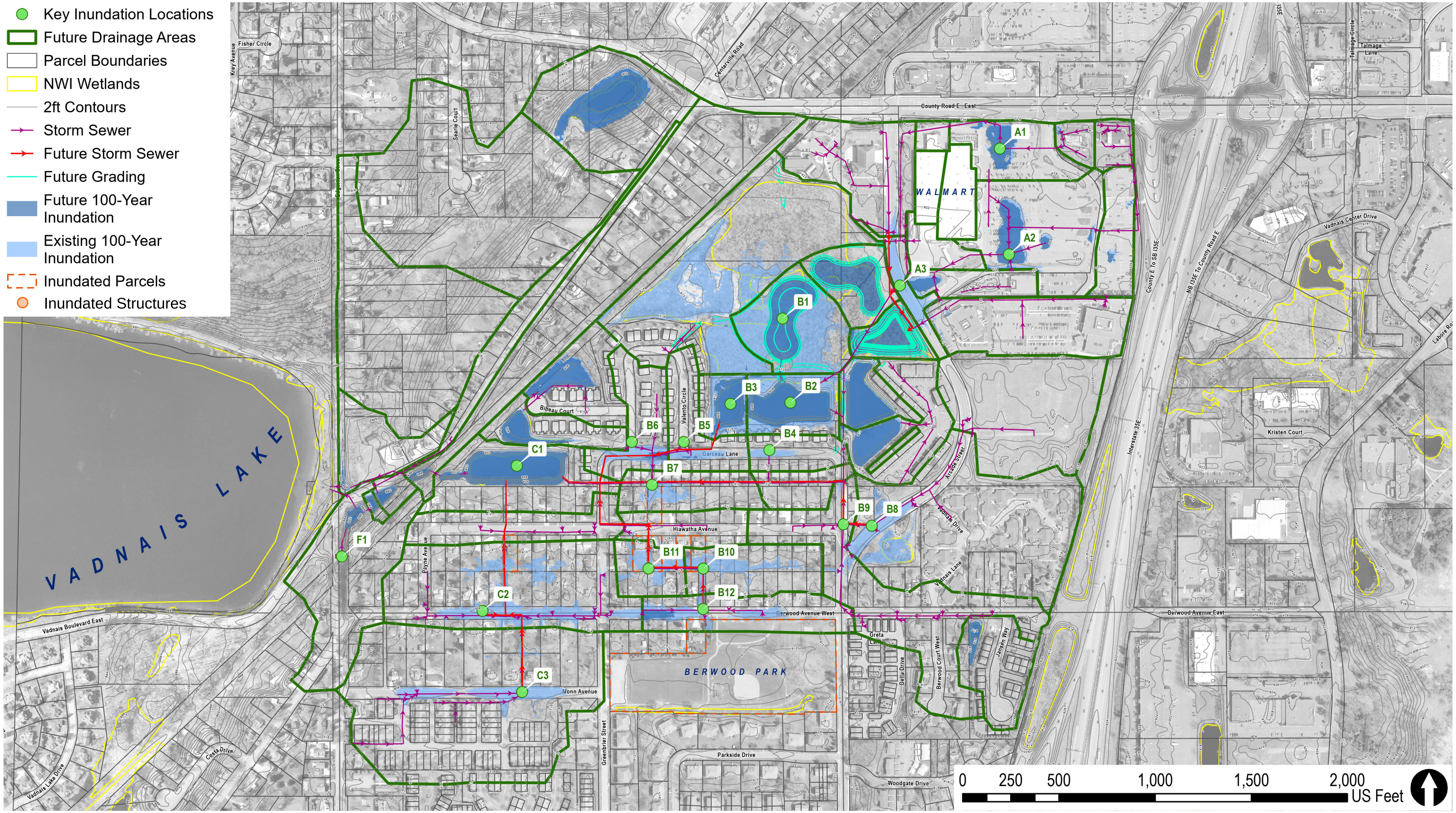


STORMWATER CONCEPT PLAN B

Vadnais Lake Area Watershed Management Organization (VLAWMO)

Figure 6.6

February 1, 2024



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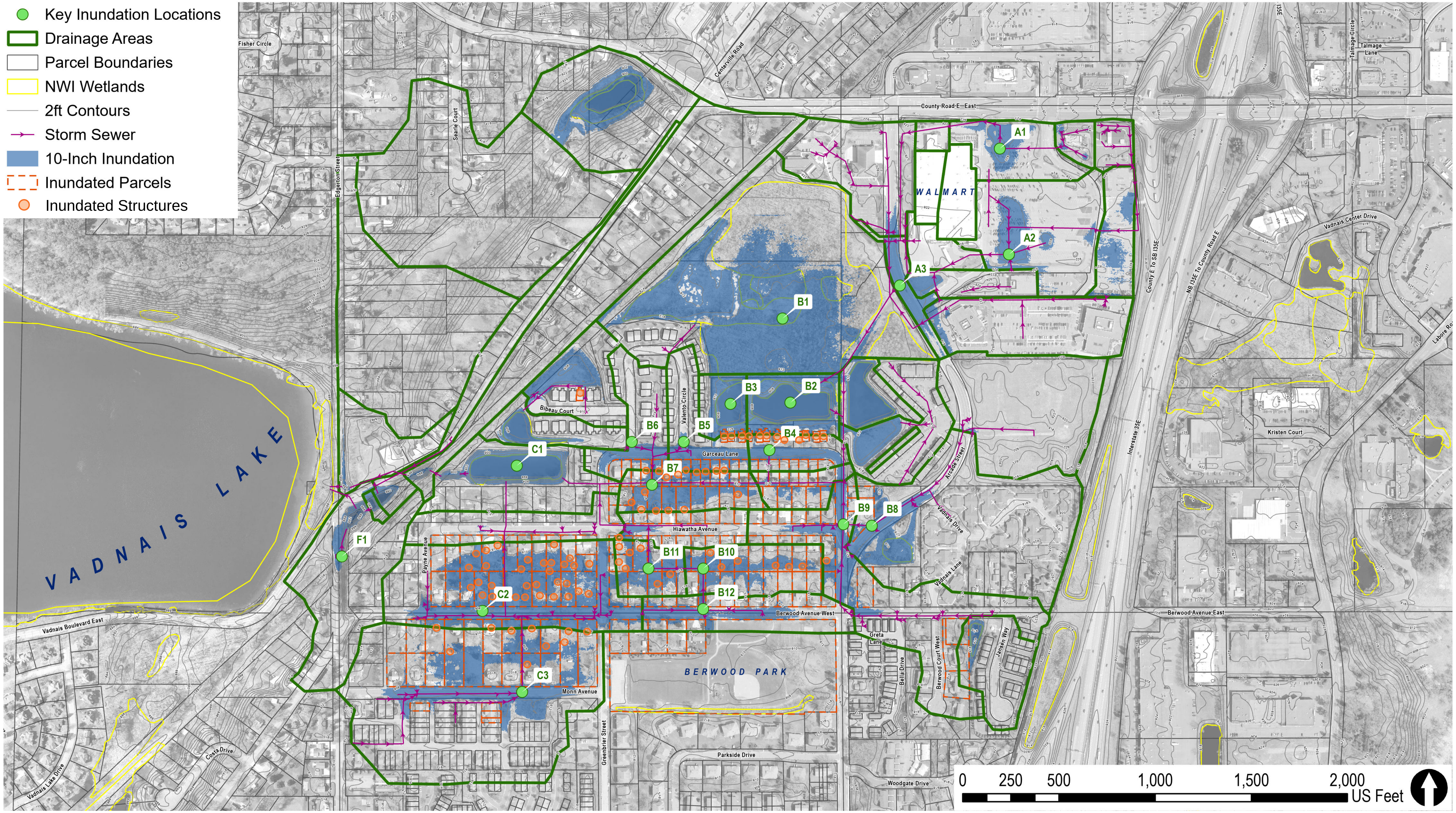
100-Year Inundation Map - Future Conditions

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 6.7

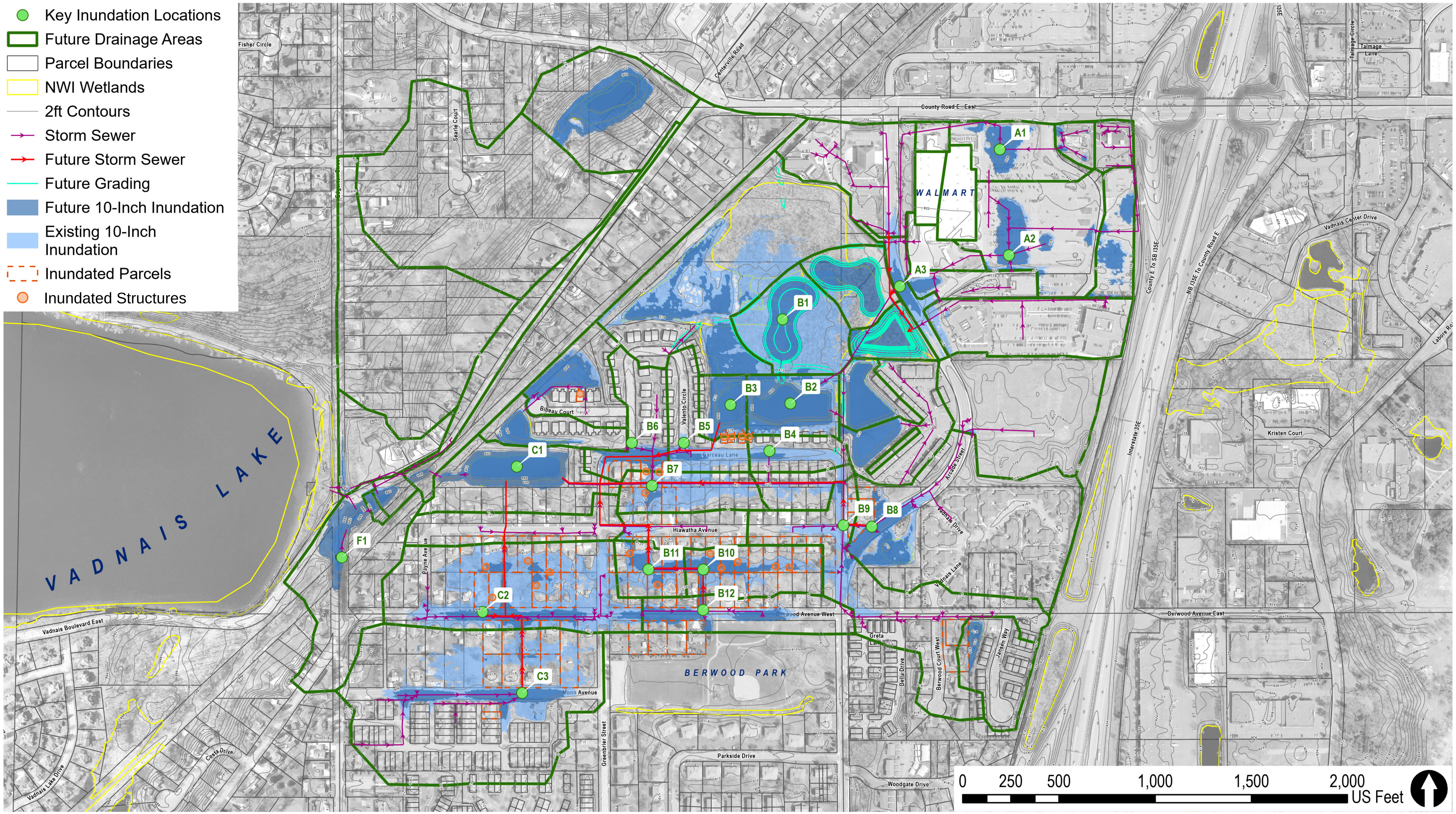


10-Inch Inundation Map - Existing Conditions

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 6.8



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10-Inch Inundation Map - Future Conditions

East Vadnais Lake Subwatershed Resiliency Study

Vadnais Lake Area Watershed Management Organization

Figure 6.9

Appendix B Tables

Table 4.3 XP-SWMM Highwater Levels Per Storm Event

	Existing HWL			Future Condition HWL		
Node Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
1680	901.0	904.8	905.5	900.7	904.8	906.0
1682: Deep Ravine	892.1	900.1	900.9	892.0	900.2	901.4
1750	885.3	887.2	888.0	885.3	887.2	888.1
Channel Start	883.8	884.6	885.3	883.8	884.7	885.7
DA 4:Low Point	884.2	885.3	888.3	884.2	885.7	890.9
Small Pocket (Channel)	898.2	901.0	902.5	898.1	901.1	903.7
Node1664	898.2	901.0	902.5	898.1	901.1	903.7
DA 5:Upper Basin	891.1	893.6	895.2	891.1	893.9	896.3
East Vadnais Lake	883.6	883.6	884.1	883.6	883.6	884.4
DA 6:Lower Basin	889.2	892.5	894.0	889.2	892.8	895.0
StormInlet135	901.6	907.8	908.8	900.8	905.6	907.8
StormInlet136	901.6	908.2	909.4	900.8	905.6	907.8
Node1677	901.6	908.6	909.2	900.8	905.6	907.8
StormInlet88	901.6	908.6	909.1	900.8	905.6	907.8
Node1679	901.2	906.5	908.2	900.7	905.1	906.8
Node1680	901.1	906.0	907.3	900.7	905.0	906.6
StormInlet86	908.0	909.0	910.1	903.7	907.3	908.8
StormInlet120	901.4	907.3	908.5	900.7	905.3	907.2
Node1685	905.0	907.9	909.6	902.9	905.7	908.1
StormInlet33	904.2	907.5	909.0	902.5	905.2	907.7
Node1687	901.1	905.9	907.0	900.7	904.9	906.7
StormInlet24	906.1	910.6	911.5	905.0	907.9	910.7
Node1689	906.0	910.2	911.4	904.8	907.5	910.2
StormInlet29	905.7	909.4	910.9	904.2	906.9	909.3
StormInlet32	905.4	909.2	910.9	903.7	906.3	909.0
Node1692	904.9	908.9	910.8	902.9	905.6	908.4
StormInlet36	909.0	910.3	910.6	906.0	909.1	910.3
Node1694	906.4	908.9	910.7	905.1	907.2	908.2
Node1695	906.1	908.9	910.8	904.1	907.2	908.1
StormInlet37	906.4	908.9	910.8	904.8	908.1	908.4
StormInlet42	905.8	909.2	910.9	904.4	908.1	909.0
Node1700	910.7	912.1	912.5	907.5	909.9	911.4
Node1701	910.7	912.1	912.5	907.5	909.9	911.5
Node1702	910.9	912.1	912.5	910.9	911.2	911.5
Node1703	906.1	909.6	911.0	904.8	906.9	909.3
Node1705	909.2	911.4	914.2	909.2	910.1	914.2
Node1707	908.2	911.2	913.2	908.2	909.1	913.2
Node1708	907.2	910.9	912.2	907.2	908.5	912.2
Node1709	906.5	910.8	911.6	906.5	908.3	911.5
StormInlet213	906.1	910.6	911.5	905.4	908.0	910.7

Table 4.3 XP-SWMM Highwater Levels Per Storm Event

	Existing HWL			Future Condition HWL		
Node Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
Node1711	915.2	918.2	919.0	912.6	914.5	916.9
Node1712	914.7	916.5	917.1	911.3	913.0	913.5
StormInlet218	913.9	914.2	914.5	911.4	913.6	914.1
Node1714	911.2	912.6	913.0	-	-	-
Node1715	910.7	912.1	912.5	910.2	910.4	911.5
StormInlet217	914.4	916.1	916.4	911.4	913.9	915.5
StormInlet221	916.3	916.6	916.7	912.2	914.6	915.4
Node1718	915.3	915.9	916.3	912.2	914.5	915.3
Node1719	915.9	916.6	917.1	913.4	915.5	916.3
Node1720	916.8	917.9	919.1	915.2	916.9	918.2
Node1721	916.1	917.0	917.6	914.0	915.9	916.8
StormInlet1400	922.7	923.3	923.5	922.7	923.2	923.5
StormInlet1399	922.2	922.2	922.3	922.2	922.2	922.3
StormInlet 1406	919.7	920.3	920.5	919.5	920.2	920.4
StormInlet1405	918.0	919.6	920.4	916.9	918.7	920.3
StormInlet1404	917.6	919.1	920.4	916.4	918.1	919.9
StormInlet1403	917.4	918.8	920.3	916.1	917.8	919.5
StormInlet1402	917.0	918.3	919.6	915.5	917.2	918.7
Node1729	920.3	921.3	921.9	920.2	921.3	921.9
Node1730	920.2	921.2	921.7	920.2	921.1	921.7
Node1731	920.1	921.1	921.6	920.0	921.1	921.6
Node1732	920.1	921.1	921.6	920.0	921.1	921.6
StormInlet1407	919.8	920.5	920.7	919.8	920.5	920.7
Node1734	920.1	921.1	921.6	920.1	921.1	921.6
Node1735	919.4	920.1	920.3	919.2	920.0	920.3
StormInlet1391	919.4	920.1	920.3	919.1	920.0	920.2
StormInlet1390	919.4	920.0	920.2	919.1	920.0	920.2
StormInlet1758	918.1	919.0	919.7	917.2	918.6	919.4
Node1739	916.5	917.5	917.9	914.9	916.7	917.3
Node1740	915.3	916.2	916.4	913.8	915.8	915.8
Node1741	916.3	917.2	917.6	914.4	916.3	916.9
StormInlet1394	919.4	920.1	920.3	919.2	920.0	920.3
StormInlet2288	906.8	908.0	908.9	906.8	908.0	908.5
Node1748	901.3	902.6	903.4	901.3	902.6	903.4
Node1749	895.4	896.3	896.9	895.4	896.3	896.9
Node1751	901.2	901.5	901.7	901.2	901.5	901.7
Node1752	921.7	922.3	922.7	921.7	922.3	922.7
Node1758	916.0	916.8	917.2	913.8	915.8	916.5
Node1765	901.5	908.2	908.9	900.8	905.5	907.6
StormInlet4012	906.1	910.6	911.5	905.9	908.1	910.8

Table 4.3 XP-SWMM Highwater Levels Per Storm Event

	Existing HWL			Future Condition HWL		
Node Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
StormApron2262	905.5	905.7	906.2	905.5	905.7	906.1
StormInlet104	908.4	909.8	910.2	905.3	909.0	909.9
StormInlet105	907.7	909.7	910.2	905.0	908.4	909.7
StormInlet116	907.0	909.7	910.2	904.2	907.7	909.5
StormInlet115	906.6	909.2	909.8	903.8	907.1	909.2
StormInlet114	906.3	909.0	909.8	903.7	906.9	909.0
StormInlet129	905.7	908.4	909.8	903.3	906.3	908.5
Node1785	914.0	916.2	917.5	914.0	916.1	917.5
StormInlet1247	912.5	915.3	916.5	912.5	915.0	916.4
StormInlet1248	910.7	912.8	913.6	910.7	911.8	913.4
StormInlet1250	909.8	911.6	912.2	909.8	910.3	912.0
StormInlet1254	908.8	910.6	911.0	908.8	909.1	910.8
StormInlet1255	908.3	910.2	910.5	908.2	908.6	910.3
StormInlet1256	908.0	910.0	910.3	907.9	908.3	910.1
Node1796	907.8	909.9	910.2	907.5	908.1	909.9
Node1797	907.0	909.8	910.3	906.7	907.9	909.8
Node1798	906.2	909.8	910.3	905.7	907.7	909.8
Node1799	906.1	910.0	910.8	905.2	907.6	910.0
Node 1745	916.5	917.1	917.6	916.5	917.0	917.5
Node1805	912.0	913.2	913.8	912.0	913.2	913.8
Node1809	911.5	912.9	913.5	911.5	912.6	913.2
StormInlet1388	915.3	916.6	916.8	913.8	916.6	916.8
Node1715.1	-	-	-	911.3	912.6	913.0
Node1715.2	-	-	-	909.6	910.9	911.9
Node1715.3	-	-	-	908.3	910.0	911.5
Node1822	-	-	-	906.4	909.8	911.4
Node1823	-	-	-	902.1	905.5	906.8
Node1824	-	-	-	901.2	904.8	906.1

Table 4.4: XP-SWMM Maximum Discharge Per Storm Event

	Existing Discharge (cfs)			Future Discharge (cfs)		
Link Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
culvert to small pocket	50.9	74.3	74.3	47.7	74.3	74.6
Berm overtopping	0.0	85.3	168.5	0.0	84.7	234.1
culvert to MH	67.5	128.5	132.5	66.3	129.4	134.8
overtopping to low point	0.0	33.4	119.0	0.0	48.4	194.0
culvert to lake from big hole	70.4	166.2	212.0	69.0	167.5	214.1
Link849	75.1	197.7	330.2	73.7	218.5	417.2
overtopping to big hole	0.0	0.0	0.0	0.0	0.0	0.0
pond to lake	6.2	37.0	124.6	6.2	51.0	172.2
overtopping to lake.1	0.0	0.0	0.0	0.0	0.0	30.9
Channel to deep ravine	50.9	150.8	227.1	47.7	149.8	285.4
RR overtopping	0.0	0.0	0.0	0.0	0.0	0.0
Channel	50.9	150.8	227.0	47.7	149.6	285.1
overtop to pond.1	0.0	33.9	120.7	0.0	48.4	195.8
M-11.1	0.0	4.8	4.8	0.0	4.8	4.8
overtop to pond.1.1	0.0	29.1	116.0	0.0	43.4	191.0
SGM 860	0.9	12.2	23.0	-0.6	-2.4	16.5
Weir135	0.0	0.0	-28.5	0.0	0.0	0.0
SGM 620	-1.4	12.3	23.0	-1.6	-5.2	16.3
SGM 1271	-2.0	12.3	23.0	-3.0	-6.5	15.5
2849.1	19.5	49.2	44.1	19.4	45.4	61.3
88to1765	0.0	0.0	3.7	0.0	0.0	0.0
2686.1	25.3	58.3	71.7	24.7	59.3	84.2
1679to1680	0.0	0.0	0.0	0.0	0.0	0.0
SGM 552d	25.3	57.6	70.9	24.7	59.1	84.1
2689.1	19.6	20.0	19.7	20.7	45.5	51.9
86 to 88	0.1	41.0	41.2	0.0	0.0	36.2
Weir86	0.0	0.0	28.5	0.0	0.0	0.0
SGM 552b	19.5	48.8	44.8	19.3	45.3	61.3
SGM 547	30.0	31.6	32.9	33.9	61.5	63.9
Link989	0.0	0.0	0.5	0.0	0.0	0.0
SGM 521d	85.5	131.1	133.3	68.5	181.0	213.8
SGM 521e	85.4	130.9	133.0	68.3	180.0	212.1
2705.1	15.5	39.0	24.8	15.9	62.5	78.7
24to1689	0.0	0.0	44.6	0.0	0.0	0.0
SGM 140	24.7	47.1	52.5	22.5	94.2	109.6
2709.1	29.5	38.8	41.8	22.5	93.0	100.0
29to32	0.0	23.5	39.9	0.0	0.0	17.6
Weir29	0.0	0.0	1.9	0.0	0.0	0.0
SGM 521b	36.2	52.3	54.3	30.3	109.7	125.2
SGM 521c	58.3	99.6	100.8	36.6	122.6	150.8
SGM 455	9.3	8.4	8.1	10.7	21.1	22.0

Table 4.4: XP-SWMM Maximum Discharge Per Storm Event

	Existing Discharge (cfs)			Future Discharge (cfs)		
Link Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
Weir	0.0	10.5	-17.6	0.0	0.0	9.0
Weir37	0.0	4.0	24.5	0.0	0.0	0.7
SGM 549a	9.3	8.3	8.1	10.7	21.1	21.9
SGM 549b	18.3	21.2	21.2	18.4	31.3	35.1
Link999	-	-	-	20.6	45.6	50.1
SGM 548	9.3	20.5	20.5	18.5	45.1	50.1
Link987	0.0	50.1	73.8	0.0	2.8	31.8
2722.1	6.0	8.5	7.7	6.0	12.5	13.1
42to32	0.0	-11.2	-19.4	0.0	0.2	10.7
Weir42	0.0	15.5	28.3	0.0	-0.3	11.1
OVERFLOW	48.8	141.8	169.4	-16.6	-37.9	-54.4
Weir1701	0.0	39.9	71.7	0.0	0.0	1.9
OCS	-	-	-	14.3	43.4	56.4
Orifice	-	-	-	4.4	4.5	4.4
SGM 546	7.7	8.7	8.7	-	-	-
EOF to channel	1.0	-17.1	-28.8	1.0	8.3	22.0
SGM 1124	7.7	8.7	8.7	0.0	-1.2	-2.2
2737.1	0.6	10.5	21.9	0.6	10.5	21.9
1705to1707	0.0	0.0	2.7	0.0	0.0	2.7
2739.1	0.6	10.4	21.4	0.6	10.5	21.5
1707to1708	0.0	0.0	3.1	0.0	0.0	3.0
2741.1	0.6	10.4	20.0	0.6	10.7	20.4
1708to1709	0.0	0.0	5.2	0.0	0.0	4.3
2743.1	0.6	10.4	19.4	0.6	10.9	20.5
1709to4012	0.0	0.0	13.1	0.0	0.0	4.4
2744.1	0.9	9.8	14.1	0.6	11.0	20.1
Natural Channel	0.0	13.5	24.1	0.0	0.0	23.8
SGM 2318	32.1	57.5	61.1	31.9	62.4	86.3
SGM 2319	32.0	57.5	61.1	81.7	122.9	114.7
SGM 1122	22.6	21.4	20.6	-	-	-
split to wetland	70.0	122.7	194.2	0.0	24.9	104.0
SGM 545	22.6	21.4	20.6	-	-	-
overlandflow1	0.0	4.1	13.7	0.0	0.0	0.0
Weir 1715-2288	0.0	0.5	30.4	0.0	0.0	0.0
direct to 1700	72.6	135.1	175.1	13.4	36.6	56.3
2760.1	6.7	14.5	14.5	6.7	53.0	113.9
CurbOvertopping	0.0	34.4	72.2	0.0	0.0	0.0
road to wetland	0.0	34.4	72.2	0.0	0.0	0.0
Link893	19.7	16.4	15.4	16.7	34.3	48.6
Link936	0.3	20.6	37.0	0.0	0.0	0.0
SGM 21	60.5	66.1	68.3	77.6	94.6	110.5

Table 4.4: XP-SWMM Maximum Discharge Per Storm Event

	Existing Discharge (cfs)			Future Discharge (cfs)		
Link Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
SGM 1417	46.8	52.8	56.7	66.7	73.9	75.8
SGM 1394	15.7	18.2	22.6	18.7	20.2	22.3
SGM 1395	16.3	18.2	22.6	18.8	19.5	22.3
SGM 1387	3.2	4.3	4.9	3.2	4.3	4.9
2775.1	1.9	1.9	1.9	2.1	2.1	2.2
Weir1399	1.4	2.8	3.4	1.4	2.8	3.4
2777.1	15.0	13.6	13.9	16.2	16.0	16.3
Weir1405	0.0	7.7	16.1	0.0	5.0	15.5
Weir1406	0.0	7.5	17.5	0.0	5.0	14.9
2779.1	14.3	15.5	16.0	16.2	16.6	17.8
1405to1404	0.0	0.0	13.1	0.0	0.0	4.0
2781.1	13.2	15.5	17.0	16.2	16.6	18.2
1404to1403	0.0	0.0	14.0	0.0	0.0	0.0
SGM 1392	13.2	15.5	18.2	16.3	16.6	18.2
SGM 1393	15.7	18.2	22.7	18.7	20.3	22.3
SGM 1380	4.7	9.9	14.0	4.7	9.9	14.0
SGM 1373	4.7	5.6	5.6	4.7	5.7	5.9
1730to1732.1	0.0	6.7	8.7	0.0	6.4	8.7
SGM 1375	-4.7	5.6	5.7	-4.8	5.7	5.8
SGM 1376	17.3	29.4	35.3	17.3	29.7	35.3
SGM 1377	12.7	12.7	12.3	13.1	13.8	13.7
Weir1407	5.2	18.9	25.1	4.2	18.4	24.7
SGM 1374	4.7	5.6	5.6	4.7	5.7	5.9
1734to1732.1	0.0	2.4	3.2	0.0	2.5	3.1
SGM 1406	14.1	13.2	12.9	14.0	13.9	13.7
2801.1	4.7	4.8	4.7	4.8	4.8	4.8
Weir1391	15.0	21.4	32.2	16.3	19.2	30.0
Link990	0.0	46.8	94.8	0.0	34.2	84.5
2803.1	43.4	41.0	40.2	52.2	50.1	49.2
Weir1390	0.0	0.5	6.6	0.0	0.0	5.1
2805.1	47.8	49.6	50.9	57.3	59.0	56.8
Weir1389	0.0	0.0	0.7	0.0	0.0	0.0
SGM 1414	30.4	34.4	36.3	43.4	43.9	44.7
SGM 1413	-17.5	-17.3	-14.7	-13.9	-14.9	-14.0
Weir935	0.0	22.3	24.4	0.0	20.6	27.8
SGM 1415	30.4	34.4	36.3	43.5	43.2	44.0
1741to217.1	0.0	0.0	0.0	0.0	0.0	0.0
SGM 1405	5.4	5.1	5.2	5.4	5.0	5.2
Weir1394	5.8	13.0	22.3	5.9	10.8	20.2
2819.1	5.7	7.0	7.6	5.7	7.0	7.3
Weir2288	0.0	0.0	25.4	0.0	0.0	10.1

Table 4.4: XP-SWMM Maximum Discharge Per Storm Event

	Existing Discharge (cfs)			Future Discharge (cfs)		
Link Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
Overlandflow	0.0	0.0	0.0	0.0	0.0	0.0
Link923	4.3	35.9	76.0	4.3	35.9	76.0
Link925	4.4	30.5	58.7	4.4	30.5	58.7
SGM 1403	5.5	5.5	5.8	5.5	5.5	5.8
SGM 1416	30.4	34.4	36.3	43.5	42.9	43.6
SGM 552a	19.5	49.3	44.7	19.3	45.3	61.3
2852.1	0.6	10.0	13.5	0.6	11.0	18.9
4012to213	0.0	3.9	18.9	0.0	0.0	12.8
Upper to Cigar	7.3	19.6	55.8	7.3	17.8	30.0
SGM 524	12.2	18.0	16.4	12.2	26.6	31.4
1	0.0	17.6	34.2	0.0	0.0	19.2
Link986	0.0	-6.6	-37.7	0.0	0.0	-7.2
2880.1	20.2	16.3	16.2	22.3	38.1	32.7
150 to 116	0.0	15.4	36.2	0.0	0.0	13.7
SGM 526	23.7	23.2	22.6	27.7	49.5	48.4
2	0.0	5.6	27.9	0.0	0.0	0.2
2884.1	23.7	23.1	22.6	27.5	49.3	48.7
115 to 114	0.0	0.0	10.5	0.0	0.0	0.0
2886.1	30.2	31.6	32.9	34.4	62.2	64.0
114to129	0.0	0.0	17.0	0.0	0.0	0.0
2887.1	30.1	31.6	32.9	34.2	62.0	64.0
129to1685	0.0	0.0	8.9	0.0	0.0	0.0
SGM 1141	3.9	4.9	5.1	3.9	5.2	5.3
SGM 1142	3.9	4.9	5.1	3.9	5.2	5.3
SGM 1143	3.9	4.8	5.1	3.9	5.2	5.2
SGM 1147	3.9	4.7	5.1	3.9	5.2	5.2
2902.1	3.9	4.7	5.1	3.9	5.2	5.2
1254to1255	0.0	0.0	0.0	0.0	0.0	0.0
2904.1	3.9	4.7	5.1	3.9	5.2	5.2
street 1255 to 1256	0.0	0.0	0.3	0.0	0.0	0.0
2906.1	3.9	4.7	5.1	3.9	5.2	5.2
street 1256 to 1796	0.0	0.0	0.0	0.0	0.0	0.0
Link988	0.0	-8.9	-13.8	0.0	0.0	-10.9
2908.1	3.6	8.3	8.6	1.5	5.9	10.2
1796 to 1797	0.0	0.0	0.0	0.0	0.0	0.0
2910.1	3.6	8.3	8.6	1.5	6.0	10.3
1797 to 1798	0.0	0.0	0.0	0.0	0.0	0.0
2912.1	3.7	8.3	-9.0	1.5	6.2	10.4
1798 to 1799	0.0	0.0	-34.8	0.0	0.0	0.0
2913.1	3.8	8.3	-10.0	1.5	6.3	10.5
1799 to 1689	0.0	0.0	-35.3	0.0	0.0	0.0

Table 4.4: XP-SWMM Maximum Discharge Per Storm Event

	Existing Discharge (cfs)			Future Discharge (cfs)		
Link Name	10 yr	100 yr	10 inch	10 yr	100 yr	10 inch
SGM 4792	1.9	6.6	10.8	1.9	6.6	10.8
Weir over trail	0.0	7.7	27.1	0.0	7.7	26.9
M-11 50% Clog	5.6	7.7	8.4	5.6	7.7	8.4
Drain tile	1.8	2.1	1.9	1.8	2.1	2.1
Link971	7.3	9.5	10.1	7.3	9.7	10.3
SGM 1412	1.9	8.8	7.5	1.9	11.2	8.9
Link980	0.0	44.2	97.0	0.0	28.3	84.1
NotchedWeir	-	-	-	42.9	118.1	144.5
WetlandA	-	-	-	31.5	109.0	183.1
WetlandB	-	-	-	22.1	83.9	138.8
Link998	-	-	-	18.2	44.6	57.5
Link1000	-	-	-	20.6	45.6	50.1
Link1001	-	-	-	20.6	45.7	50.2
Link998	-	-	-	18.2	44.6	57.5

Table 5.1 Decision Matrix (Weighted)

Concept Alternative Number	Concept Alternative Location	Concept Alternative Benefit	Main Goals & Benefits								Considerations													
			Rate Control	Water Quality	Volume Control	Flood Control	Ease of BMP Maintenance	BMP Access	Future Public Benefit/Amenity	Summary	Proximity to Low Point	Located Within Public Parcel	Existing Utilities	Soil Permeability	Soil Contamination	DWSMA	High Groundwater	Wetlands Present	Ease of Routing	Size of Draiange Area	Ownership of Drainage Area	Collaboration with Future Projects	Potential Funding	Summary
1	Arcade South	Flood Control Water Quality/Quantity	●	●	●	●	◔	●	○	●	●	●	◐	○	◐	●	○	○	●	◐	●	○	●	◕
2	Arcade North (City Owned)	Flood Control Water Quality/Quantity	●	●	●	●	◔	●	○	●	●	●	◐	○	◐	●	○	○	●	◐	●	○	●	◕
3	Cigar Pond (City Owned)	Flood Control Water Quality/Quantity	●	●	●	●	◐	◕	○	●	●	●	◐	○	○	●	○	●	◐	●	◐	●	◐	◕
4	1700/1701 Pond (City Owned Pond)	Flood Control Water Quality/Quantity	●	●	●	●	◐	◕	○	●	●	●	◐	○	○	●	○	●	●	●	◐	●	◐	◕
5	Large Wetland (City Owned)	Flood Control Water Quality/Quantity	●	●	○	●	◐	●	●	●	●	●	◐	○	◐	●	○	○	●	●	◐	○	●	◕
6	Private North Parcel (3548 Edgerton St)	Flood Control Water Quality/Quantity	◐	●	●	○	◔	○	○	◐	○	○	◐	◐	◐	●	◐	●	●	◐	○	○	●	◐
7	County Lot (Centerville Rd)	Flood Control Water Quality/Quantity	◐	●	●	○	◔	●	○	◕	○	●	◐	●	◐	●	◐	●	●	◐	●	○	●	◕
8	South Residential Area 1 (Villas on Edgerton)	Flood Control Water Quality/Quantity	●	●	●	◐	◔	●	○	◕	●	○	◐	◐	◐	●	◐	●	●	◐	◐	○	●	◕
9	South Residential Area 2 (630/644 Berwood Ave W)	Flood Control Water Quality/Quantity	●	●	●	◐	◔	●	○	◕	●	○	◐	◐	◐	●	◐	●	●	◐	◐	○	●	◕

Table 5.2 Decision Matrix Criterion

CRITERION	DESCRIPTION	●	◐	○
Project Parameters				
Rate Control	Potential to meet the rate control required by the Watershed District/City.	High	Medium	Low
Water Quality	Potential to meet the water quality required by the Watershed District/City.	High	Medium	Low
Volume Control	Potential to meet the volume control required by the Watershed District/City.	High	Medium	Low
Flood Control	Potential to provide control required by the Watershed District/City.	High	Medium	Low
Ease of BMP Maintenance	Level of maintenance for a given BMP.	Low	Medium	High
BMP Access	Ease of accessing the BMP from public ROW/existing easements.	High	Medium	Low
Future Public Benefit/Amenity	Level of public benefit/Amenity	High	Medium	Low
Proximity to Low Point	Proximity of any potential BMP location to the low point of the roadway.	Within 500 feet.	Between 500 and 1000 feet.	Greater than 1000 feet to low point
Located within Public Parcel	BMP location within a Public Parcel	Yes	N/A	No
Existing Utilities	Number of existing utilities/significant existing utilities that would limit BMP types.	Low	Medium	High
Soil Permeability	Soil permeability of the underlying in-situ soils at a particular BMP location.	High	Medium	Low
Soil Contamination	Soil contamination at a BMP location that would affect the type of BMP.	No	Unknown	Yes
DWSMA	BMP is NOT within a DWSMA the would affect the type of BMP.	Yes	N/A	No
High Groundwater	Potential of high groundwater effects on a given BMP location.	Low potential	Medium potential	High potential
Wetlands Present	Wetland presence at a BMP location that would limit the size of the BMP.	No	N/A	Yes
Ease of Routing	Ease routing water to a proposed BMP location.	High	Medium	Low
Size of Drainage Area	Size of drainage area routed to potential BMP	Large	Medium	Small
Ownership of Drainage Area	Potential to treat public water only	High	Medium	Low
Collaboration with Future Projects	Known future project to collaborate with	Yes	N/A	No
Potential Funding	Potential Funding available	High	Medium	Low

Appendix C Partner Meeting Notes

Record of Meeting

SRF No 16829.

Location: Vadnais Heights City Hall

Client: Vadnais Lake Area Watershed Management Organization (VLAWMO)

Date: 9/29/2023

Subject: East Vadnais Lake Subwatershed Resiliency Study Stakeholder Meeting #1

Attendees: Lauren Sampedro (VLAWMO), Phil Belfiori (VLAWMO), Molly Churchich (Ramsey County) Jeremy Erickson (SPRWS), Jim Hauth (Vadnais Heights), Nick Ousky (Vadnais Heights), David Filipiak (SRF), Jacques DuVal (SRF), Delaney Moberly (SRF)

From: Delaney Moberly

Summary of Meeting

- Available Data
  - Reviewed data requested in the original RFP.
    - Geotechnical Investigation
      - Confirmed that data is mostly at Centerville/Edgerton intersection
      - North Oaks is running a pipe up Centerville to connect to SPRWS and may have done some borings. SPRWS to check if they have any.
    - Field Verification of Storm Sewer Infrastructure/Outlet Control Structures
      - Discussed later in context of study areas. None available at this point, SRF will obtain where relevant.
    - Survey Work of Existing Conditions/Utilities
      - Discussed later in context of study areas. None available at this point, SRF will obtain where relevant.
    - Existing H&H Models
      - Have models from County (HydroCAD) and model from Ramsey County Flood Feasibility Study (XP-SWMM). Planning to stay in XP-SWMM and expand the model from the County project.
    - Stormwater & Water Quality Models
      - Nothing is available from any of the stakeholders.
    - SPRWS America Water Infrastructure Act Risk Assessment Report
      - Marked as confidential, primarily focused on weak spots to their system from malicious attacks or from catastrophic events and not on water quality.

            - If there is any language about goals for surface water quality that could be helpful for securing funding for potential future projects.
                - Funding for drinking water source water quality less competitive than surface water grants
            - Can send over the table of contents to see if any specific sections might be helpful to get more detail on.
        - SPRWS Raw Water Quality & Water Level Data
            - Have received quite a bit of data. At this point only wanted to confirm datum conversion between MSL to NAVD 88
        - Wetland Delineations
            - Only delineations in the last 5 years was for the County Flood project. VLAWMO can do desktop delineation if helpful.
                - Otherwise can use national wetland inventory
            - Likely don't need full delineation for any areas until getting to the project phase.
        - Land Use & Available Space
            - Use Ramsey County GIS data available online. Vadnais Heights to confirm if they have anything more recent in their comprehensive plans.
        - Low Flood/Low Building Openings
            - Vadnais Heights and VLAWMO have a pretty good idea of what areas might be of concern, but do not have survey to date.
                - Areas of concern include Berwood Ave, Garceau Ln, and known street flooding along Arcade between City Hall and Walmart.
        - Overland Emergency Outfalls (EOFs)
            - Might be included in some as-builts, but Vadnais Heights does not have any additional information or requirements.
        - As-Builts of Existing Stormwater Management Features
            - Vadnais Heights has provided quite a few which cover almost the entirety of the subwatershed. Should reach out if there are any missing.
        - Ramsey County Flood Feasibility Study Results
            - Have the results and plans. SRF to confirm that Jim has the final version of the report.
- Goals/Objectives
    - Overarching themes were flooding and water quality.
    - Vadnais Heights
        - Understand how the upstream part of subwatershed impacts the downstream
            - E.g. understand how Berwood area to Arcade impact the Centerville/Edgerton intersection in terms of capacity and flooding.

    - Slow water down in the upstream parts of the watershed to get increased water quality benefits.
    - Understand what elements of the storm sewer network need to be updated to alleviate street flooding, without creating new issues.
  - Ramsey County
    - Captured in the RFP, primarily focused on reducing localized flooding.
    - Does not have any other projects currently planned outside of pavement rehab.
  - SPRWS
    - Focused on water quality improvement. East Vadnais Lake is a source of pride to SPRWS.
    - Improved water quality helps to reduce treatment costs.
    - East Vadnais Lake is a source of water for them. Pumps turn on based on lake levels, so in larger storm events a larger percent of their water is pulled from the watershed.
    - Their funding is all tied to water sales, it is key for them to be able to tie expenditures back to improved source water quality.
  - VLAWMO
    - Expand on County Edgerton Road flood project
    - Improve water quality
    - Multi-beneficial BMPs
    - Resiliency
    - Working to buildable projects that solve problems
- Opportunities to Study
  - The "splitter area" just west of Arcade and north of Arcade Estates West Townhomes.
    - Large (12'x12'?) grate on top of structure with significant flows coming into it and much smaller pipe leaving.
    - Do see flooding along Arcade in this area. But do not have reports of flooding in homes in the City.
    - VLAWMO/Vadnais Heights suspect that this (and possibly other areas) switch from gravity to pressure flow.
      - This and other potential transition points would be good places to confirm with survey.
    - Vadnais Heights fully expects to find that segments of their network need to be upsized to eliminate pressure flow conditions.
  - Walmart
    - Originally built in the 1990's, did some parking lot work in 2011.
    - Unclear how they are meeting water quality/rate control requirements. Might have credit in the pond downstream of the "splitter area."

        - Is there an opportunity to do underground in their parking lot if they are redoing it anytime soon?
    - Metropolitan Council Park-And-Ride facility
        - Another mostly impervious area, is there opportunity to do underground storage/treatment?
    - Gully along railroad tracks and Centerville Rd
    - Ditch east of Edgerton and north of the Big Woods/old Garceau Hardware site
        - Large parcel near beginning of ditch only partially utilized, Vadnais Heights could reach out to property owner about use/sale.
        - Possible contamination issues from hardware side and old hospital dump.
        - Significant drainage area (~50 acres) comes through this ditch to "Big Hole" at Centerville/Edgerton intersection and then into lake.
    - Cigar Pond
        - Has 9' bounce, does it have capacity to take on more water?
        - What happens to upstream system if it does?
    - Concrete cattlepass/box culvert opening under Centerville by ravine.
        - Appears to be being undermined by flows, can these be reduced?
    - Big wetland adjacent to City Hall
        - Do not believe it to be a very high-quality wetland. Can it take on some more water?
    - Railroad
        - Are there any opportunities to partner with them on any projects?
        - City currently has to pay for any crossings, getting more expensive.
- Resiliency
    - What does resiliency mean to each stakeholder
        - Vadnais Heights
            - Handling changing climate. Understanding areas of constraints and identifying a plan to address them.
        - Ramsey County
            - Maintain level of service on their roadways. Prevent closures.
        - SPRWS
            - Slowing down flashiness of the subwatershed to keep East Vadnais Lake at its current state.
- Schedule/Next Steps
    - SRF to work on identifying critical locations to get survey and then send to the group to confirm.
        - Will try to save some budget for early spring for any follow up locations that come out of the potential BMP options
    - Next meetings will be with individual stakeholders. Planning to start with Vadnais Heights near the end of October/early November.
    - Will continue to share information via OneDrive

- Will include Lauren and Phil on all emails as the overall project managers.

Actions Needed

Actions Needed	Responsibility
Check if new pipe connection along Centerville by North Oaks has any soil boring associated with it	SPRWS
Send over table of contents, figures from SPRWS America Water Infrastructure Act Risk Assessment Report	SPRWS
Check on datum conversation from MSL to NAVD 88	SPRWS
Check for land use/available space information in Vadnais Heights comprehensive plans	Vadnais Heights
Send final version of Ramsey County Flood study to Jim Hauth	SRF
Identify critical locations for survey and send to stakeholders for concurrence	SRF
Set up individual stakeholder meetings	SRF

Record of Meeting

SRF No 16829

Location: Zoom

Client: Vadnais Lake Area Watershed Management Organization (VLAWMO)

Date: 11/6/2023

Subject: East Vadnais Lake Subwatershed Resiliency Study - Vadnais Height Meeting

Attendees: Lauren Sampedro (VLAWMO), Phil Belfiori (VLAWMO), Jim Hauth (Vadnais Heights), Nick Ousky (Vadnais Heights), David Filipiak (SRF), Jacques DuVal (SRF), Delaney Moberly (SRF)

From: Delaney Moberly

Summary of Meeting

- Started with high level overview of the existing conditions model, generally seeing the following:
    - The model shows flooding in locations previously called out by the city, as well as in some additional locations around neighborhoods on the south end of the model.
    - There appear to be a general flood path starting up at Arcade by Walmart, down into the ponding areas north of Garceau, which then overtop onto Garceau, and in turn overtop into the Cigar pond area.
    - In areas with trunk lines we expect to contain water these were initially modeled as "sealed" which ensures that water will stay in the pipes. Will be reviewing this and adding in overland flows where applicable.
    - Initially used generalized curve numbers for hydrology. Will be refining this with Ramsey County impervious data to refine runoff.
- Looked at specific areas of concern from north to south in the model.
    - Walmart
        - Discussed if there was any ponding on the site, above or below ground. The model accounts for a small BMP on the site and some surface ponding in the parking lot. Nick indicated that we do not believe there to be any underground storage.
        - Assumed there could be ponding of water on the roof, agreed this was a reasonable assumption, doesn't appear to be any surface overflows to Arcade from street view.
        - Assumed that individual developments immediately upstream of Walmart (Credit Union, KFC) are holding back the 100-year event and discharging through existing pipes

- Ortho site
  - Newer development close to the road used treatment from sliver pond, will need to review model and see if it makes sense to include that storage.
  - Assumed this development would hold back the 100-year event and discharge through existing pipes.
- Arcade flooding near Walmart/splitter grate
  - Lots of impervious with very little storage, unclear if street flooding is happening first, or if water is going over to the wetland first. Look at 1" or 1 year even to see what the 24" pipe is able to carry before overflowing to wetland.
  - Discussed if tailwater conditions from the wetland and the ponds just north of Garceau could be backing water up into Arcade and contributing to the flooding.
- Arcade Estates
  - Need to double check as-builts Nick is sending over to make sure all the storage on site is captured.
- Edgerton/Centerville area
  - Significant flow across Garceau property today. Edgerton project does include some CBs along Centerville to help pick some of this up, and assumed that the Big Woods development would be putting in curb and gutter along Centerville which should help cut off that flow.
    - Vadnais Heights was ok with continuing with the same modeling assumptions as were used in the Edgerton project.

- Survey
  - Want to get emergency overflows (EOFs) from ponds at Garceau, might also want to check some spots in the wetland.
  - Want survey at splitter/overflow from Arcade.
  - Want EOF from western pond to Garceau, plus top of curb.
    - City has a project in this area but has not obtained survey yet..
  - Hold off doing full survey on back pitched pipe from Hiawatha to Cigar.
    - Isn't standard for the city to put in pipes like this. Could do some survey, but concerned about how far back this might need to be chased through the trunk line.
  - Don't want to do any low-floor elevations at this point.
    - Jim sending an email to Ken about any historic flooding locations throughout the study area.
- BMPs
  - If model shows more storage is needed, we could look at privately owned parcels by Monn Ave in more detail for a possible BMP site. Don't know if parcel at the Monn development has any plans laid for it, but currently is fully wooded.
  - Thought city parcels on the south end of Arcade seem like good possibilities.

- Wedge by the wetland also looks to be a good location.

Actions Needed

Actions Needed	Responsibility
Send over as-builts for Arcade Estates BMPs	Vadnais Heights
Move forward with survey based on discussion today	SRF
Review storage at Arcade Estates, ortho sites	SRF
Provide input on flooding	Vadnais Heights (Ken)

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Record of Meeting

SRF No. 16829

Location: Zoom

Client: Vadnais Lake Area Watershed Management Organization (VLAWMO)

Date: 12/11/2023

Subject: VLAWMO Resiliency Study Stakeholder Meeting #2

Attendees: Lauren Sampedro (VLAWMO), Phil Belfiori (VLAWMO), Molly Churchich (Ramsey County) Jeremy Erickson (SPRWS), Jim Hauth (Vadnais Heights), Nick Ousky (Vadnais Heights), Erin Spry (Vadnais Heights), Ken LaCasse (Vadnais Heights), David Filipiak (SRF), Jacques DuVal (SRF), Delaney Moberly (SRF)

From: Delaney Moberly

Summary of Meeting

- Existing Model Updates/Results
    - Model Parameters/Assumptions
        - Collected limited field survey of key overtopping elevations and incorporated that into the modeling.
            - During the fieldwork we observed a fairly significant channel at the south end of the wetland which routes most water to the dry area just west of the pond north of Garceau.
        - Initially the model used generalized curve numbers based on the land use to get runoff in the model. After looking at initial results, decided to apply a directly connected impervious area (DCIA) multiplier (60%) to account for impact of disconnected impervious in residential areas.
            - Basic effect is to reduce the impervious in residential areas.
            - Fairly common method for XP-SWMM modeling in residential areas, have used before in models for Minneapolis, Bloomington.
    - Draft Flood Inundation Maps
        - Reviewed draft maps, did note that they are based on the LiDAR data we have available, which is not always the highest resolution.
            - Pointed out one place that we see this is by the splitter on Arcade, where the maps only show flooding in the 100 year event. This is because the LiDAR contours are higher than the actual rim elevations in this area. So while the high water levels in the model show flooding in the 10 year, the mapping does not.
            - Do plan to update the LiDAR with the survey/final grading from the Edgerton project, and the survey completed with this project.

        - Phil noted that there was not much for flooding by Centerville/Edgerton intersection (the location of the County project being constructed in 2024). This is because the modeling does include the proposed improvements there as part of the existing condition – the proposed contours will be reflected in the final mapping.
        - Based on Ken's experience, this flood mapping makes sense and matches with what Vadnais Heights would expect to see.
        - Noted that Berwood Park is a low area, and that the pond just north of Garceau does take a long time to drain out, which was consistent with what the model was showing.
        - Also noted that this model is modeling the capacity of the pipes and not any of the surface inlets. So, some flooding might be greater if inlets are clogged/undersized.
        - Will send out inundation mapping to the group and request that folks point out if anything looks off upon further review.
- Alternatives Discussion
    - Initially had 7 possible alternatives and added 8 and 9 after seeing some initial flooding near Monn Ave in the southwest portion of the subwatershed.
    - For alternatives, were looking for places that could provide water quality, water quantity, and flood control that we could also get water to/out of, ideally have public ROW, and have the fewest constraints.
        - Site #1 provided some good opportunities to reduce flooding as well as improve water quality and quantity. It is a public parcel which can take in public water.
        - Site #2 is in proximity to the flooding on Arcade/the splitter box. If it can hold back enough water, it could provide detention upstream of the pond north of Garceau. Would ideally find a way to bring in just public water to keep long term O&M simpler.
        - Site #3 was initially considered for lowering the dead storage at Cigar pond, but thought it might be more effective to use in conjunction with the small wet pond to the north. Would reconfigure the area so the smaller basin to the north could provide water quality.
        - Site #4 would take a similar approach to site #3. Would want to reroute the channel from wetland to first send water to wet pond and then back water up into the dry area to provide water quality/quantity benefits.
        - Site #5 is a big wetland with a lot of potential to hold back water within the wetland and provides some water quality benefits (e.g. a meandering channel with pools to provide habitat). Noted that this would have quite a bit of permitting.

        - Site #6 has a significant drainage area coming to it and so could provide quite a bit of water quality benefits but wouldn't provide much in terms of flood benefit given its position within the subwatershed.
        - Site #7 has a fairly small drainage area and is a fairly narrow site with quite a few ash trees. Like #6 is downstream of most of the flooding and not able to provide much benefit on that element.
        - Sites #8 & 9 were initially brought in to address flooding near Monn Ave. that the modeling shows only minor flooding so these might be sites to keep in mind for future water quality projects.
    - Alternatives Matrix
        - Walked through the different criterion used for the matrix. In general folks felt like the list was fairly comprehensive. Did discuss adding in access and utilities. Please note that full circles in the matrix were good, while empty circles were bad.
        - Summarized the project benefits separately from constraints. Did also weight some of the constraints higher than others (Located Within Public Parcel, Collaboration with Future Projects, and Potential Funding).
            - Jim asked if drinking water quality grants were considered with the ranking for Potential Funding. While we tried to keep that in mind, those have not been thoroughly investigated yet.
        - Stepped through the rankings and pointed out a few key points of interest.
            - Ease of maintenance was tied to the type of BMP proposed, the key element being that wet ponds have a longer life cycle than infiltration/filtration basins.
            - Site #5 was the only spot that was expected to have any meaningful future public benefit/amenity. Noted that due to its nature as a wetland, we would not expect the soils to be conducive for infiltration which resulted in the low ranking on volume control. It does still have the potential to provide water quality via filtration.
            - One thing to note was that the matrix shown in the meeting had Site #3 ranked for the option of just lowering the dead storage instead of the larger re-plumbing plan with a water quality basin to the north. The rankings will be updated in the final version sent out with these meeting notes to reflect the approach to water quality.
        - In general, the first 5 sites seemed to provide the most benefits.
    - Next Steps
        - the next step is to reduce the alternatives to three sites to investigate further. Group felt that site #4 should move forward, but quite a few of the sites ranked well so need input from the stakeholders as to which ones they would like to see progress.

  - Jim noted that the city wants to maximize capacity (flood and volume control) while also providing for rate control and water quality impacts. Felt like site #4 would be good to move forward, along with #3 and #1. There is known development planned along Arcade so looking closer into #1 to plan for that future runoff makes a lot sense. Intrigued by #5, is in line with some of the goals the City has discussed internally about connecting the public to the wetlands, just not sure how to deal with the regulatory and funding elements.
  - Jeremy noted that it would be helpful to have a bit of time to review the matrix in more detail before deciding.
- From here will plan to send out the matrix and mapping for stakeholders to review and provide comments. The original date of December 22 has been adjusted for the holidays to Friday, January 5, 2024.

Actions Needed

Actions Needed	Responsibility
SRF to provide inundation mapping to stakeholders	SRF
Stakeholders to review inundation mapping and respond if any areas don’t match up with what they would expect to see	Stakeholders
SRF to send out updated matrix, criterion for review	SRF
Stakeholders to review matrix and provide input for which three BMP sites we would like to move forward with	Stakeholders

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Appendix D Probable Construction Costs

EAST VADNAIS LAKE SUBWATERSHED
WATER QUALITY/FLOOD RESILIENCE STUDY

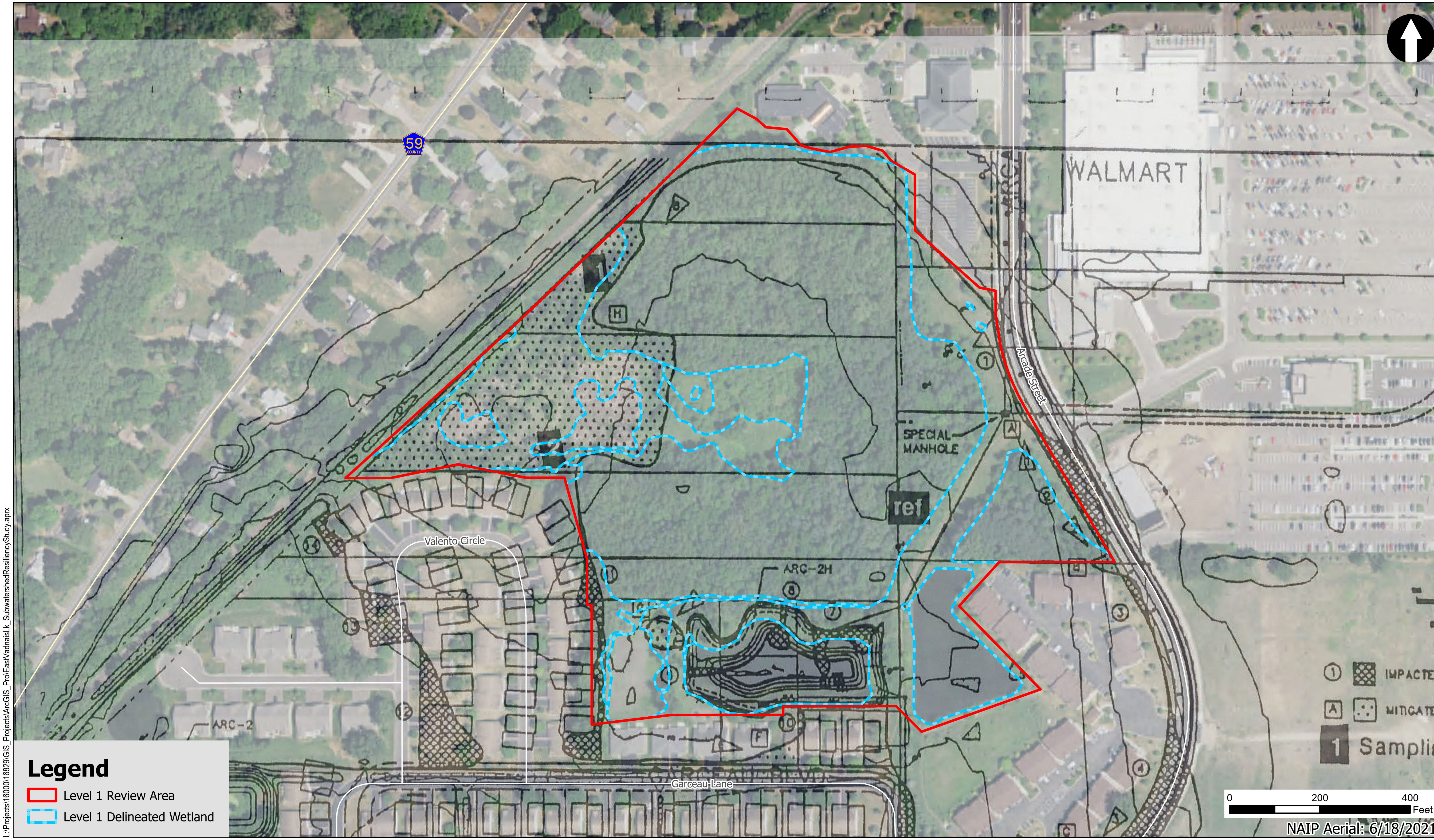
Concept Cost Estimate (based upon 2023 bid price information)

Prepared By: SRF Consulting Group, Inc., April, 2024

	ITEM DESCRIPTION		UNIT	UNIT PRICE	ULTIMATE FINAL CONDITIONS EST. QUANTITY	ULTIMATE FINAL CONDITIONS EST. AMOUNT	POND 3 EST. QUANTITY	POND 3 EST. AMOUNT
GRADING REMOVAL COSTS								
GrP	Clearing and Grubbing		acre	$19,000	11	$203,696		
GrP 1a	2106 Excavation - common & subgrade	(1)	cu. yd.	$15.00	54,912	$823,684		
GrP 2a	2106 Common Embankment (CV)	(1)	cu. yd.	$10.00	5,763	$57,633		
GrP 4b	Aggregate Walk / Trail	(2)	sq. yd.	$10.00	3,868	$38,677		
GrP 8b	Removals - Drainage		l.s.	$31,000	1	$31,000		
	SUBTOTAL GRADING and REMOVAL COSTS:					**$1,155,000**		
DRAINAGE, UTILITIES AND EROSION CONTROL								
Dr 1	Storm Sewer	(3)	l.s.	$900,000	1	$900,000		
Dr 2	Pretreatment (underground proprietary device)		each	$50,000	2	$100,000		
Dr 3	Control Weirs	(4)	each	$112,000	3	$336,000		
Dr 4	Outlet Control Structure		l.s.	$15,000	1	$15,000		
Dr 5	Wetland Restoration/Planting	(5)	l.s.	$105,000	1	$105,000		
Dr 6	Engineered Soil (Wetland A)		cu. yd.	$60	3600	$216,000		
Dr 7	Erosion Control		5%			$58,000		
Dr 8	Storm Sewer Improvements from South Arcade Street	(6)	l.s.	$1,036,000	1	$1,036,000		
Dr 9	Storm Sewer Improvements from Berwood Avenue	(6)	l.s.	$484,000	1	$484,000		
Dr 10	Storm Sewer Improvements from Monn Avenue	(6)	l.s.	$591,000	1	$591,000		
Dr 11	Pump Station/Adaptive Management System		l.s.	$792,000			1.00	$792,000
	SUBTOTAL DRAINAGE, UTILITIES AND EROSION CONTROL					**$3,841,000**		**$792,000**
RETAINING WALLS & OTHER MINOR STRUCTURAL COSTS								
RW 1	Boardwalk/Bridge Crossings	(7)	lin. ft.	$1,300	120	$156,000		
RW 2	Boardwalk/Bridge Abutments		each	$10,000	6	$60,000		
	SUBTOTAL RETAINING WALLS & OTHER MINOR STRUCTURAL COSTS:					**$216,000**		
	SUBTOTAL CONSTRUCTION COSTS:					**$5,212,000**		**$792,000**
MISCELLANEOUS COSTS								
M 1	Mobilization		5%			$261,000		$40,000
M 2	Non Quantified Minor Items		15%			$782,000		$119,000
	SUBTOTAL MISCELLANEOUS COSTS:					**$1,043,000**		**$159,000**
ESTIMATED TOTAL CONSTRUCTION COSTS without Contingency:						**$6,255,000**		**$951,000**
1	Contingency or "risk"		30%			$1,877,000		$286,000
ESTIMATED TOTAL CONSTRUCTION COSTS PLUS CONTINGENCY:						**$8,132,000**		**$1,237,000**
	TOTAL PROJECT COST					**$8,132,000**		**$1,237,000**
	INFLATION COST (CURRENT YR. TO YR. OF OPENING)		Years	3%				
	TOTAL PROJECT COST (OPENING YEAR DOLLARS)					**$8,132,000**		**$1,237,000**

NOTE:
(1) Assume 4" topsoil salvaged from common excavation.
(2) Assumes 4" aggregate surfacing for trails.
(3) Includes storm sewer that would be installed with 2025 Garceau reconstruction
(4) Assumes sheet pile w/concrete caps for weir outfalls between wetlands.
(5) Assumes native seeding, shrubs, and trees.
(6) Includes added capacity improvements, 30% restoration.
(7) Assumes 8' width, pedstrian loads, helical piles, hand rail on each side

Appendix E Level 1 Wetland Delineation Figures and Documentation

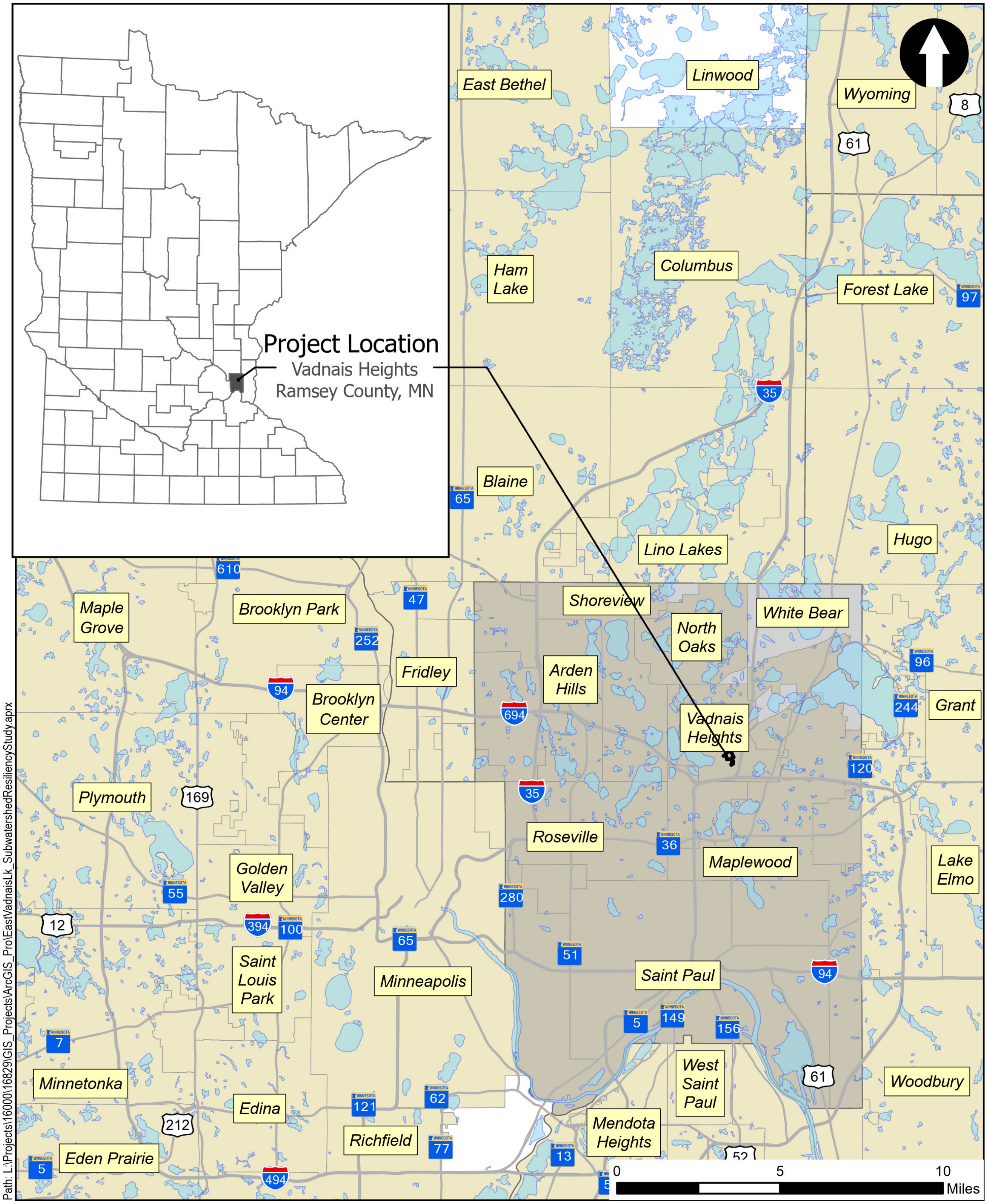


North Area Wetland Impacts and Mitigation

East Vadnais Lake Subwatershed Resiliency Study

City of Vadnais Heights

Figure 6



North Area State Location

East Vadnais Lake Subwatershed Resiliency Study

City of Vadnais Heights

Figure 1

North Area Project Location

East Vadnais Lake Subwatershed Resiliency Study

City of Vadnais Heights

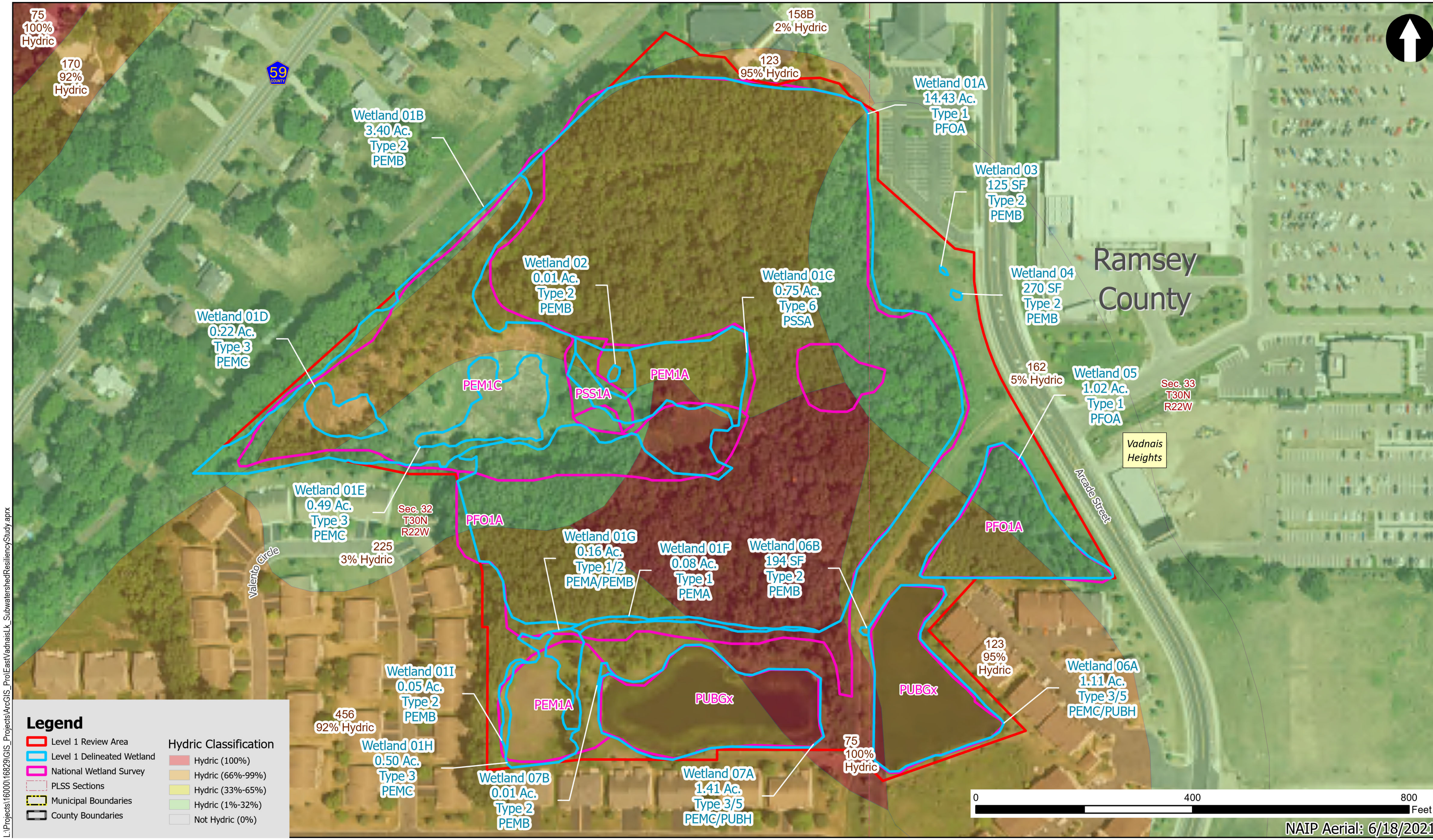
Figure 2

North Area Level 1 Delineation Map

East Vadnais Lake Subwatershed Resiliency Study

City of Vadnais Heights

Figure 3

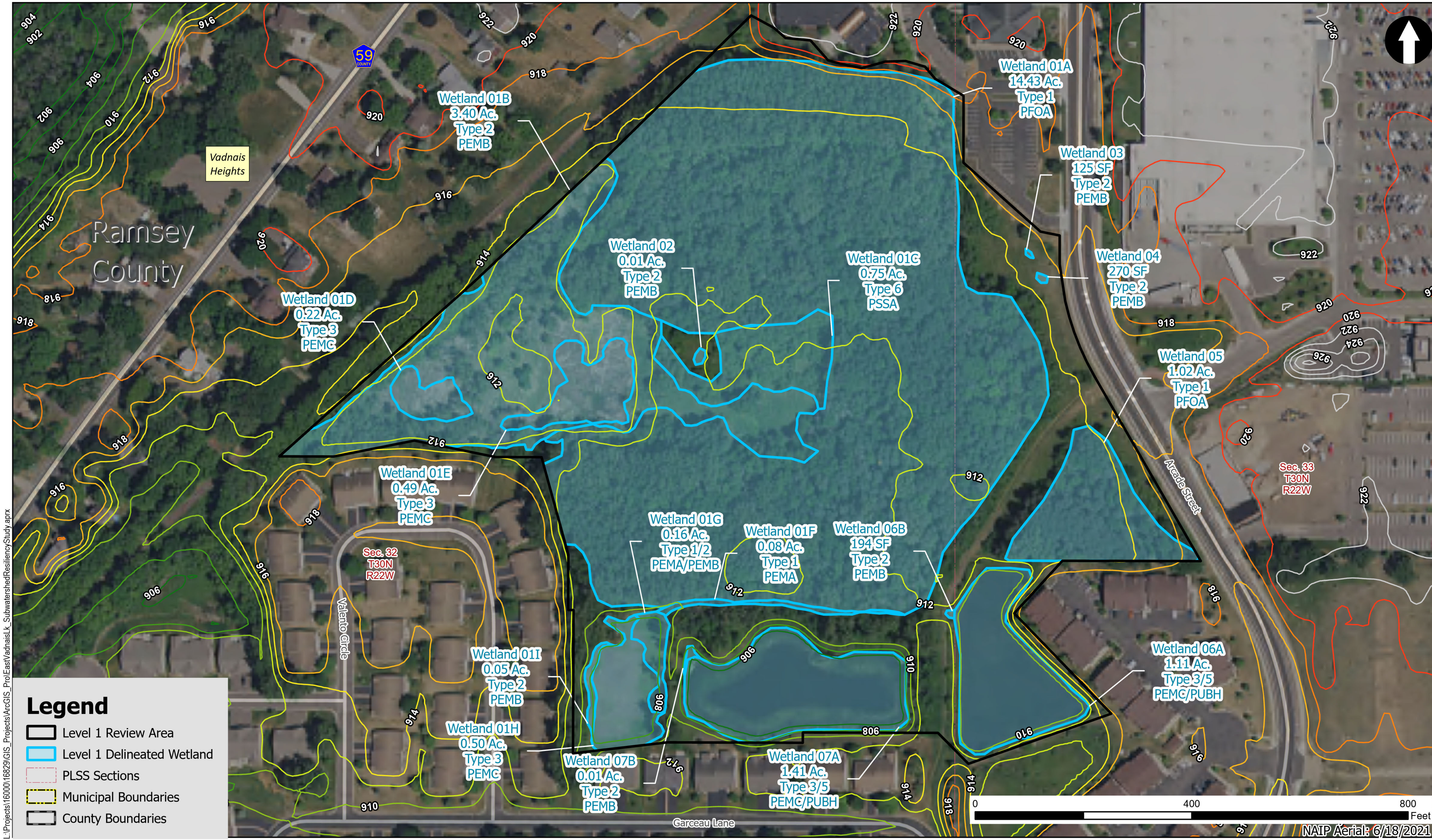


North Area NRCS SSURGO Soils

East Vadnais Lake Subwatershed Resiliency Study

City of Vadnais Heights

Figure 4



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North Area LiDAR 2-Foot Contour

East Vadnais Lake Subwatershed Resiliency Study

City of Vadnais Heights

Figure 5

Field data sheet reference (if applicable): ____________

Wetland Hydrology from Aerial Imagery - Recording Form

Project Name: North Area East Vadnais Lake Subwatershed Resiliency Study   Date: 1/31/2024   County: Ramsey

Investigator: J. Fesenmaier, SRF Consulting   Legal Description (T, R, S): T30N, R22W, Sec. 32

Summary Table

Date Image Taken (M-D-Y)	Image Source	Climate Condition (wet, dry, normal)[i]	Image Interpretation(s)				
			Wetland 01A	Wetland 01B	Wetland 01C	Wetland 01D	Wetland 01E
6/18/2021	FSA NAIP	Normal	NV	WS	NV	WS	WS
10/16/2017	FSA NAIP	Normal	NV	WS	NV	WS	WS
9/27/2015	FSA NAIP	Normal	NV	WS	NV	WS	WS
9/12/2010	FSA NAIP	Normal	NV	WS	NV	WS	WS
7/15/2006	FSA NAIP	Normal	NV	WS	NV	WS	WS

Normal Climate Condition	Wetland 01A	Wetland 01B	Wetland 01C	Wetland 01D	Wetland 01E
Number	5	5	5	5	5
Number with wet signatures	0	5	0	5	5
Percent with wet signatures	0%	100%	0%	100%	100%

KEY		
WS - wetland signature	SS - soil wetness signature	CS - crop stress
NC - not cropped	AP - altered pattern	NV - normal vegetative cover
DO - drowned out	SW - standing water	NSS - no soil wetness signature
Other labels or comments:		

- Use above key to label image interpretations. It is imperative that the reviewer read and understand the guidance associated with the use of these labels. If alternate labels are used, indicate in box above.
- If less than five (5) images taken during normal climate conditions are available, use an equal number of images taken during wet and dry climate conditions and use as many images as you have available. Describe the results using this methodology in your report.

[i] Use MN State Climatology website to determine climate condition when image was taken. (http://climate.umn.edu/)

[2] Wetlands are in a forested area or adjacent to different typed wetlands, so no wetland signatures were identified in the desktop review and verified in the field review. These area were determined to be wetlands due to the area including hydric soils, mapped by NWI, hydrophytic vegetation with discernable break, and/or low geomorphic position relative to surrounding area.

Field data sheet reference (if applicable): ____________

Wetland Hydrology from Aerial Imagery - Recording Form

Project Name: North Area East Vadnais Lake Subwatershed Resiliency Study   Date: 1/31/2024   County: Ramsey

Investigator: J. Fesenmaier, SRF Consulting   Legal Description (T, R, S): T30N, R22W, Sec. 32

Summary Table

Date Image Taken (M-D-Y)	Image Source	Climate Condition (wet, dry, normal)[i]	Image Interpretation(s)				
			Wetland 01F	Wetland 01G	Wetland 01H	Wetland 01I	Wetland 02
6/18/2021	FSA NAIP	Normal	NV	NV	DO	WS	WS
10/16/2017	FSA NAIP	Normal	NV	NV	SW	WS	WS
9/27/2015	FSA NAIP	Normal	NV	WS	DO	WS	NV
9/12/2010	FSA NAIP	Normal	NV	WS	SS	WS	NV
7/15/2006	FSA NAIP	Normal	NV	NV	DO	NV	NV

Normal Climate Condition	Wetland 01F	Wetland 01G	Wetland 0H	Wetland 01I	Wetland 02
Number	5	5	5	5	5
Number with wet signatures	0	2	5	4	2
Percent with wet signatures	100%	40%	100%	80%	40%

KEY		
WS - wetland signature	SS - soil wetness signature	CS - crop stress
NC - not cropped	AP - altered pattern	NV - normal vegetative cover
DO - drowned out	SW - standing water	NSS - no soil wetness signature
Other labels or comments:		

- Use above key to label image interpretations. It is imperative that the reviewer read and understand the guidance associated with the use of these labels. If alternate labels are used, indicate in box above.
- If less than five (5) images taken during normal climate conditions are available, use an equal number of images taken during wet and dry climate conditions and use as many images as you have available. Describe the results using this methodology in your report.

[i] Use MN State Climatology website to determine climate condition when image was taken. (http://climate.umn.edu/)

[2] Wetlands are in a forested area or adjacent to different typed wetlands, so no wetland signatures were identified in the desktop review and verified in the field review. These area were determined to be wetlands due to the area including hydric soils, mapped by NWI, hydrophytic vegetation with discernable break, and/or low geomorphic position relative to surrounding area.

Field data sheet reference (if applicable): ____________

Wetland Hydrology from Aerial Imagery - Recording Form

Project Name: North Area East Vadnais Lake Subwatershed Resiliency Study   Date: 1/31/2024   County: Ramsey

Investigator: J. Fesenmaier, SRF Consulting   Legal Description (T, R, S): T30N, R22W, Sec. 32

Summary Table

Date Image Taken (M-D-Y)	Image Source	Climate Condition (wet, dry, normal)[i]	Image Interpretation(s)				
			Wetland 03	Wetland 04	Wetland 05	Wetland 06A	Wetland 06B
6/18/2021	FSA NAIP	Normal	WS	NV	NV	SW	NV
10/16/2017	FSA NAIP	Normal	WS	WS	NV	SW	WS
9/27/2015	FSA NAIP	Normal	NV	WS	NV	SW	NV
9/12/2010	FSA NAIP	Normal	NV	NV	NV	SW	SW
7/15/2006	FSA NAIP	Normal	NV	NV	NV	SW	NV

Normal Climate Condition	Wetland 03	Wetland 04	Wetland 05	Wetland 06A	Wetland 06B
Number	5	5	5	5	5
Number with wet signatures	2	2	0	5	2
Percent with wet signatures	40%	40%	0%	100%	40%

KEY		
WS - wetland signature	SS - soil wetness signature	CS - crop stress
NC - not cropped	AP - altered pattern	NV - normal vegetative cover
DO - drowned out	SW - standing water	NSS - no soil wetness signature
Other labels or comments:		

- Use above key to label image interpretations. It is imperative that the reviewer read and understand the guidance associated with the use of these labels. If alternate labels are used, indicate in box above.
- If less than five (5) images taken during normal climate conditions are available, use an equal number of images taken during wet and dry climate conditions and use as many images as you have available. Describe the results using this methodology in your report.

[i] Use MN State Climatology website to determine climate condition when image was taken. (http://climate.umn.edu/)

[2] Wetlands are in a forested area or adjacent to different typed wetlands, so no wetland signatures were identified in the desktop review and verified in the field review. These area were determined to be wetlands due to the area including hydric soils, mapped by NWI, hydrophytic vegetation with discernable break, and/or low geomorphic position relative to surrounding area.

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Wetland Hydrology from Aerial Imagery - Recording Form

Project Name: North Area East Vadnais Lake Subwatershed Resiliency Study   Date: 1/31/2024   County: Ramsey

Investigator: J. Fesenmaier, SRF Consulting   Legal Description (T, R, S): T30N, R22W, Sec. 32

Summary Table

Date Image Taken (M-D-Y)	Image Source	Climate Condition (wet, dry, normal)[i]	Image Interpretation(s)				
			Wetland 07A	Wetland 07B			
6/18/2021	FSA NAIP	Normal	SW	WS			
10/16/2017	FSA NAIP	Normal	SW	NV			
9/27/2015	FSA NAIP	Normal	SW	WS			
9/12/2010	FSA NAIP	Normal	SW	NV			
7/15/2006	FSA NAIP	Normal	SW	NV			
Normal Climate Condition			Wetland 07A	Wetland 07B			
Number			5	5			
Number with wet signatures			5	2			
Percent with wet signatures			100%	40%			

KEY		
WS - wetland signature	SS - soil wetness signature	CS - crop stress
NC - not cropped	AP - altered pattern	NV - normal vegetative cover
DO - drowned out	SW - standing water	NSS - no soil wetness signature
Other labels or comments:		

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[2] Wetlands are in a forested area or adjacent to different typed wetlands, so no wetland signatures were identified in the desktop review and verified in the field review. These area were determined to be wetlands due to the area including hydric soils, mapped by NWI, hydrophytic vegetation with discernable break, and/or low geomorphic position relative to surrounding area.

Field data sheet reference (if applicable): ____________

Wetland Determination from Aerial Imagery - Recording Form

Project Name: North Area East Vadnais Lake Subwatershed Resiliency Study   Date: 1/31/2024   County: Ramsey

Investigator: J. Fesenmaier, SRF Consulting   Legal Description (T, R, S): T30N, R22W, Sec. 32

Use the Decision Matrix below to complete Table 1.

Hydric Soils present[1]	Identified on NWI or other wetland map[2]	Percent with wet signatures from Exhibit 1	Field verification required[3]	Wetland?
Yes	Yes	>50%	No	Yes
Yes	Yes	30-50%	No	Yes
Yes	Yes	<30%	Yes	Yes, if other hydrology indicators are present
Yes	No	>50%	No	Yes
Yes	No	30-50%	Yes	Yes, if other hydrology indicators are present
Yes	No	<30%	No	No
No	Yes	>50%	No	Yes
No	Yes	30-50%	No	Yes
No	Yes	<30%	No	No
No	No	>50%	Yes	Yes, if other hydrology indicators are present
No	No	30-50%	Yes	Yes, if other hydrology indicators are present
No	No	<30%	No	No

[1] The presence of hydric soils can be determined from the "Hydric Rating by Map Unit Feature" under "Land Classifications" from the Web Soil Survey. "Not Hydric" is the only category considered to not have hydric soils. Field sampling for the presence/absence of hydric soil indicators can be used in lieu of the hydric rating if appropriately documented by providing completed field data sheets.

[2] At minimum, the most updated NWI data available for the area must be reviewed for this step. Any and all other local or regional wetland maps that are publically available should be reviewed.

[3] Area should be reviewed in the field for the presence/absence of wetland hydrology indicators per the applicable 87 Manual Regional Supplement, including the D2 indicator (geomorphic position).

Table 1.

Area	Hydric Soils Present	Identified on NWI or other wetland map	Percent with wet signatures from Exhibit 1	Other hydrology indicators present[1]	Wetland?
Wetland 01A	Yes	Yes	0%	Yes[2]	Yes
Wetland 01B	Yes	Yes	100%	N/A	Yes
Wetland 01C	Yes	Yes	0%	Yes[2]	Yes
Wetland 01D	Yes	Yes	100%	N/A	Yes
Wetland 01E	Yes	Yes	100%	N/A	Yes
Wetland 01F	Yes	Yes	100%	N/A	Yes
Wetland 01G	Yes	Yes	40%	N/A	Yes
Wetland 01H	Yes	Yes	100%	N/A	Yes
Wetland 01I	Yes	Yes	80%	N/A	Yes
Wetland 02	Yes	Yes	40%	N/A	Yes
Wetland 03	Yes	No	40%	Yes[2]	Yes
Wetland 04	Yes	No	40%	Yes[2]	Yes

[1] Answer "N/A" if field verification is not required and was not conducted.

[2] Wetlands are in a forested area or adjacent to different typed wetlands, so no wetland signatures were identified in the desktop review and verified in the field review. These area were determined to be wetlands due to the area including hydric soils, mapped by NWI, hydrophytic vegetation with discernable break, and/or low geomorphic position relative to surrounding area.

Field data sheet reference (if applicable): ____________

Wetland Determination from Aerial Imagery - Recording Form

Project Name: North Area East Vadnais Lake Subwatershed Resiliency Study   Date: 1/31/2024   County: Ramsey

Investigator: J. Fesenmaier, SRF Consulting   Legal Description (T, R, S): T30N, R22W, Sec. 32

Use the Decision Matrix below to complete Table 1.

Hydric Soils present[1]	Identified on NWI or other wetland map[2]	Percent with wet signatures from Exhibit 1	Field verification required[3]	Wetland?
Yes	Yes	>50%	No	Yes
Yes	Yes	30-50%	No	Yes
Yes	Yes	<30%	Yes	Yes, if other hydrology indicators are present
Yes	No	>50%	No	Yes
Yes	No	30-50%	Yes	Yes, if other hydrology indicators are present
Yes	No	<30%	No	No
No	Yes	>50%	No	Yes
No	Yes	30-50%	No	Yes
No	Yes	<30%	No	No
No	No	>50%	Yes	Yes, if other hydrology indicators are present
No	No	30-50%	Yes	Yes, if other hydrology indicators are present
No	No	<30%	No	No

[1] The presence of hydric soils can be determined from the "Hydric Rating by Map Unit Feature" under "Land Classifications" from the Web Soil Survey. "Not Hydric" is the only category considered to not have hydric soils. Field sampling for the presence/absence of hydric soil indicators can be used in lieu of the hydric rating if appropriately documented by providing completed field data sheets.

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[3] Area should be reviewed in the field for the presence/absence of wetland hydrology indicators per the applicable 87 Manual Regional Supplement, including the D2 indicator (geomorphic position).

Table 1.

Area	Hydric Soils Present	Identified on NWI or other wetland map	Percent with wet signatures from Exhibit 1	Other hydrology indicators present[1]	Wetland?
Wetland 05	Yes	Yes	0%	Yes[2]	Yes
Wetland 06A	Yes	Yes	100%	N/A	Yes
Wetland 06B	Yes	No	40%	Yes[2]	Yes
Wetland 07A	Yes	Yes	100%	N/A	Yes
Wetland 07B	Yes	Yes	40%	N/A	Yes

[1] Answer "N/A" if field verification is not required and was not conducted.

[2] Wetlands are in a forested area or adjacent to different typed wetlands, so no wetland signatures were identified in the desktop review and verified in the field review. These area were determined to be wetlands due to the area including hydric soils, mapped by NWI, hydrophytic vegetation with discernable break, and/or low geomorphic position relative to surrounding area.

Appendix B Tables

Appendix C Partner Meeting Notes

Appendix D Probable Construction Costs

Appendix E Level 1 Wetland Delineation Figures and Documentation