TROUT STREAMS GAPS ANALYSIS AND MANAGEMENT PLAN

August 4, 2022

FINAL REPORT

PREPARED FOR:
Lower Minnesota River Watershed District
112 E. 5th Street, #102
Chaska, MN 55318

PREPARED BY:
Young Environmental Consulting Group, LLC
6040 Earle Brown Drive, Suite 306
Brooklyn Center, MN 55430

LOWER MINNESOTA RIVER
WATERSHED DISTRICT

Young Environmental Consulting
Group, LLC

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Revision 1
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Young Environmental Consulting Group, LLC
www.youngecg.com
Brooklyn Center, Minnesota

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AMA	Aquatic Management Area
Bls	Below land surface
BKD	Bacterial kidney disease
C	Celsius
cfs	Cubic feet per second
cm/s	Centimeters per second
District	Lower Minnesota River Watershed District
F	Fahrenheit
GPM	Gallons per minute
HSI	Habitat suitability index
HVRA	High-value resource area
LMRWD	Lower Minnesota River Watershed District
MCES	Metropolitan Council of Environmental Services
mg/L	Milligrams per liter
MHAPO	Minnesota Historical Aerial Photographs Online
M-IBI	Macroinvertebrate Index of Biological Integrity
MnDNR	Minnesota Department of Natural Resources
MnDOT	Minnesota Department of Transportation
ppm	Parts per million
SNA	Scientific and natural area
TH	Trunk highway

Abbreviation	Term/Phrase/Name
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VHS	Viral hemorrhagic septicemia
WMA	Wildlife management area
WOMP	Watershed outlet monitoring program
WWTP	Wastewater treatment plan
Young Environmental	Young Environmental Consulting Group, LLC

EXECUTIVE SUMMARY

The Lower Minnesota River Watershed District (LMRWD or District) is home to many types of rare and unique resources that unfortunately do not come with an owner's manual. Although the District is working toward completing management plans for the calcareous fens within the District boundaries, it is also home to trout streams, including the only remaining identified trout stream in Hennepin County. Historically there has been development and disturbance in and around these trout streams, which has led to confusion related to names, locations, and even designation status as a trout water. This document puts the LMRWD trout streams in context using historic data to document the changes in the landscape, identifies the different trout species' needs and management requirements, reviews the data collected to date for each trout stream, analyzes the gaps in data needed to effectively manage the resource in the future, and includes recommendations for the long-term management of each stream.

The LMRWD is home to five state-designated trout streams, two trout lakes, and several additional undesignated streams that are suspected to have sustained trout populations in the past. In 2019, the District completed a geomorphic assessment of these and potential trout streams in the District to assess the health of these creeks. Of the streams identified in the 2019 geomorphology report, three were suspected to have trout populations (Assumption Creek, Eagle Creek, and Ike's Creek). The remaining creeks (Kennaley's Creek and Unnamed 4) were not suspected to have adequate baseflow to support trout. The MnDNR manages the state-designated trout streams (Assumption Creek, Eagle Creek, Kennaley's Creek, Unnamed 1, and Unnamed 4) and provided a wealth of data related to these streams. This study builds on these previous efforts to identify the viable trout streams within the District and any data that may need to be collected to better manage these resources over the long term.

In collaboration with our project partners, MnDNR and USFWS, the District and Young Environmental hosted several collaborative work sessions to review the project approach and obtain feedback at several points within the project development. The MnDNR and USFWS also provided much of the data used in the gaps analysis of this report. Additional data were collected from online sources and data requests to the University of Minnesota and Metropolitan Council.

This plan focuses on the management of three trout species—brook trout, brown trout, and rainbow trout—within the LMRWD. Although all three species require cold water habitat, each has slightly different needs that affect their distribution and survival rates. Brook trout, while native, have the narrowest range of optimal stream temperatures and habitat requirements. They tend to be found in the headwaters of small groundwater-fed streams, whereas brown and rainbow trout can tolerate a wider range of habitat conditions and tend to prefer the middle to lower reaches of groundwater-fed streams.

The trout streams in this study were evaluated based on the general range of parameters suitable for both brook and brown trout. The following provides a high-level summary of each of the streams reviewed, and additional details are provided in the individual stream summary sections.

Assumption Creek (M-55-17)

Assumption Creek is a state-designed trout stream located within the Seminary Fen Scientific Natural Area (SNA) in the City of Chaska. Because of the interconnectedness of groundwater between Assumption Creek and Seminary Fen, the data collected and reviewed for Assumption Creek will be incorporated in the *Seminary Fen and Assumption Creek Management Plan*.

Black Dog Creek (M-55-4)

Black Dog Creek is a state-designated trout water, although it once supported trout populations. Major changes in the watershed and realignment of the creek itself have left Black Dog Creek with only a remnant of its former drainage area. With over a 90 percent reduction in direct drainage area, this creek can no longer provide adequate baseflows to support trout fisheries, despite numerous groundwater seeps and springs associated with the nearby Black Dog Lake fen complex. It is recommended that Black Dog Creek not be managed as a trout resource, but, similar to Assumption Creek, it should be managed as part of the larger Black Dog Lake fen complex. Paramount to the management of both the creek and the fen is establishing the groundwater contribution to these resources, given ongoing concerns about overuse and excess pumping from the underlying aquifer.

Eagle Creek (M-55-9 and M-55-9-3)

Eagle Creek is a state-designated trout water, located in the cities of Savage and Shakopee. Like many trout streams, Eagle Creek has experienced drastic changes in its watershed, which has resulted in a much smaller drainage area than under pre-settlement conditions. Unlike many other streams within the LMRWD, it is supported by countless springs, which appear to provide adequate baseflow year-round to support a brown trout population. Because it is state-designated and currently host to a resident trout population, it is recommended that Eagle Creek continue to be managed as a trout water resource. This management should include a three-pronged approach: continue monitoring baseline conditions throughout the year, with a focus on the groundwater supply to the creek; in partnership with the MnDNR, City of Savage, Trout Unlimited, and others, restore degraded reaches, including identifying the sediment sources in the creek and stabilizing erosion; and protect the existing trout habitat.

Ike's Creek (M-55-2-1)

Ike's Creek is not a state-designated trout water; however, it has protections through local and District regulations. Ike's Creek has always had a relatively small drainage area, based on historic topography from the 1890s, although it has been reduced by development over time. It is supported by groundwater springs and has a good habitat for trout. It once supported a native brook trout population that inexplicably disappeared, but the USFWS recently reintroduced a thriving brook trout population. Given the active fishery, it is recommended that Ike's Creek be managed as a trout water resource. Additional data are needed on the groundwater inflows and stream flows, as there has been concern the baseflow has been decreasing over time. Chloride pollution is also a concern, and the District and USFWS are actively monitoring these levels.

Kennaley's Creek (M-55-4-0.5)

Kennaley's Creek is a state-designated trout water but is not actively managed by the MnDNR, meaning it is not stocked as a trout fishery and is monitored on an as-needed basis. No trout have been observed in the creek since 1982. As part of the Black Dog Creek system, Kennaley's Creek was drastically altered by the 1977 construction of Trunk Highway (TH) 77 (Cedar Avenue), reducing the directly connected watershed and modifying the landscape through the placement of construction spoil materials in the upper reaches.

Kennaley's Creek baseflows are supported by groundwater springs that also support the Nicols Meadow fen complex, but monitoring data from the MnDNR indicate these flows are often inadequate to support trout. The nearby Seneca Wastewater Treatment Plant, constructed in 1972 and expanded in 1992, pumps water from the same aquifer that supports Kennaley's Creek and Nicols Fen, as well as Black Dog Lake Fen, and it may be contributing to the lack of baseflow.

Although Kennaley's Creek is a designed trout water, it is not likely viable as a trout habitat due to the persistent low flows in the channel. Because of the public pressure to maintain the trout water designation, the MnDNR has managed the creek as a potentially restorable resource but without plans for restoration. A restorable resource is considered to be an ideal habitat for trout, if certain conditions can be reversed. In the case of Kennaley's Creek, and much like other creeks in the LMRWD, the hydrogeology and groundwater contribution to the creek's baseflows need to be established to determine whether the creek could maintain a viable trout population in the future. Until the hydrogeology is better understood, it is recommended that the creek should be managed as part of the larger Nicols Meadow fen complex.

Unnamed 1 (M-55-4-1)

Unnamed 1, or Harnack Creek, is another former tributary to the Black Dog Creek watershed that was permanently altered by the construction of TH 77, and no trout have been observed since 1985. Supplied mostly by groundwater that keeps water temperatures cool with sufficient water to maintain a trout habitat, Unnamed 1 has the potential to support trout if it can be protected from stormwater intrusions, beaver activity, and frequent flood events. It is recommended that the hydrogeology and groundwater contribution to the creek's flows be established as part of the Kennaley's Creek recommendations. Additionally, given the concerns about habitat degradation, it is also recommended the sources be located and mitigated to prevent further disruption to the ecosystem. Until both of these issues are better understood, it is recommended the creek be managed as part of the larger Nicols Meadow fen complex.

Unnamed 4 (M-55-4-4)

Unnamed 4, or Naas Creek, is a state-designated trout water but not actively managed by the MnDNR. It was once part of the Black Dog Creek watershed and may be a portion of Black Dog Creek's former alignment. Like many watersheds, the directly connected drainage area for this creek has been reduced through development in the upper watershed. Brook trout have been anecdotally observed in the creek, which was once home to a large trout farming operation; however, trout have not been sampled in the creek since 1980. It is thought that development in the upper watershed has increased stormwater runoff and reduced water quality in the creek, threatening the trout fishery. Erosion has been observed in the upper watershed gullies, lending credibility to this concern, even if the creek is potentially restorable. Until the stormwater and erosion issues have been addressed, it is recommended that resources be directed to more viable streams in the lower Minnesota River watershed and Unnamed 4 be managed as part of the larger Black Dog Lake fen complex.

Unnamed 7 (M-55-4.3)

Unnamed 7 is former state-designated trout water, but it has been removed from the state list because of consistently low baseflows which cause high stream temperatures, lack of habitat, and ultimately the lack of fish. While the creek has the cold water needed to support trout, it unfortunately does not have sufficient groundwater seeps or large enough drainage area to maintain consistent baseflows in the channel. Under present conditions, the stream may be too small to maintain a significant trout habitat through winter and support the macroinvertebrate populations required as a food source. Like Unnamed 4, it is suggested this stream be considered potentially restorable, but resources should be directed to more viable streams in the lower Minnesota River watershed.

1.0 INTRODUCTION

The incised Minnesota River Valley intercepts several groundwater aquifers along its flanks. These exposed aquifers discharge as springs that form small streams or that supplement the flow of existing streams that drain into the Minnesota River. The cold, clear water discharging from the aquifers provides the basis for streams and pools that may be conducive to organisms adapted to cold-water habitats, including stream trout.

1.1 Purpose and Scope

The purpose of this study is to summarize existing information about cold-water habitats in the lower Minnesota River valley, determine whether there are areas capable of supporting a self-sustaining or managed trout fishery, and identify gaps in the information about those resources. This study also identifies the key issues and concerns relative to the management of cold-water resources and trout fisheries in the Lower Minnesota River Watershed District (LMRWD), including such items as land use, development pressures, public access, and climate change.

1.2 Trout Species in LMRWD

Minnesota is home to four types of trout species: brook trout, lake trout, brown trout, and rainbow trout. The Minnesota Department of Natural Resources (MnDNR) states that only two of these species, brook and lake trout, are native to Minnesota; brown and rainbow trout were both introduced to Minnesota in the late 1800s (Minnesota Department of Natural Resources 2020g). The MnDNR classifies trout as game fish under Minnesota Administrative Rule 6133.0080. For this study of trout streams within the LMRWD, only the three stream trout species (brook, brown, and rainbow) are evaluated and discussed in the following sections.

1.2.1 Brook Trout (*Salvelinus fontinalus*)

One of two native Minnesota trout species, brook trout are members of the char family and are adapted to cold, clear, and well-oxygenated spring-fed streams. They are also known as speckled or spotted trout, brookies, and squaretails, and they are distinctive, with red dots surrounded by blue halos along their sides (**Figure 1**). Brook trout can inhabit lakes, rivers, creeks, and spring-fed ponds. They prefer a variety of in-stream habitat features, such as boulders and logs, to protect themselves from predators and strong currents. Brook trout have a variety of prey, including various forms of aquatic insects, terrestrial insects that fall in the water, crustaceans, frogs, mollusks, fish, and even small land mammals. Considered an indicator species, an abundance of brook trout is indicative of a healthy environment and water quality. Sensitive to low oxygen, pollution, algae growth, and changes in pH, brook trout populations are affected by watershed land uses, which can decrease the quality of cold-water habitats. Summer temperatures that reduce streamflow and increase water temperatures cause significant stress in brook trout (U.S. Fish and Wildlife Service 2020b).

Figure 1. Brook trout (Minnesota Department of Natural Resources, 2020d).

1.2.2 Brown Trout (*Salmo trutta*)

Native to Europe, brown trout were introduced over a century ago and have become naturalized (established natural reproducing populations) in many trout streams in southeast Minnesota. Brown trout are a member of the salmon family and can vary in coloration but tend to be covered with black spots surrounded by a light halo on their sides, back, and dorsal fin. Brown trout are the hardiest of the three Minnesota stream trout species and can tolerate warmer and less clear water than either brook or rainbow trout (Minnesota Department of Natural Resources 2020g). Because of this, brown trout tend to displace native brook trout due to their size, diet, and tolerance for less ideal habitat. They can live in a range of aquatic systems and habitats and prey on aquatic and land-based invertebrates—and even upon the smaller brook trout (U.S. Fish and Wildlife Service 2020d).

Figure 2. Brown trout (Minnesota Department of Natural Resources, 2020d).

1.2.3 Rainbow Trout (*Oncorhynchus mykiss*)

Native to healthy mountain streams and lakes west of the Rocky Mountains, rainbow trout are a member of the salmon family and are one of the top sport fish because of their colorful appearance and fight (**Figure 3**). Often confused with steelhead, rainbow trout and steelhead are members of the same species; however, steelhead are anadromous and spend most of their lives in the ocean or in Lake Superior before migrating into freshwater rivers to breed, whereas rainbow trout are solely freshwater species (National Wildlife Federation 2020). Rainbow trout require good-quality habitats, like brook trout, and are at risk from urbanization and agricultural runoff in their native habitat. The construction of dams, culverts, and road crossings have significantly contributed to population declines by preventing their migration, which is critical to the successful completion of their life cycles (U.S. Fish and Wildlife Service 2020e). Rainbow trout were stocked to increase public angling opportunities in southeast Minnesota, as they are prized as a game fish. Most rainbow trout are stocked at a catchable size between 8 and 11 inches and typically do not reproduce successfully. Additionally, as of 2022 and within the LMRWD boundary, rainbow trout are only stocked in trout lakes, not in any streams (Nemeth 2020a, 2022).

Figure 3. Rainbow trout (Minnesota Department of Natural Resources, 2020d).

1.3 Minimum Trout Stream Criteria

There is no legal definition on what constitutes a trout stream in Minnesota; however, the state has adopted state rules that they designate specific streams and lakes as trout waters. This designation gives the MnDNR the authority to stock trout, manage their populations, enforce fishing seasons and methods, and maintain public access. It also allows the MnDNR to work with local partners to improve fish habitats.

The MnDNR has defined the minimum criteria required for trout designation and has developed a *Trout Stream Designation Request* that lists several criteria and factors that indicate whether a stream meets the minimum threshold for state designation, including the following:

- Water temperature less than 72 degrees Fahrenheit in July and August
- Dissolved oxygen concentrations greater than 5 mg/L
- The Public Waters Inventory must have definable bed and banks for all streams and tributaries.

If a stream meets the minimum criteria, then the MnDNR will evaluate additional factors to determine if it is viable for trout management. These other factors can include the following:

- **Baseflow conditions:** For trout to survive, the stream must have adequate baseflow that will provide enough depth (cover) and prevent the stream from freezing solid in the winter and from fish being stranded in the summer during low flow conditions.

- **Geomorphology:** The size and shape of the stream can provide refuge during droughts in pools and during large rain events in backwater areas. This can also include the makeup of the channel substrate, which can affect the water clarity and provide an adequate spawning habitat.
- **In-stream blockages:** Culverts, beaver dams, or other blockages can impede the trout's ability to migrate up and downstream for spawning and to seek cooler water temperatures or a suitable refuge habitat during high flows.
- **Tree canopy cover:** Canopy covers can help regulate stream temperatures in the summer, as well as provide the fish with protection from predators. If no cover or shading exists, then the stream may reach lethal temperatures for trout in the summertime.
- **Presence of trout:** While not necessary, an existing trout population is a good indication that the stream may be suitable for designation.
- **Public access:** The MnDNR, by law, cannot stock fish on privately owned stream segments unless the landowners have agreed to a public fishing easement on their property.

If the MnDNR determines a stream meets the minimum criteria, and the evidence suggests the habitat could support a sustainable trout population or that it could support a trout population with future changes in the watershed, then the MnDNR staff will recommend designation to the commissioner. Ultimately, the commissioner will determine whether the biology and social needs support designation status and provide the proposal for a public comment period. During this period, anyone may comment on the proposed designation and subsequent requirements (including stream buffers and public access, as well as more stringent fishing and permitting regulations). The commissioner must consider all public comments received in making their recommendations to the state legislature and codify it in Minnesota Administrative Rule 6264.0050, Subpart 4.

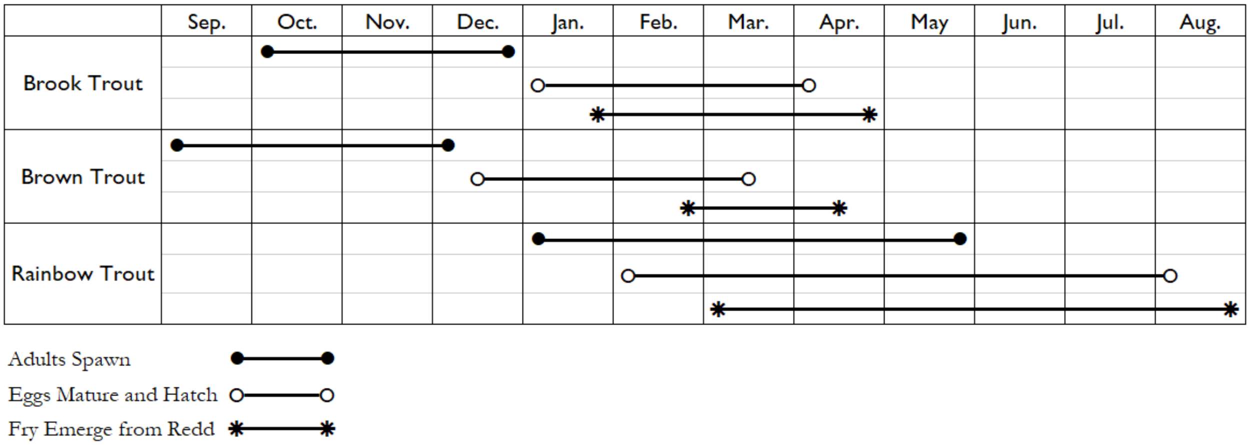
1.4 Optimal Trout Habitat

Many trout species, including the three trout species within the LMRWD, share similar diet and habitat needs to thrive—they share an affinity for cold, clear, well-oxygenated water and a preference for groundwater upwellings. Groundwater and spring-fed streams are especially important in climates, such as Minnesota's, because the constant source of upwelling water regulates in-stream temperatures during the hot summers and can prevent the stream from freezing in the winter. This is vitally important to trout because they lay their eggs in the late fall, in small nests they prepare and excavate within gravel streambeds called redds. For survival, trout eggs require constant, well-oxygenated water, protection from freezing, and protection from suffocation because of snow or accumulated fine-grained sediments on the redd (Dieterman and Mitro 2019). Adults also need protection from the harsh Minnesota winters and rely on deeper stream areas, often near springs or groundwater discharge, to survive (Ferrington 2020).

When trout emerge from the redds (called fry), they require a habitat that provides cover from predators and refuge from high flows in the channel. Cover requirements tend to be the same for each species: low stream bottom visibility, a minimum of 6 inches of water flowing less than 0.5 feet per second, overhanging or submerged vegetation, undercut banks, in-stream objects (debris, rocks, stumps, etc.), pools, and surface turbulence (Raleigh 1982; Raleigh et al. 1984, 1986). All life stages are vulnerable to flood events, due to the high flows, turbulence, and turbidity; however, fry are especially vulnerable, and the entire year-class can be decimated by a single flood.

Figure 4 shows the three trout species and a graphical representation of their generalized life stages. Although rainbow trout are not known to reproduce in Minnesota, their life cycle is provided for reference. During these critical periods, each year class has different needs. The adults need adequate spawning sites to reproduce, the eggs need adequate oxygen and flow to survive the winter, and fry need protection from predators and spring floods. In **Figure 4**, it is apparent that brook and brown trout share similar spawning and development patterns, with brown trout beginning spawning earlier; however, both species tend to emerge from the redd in the same period of late winter and early spring, often when spring flooding begins to occur. It is important that spawning and rearing habitat be protected from the larger Minnesota River flood events because the high velocities and sedimentation that often occurs with these events could be lethal to fry and juvenile trout.

Figure 4. Trout species life cycles, adapted from Dieterman and Mitro (2019) and Raleigh et al. (1984).



In addition to sharing similar life cycles, the United States Fish and Wildlife Service (USFWS) Habitat Suitability Index (HSI) models for the three different species show overlap in similar habitat requirements, including the following:

1. Stream baseflow at least 25 percent of the average annual daily flow
2. Juvenile over-wintering cover area greater than or equal to 15 percent of the total stream area
3. Adult over-wintering cover area greater than or equal to 25 percent of the total stream area
4. Overhead canopy cover providing 50 to 75 percent midday shade
5. Dissolved oxygen levels greater than or equal to 7 mg/l at temperatures less than 50°F and 12 mg/l at temperatures greater than 50°F.

Information was not found that definitively shows different habitat requirements for the three trout species; however, the HSI data did show minor differences in some habitat needs. For example, in streams where the three species coexist, brook trout are typically found in the headwaters and more confined stream reaches, whereas the rainbow trout are located in the midstream reaches, and the brown trout are in the flatter gradient area toward the mouth. Additional habitat characteristics are summarized in **Figures 5** through **8** and tend to highlight the wider range of tolerable habitat conditions exhibited by the introduced species. Generally, the introduced species can tolerate warmer temperatures (**Figure 6**), higher velocities (**Figure 7**), and more variety in substrate material (**Figure 8**) than the native brook trout. Combined with their longer lifespan and larger size, brown trout especially tend to outcompete and displace brook trout in streams where they coexist

(Dieterman and Mitro 2019). The two exceptions appear to be that brook trout tolerate a wider range of pH (**Figure 5**) from 4 to 9, and redd velocities during spawning (**Figure 7**) from 1 to 90 cm/s.

Figure 5. Range of tolerable (dashed) and optimal (solid line) pH by trout species, adapted from Raleigh 1982 and Raleigh et al. (1984, 1986).

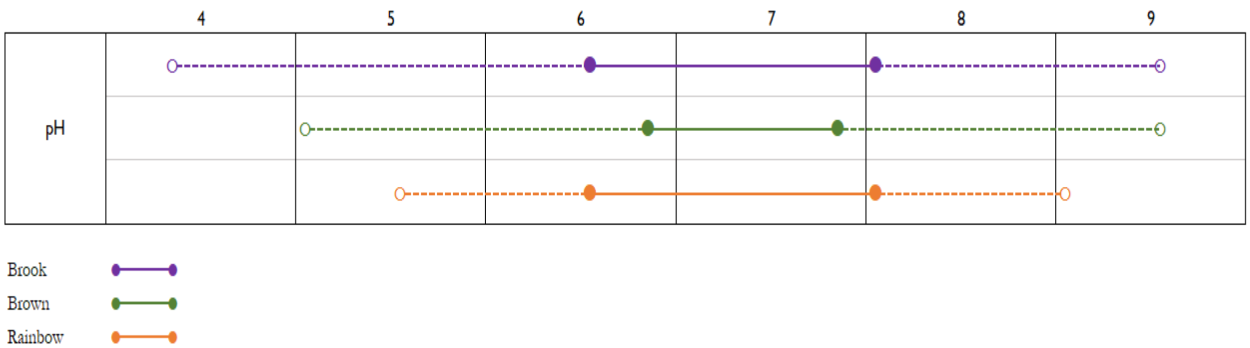


Figure 6. Temperature range for trout (in degrees Celsius, tolerable in dashed, optimal in solid line), adapted from Raleigh (1982) and Raleigh et al. (1984, 1986).

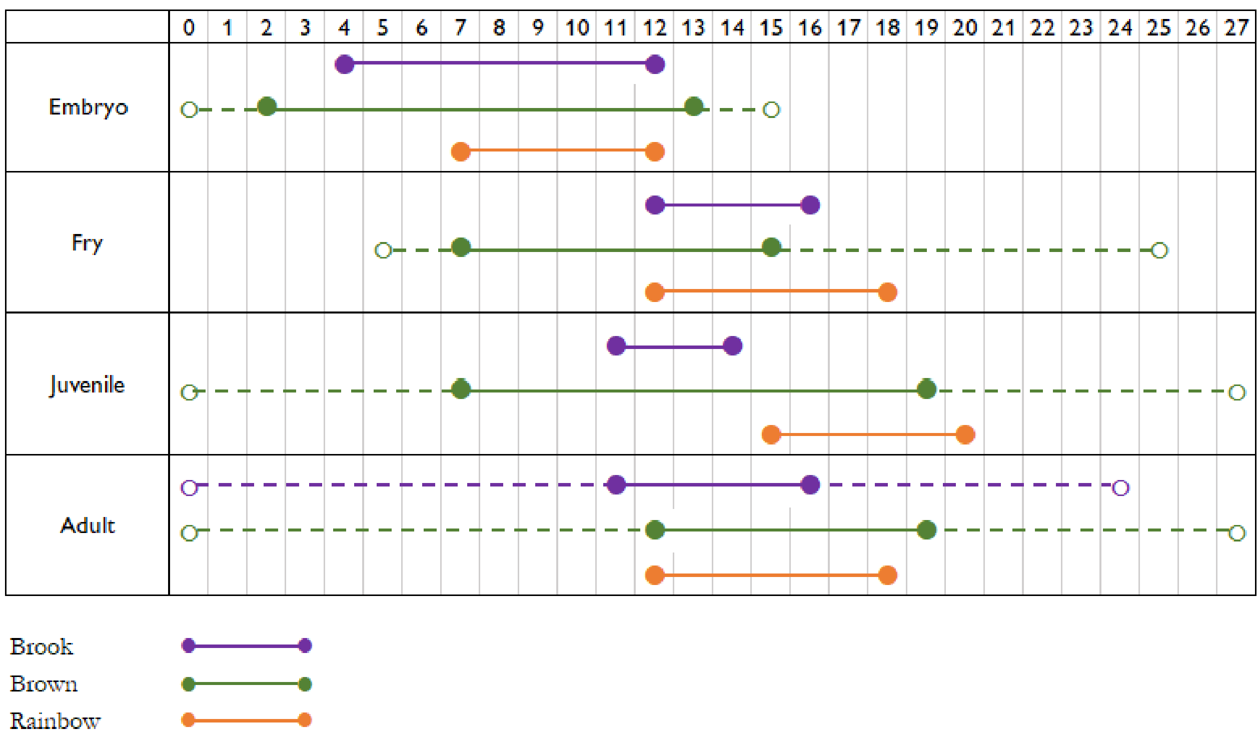


Figure 7. Optimal redd velocities for trout species (in cm/s, tolerable in dashed, optimal in solid line), adapted from Raleigh (1982) and Raleigh et al. (1984, 1986).

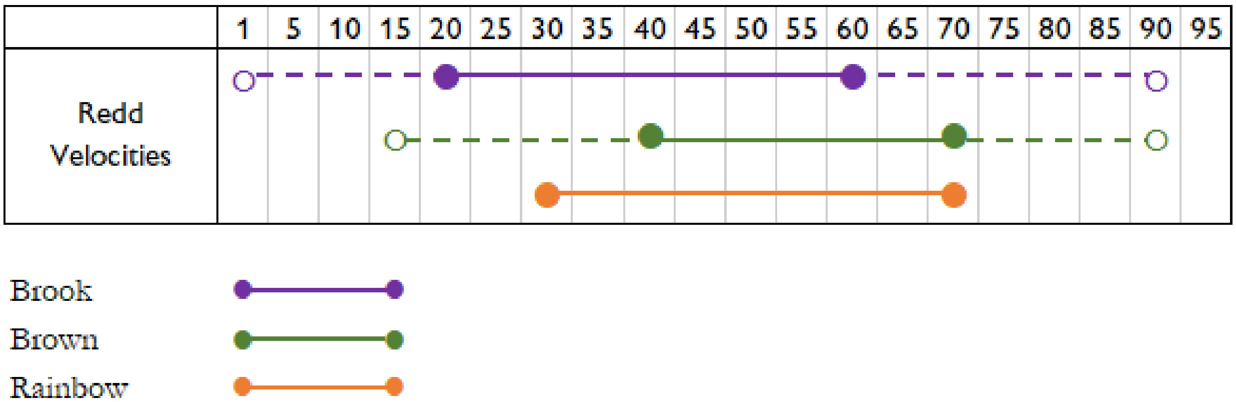
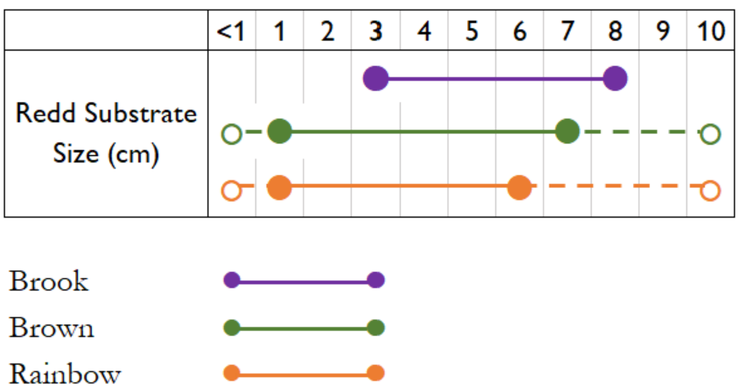


Figure 8. Optimal redd substrate sizes for trout species (tolerable in dashed, optimal in solid line), adapted from Raleigh (1982) and Raleigh et al. (1984, 1986).



Trout need connected stream habitats to thrive as they migrate up and downstream during various parts of their life cycle. Adults migrate upstream to spawn and lay eggs in the redds. If there are impediments to this access, such as culverts or beaver dams or even low flows, adults cannot access the prime spawning habitat and have to dig their redds in suboptimal conditions, threatening the next generation of trout. Rainbow trout are the most vigorous swimmers and have been documented to jump several feet. Brook trout, despite their smaller size, have been documented jumping up to two feet in laboratory conditions (Kondratieff and Myrick 2006). For this analysis, and because jumping height depends on the size of the fish and depth of the recovery pool, any barrier higher than one foot is considered an impediment to fish migration.

For brook and brown trout to thrive in the LMRWD, they need adequate spawning habitats for embryo development, rearing habitat for the trout to grow and reach maturity, and overwintering habitat to survive the winter. Rainbow trout generally are stocked on an annual basis, so life-cycle habitats are less of a concern.

The following sections summarize the general optimal conditions for brook and brown trout habitats within the LMRWD. Based on the literature reviewed, the following characteristics provide the optimal habitat conditions to promote the success of brook and brown trout in the LMRWD streams. Although the following does not cover all the trout needs at various age classes, it is assumed these generalized characteristics represent the most limiting factors, and, if met, would also provide ideal conditions for the remaining age classes of all three trout species.

1.4.1 Spawning Habitat

Adequate spawning habitat is vital for trout populations to be self-sustaining and reproduce in the wild. Good spawning habitats not only allow the embryos to develop and hatch safely but also must be accessible to adults. Based on the data reviewed in this study, the following summarizes the optimal spawning habitat characteristics for brook and brown trout in the LMRWD.

- Access for adults to migrate to spawning grounds. Throughout the creek reach, the following are needed to ensure adults can migrate safely:
  - Jump heights less than 1 foot
  - In-stream velocities less than 0.5 fps (15 cm/s)
  - Minimum of 6 inches of water to provide cover and prevent stranding
- Constant baseflow or adequate depth in the channel to prevent the creek from freezing solid during the winter while the eggs develop
- Well-oxygenated water for embryo development (dissolved oxygen concentrations ≥ 7 mg/l)
- A gravel substrate to protect the eggs and facilitate oxygenated water through the redd (3 to 8 cm in diameter)
- Less than 5 percent fines to prevent eggs from being smothered
- Protection from Minnesota River spring flood events (i.e., located outside of the Minnesota River floodplain)

1.4.2 Summer Habitat

After eggs hatch in the spring, fry and juveniles need a good rearing habitat to help them grow throughout the hot summer temperatures and survive to their first Minnesota winter. If the following conditions are met, adequate habitat for adults will also exist, as they can survive a wider range of suboptimal conditions. If a stream cannot support a self-sustaining population, these conditions also represent the minimum needed for a put-and-take fishery management scheme, where the MnDNR stocks trout annually for anglers to catch and remove from the system.

- Well-oxygenated water (dissolved oxygen concentrations ≥ 9 mg/l during the summer)
- Water temperatures less than 57°F
- Adequate food sources for growth (i.e., healthy macroinvertebrate populations)
- Refuge from flood events and turbulent, high flows (velocities less than 0.3 fps)
- Cover and protection from predators (i.e., minimum channel depth of 6 inches and undercut banks or large woody debris [LWD] for shelter)

1.4.3 Overwintering Habitat

After surviving the warmer creek conditions of the summer, juveniles and adults need areas within the creek to survive Minnesota winters. The number one requirement is that the creek must remain open during the winter and cannot freeze solid—or else the fish will die. Groundwater upwelling, as well as warmer surface water inputs, can provide adequate baseflow to keep the creek open during the winter. Based on the data reviewed in this study, the following summarizes the optimal overwintering habitat characteristics for brook and brown trout in the LMRWD.

- Adequate depth or baseflow in the channel to prevent the creek from freezing solid during the winter (i.e., groundwater upwelling or deep pool habitat)
- Access to winter habitat. Throughout the creek reach, the following is needed to ensure juveniles can migrate safely:
  - Jump heights less than 1 foot
  - In-stream velocities less than 0.3 fps (9 cm/s)
  - Minimum of 6 inches of water to provide cover and prevent stranding
- Well-oxygenated water (dissolved oxygen concentrations ≥ 7 mg/l during the winter)
- Adequate food sources to survive the winter (i.e., healthy macroinvertebrate populations)
- At least 15 percent of the total stream area should provide cover and refuge (a minimum channel depth of 6 inches and undercut banks or LWD for shelter)

1.5 Existing Management of Trout Waters in the LMRWD

Trout waters are regulated by several different entities, especially so within the LMRWD (**Figure 9**), and the following provides a summary of the roles and responsibilities of each agency.

1.5.1 Federal Role

The USFWS manages the Minnesota Valley National Wildlife Refuge, which was established in 1976 to preserve wildlife resources threatened by commercial and industrial development. It is part of the National Wildlife Refuge System, which manages lands and waters set aside "to conserve America's fish, wildlife, and plants" (U.S. Fish and Wildlife Service 2020a). Several of the trout streams are part of the Minnesota Valley National Wildlife Refuge, and Ike's Creek is managed entirely by the USFWS. The USEPA and U.S. Army Corps of Engineers also play an indirect role in the conservation and sustainability of trout streams, as far as protecting water quality through Section 404 of the Clean Water Act.

1.5.2 State Role

The MnDNR Fish and Wildlife Division's mission is to "work with Minnesotans to manage, conserve and enhance the state's wildlife, fishes and the habitats on which they depend." They manage 16,000 miles of fishable rivers and streams within the state (Minnesota Department of Natural Resources 2020d). The MnDNR manages the state-designated trout waters, including monitoring trout populations, habitat management, fishing access and permits, and fish stocking. The MnDNR prefers that trout populations be self-sustaining; however, it will stock brook, brown, and rainbow trout for three reasons (Minnesota Department of Natural Resources 2020f): to ensure a population of larger trout in heavily fished streams; to supplement an existing population, especially in streams where trout have a good adult habitat but poor reproductive success; or to reintroduce trout into former streams that may now have sustainable trout habitats.

Specifically, within the LMRWD, the MnDNR manages Assumption Creek, Eagle Creek, Ike's Creek, Kennaley's Creek, Unnamed #1, and Unnamed #4. The decision to stock trout and the type of fishery management were based on angler pressures and habitat conditions. The MnDNR no longer stocks the trout streams within the LMRWD, but previously they had stocked rainbow and brown trout in put-and-take management schemes in several District streams. With this management scheme, the MnDNR typically stocks the stream with brown trout fingerlings in late May and June from one of its hatcheries (Minnesota Department of Natural Resources 2020d).

1.5.3 Regional Role

The LMRWD provides watershed-based regulation that implements stringent development requirements through the establishment of the High Value Resources Area (HVRA) overlay district. The HVRA aims to protect trout waters and calcareous fens within the District from development pressures.

The Metropolitan Council supports regional development and the protection of natural resources through its Thrive MSP 2040 and Water Resources Policy Plan, which promotes collaboration with partners to ensure the long-term sustainability and health of the Twin Cities' water resources. The Council developed a Priority Waters List in 1982, updated in 2015, and is undergoing a reprioritization in 2022. This list of regionally significant waterbodies includes six of the LMRWD trout streams, due to their high healthy habitat scores, which indicates a wide range of benefits for both wildlife and people, including food, water and shelter for native species, as well as increased property values for neighboring residences. The Metropolitan Council, through its Environmental Services (MCES) division, also conducts regular water quality monitoring of Eagle Creek, in cooperation with LMRWD and Scott Soil and Water Conservation District (SWCD) since 1999, and Ike's Creek, since 2021 (Metropolitan Council 2014a, 2022).

1.5.4 Local Role

Local municipalities are not required to share the responsibility for ensuring these resources are managed for future generations and accessible to the public; however, some choose to be part of the process. An example of local regulation includes Ike's Creek in the City of Bloomington. Ike's Creek is not a state-designated trout stream. It was considered by the MnDNR for trout stream designation in 2017, but at the request of the City and local stakeholders, it ultimate does not have that designation because it is already protected by existing ordinances and permitting requirements (Berg et al. 2019). It is cooperatively managed by the City, the LMRWD, MnDNR, and USFWS.

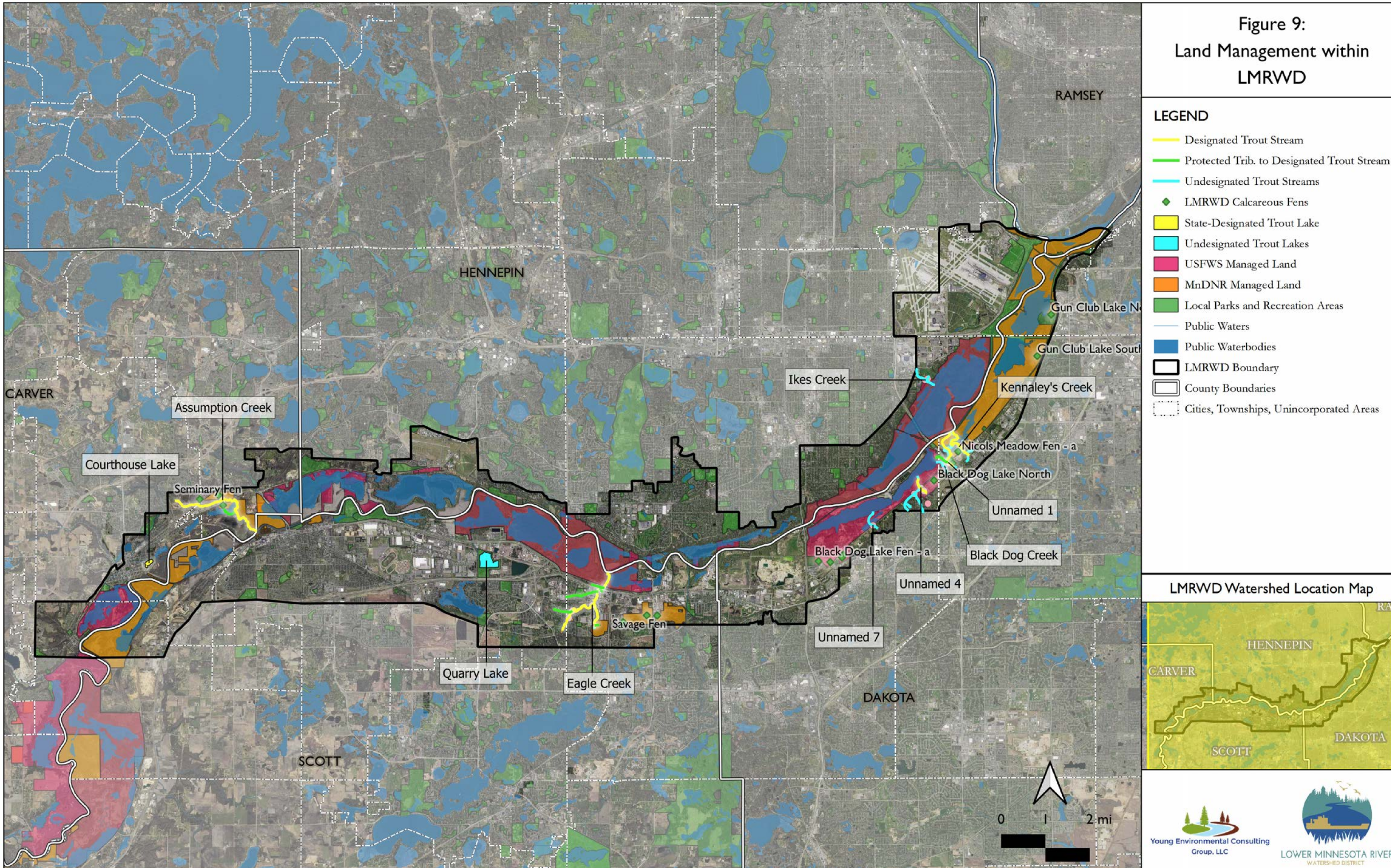


Figure 9:
Land Management within LMRWD
LEGEND
Designated Trout Stream
Protected Trib. to Designated Trout Stream
Undesignated Trout Streams
LMRWD Calcareous Fens
State-Designated Trout Lake
Undesignated Trout Lakes
USFWS Managed Land
MnDNR Managed Land
Local Parks and Recreation Areas
Public Waters
Public Waterbodies
LMRWD Boundary
County Boundaries
Cities, Townships, Unincorporated Areas
LMRWD Watershed Location Map
RAMSEY
HENNEPIN
CARVER
SCOTT
DAKOTA
Assumption Creek
Courthouse Lake
Seminary Fen
Quarry Lake
Eagle Creek
Savage Fen
Ikes Creek
Gun Club Lake North
Gun Club Lake South
Kennaley's Creek
Nicols Meadow Fen - a
Black Dog Lake North
Unnamed 1
Black Dog Creek
Black Dog Lake Fen - a
Unnamed 4
Unnamed 7
0 1 2 mi
Young Environmental Consulting Group, LLC
LOWER MINNESOTA RIVER WATERSHED DISTRICT

1.6 Threats to LMRWD the Trout Habitat

Trout need clean, cold water with diverse habitats that provide refuge from predators and sustained stream flows, as well as a varied diet, to thrive. The following highlights several threats to trout habitats, and the long-term management of the LMRWD trout streams will need to mitigate their effects.

1.6.1 Land Use Changes

Native trout populations developed within the Minnesota ecological regime of prairie and deciduous forest biomes. Upland prairie and prairie wetland biomes dominated the LMRWD landscape pre-settlement, along with abundant prairie wetland communities of prairie pothole marshes populated with sedges and rushes. The deciduous forests of the LMRWD during the pre-settlement era were oak woodland and maple-basswood forests. The location and extent of the oak woodland community was significantly influenced by fire. This vegetative community consisted of small groves of trees, intermittently mixed with open prairie and a community of scrub forest and dense shrub thicket. The maple-basswood forests were restricted to areas with natural fire breaks such as rivers, lakes, and rough topography because they were highly fire sensitive, but they conveniently provided shade and cover for trout streams (Wendt and Coffin 1988).

With changes in the landscape, from European settlement and intensive agricultural production to development and urbanization, the ecosystems that the native brook trout evolved in have been drastically altered. Agriculture has resulted in the straightening of natural channels and the installation of tile to drain saturated fields, which reduces groundwater recharge while increasing nutrient and sediment runoff. Increased urbanization has created impervious surfaces that further prevents groundwater recharge and increases stormwater runoff. The runoff from urbanized areas also is typically warmer and more polluted with nutrients and sediment than natural conditions and can result in the loss of the in-stream cold water habitat trout need for survival.

The MnDNR Watershed Health Assessment Framework has developed an index to measure how much the landscape has been altered by human activities in the watershed since European settlement in the 1890s. It includes activities such as wetland fill, ditch construction, stream realignments, and tile drainage. These alterations change stream dynamics by increasing flows, turbidity, and temperature, in addition to reducing groundwater recharge. This metric shows the range of watershed alteration within the LMRWD, with some sub-catchments having experienced a high level of alteration (low score) while others have remained in a relatively untouched state (high score; see **Figure 10**; MnDNR 2020c).

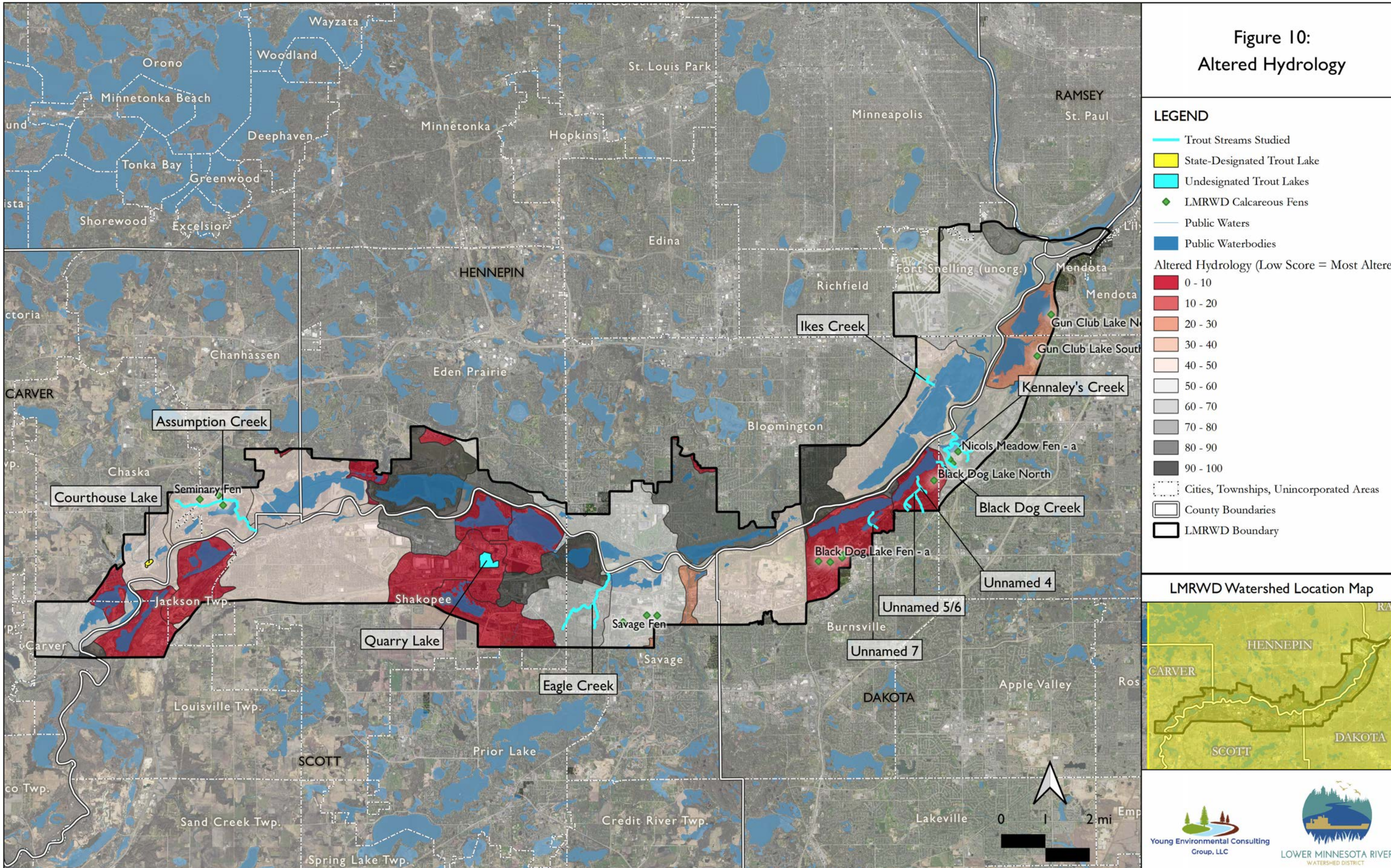


Figure 10:
Altered Hydrology

1.6.2 Groundwater

In Minnesota, trout rely on a constant source of cool groundwater to sustain baseflows in the stream channel during the summer and prevent the creek from freezing solid in the wintertime. Increased development and impervious surfaces can prevent infiltration of rainfall into the soil and underlying aquifer. Pumping groundwater from the aquifer can also reduce the baseflow in trout streams by diverting it to drinking water and industrial uses. Land use over highly permeable soils can also increase the risk of groundwater contamination, which can also pollute trout streams. Much of the LMRWD is highly susceptible to surface pollution, with pollution sensitivity scores between 3 and 58 (Minnesota Department of Natural Resources 2020b).

1.6.3 Introduced Species Competition

The only native trout species in Minnesota is the brook trout. Brown and rainbow trout have been introduced over the years and have been shown to out-compete brook trout in spawning and nursery habitats (U.S. Fish and Wildlife Service 2020c). The introduced species are larger, have a longer lifespan, and tend to have a wider range of tolerable habitat conditions than the native brook trout (Dieterman and Mitro 2019).

1.6.4 Disease

Brook, brown, and rainbow trout are all susceptible to whirling disease, caused by the *Myxobolus cerebralis* parasite. The parasite invades the host fish cartilage, causing skeletal deformities and damage to the central nervous system, ultimately causing the infected fish to swim erratically, unable to effectively feed or evade predators (Becker 2003). The European parasite is common in brown trout, which is generally tolerant of the infection, but it has devastated wild and game trout populations in parts of the United States, where the disease has spread. The disease has likely been spread from stocking infected fish; movement of water contaminated with the *Myxobolus cerebralis* spores; and contaminated watercrafts and equipment (Kipp et al. 2019). Whirling disease has not been detected in Minnesota, but the MnDNR monitors potential pathways to prevent its introduction to the state.

Bacterial kidney disease (BKD) is a deadly disease caused by the bacteria *Renibacterium salmoninarum*, commonly found in cold water streams and lakes across the country. BKD is common in wild trout populations and can infect stocked trout populations of all species, potentially requiring the culling of an entire hatchery to control outbreaks. Infected fish die within nine months of exposure and can pass the disease from parent fish to their offspring. Though the disease does not pose a risk to anglers, brook trout appear to be the most susceptible, and cases of BKD may be increasing in Colorado and the western United States (Delta County Independent 2022).

Rainbow trout are known to carry Viral Hemorrhagic Septicemia (VHS) virus, however the MnDNR is actively monitoring and testing for it. It has been found in Lake Superior but has not been detected in any inland waters in the State (Minnesota Department of Natural Resources 2020).

1.6.5 Climate Change

The changing global climate also has repercussions on trout fisheries, particularly because trout require cold water to survive. The LMRWD completed an analysis of the future climate trends within the District as part of the *Fens Sustainability and Gaps Analysis*. From that analysis, climate change may help with trout survival in the LMRWD because warmer average low temperatures in the winter can increase overwintering habitat and survival of trout eggs; decreased summer average high temperatures could help regulate summer temperatures in the stream; and there is a predicted decrease in summer droughts.

However, these benefits of the changing climate will likely be offset by an increased growing season and increased sediment and pollutant loading caused by intense and heavy precipitation (Young Environmental 2020a). In addition, research on climate change in North Shore trout streams indicate that groundwater temperatures are expected to rise along with air temperatures, but that maintaining tree cover in the catchment may help lower shallow groundwater temperatures (L. B. Johnson 2018).

2.0 METHODS

The following methods were used in this study to compile available data on trout streams within the LMRWD, to complete a gaps analysis for each trout stream, and to develop a long-term strategic management plan for these resources.

2.1 Data Collection

The information used in this study was primarily provided by project partners (MnDNR and USFWS), previous LMRWD studies, and supplemented from various online sources as noted.

2.1.1 MnDNR Information

The MnDNR has a wealth of data on the trout streams and past management activities within the LMRWD. Available data for each trout stream were compiled and aggregated by the MnDNR and provided to Young Environmental for review and assessment. This included documents such as stream surveys from studied streams, as well as supplemental information, such as internal and external communications regarding resource concerns, management recommendations and stream management plans, raw data, and related documentation. The enormous amount of data provided by the MnDNR was compiled and documented in a data matrix sheet in an effort to track submittals; it is provided as **Appendix A** for reference.

Additional MnDNR data were obtained from the Minnesota Geospatial Commons website, including trout species data and data from the Watershed Health Assessment Framework, which was used to evaluate individual species' needs and the overall condition of the LMRWD watershed as it relates to trout habitat. In addition, springs information was obtained from the MnDNR Minnesota Springs Inventory, which contains both reported and verified spring locations and supplemental information on groundwater. This was used to confirm the presence of groundwater upwelling within each trout stream. Pre-settlement vegetation studies from the original Minnesota land surveys were also used to evaluate the original conditions and extents of these trout streams and watersheds.

2.1.2 USFWS Information

The USFWS has been collecting monitoring data within the Minnesota River Valley Wildlife Refuge for years and collaborates with the MnDNR and MCES to monitor streams. Recently the USFWS has been working to reintroduce brook trout in Ike's Creek. The USFWS provided feedback on the study, as well as additional monitoring data sources to include in the study.

The USFWS also developed HIS models for brook, brown, and rainbow trout; these models were created in the 1980s but have been confirmed by the MnDNR to be still valid for aiding in impact assessment and habitat management activities. The HSI models were used to gather information and graphs for the three trout species: brook, brown, and rainbow. These data were then used to establish optimal habitat conditions for trout presented in Sections 1.3 and 1.4.

2.1.3 LMRWD Information

The LMRWD has independently been collecting data on all the high-value resources within the District for many years. The District developed the HVRA Overlay District with more stringent development standards for projects located within the area that directly contribute stormwater runoff to prevent sediment, pollution, and warm water from disrupting the native plant communities and fisheries. In May 2020, the District completed the *Fens Sustainability Gaps Analysis for Carver, Dakota, and Scott Counties, Minnesota* study of the calcareous fens, which laid the foundation for long-term management and protection of these rare vegetative communities. The District also completed a *Geomorphic and Habitat Assessment of Trout Streams in the Lower Minnesota River Watershed District* that evaluated the 2019 stability and habitat viability for eight creeks in the District. Both studies and their recommendations have been incorporated into this report.

In addition, the LMRWD has completed its *Gully Inventory and Condition Assessment* of the District, with data collected from 2008, 2020, and 2021. The recommendations from these reports have been incorporated into this report.

Finally, the LMRWD completed a value engineering workshop to solicit input from county and state agency partners about effective ways of understanding available groundwater and its recharge area and to identify approaches (static and/or dynamic monitoring, models, or a hybrid of monitoring and modeling) to improve our understanding of the hydrogeology supporting fens and trout waters in the District. The outcome of the workshop held May 5, 2021, which included MnDNR, Metropolitan Council, and Dakota, Scott and Carver SWCDs, was for the LMRWD to continue its existing monitoring program. Additionally, groundwater modeling or a dynamic monitoring network, was determined to be unnecessary, given the MnDNR's more robust data analysis approach, tied to observation wells networks.

2.1.4 Other Data Sources

Additional data were collected to confirm our gaps analysis, management strategies, and recommendations, including the following:

- **Historic Aerial Images:** Historical photographs of each stream were acquired through the University of Minnesota's Minnesota Historical Aerial Photographs Online website and ranged from 1920 to 2000. These were used to confirm land use changes within the trout stream drainage areas, such as the stream straightening, new ditches, and road construction. Summaries of these analysis are incorporated in the subsequent watershed history and land use sections.
- **Historic Quadrangle Maps:** The U.S. Geological Survey (USGS) makes available all their topographic maps, including the original land surveys from the late 1800s. These maps were used to approximate the historic watershed extents for the LMRWD trout streams.
- **Geology:** Geology information from the Minnesota Geological Survey was obtained from the University of Minnesota's Digital Conservancy website. Bedrock and surficial geology were used to confirm areas within the watershed that are likely to have groundwater springs that could support trout habitats. Specifically, the Jordan sandstone geologic layer is known for its many springs and associated brown trout abundance in the Driftless area of southeastern Minnesota (Dieterman and Mitro 2019).
- **Land Use Data:** Land use data were the same as previously compiled for the 2020 Fens Sustainability and Gaps Analysis report. These data contain 2016 and future land use information from the cities within the LMRWD. For areas that were not part of this report, the same methodology was used to determine the land use changes within each HVRA.

Staff from the University of Minnesota and Trout Unlimited were also consulted and invited to participate in the technical work group meetings. Although they were unable to join these meetings, they provided research papers and newsletter articles that supported the findings in this report.

2.2 Project Partner Coordination

A technical work group was developed from staff from the MnDNR, USFWS, the District administrator, and Young Environmental. The group met several times over the summer and fall of 2020 to discuss the data collected and study approach. A project partner site walk to Burnsville and Eagan creeks (Kennaley's Creek, Unnamed 1, and Unnamed 4) was held on October 13, 2020.

2.3 Stream Viability

In consultation with the technical work group, a two-phased approach was developed to determine if the LMRWD trout streams should be considered viable. The first phase includes using the MnDNR minimum trout stream criteria described in **Section 1.3**; the LMRWD streams were screened to determine whether the trout stream designation was still valid or if other creeks should be considered for designation. For those that met the minimum criteria, a secondary screening was conducted to evaluate the potential for optimal habitat conditions using the biologic characteristics described in **Section 1.4**, as well as social characteristics described here. Similar to the process the MnDNR uses, a trout stream is considered viable in this study if it presently does or, with watershed modifications, could sustain a trout population, as determined by the biological characteristics. In addition, a component of this viability considers the social aspect of trout streams, which includes public access to the creek and the local demand for a trout fishery.

2.4 Management Schemes

Brook trout represent the ideal in the LMRWD streams because they are a native species, but they also are the most sensitive. Brown trout are more generalized and can handle more disturbance than brook trout. Rainbow trout are a game fishery; they represent the minimum threshold, and they are only stocked with the intention that they be harvested (put-and-take). Trout must also be matched according to the size of the stream; rainbow trout are the biggest and therefore need a larger stream with deeper pools than the smaller brook trout. Given the size of most of the streams within the LMRWD, rainbow trout are physically too large for the small creeks, in addition to being an introduced species, and they have not been considered in the management strategies within this report.

For the LMRWD, a self-sustaining population of brook trout represent the ideal, but, given habitat conditions and stream constraints, brown trout may also be considered. To this end, three management strategies have been developed to categorize the LMRWD trout waters:

1. **Trout Streams:** This category represents creeks that have an active trout fishery or resident trout population and, under present conditions, they have a reliable groundwater connection to keep waters cool and oxygenated in the summer and prevent the creek from freezing solid in the winter.

2. **Restorable Trout Streams:** This category represents creeks that once supported limited trout populations but are presently unable to sustain adequate baseflows for trout. With intervention these creeks may be restorable; however, additional information is needed to determine potential viability.
3. **Fens:** Like calcareous fens within the LMRWD, trout streams rely heavily on the discharge of cold, clean groundwater. Most of the trout streams within the LMRWD are part of the HVRA for a nearby calcareous fen. Creeks that fall into this category have been degraded to the point where, even with increased groundwater supply, they may no longer be able to sustain a trout population and may be better managed as part of the calcareous fen watershed.

3.0 PHYSICAL SETTING

The trout streams studied are located within the lower Minnesota River Valley and are often adjacent to wetland areas, including fens, where groundwater seeps and springs abound. Many of the streams are very small, originating from groundwater and surface water discharge in upland areas, and they discharge into the Minnesota River floodplain. The following provides a general discussion on the trout streams within the District and the factors that can affect the groundwater quantity and quality on which the trout depend.

3.1 Trout Waters of the LMRWD

There are two main regions in Minnesota known for their trout waters: the North Shore along Lake Superior and the Driftless region in the southeast corner of the state, along the Mississippi River. Although the Lower Minnesota River Valley supports trout fisheries, it is less well-known, even though it contains a similar habitat and recreation potential opportunities as the southeast Driftless area. The incised Minnesota River Valley intercepts bedrock formations containing several groundwater aquifers. These breached aquifers form springs that have created small streams and may supplement the flow of existing creeks and tributaries into the Minnesota River. The cold, clear groundwater discharging from these springs provides the basis for cold water-dependent species to thrive, such as stream trout and the rare calcareous fen plant communities.

The LMRWD is home to seven state-designated trout waters (**Figure 11**):

1. Assumption Creek, located within the City of Chanhassen in Carver County
2. Eagle Creek, located within the City of Savage in Scott County
3. Kennaley's Creek (also known as Kennealy's, Kenallys, or Kennalys Creek), City of Eagan, Dakota County
4. Unnamed #1 (also known as Harnack Creek), City of Eagan, Dakota County
5. Unnamed #4 (also known as Naas Creek), City of Burnsville, Dakota County
6. Courthouse Lake, City of Chaska, Carver County
7. Quarry Lake, City of Shakopee, Scott County

The District has several other streams that are thought to have supported trout at one time, but they have not received a state designation:

- Black Dog Creek, Cities of Burnsville and Eagan, Dakota County
- Ike's Creek (also known as Hust Creek), City of Bloomington, Hennepin County
- Unnamed #2, City of Burnsville, Dakota County
- Unnamed #7, City of Burnsville, Dakota County

Very little information exists for Black Dog Creek and the unnamed creeks; however, the information available is presented in the subsequent sections. No additional data were found for Unnamed 2, and it is unclear exactly where this creek is located. The 2019 geomorphic assessment concluded that Unnamed 2 is part of Unnamed 4 and is included in the discussion of Unnamed 4 presented in this report.

Courthouse Lake and Quarry Lake are not part of this study because their trout populations are predominately put-and-catch for recreational stream trout but referenced to provide a comprehensive look at all the trout fisheries within the LMRWD. The LMRWD developed sustainable lake management plans for each lake in 2020.

Assumption Creek has not been assessed in this report. The complex hydrology that interconnects the creek with the Seminary Fen wetland complex warrants a separate, stand-alone evaluation for the management of these resources.

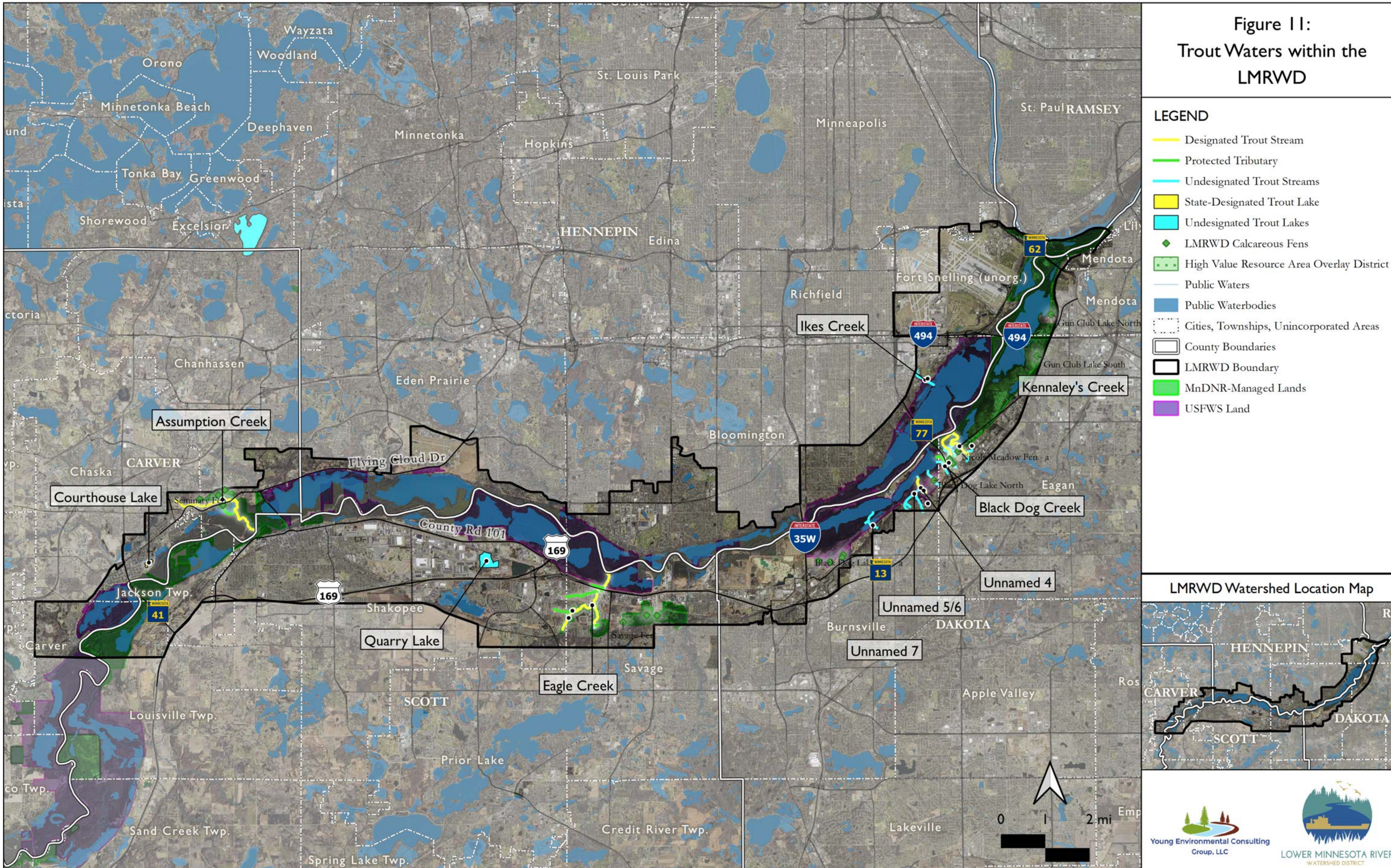


Figure 11: Trout Waters within the LMRWD

3.2 Groundwater Sources

The District has been actively monitoring groundwater to better understand groundwater level fluctuations and chemistry. The LMRWD has been developing strategies to optimize groundwater monitoring within the District by reducing redundancies, collaborating with monitoring partners, and, in 2021, hosting the Groundwater Recharge Value Engineering workshop that validated its efforts and those of its partners to date (Young Environmental 2020e).

In addition to a steady supply of groundwater, trout also prefer in-stream habitats with springs or groundwater seeps. From the MnDNR Minnesota Spring Inventory, there are 456 potential and verified springs within the District boundaries (Minnesota Department of Natural Resources 2020e).

The MnDNR Watershed Health Assessment Framework has developed an index score to assess how vulnerable each watershed in the state is to groundwater pollution. Most of the LMRWD is highly vulnerable to groundwater contamination. The soils within the District are generally associated with high potential rates of recharge from surface waters, and water moves easily through the underground deposits (Minnesota Department of Natural Resources 2020b). **Figure 12** shows the overall risk to the LMRWD groundwater resources.

3.3 Geology

The geologic atlases of Carver, Dakota, Hennepin, and Scott Counties, Minnesota, show the surficial and bedrock geology and other physical and hydrologic features in the District. The surficial geology data show unconsolidated sedimentary units present in the lower Minnesota River Valley area, where the streams are located, consist of organic deposits, terrace deposits, and floodplain alluvium (**Figure 13**). Terrace deposits are located at the higher elevations bordering the floodplain, consisting of sand and gravel. Floodplain alluvial deposits consisting of poorly bedded clayey silt are located at lower elevations near the Minnesota River.

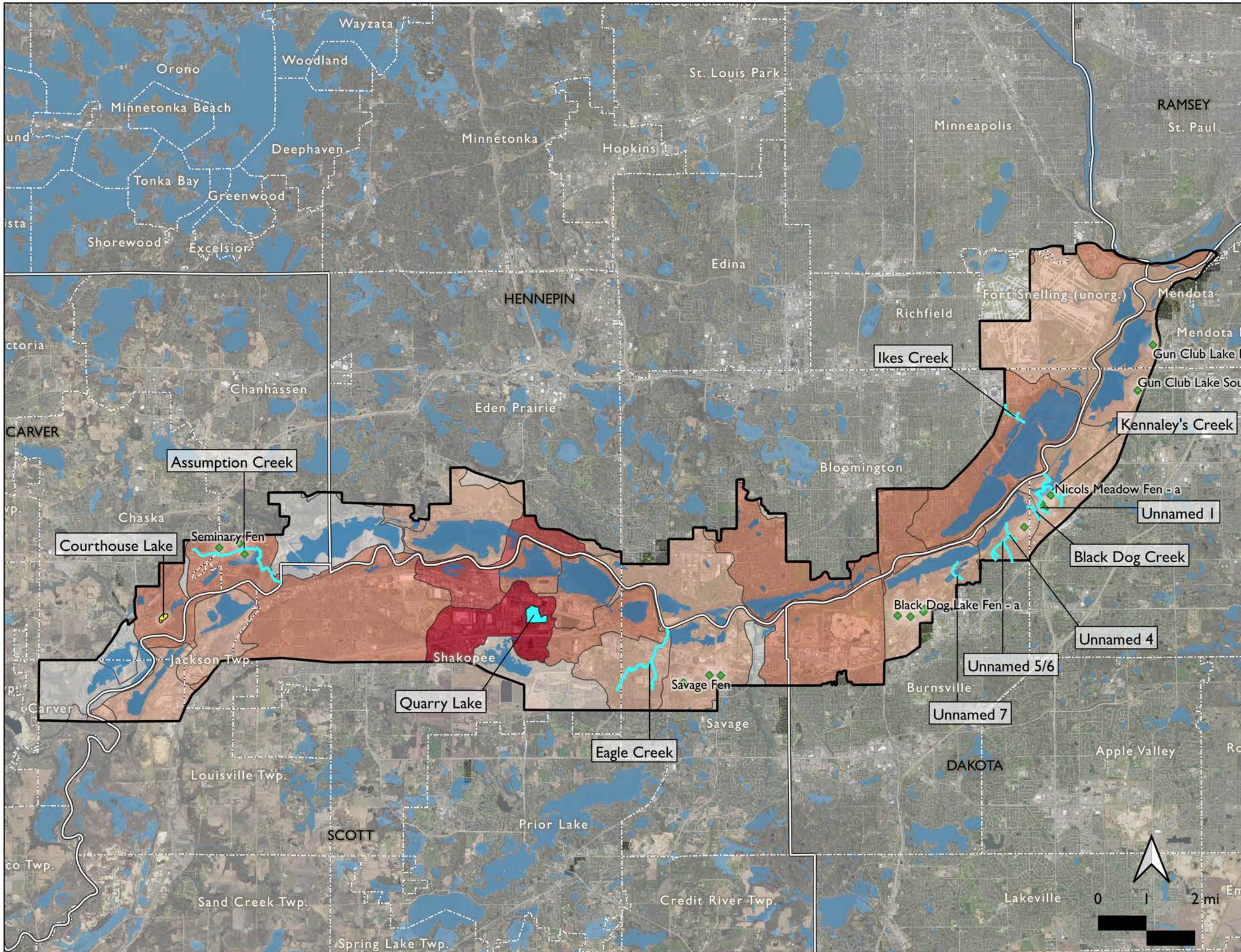
The depth to bedrock in the vicinity of the streams (**Figure 14**) ranges from less than 50 feet below the land surface (bls) in the east to approximately 250 feet bls in the western part of the basin. A buried bedrock valley exposing the Tunnel City group runs from south to northwest of Eagle Creek then runs west to northeast of the LMRWD. It passes beneath the LMRWD near Ike's Creek and northeast of Kennaley's Creek. The buried valley also extends from west of Eagle Creek to the west and widens beneath Assumption Creek on the north side and beneath the Minnesota River. At its deepest point, the uppermost bedrock units are approximately 350 to 400 feet bls. The regional groundwater flow direction within the unconsolidated deposits in the Minnesota River Valley is generally upward and toward the Minnesota River.

3.4 Soils

The MnDNR Watershed Health Assessment Framework has developed a soil erosion susceptibility index, which ranks soils on a small sub-catchment level to assess the potential for excessive erosion. The soils within the LMRWD are highly erodible due to the steep slopes within the bluff zones and the inherent soil erodibility (**Figure 15**). The District has implemented a Steep Slopes Overlay District as part of its Steep Slopes Rule to prevent excess erosion within the Minnesota River Valley bluffs.

This directly affects trout streams because excess sediments from upstream erosion entering the system reduces water quality, increases turbidity, and can destroy trout habitats. This was demonstrated by the MnDNR's Watershed Health Assessment Framework score for Steep Slopes Near Streams (**Figure 15**). This score indicates areas where steep slopes and streams are dense and can identify regions that are more susceptible to bank erosion and mass wasting events (Minnesota Department of Natural Resources 2020a). Although many of the LMRWD creeks are known to have experienced significant sedimentation, Assumption Creek is highlighted as being especially vulnerable.

Figure 12:
Groundwater Pollution Sensitivity



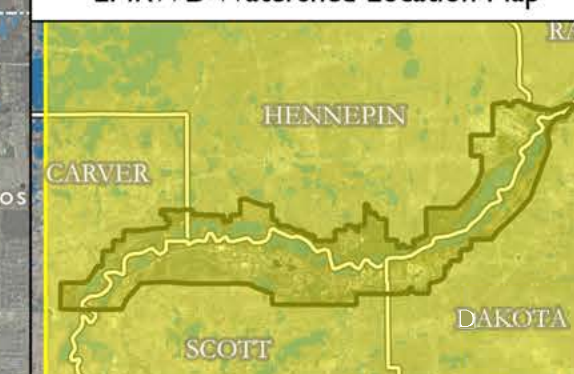
LEGEND

- Trout Streams Studied
- State-Designated Trout Lake
- Undesignated Trout Lakes
- LMRWD Calcareous Fens

Pollution Sensitivity (Low = Most Sensitive)

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map



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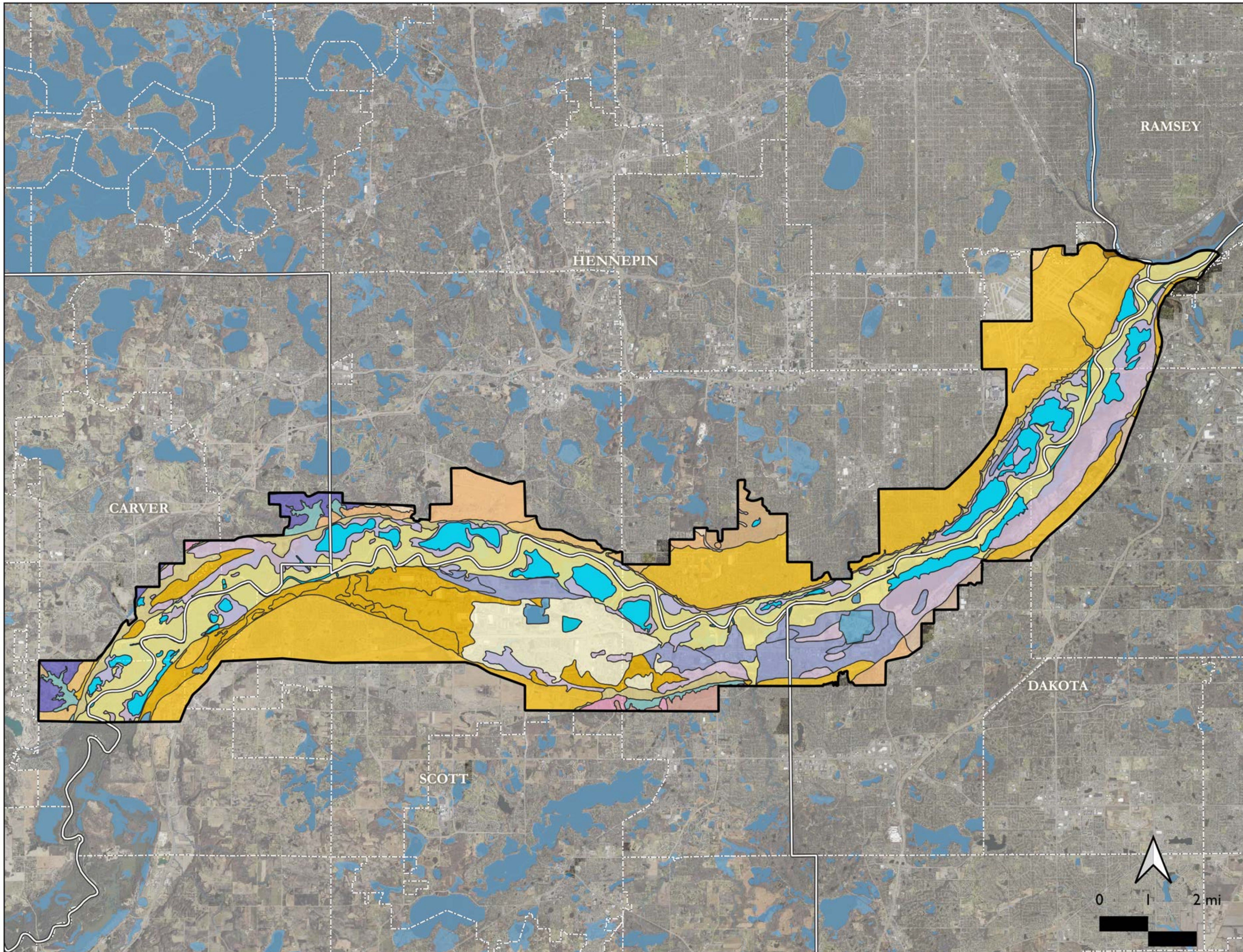
LOWER MINNESOTA RIVER WATERSHED DISTRICT

Figure 13: Surficial Geology of the LMRWD



LEGEND

- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

Surficial Geology

- Opc - Prairie Du Chien Group
- Osp - St. Peter Sandstone
- Qa - Floodplain Alluvium
- Qc - Colluvium
- Qct - Cromwell Formation;Till
- Qe - Eolian Sand
- Qf - Alluvial Fan Deposit
- Qna - New Ulm Formation
- Qnb - New Ulm Formation
- Qnd - New Ulm Formation
- Qnh - New Ulm Formation
- Qni - New Ulm Formation
- Qno - New Ulm Formation
- Qnt - New Ulm Formation
- Qp - Quarternary Peat and Muck
- Qwb - Langdon Terrace
- Qwg - Grey Cloud Terrace
- Qwl - Langdon Terrace
- Qwr - Richfield Terrace
- Qws - St. Mary's Terrace
- Water

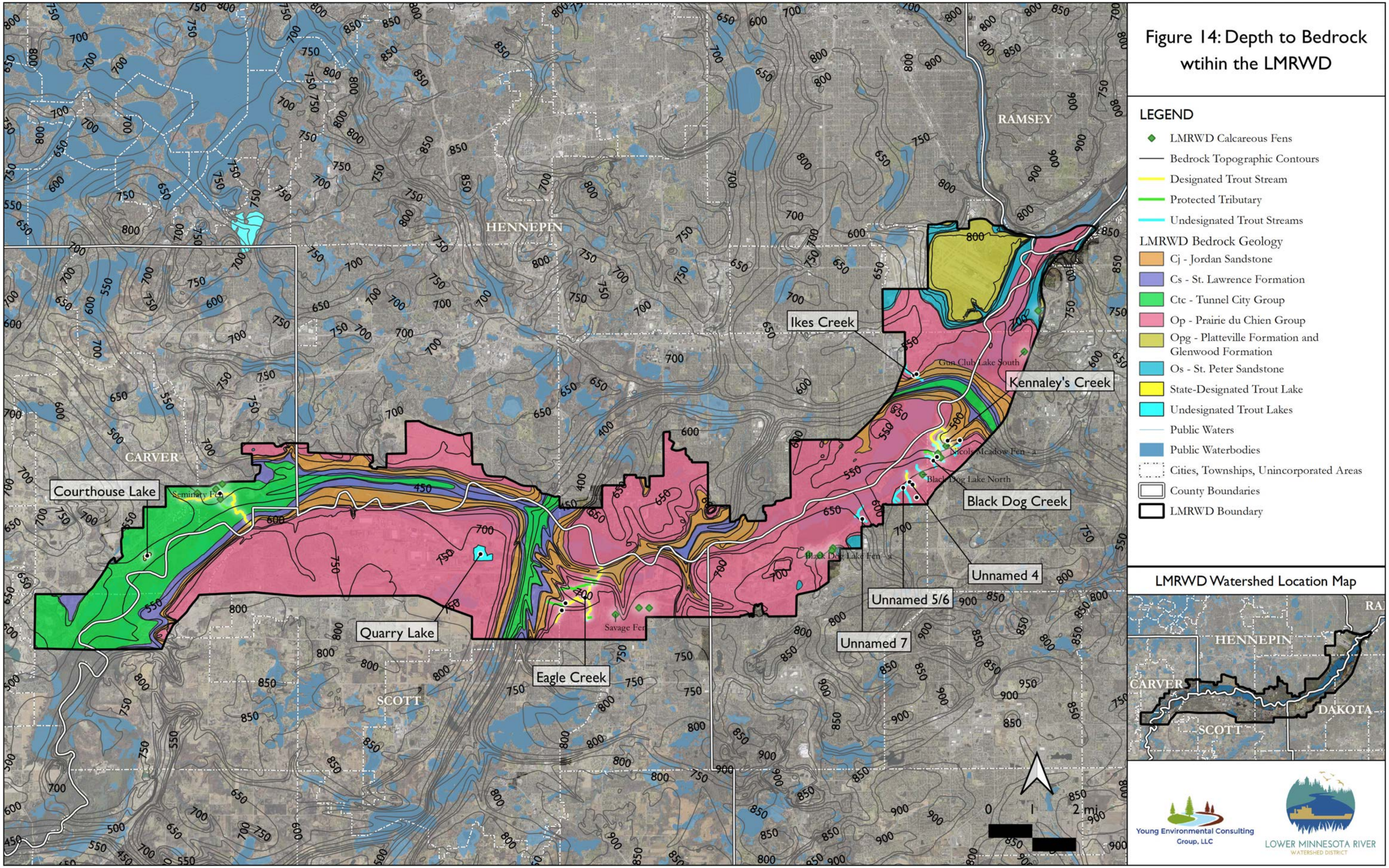


Figure 14: Depth to Bedrock wtihin the LMRWD

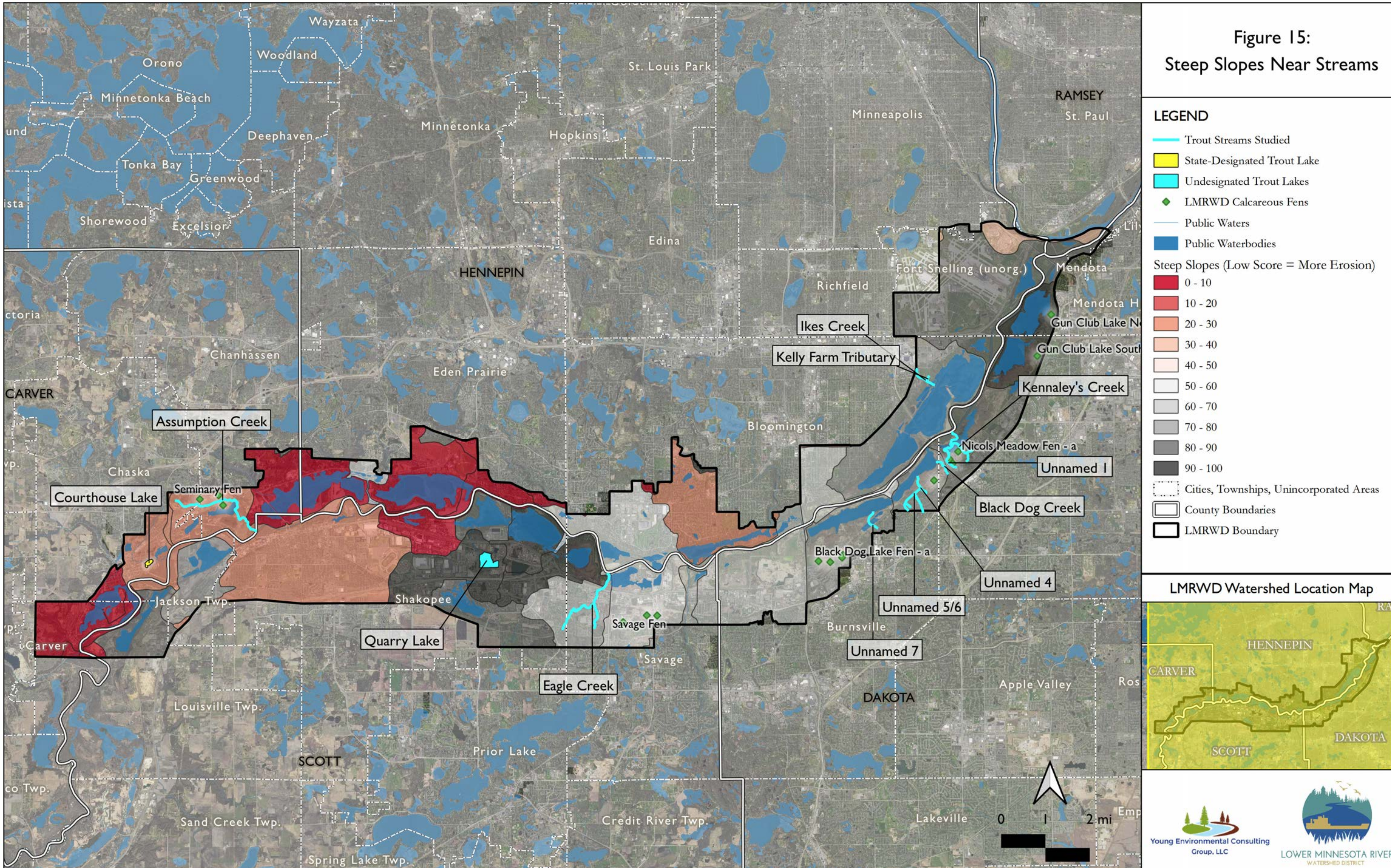


Figure 15:
Steep Slopes Near Streams
LEGEND
Trout Streams Studied
State-Designated Trout Lake
Undesignated Trout Lakes
LMRWD Calcareous Fens
Public Waters
Public Waterbodies
Steep Slopes (Low Score = More Erosion)
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Cities, Townships, Unincorporated Areas
County Boundaries
LMRWD Boundary
LMRWD Watershed Location Map
HENNEPIN
CARVER
SCOTT
DAKOTA
Young Environmental Consulting Group, LLC
LOWER MINNESOTA RIVER WATERSHED DISTRICT
Wayzata
Woodland
Orono
St. Louis Park
Minnetonka Beach
Minnetonka
Hopkins
Deephaven
Tonka Bay
Greenwood
Shorewood
Excelsior
Minneapolis
RAMSEY
St. Paul
Edina
HENNEPIN
Fort Snelling (unorg.)
Mendota
Richfield
Mendota H
Gun Club Lake N
Gun Club Lake South
Ikes Creek
Kelly Farm Tributary
Chanhassen
Eden Prairie
CARVER
Kennaley's Creek
Assumption Creek
Bloomington
Nicols Meadow Fen - a
Unnamed 1
Chaska
Seminary Fen
Courthouse Lake
Black Dog Creek
Black Dog Lake Fen - a
Unnamed 4
Jackson Twp.
Shakopee
Unnamed 5/6
Savage Fen
Burnsville
Quarry Lake
Carver
Unnamed 7
Savage
Eagle Creek
Apple Valley
DAKOTA
Louisville Twp.
SCOTT
Prior Lake
Sand Creek Twp.
Credit River Twp.
Lakeville
Spring Lake Twp.
0 1 2 mi

4.0 BLACK DOG CREEK

Black Dog Creek (Tributary Number M-55-4) is a small stream located in Dakota County within the City of Burnsville that discharges into Black Dog Lake within the Minnesota River floodplain (**Figure 16**).

4.1 Watershed History and Land Use

The Dakota people established Black Dog's Village (*Ohanska*) near the confluence of Black Dog Creek and the Minnesota River that encompassed much of the lower watershed (Shakopee Mdewakanton Sioux Community 2002). Black Dog's Village is believed to have been established around 1750 and remained an active community, trading fish caught in Black Dog Lake for goods until relocation in 1856 (Dakota County Historical Society 2016). Farming was introduced to the area in 1837 by the US government with the purpose of teaching the residents of Black Dog's Village to farm the land. The railroad was built in 1865 to transport agricultural produce (Eagan Historical Society 1998).

The neighboring community of Nicols Station, named for the Nicols flag station constructed in 1867, grew as part of the Minnesota River Valley onion farming boom. In 1890, the Old Cedar Avenue Bridge was constructed east of Black Dog Creek to connect Dakota County to the City of Bloomington on the north side of the Minnesota River (Eagan Historical Society 1998). By the early 1900s, Nicols became known as the "Onion Shipping Capital of America." Around this time, Nicols also became well-known for its molding sand, a rare, naturally occurring combination of silica sand and clay, used by metal foundries until the 1950s. The onion and sand industries supported this small but thriving town. Due to the town's renown and prosperity, Black Dog, Kennaley's, and other spring-fed creeks, such as Unnamed 1, became popular fishing and recreation sites for residents and tourists (Dakota County Historical Society 1989).

The 1896 USGS quadrangle maps for St. Paul and Minneapolis show an almost entirely different alignment for Black Dog Creek and a significantly larger watershed of 4,754 acres, located primarily where present-day Unnamed 4 exists (**Figure 17**). In the 1896 maps, upper Black Dog Creek is part of the much larger Black Dog Lake watershed, which outlets to the Minnesota River, where present-day Kennaley's Creek and Unnamed 1 now exist. The overall Black Dog Lake watershed encompassed over 13,600 acres in 1896, with numerous wetlands and small tributary creeks prior to the development in the 1900s. Many of the present-day trout streams were once tributary to Black Dog Lake and Creek, but due to watershed alterations and channel realignments, the Black Dog Creek drainage area is now only 29 acres, compared to over 4,500 acres in 1896.

In the 1950s, the former Black Dog's Village became the site of the Black Dog coal power plant, which is still in operation today, but it has been converted entirely to natural gas as of 2015 (Dunbar 2019). While operating as a coal-powered plant, Black Dog Lake was used as a cooling water pond, which likely increased the water temperatures within the lake (Shodeen 1976).

In 1977, the Old Cedar Avenue road was replaced with the construction of the Minnesota Department of Transportation (MnDOT) Trunk Highway (TH) 77 Bridge and roadway, which severed the connections among Kennaley's Creek, Unnamed 1, and Black Dog Creek (WSB & Associates 2008). The early project planning maps (**Figure 18**) show what is now known as Black Dog Creek, then called Stream 2, and Unnamed 1 (Stream 1) as individual creeks, entering Black Dog Lake at separate locations. To accommodate the new highway, MnDOT re-routed Unnamed 1 north, directly to the former Black Dog Creek, severing its connection to Black Dog Lake (**Figure 18**). Black Dog Lake now drains directly to the Minnesota River through a controlled outlet.

Land use today is predominantly park, recreational, or preserve, with the Minnesota Valley National Wildlife Refuge dominating the remaining Black Dog Creek watershed. The MnDOT right-of-way along Cedar Avenue makes up the remaining portion of the watershed (Metropolitan Council 2016). There are no proposed changes in future land uses because the majority of the watershed is within the Minnesota Valley National Wildlife Refuge, and the remaining areas are owned by MnDOT and Union Pacific (Metropolitan Council 2020). The minor increase in transportation shown in **Table 1** is not a true increase but rather a better representation of the Union Pacific railroad, which was not included in the 2016 data.

Table 1. Existing and future land uses within the Black Dog Creek watershed (Metropolitan Council 2016, 2020).

	2016 Area (ac)	Future Area (ac)	Change (ac)
Open Water	<1	<1	<1
Park, Recreational, or Preserve	22	18	-4
Transportation	6	10	4

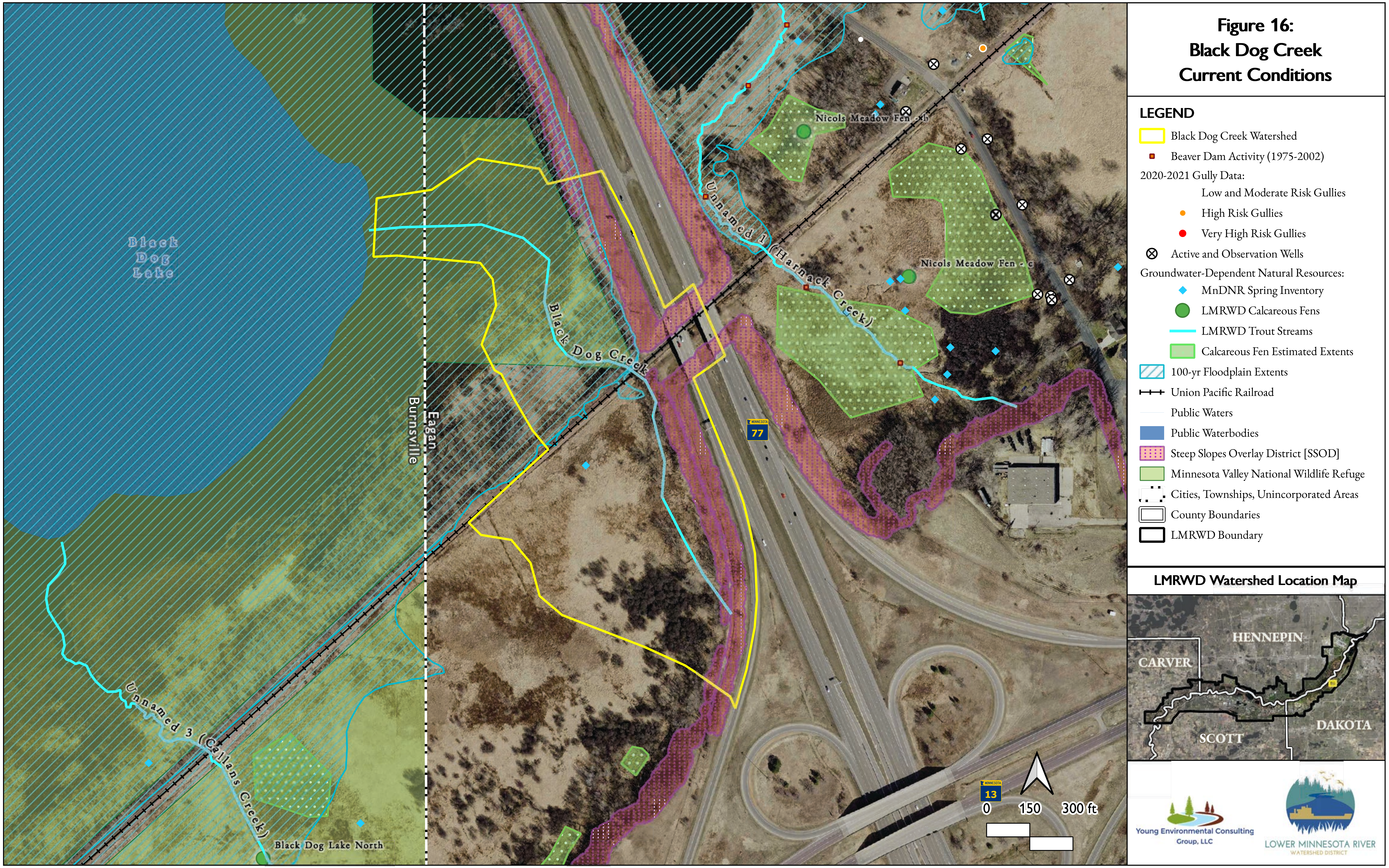
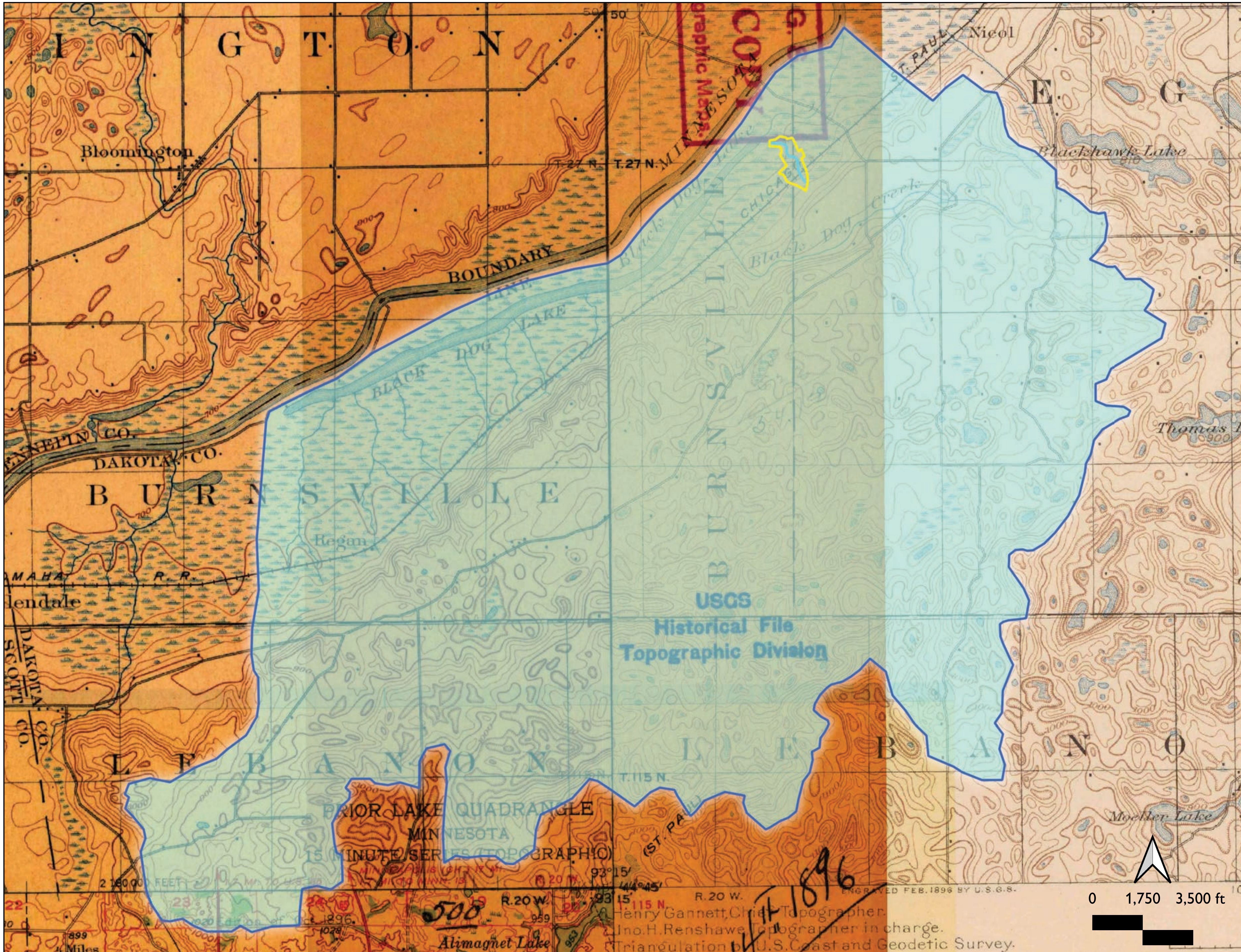


Figure 16: Black Dog Creek Current Conditions

Figure 17: Black Dog Creek Historic Watershed



LEGEND

- Black Dog Creek (Present Day)
- Black Dog Creek Present Day Watershed
- Black Dog Creek 1896 Watershed
- Historic USGS Quad Sheets (1896-1957)

LMRWD Watershed Location Map

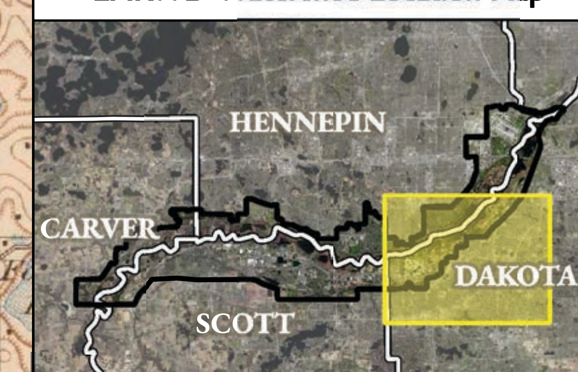


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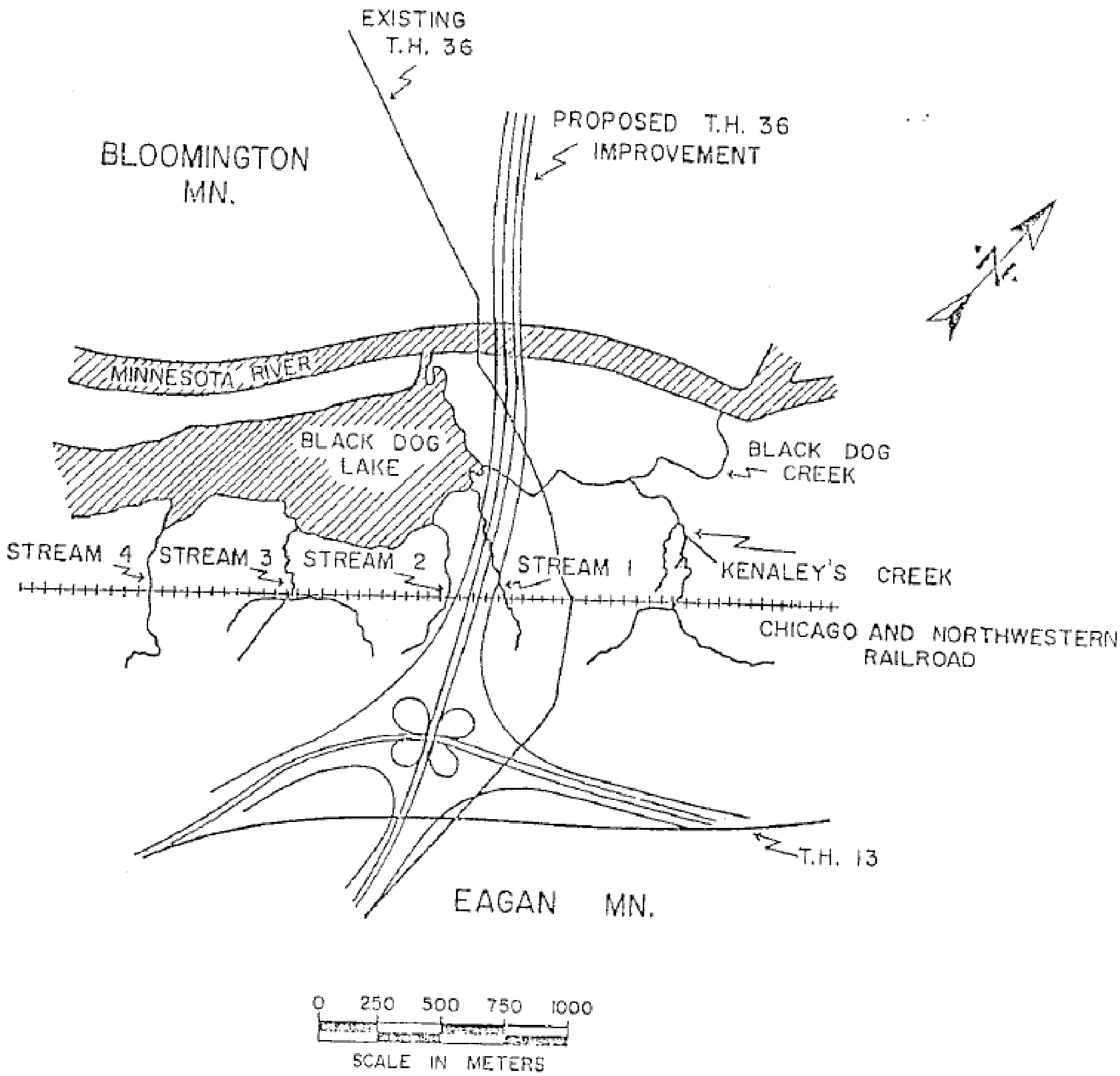
Figure 18. Black Dog Creek and the proposed TH 77 (TH 36) alignment in 1978 (WSB & Associates 2002). Note this figure erroneously identifies TH 77 as TH 36.



4.2 Fisheries

Black Dog Creek is designated as a trout water but has been dropped from the state list because the waters were not reliably cold enough to support trout, and they were outcompeted by warm water fish species. An electrofishing survey from 1976 (prior to the construction of TH 77) found a single brook trout and 16 brown trout, despite the mucky sand bottom. Upstream of the railroad, it was noted that the stream bottom changed from sand-silt to pebbles and rock-rubble, ideal spawning locations and where all the juvenile fish were found (F. Tureson 1976). Much of this reach is now under the south abutment of the TH 77 overpass bridge.

4.3 In-Stream Habitat

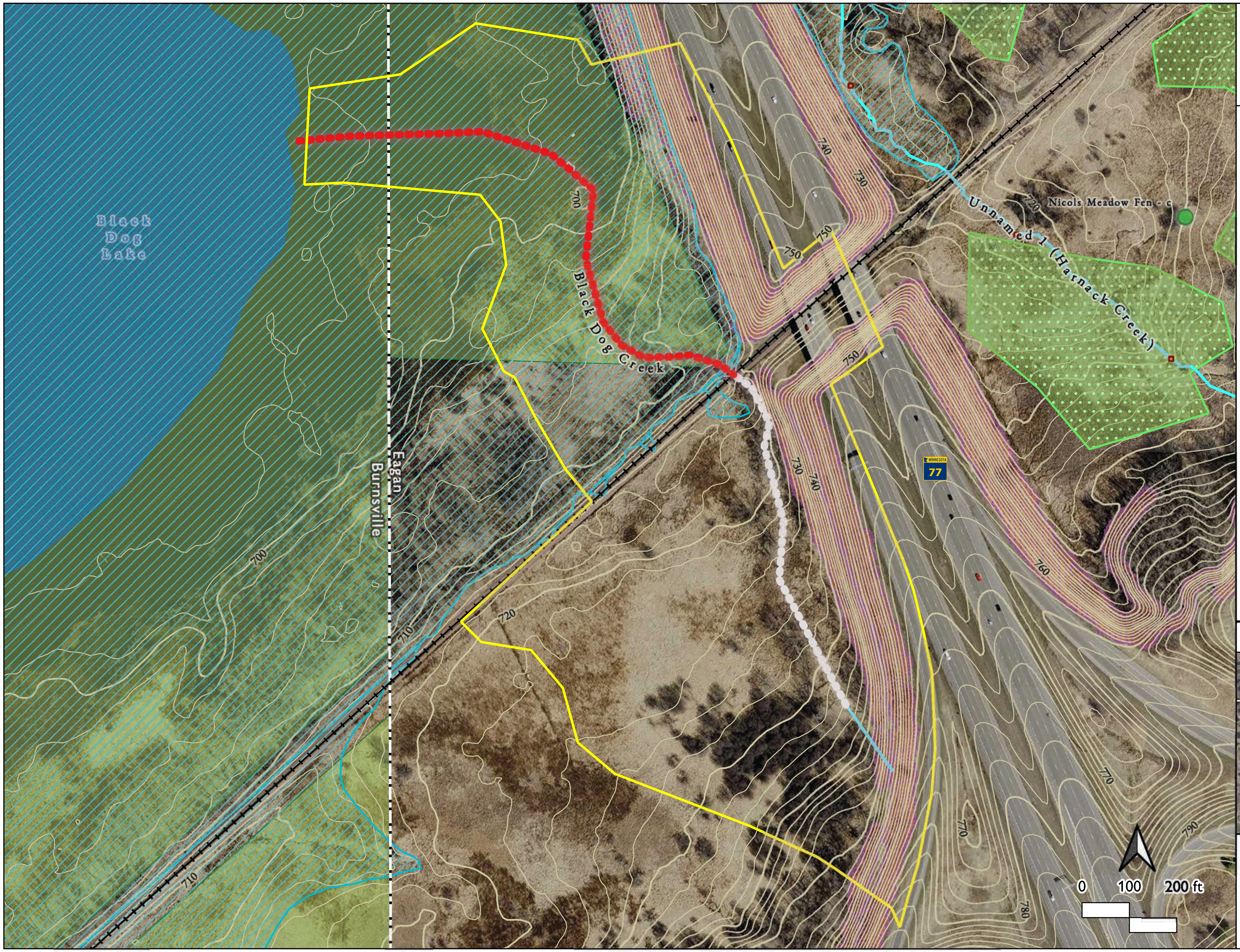
No data were found that provided information on the potential for trout habitats in Black Dog Creek. The creek is also located within the Minnesota River floodplain and subject to periodic flooding, which can sweep away young fish with fast flows and deposit fine sediments in the channel, smothering potential spawning habitat. No stream surveys or geomorphic assessments were found that discussed the current quality of the habitat within Black Dog Creek. Prior to the construction of TH 77, a good spawning habitat was located 200-ft upstream of the Union Pacific railroad (F. Tureson 1976); it may be beneficial to determine if that or a similar condition remains in the upper reaches of Black Dog Creek (**Figure 19**).

As part of the LMRWD *2021 Gully Inventory and Condition Assessment*, this area was surveyed for gullies, and, although none were found, the area was difficult to access and had heavy vegetation. Several gullies were noted in the upper watershed and contributed to the Black Dog fen complex (**Figure 16**).

4.4 Streamflow

No data were found that provided information on average, peak, or annual stream flows in Black Dog Creek. LMRWD and MnDNR staff visited the site on October 13, 2020, and observed very little flow in the channel; most of the channel under the Union Pacific rail bridge was dry (**Figure 20**).

Figure 19: Black Dog Creek Potential Trout Habitat



LEGEND

- Black Dog Creek Watershed
- Beaver Dam Activity (1975-2002)
- Potential Trout Habitat
  - Good Conditions
  - More Investigation Needed
  - Poor Conditions
- Groundwater-Dependent Natural Resources
  - MnDNR Spring Inventory
  - LMRWD Calcareous Fens
  - LMRWD Trout Streams
  - Calcareous Fen Estimated Extents
- Union Pacific Railroad
- Dakota Co. 2-ft Contours
- Public Waters
- Dakota Co. 100-yr Floodplain
- Public Waterbodies
- Steep Slopes Overlay District [SSOD]
- Minnesota Valley National Wildlife Refuge
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map

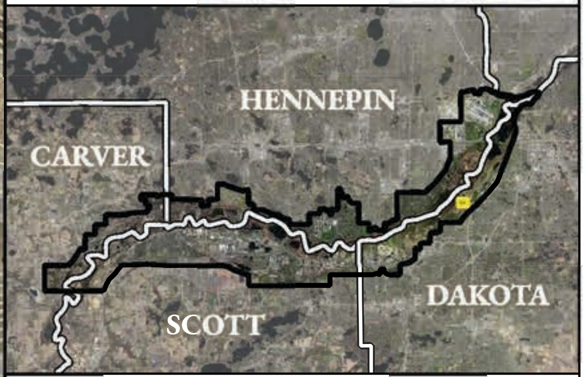


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Figure 20. Black Dog Creek looking upstream from Union Pacific Bridge on October 13, 2020.

4.5 Groundwater

One cluster of unnamed groundwater seeps is located within the current Black Dog Creek watershed. The MnDNR inventoried these seeps in 2017 and, at the time, noted it had iron precipitate (Minnesota Department of Natural Resources 2020e). There are no groundwater wells within the watershed; however, there are several located in the nearby Nicols Meadow fen complex.

The 2020 *Fens Sustainability Gaps Analysis for Carver, Dakota, and Scott Counties, Minnesota* noted concerns that groundwater elevations in the Black Dog Lake Fen and Nicols Meadow fen complexes may have been artificially lowered due to nearby groundwater appropriations. These pumping activities could also be affecting the groundwater contributions in Black Dog Creek's baseflow, leading to lower water levels and warmer temperatures in the creek.

4.6 Geochemistry and Water Quality

No data were found that provided information on the geochemistry or water quality of Black Dog Creek. The MnDNR Spring Inventory noted the seep cluster had iron precipitate, indicating high levels of dissolved iron in the groundwater. High levels of iron can negatively affect macroinvertebrate populations in the creek, which are a major food source for trout.

Recent dissolved oxygen concentrations were not found in the Black Dog Creek data reviewed. This information would help assess whether Black Dog Creek could support trout.

4.7 Public Access

The majority of the creek is part of the Minnesota Valley National Wildlife Refuge and under federal ownership and management; however, the only land access to the creek is via TH 77 or the Union Pacific railroad right-of-way. TH 77 and TH 13 are state highways, and parking along these roads is illegal. The Union Pacific railway is private land, and anglers using the railroad to access the creek are trespassing. There is no public access to Black Dog Creek.

4.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4 and the data reviewed, the following tables highlight the data gaps needed to determine the quality of trout habitat in Black Dog Creek. The minimum and optimal criteria are shown in the following tables.

Table 2. Black Dog Creek spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Unknown**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Unknown**
Adult Access: Jump Height < 1 ft	**Yes**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**No**
Constant Baseflow	**Unknown**
Gravel Substrate	**Yes**
Protection from Flooding	**No**

Table 3. Black Dog Creek summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Unknown**
Min. Water Temperatures < 72°F	**Unknown**
Optimal Dissolved Oxygen ≥ 9 mg/L	**Unknown**
Optimal Water Temperatures < 57°F	**Unknown**
Healthy Macroinvertebrate Population	**Unknown**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Unknown**
Cover > 6 in	**Unknown**

Table 4. Black Dog Creek overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Unknown**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Unknown**
Constant Baseflow or Deep Pools	**Unknown**
Cover ≥ 15% of Total Stream Area	**Unknown**
Healthy Macroinvertebrate Population	**Unknown**
Juvenile Access: Jump Height < 1 ft	**Yes**
Juvenile Access: Velocity < 0.3 fps	**Unknown**
Juvenile Access: Cover > 6 in	**Unknown**

There is not enough recent data to determine whether Black Dog Creek meets the minimum criteria for trout habitat. It may be beneficial to conduct a stream survey to determine the current state of the creek.

4.9 Management Strategies

Based on the information presented, Black Dog Creek does not meet the minimum characteristics of a trout water. The following highlight the major challenges Black Dog Creek faces:

1. **Tributary Area:** Although trout were once found in the channel, the Black Dog Creek watershed has been drastically reduced and may no longer have adequate baseflows and may be subject to stormwater runoff from TH 77 and TH 13. It may never support a fishery due to low flows and lack of cover depth in the channel.

2. **In-Stream Habitat:** The construction of TH 77 decimated the former trout spawning habitat, in addition to reducing the remaining watershed and severing the connection between Black Dog Creek and Unnamed 1. The stream is unlikely to provide adequate cover depth for trout and is subject to periodic flooding from the Minnesota River.
3. **Groundwater:** Black Dog Creek relies on the same groundwater sources as Black Dog Lake Fen, and there is substantial evidence that nearby Black Dog Lake Fen has been suffering from reduced groundwater elevations for many years. Without springs and groundwater seeps providing baseflow to the creek, the little water present in the creek is likely to be too warm to support trout.

Given the small watershed size and lack of recent habitat data, it is unlikely Black Dog Creek will be able to support a trout fishery, and thus it should not be managed as a trout water. It is still a valuable resource to the District, especially as part of the larger Black Dog fen complex. It may be best managed as part of the fen, rather than a stand-alone resource. Based on the data reviewed, the following management strategies are recommended for Black Dog Creek and summarized in **Table 5**:

- **BD-0:** Continue to implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek.
- **BD-1:** Evaluate the current HVRA boundary around Black Dog Creek and work with the cities of Eagan and Burnsville to confirm the direct runoff boundary and identify any stormwater inputs. This work could be done as part of a larger review of the stormwater inputs to the Black Dog fen complex, including Unnamed 4 discussed in **Section 9**, and as part of the Black Dog Fen Management Study recommended in the *2020 Fens Sustainability and Gaps Analysis* report.
- **BD-2:** Black Dog Fen Hydrogeologic Investigation: Due to concerns surrounding groundwater appropriations and low baseflows, a hydrogeologic investigation would be beneficial to determine whether the creek's subsurface hydrology can be restored.

Table 5. Black Dog Creek management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
BD-1	Black Dog Fen Management Study	Study	2024
BD-2	Black Dog Fen Hydrogeologic Investigation	Study	2026

BD-1 is part of ongoing work the LMRWD is already conducting; however, the outcomes should be reviewed to determine if BD-3 is warranted.

5.0 EAGLE CREEK

Eagle Creek (Tributary Numbers M-55-9 and M-55-9-3) is a nearly three-mile stream located in Scott County within the cities of Savage and Shakopee (**Figure 21**). It is the only trout stream in Scott County, is a state-designated trout water, and is known to have a wild, resident brown trout population. The stream is nearly 15,000 feet long, with more than half of that considered suitable for stream trout. Eagle Creek is made up of two branches, the main branch and east branch. From its origin, the main branch of Eagle Creek flows through residential areas in the steep, upper reaches before it joins with the east branch near 126th Street in Savage. The east branch has a similar slope and originates near the Savage Fen complex before joining with the main branch and continuing downstream under Highway 13 and the Union Pacific railroad crossings onto the relatively flat floodplain of the Minnesota River.

5.1 Watershed History and Land Use

Topographic maps and land surveys from the 1890s show the Eagle Creek watershed as being relatively undisturbed. The disturbances in the watershed appear to be primarily related to the construction of the Chicago–St. Paul-Minneapolis railroad (now owned by Union Pacific) in 1865 and local roads that cross the low-lying marshes to the high ground on the bluffs (**Figure 22**). The Dakota village of Eagle Head's encompassed much of the lower Eagle Creek watershed, with the primary settlement being an 1830s village near Boiling Springs. Known as *Maka Yusota*, Boiling Springs is a pre-settlement sacred site to the Dakota people (Shakopee Mdewakanton Sioux Community 2002). Land in Scott County opened to European settlement in the 1850s, and by 1913 all the lands within the Eagle Creek watershed were platted (Shakopee Mdewakanton Sioux Community 2000; The Farmer 1913).

The Eagle Creek watershed remained an agricultural community, with the added tourist attractions of a wild brown trout fishery and Boiling Springs (Shakopee Mdewakanton Sioux Community 2000). Aerial photography from archived images shows a substantial transition in land use over time. From 1937 to 1945, major roadways were constructed through the Eagle Creek watershed and south of the Minnesota River; the land was used mostly for agriculture. From 1945 through the 1970s, Eagle Creek experienced very little land use change, other than expansions to Highway 13 and other roadways.

Aerial photographs showed increasing urban development near the creek in 1967, which expanded considerably by 1971. In the early 1990s, widening of Highway 13 over the creek caused stormwater management and flow concerns regarding Eagle Creek's trout habitat (Polomis 1997; Shodeen 1995).

Urban development intensified in the 1990s, replacing crop land, meadow, and overgrown pastureland. Plant Ecologist, Fred Harris, described in 1995 how the present conditions show the loss of native ecosystems and identified the three remaining remnants of native oak savanna and sand prairie a few miles west of Eagle Creek (F. Harris 1995). Evidence of habitat damage from past cattle grazing and bank trampling could still be seen in 1996 but appeared to be improving (Willey 2003).

In the early 1990s, the land surrounding Boiling Springs was sold for residential development. Locals were concerned about the impacts this development could have not only on the springs but also on the trout fishery. Through the efforts of nonprofits, residents, the Shakopee Mdewakanton Sioux Community, Trout Unlimited, and others, the area around Eagle Creek and its springs was designated as the state's first Aquatic Management Area (AMA). The AMA creates a buffer around Eagle Creek to protect the stream from future development and provides angler and management access (Shakopee Mdewakanton Sioux Community 2000).

Land use today is predominantly park, recreational, or preserve, with the 233-acre AMA dominating the Eagle Creek watershed. Single family residential makes up the majority of the main branch watershed, whereas the lower and east branches near the creek are a mix of commercial to the east and residential to the west. Light industrial and commercial development is more common where the creek intersects with Highway 13. The land north of Highway 13 and the Union Pacific railroad is within the Minnesota Valley Wildlife Refuge (Metropolitan Council 2016; **Figure 23**).

Land use is not likely to substantially change in the future, as much of the Eagle Creek watershed is protected by the Eagle Creek AMA and Minnesota Valley Wildlife Refuge. Projected land uses for the cities of Shakopee and Savage confirm the land immediately adjacent to the creek will remain parkland, with the majority of future development occurring in the upper watershed primarily for residential land uses (Metropolitan Council 2020; **Figure 23**; **Table 6**).

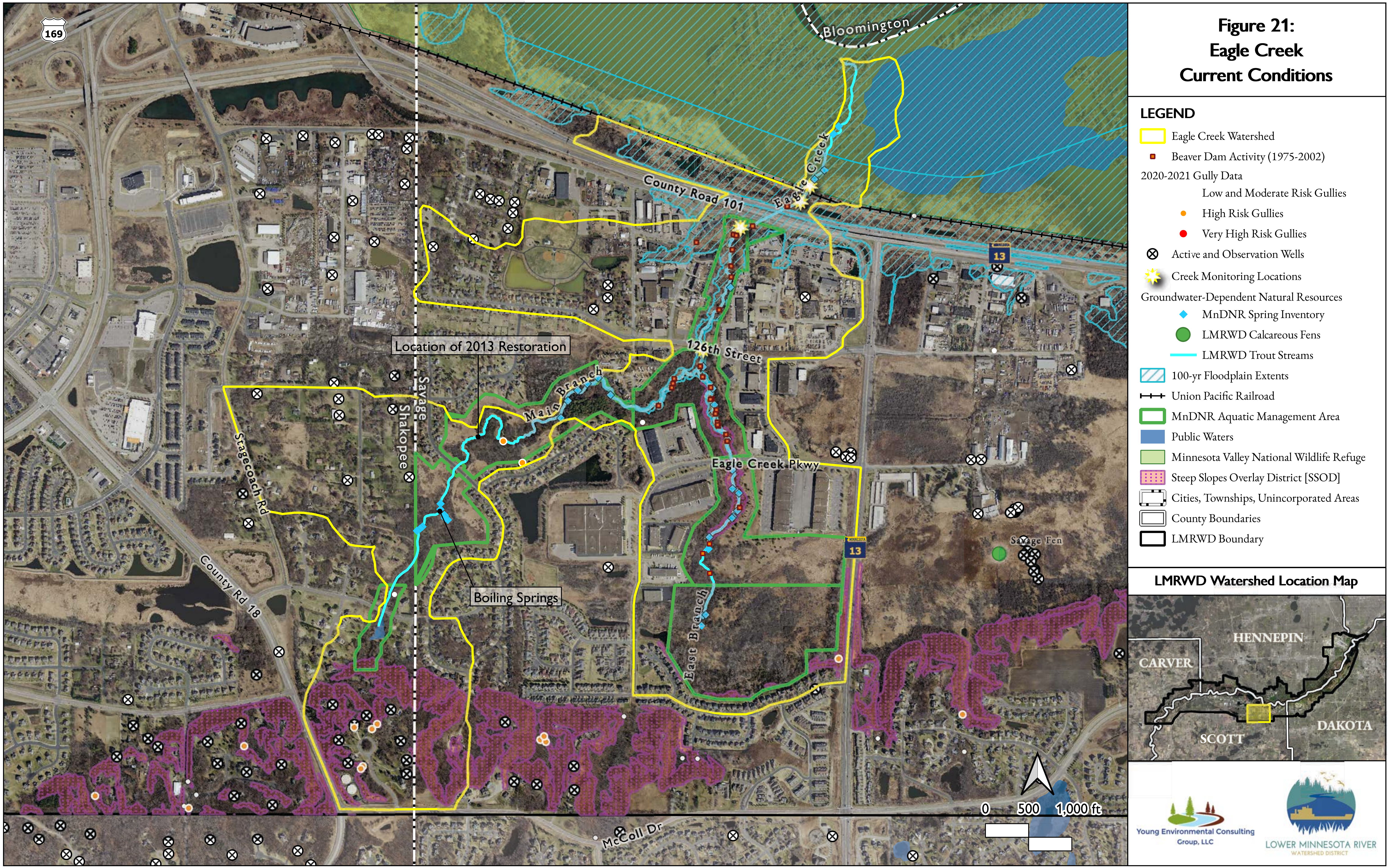
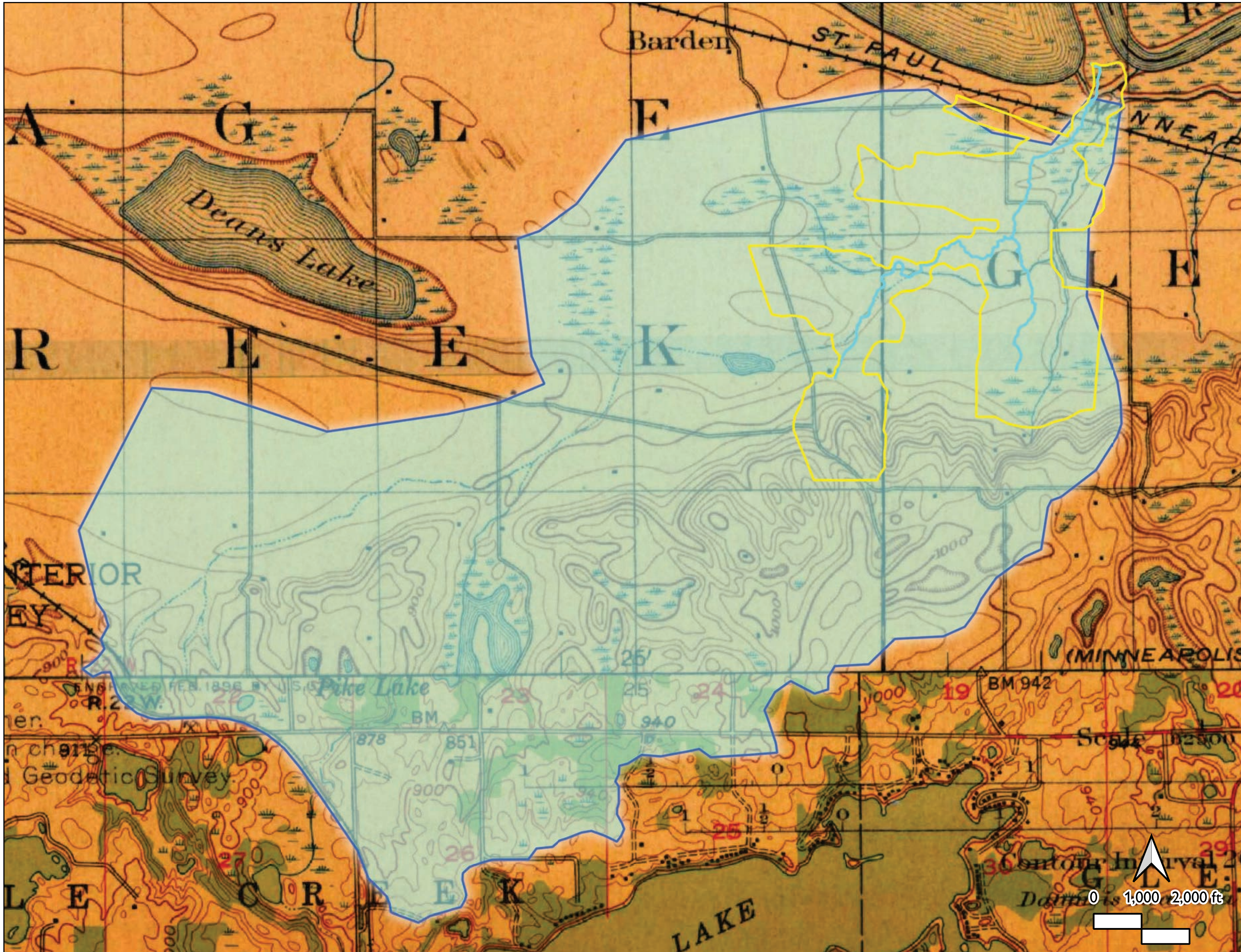


Figure 21: Eagle Creek Current Conditions

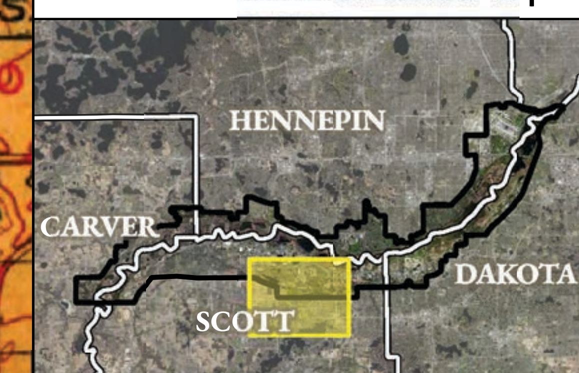
Figure 22: Eagle Creek Historic Watershed



LEGEND

- Eagle Creek (Present Day)
- Eagle Creek Present Day Watershed
- Eagle Creek 1896 Watershed
- Historic USGS Quad Sheets (1896-1957)

LMRWD Watershed Location Map



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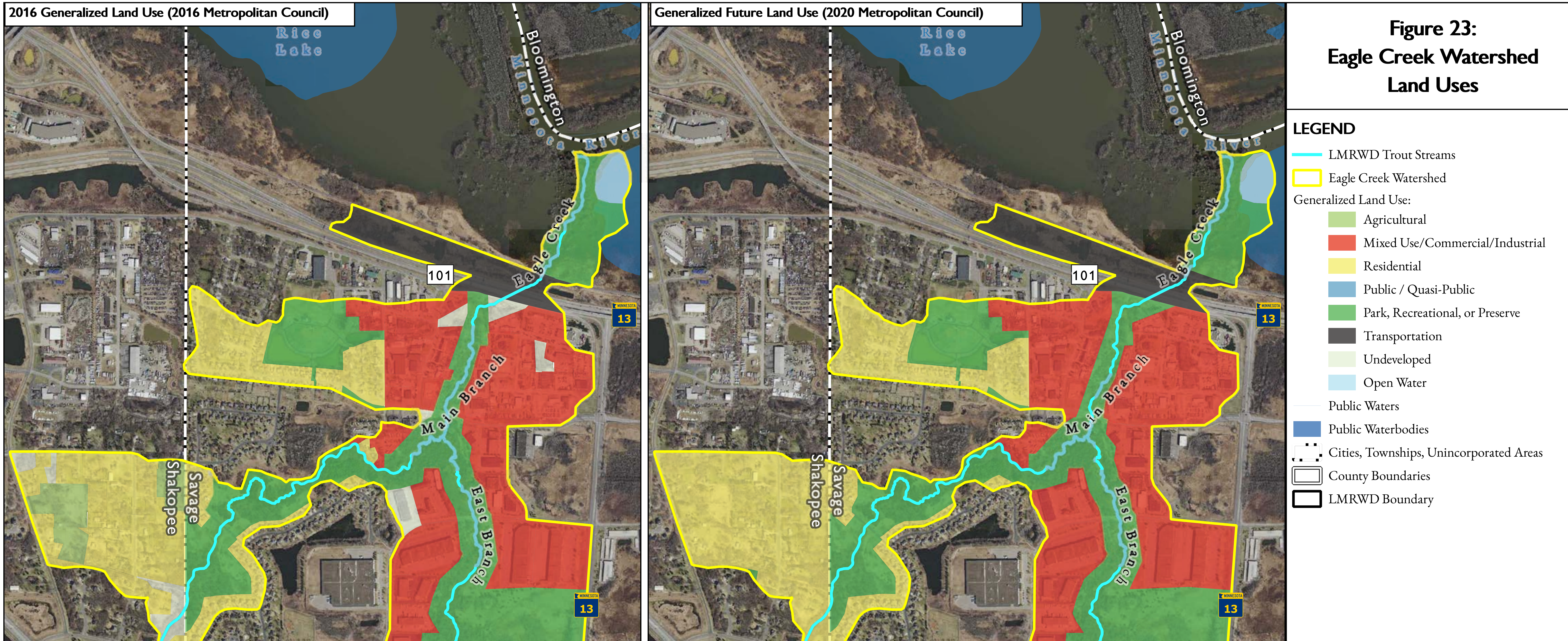

Figure 23:
Eagle Creek Watershed
Land Uses

LMRWD Watershed Location Map

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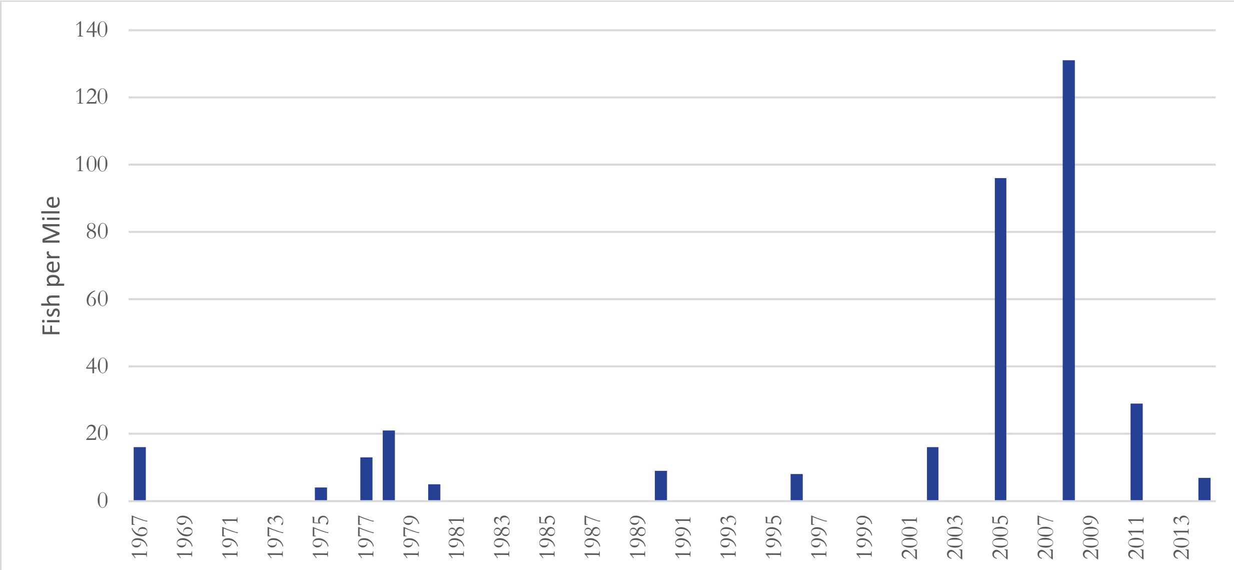
Table 6. Existing and future land uses within the Eagle Creek watershed (Metropolitan Council 2016, 2020).

	2016 Area (ac)	Future Area (ac)	Change (ac)
Agricultural	16	0	-16
Open Water	5	5	0
Park, Recreational, or Preserve	202	204	2
Residential	161	211	50
Transportation	27	28	1
Undeveloped	66	0	-66
Mixed Use/Commercial/Industrial	149	179	30

5.2 Fisheries

Eagle Creek was managed as an intensively stocked put-and-take trout fishery from 1945 to 1978, meaning most fish were harvested soon after stocking. Rainbow trout were also stocked regularly from 1945 to 1966 then sporadically until 1974 (Willey 2003). Rainbow trout were so popular and easy to catch that it resulted in numerous over-limit violations; in 1967, the MnDNR switched to stocking the more elusive brown trout to make fishing harder (Haugstad 1967b). The MnDNR surveys Eagle Creek at roughly three-year intervals. Records going back to 1996 show that, although the creek has not been stocked since 1978, brown trout have had sporadic reproductive success. By 2008, Eagle Creek was considered a major success story, with the creation of the AMA and buffer zone directly contributing to the increasing trout populations (David Peterson 2008); however, more recent MnDNR fisheries surveys have shown a smaller population in the creek (**Figure 24**).

Figure 24. Trout populations per creek mile in Eagle Creek based on MnDNR surveys (1967–2014).

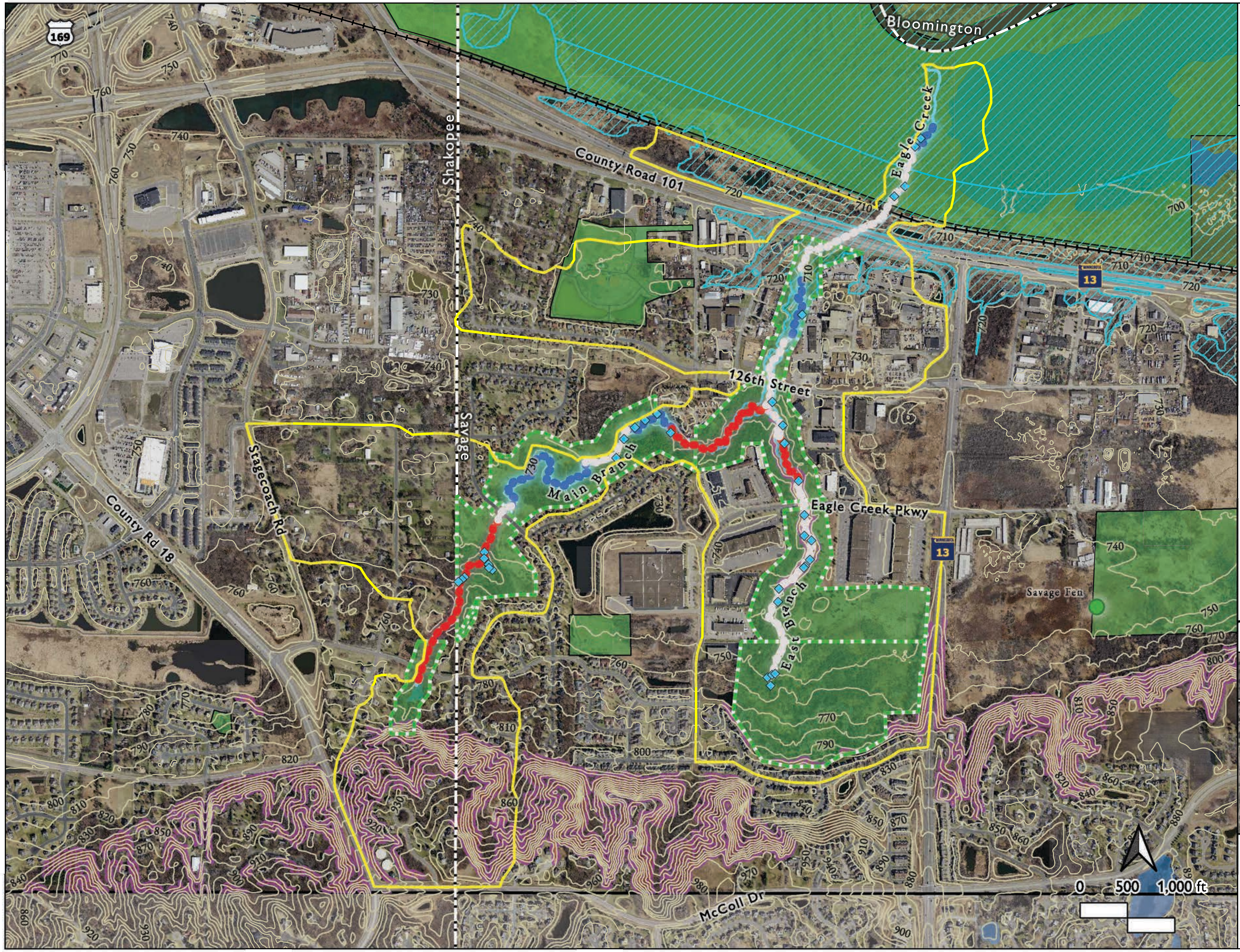


The MnDNR had not stocked Eagle Creek since 1978, and all the trout found since were considered wild; the best habitat is found where the two branches merge near the frontage road (Abeln 2020). The MnDNR sampled Eagle Creek in 2017, 2019 and 2020. In 2017 trout were noted and in 2019, three unspecified trout species were observed on separate occasions, which confirms the belief there is a current population of trout residing in the main branch of Eagle Creek (Berg et al. 2019). The 2020 fish survey did not capture any trout and in November 2021 and May 2022 the MnDNR stocked Eagle Creek with the Minnesota Driftless Strain of Brook Trout (Nemeth 2022).

5.3 In-Stream Habitat

Since 1954, there have been concerns with soil erosion in the watershed and from streambanks polluting Eagle Creek and threatening the fishery. Excessive sand entering the creek from pasture lands and gullies are thought to reduce the stream's capability to support a reproducing trout population (Haugstad 1967b). The 1996 MnDNR stream survey of Eagle Creek concluded that the best brown trout habitat, despite the excessive sand in the system, was the portion of the main branch between Independence Avenue and the Union Pacific railroad, and the east branch from its confluence with the main branch to 3,000 feet upstream (Polomis 1997; **Figure 25**). Sand and fine particles within the creek remain one of the most limiting factors to trout abundance, as the lack of gravel habitat prevents trout from successfully spawning the next generation (Melchior 1998).

Figure 25: Eagle Creek Potential Trout Habitat



LEGEND

- Eagle Creek Watershed
- Potential Trout Habitat
  - Good Conditions
  - More Investigation Needed
  - Poor Conditions
- Groundwater-Dependent Natural Resources
  - MnDNR Spring Inventory
  - LMRWD Calcareous Fens
  - LMRWD Trout Streams
- Union Pacific Railroad
- Scott Co. 10-ft Contours
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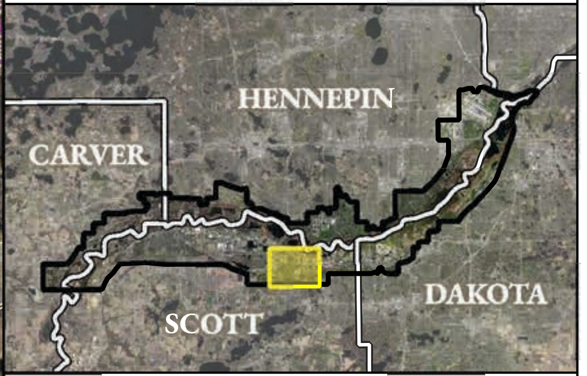
LMRWD Watershed Location Map



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The in-stream habitat for both branches provides adequate cover and refuge opportunities from logs, in-stream vegetation, woody debris, and overhanging vegetation. The east branch additionally has undercut banks to provide cover for trout (Bacigalupi 2006; **Figure 26**).

Figure 26. East branch Eagle Creek cover habitat in July 2019 (Berg et al. 2019).

Water temperature does not appear to be a limiting factor within Eagle Creek due to the predominance of groundwater springs in the watershed. Shallow pools and lack of channel variability, specifically channel riffles, are a habitat concern, likely caused by the deposition of excess sandy sediment. The channel may not receive adequate flows to flush the fine sediment from the system, and there are areas within the watershed where the channel has over-widened, decreasing the channel depth. This same study also identified areas of bank erosion near the Town and Country Campground and on the east branch, near the confluence, as candidates for future restoration (Berg et al. 2019; **Figure 27**).

Figure 27. East branch Eagle Creek bank erosion in June 2019 (Berg et al. 2019).

The Eagle Creek West Branch Habitat Improvement Project in May 2013 by the MnDNR improved approximately 1,840 feet of the stream by narrowing the channel, with the goal of improving sediment transport and creating a more complex trout habitat, such as deep pools and undercut banks for cover (Nemeth 2014). In 2019, the reconstructed reach appeared to be stable but was experiencing heavy aggradation. The reconstructed reach received the highest habitat score in Eagle Creek, but, because of the aggradation of fine particles, it also received the lowest substrate score, indicating this reach is not suitable for spawning (Berg et al. 2019; **Figure 28**).

Figure 28. Photos of the reconstructed reach on Eagle Creek in June 2019 (Berg et al. 2019).

The LMRWD also funded a cost-share project in 2019 to restore an acre of land to native oak savannah adjacent to Eagle Creek within the improved reach. The goals were to protect water quality by providing a buffer between landscaped lawns, remove invasive species, and improve pollinator habitat (Loomis 2019). This buffer will eventually mature and provide additional cover for trout in this fairly open reach.

Additional habitat enhancements are feasible, but "Eagle Creek has natural limitations that prevent a dramatically improved, numerically high and self-reproducing brown trout fishery," including the abundance of sand-based substrate, the naturally small stream size and low flows in Eagle Creek, lack of spawning substrates, and the presence of beaver dams (Willey 2003).

Beaver activity and dam construction can limit access to spawning sites and create fish barriers to more suitable habitat. Beaver activity has been noted throughout multiple years, peaking between 1990 and 1995 (Polomis 1997). In 1997, fourteen beaver dams were removed from the main stem and east branch (**Figure 25**), and most were determined to be inactive at the time (Melchior 1998).

Overall, the habitat conditions for trout appear to be the most ideal along the Main Branch, upstream of Highway 13 (**Figure 25**). The restored reaches will require periodic upkeep, including the removal of invasive vegetation. Trout Unlimited has been coordinating buckthorn removal efforts and may continue to be a good partner for this work (Abeln 2020).

5.4 Streamflow

Using the USGS topographic maps from 1896, the historic Eagle Creek watershed is estimated to be roughly 4,900 acres, once encompassing Pike Lake and portions of the Deans Lake watershed (**Figure 22**). The historical Eagle Creek watershed is estimated to have been reduced by 65 percent because of urbanization and development in the watershed, which diverted surface water runoff away from Eagle Creek. These changes happened gradually over many years as resource managers saw opportunities to modify the storm-drainage system, including a siphon system to divert warmer surface flows away from the creek. Today, the creek no longer has a surface water component and is primarily fed by groundwater discharge (Bacigalupi 2006).

The USGS sporadically operated a streamgage upstream of Highway 101 (05330858), collecting flow data in 1968 and 2003 (Mitton et al. 2004). The MnDNR collects flow data during their stream assessments and measured 12.5 cfs upstream of Highway 101 in 2002 (Willey 2003), with an average flow of approximately 11 cfs between 1954 and 2002. More recently, the flow of Eagle Creek was estimated to be 8.4 cfs based on data from 1999–2011 at the MCES Watershed Outlet Monitoring Program (WOMP) station. The WOMP station monitors streamflow and water chemistry in Eagle Creek just below the confluence with the east branch above 126th Street (**Figure 21**). A report from 2014 summarized the flows between 1999 and 2012, stating that the average flow in the channel was 8.4 cfs (Metropolitan Council 2014a), the same as the MnDNR data. A review of the unpublished Eagle Creek monitoring data obtained from the MCES Environmental Information Management System (EIMS) website (https://eims.metc.state.mn.us/) from 2010 to 2021 showed streamflow during sample-collection visits averaged 9.5 cfs, with the lowest flow sampled at 7.2 cfs.

5.5 Groundwater

The groundwater baseflow entering the stream is the dominant component that supports Eagle Creek streamflows; the MnDNR Spring Inventory shows 36 seeps and springs along Eagle Creek (**Figure 21**). Surface water measurements from 2019 confirmed the stream had consistent groundwater input throughout the portions of the stream that were observed (Berg et al. 2019).

Boiling Springs is a unique feature within the Eagle Creek watershed. Known to the Dakota people as *Maka Yusota*, it was added to the US National Register of Historic Places in 2003 because of its cultural importance. It is named because the upwelling of groundwater forces sand to the surface of a pool in the creek, giving it the appearance of boiling (Anfinson 2003). Boiling Springs is a visual demonstration of the impact groundwater has on the Eagle Creek system, regulating water temperatures and preventing the creek from freezing solid in the winter (**Figure 29**).

Figure 29. Winter at Boiling Springs postcard from 1930 (Minnesota Historical Society 1930).

In surveys prior to 1996, Boiling Springs was listed as the primary source of water in Eagle Creek, with nine individual springs in this vicinity. Fieldwork in 1996 demonstrated that the true source of baseflow is springs approximately 0.6 miles further upstream, which also "form the source of the largest tributary flowing into the Boiling Springs area" (Polomis 1997). It has been estimated that Boiling Springs contributes 2.5 cfs to the overall flow in Eagle Creek (Melchior 1998).

A study by the MCES WOMP produced a report summarizing the results of data collection from Eagle Creek (Metropolitan Council 2014a). That report reviewed information to assess the vulnerability of Eagle Creek to nearby withdrawals of groundwater. The evaluation suggested that the entire stream is potentially vulnerable to groundwater withdrawals, but unfortunately the areas of recharge that supply water to the creek are not clearly identified, so the creek's susceptibility to groundwater withdrawals and contamination is poorly understood (Metropolitan Council, 2021). From the Minnesota Well Inventory, there are 33 active wells located within the Eagle Creek watershed, and the vast majority are domestic wells. However, several are used for withdrawing groundwater for commercial or industrial purposes, with pump rates of up to 200 to 500 gallons per minute (Minnesota Department of Health 2020).

One of the greatest factors concerning Eagle Creek and other groundwater-dependent resources in the lower Minnesota River basin is the uncertainty and sustainability of the groundwater supply. Most of the streamflow measurements provided from stream surveys are valuable estimates but do not provide the information needed to document extreme low flows, which would adversely affect the habitat of trout and the macroinvertebrate populations they rely upon. Developing a more robust stream gaging operation or network would help address those concerns.

5.6 Geochemistry and Water Quality

Streamflow was sampled in 1996, and the water chemistry was found to "reflect a hardwater stream with no obvious water quality problems" (Polomis 1997).

In 2002, the spring water that feeds the upper reaches of Eagle Creek was found to have a dissolved oxygen level of 5.4, which is concerning because it is at the lower threshold of the optimal range and may be insufficient "to support trout rearing and metabolic maintenance requirements" (Willey 2003). The MCES WOMP station collected monthly water quality readings between 1999 and 2015 and recorded only one dissolved oxygen reading slightly below the 7 mg/L threshold (Scott County Soil and Water Conservation District 2014); however, unpublished monitoring data on the EIMS website showed no major changes in the quality of Eagle Creek since 2010. Water temperature ranged from 5.3 to 16.1 degrees Celsius. Dissolved oxygen concentrations remained safe for trout, ranging from 6.9 to 10.5 mg/L. The MnDNR stream surveys have found the dissolved oxygen is consistently above the minimum requirement. There are occasional dips below the optimal range, but these are well above lethal levels (3 mg/L) and should be tolerable to a healthy trout population.

There is also evidence of groundwater seepage, with visible deposits from iron-reducing bacteria from the MnDNR Springs Inventory data, indicating that the upwelling groundwater has high concentrations of iron, which can negatively affect the development and population of the macroinvertebrates trout depend on as a food source. Other than sporadic observations, iron concentrations in the groundwater have not been monitored.

Chloride in the stream from anthropogenic sources such as road salt applications and water softener discharges has been a concern for Eagle Creek. Chloride concentrations were sampled from four stream sites on June 18, 1996, and they ranged from 11.7 to 15.2 milligrams per liter (mg/L). The MCES began sampling Eagle Creek for chlorides in 2001, with annual flow-weighted mean concentrations that initially were less than 20 mg/L but appeared to increase annually to more than 30 mg/L by 2012. These concentrations are well below the 230 mg/L standard (MPCA 2018). From the Metropolitan Council's EIMS website, conductance, a surrogate for dissolved materials, averaged about 650 mg/L and showed a modest upward trend from 2010 through 2021. Part of this trend may be the result of increasing chloride concentrations, which averaged about 35 mg/L in the early 2010s but had increased to more than 50 mg/L by 2020–21. Although chloride concentrations were well below the 230 mg/L water-quality criteria (MPCA 2018), this suggests contamination from external sources may be affecting the quality of water in Eagle Creek. This may come indirectly from the groundwater that provides much of the flow to Eagle Creek, but data are not available to assess that possibility.

With the creek's proximity to residential lawns and industrial developments, stormwater runoff, especially excess nutrients from fertilizers, can cause water quality impairments. In 2019, filamentous benthic algae were noted, indicating excess nutrient loading may be occurring in Eagle Creek (Berg et al. 2019).

From the 2014 monitoring report, Eagle Creek met the state water quality standards, with the exception of bacteria, turbidity, and suspended solids. Spring-fed streams often have higher bacteria, sediment, and turbidity levels because the year-round open water can attract a large number of waterfowl (Scott County Soil and Water Conservation District 2014). However, spikes in bacteria are showing up in the creek at odd times of the year. In addition, it is not known how bacteria impairments may affect trout populations; however, higher turbidity and increased suspended solids have been shown to be detrimental to spawning habitats by smothering the fertilized eggs.

Unfortunately, the exact thresholds are not known at this time and should be discussed with the MnDNR for future creek-monitoring activities.

5.7 Public Access

Eagle Creek is probably the most accessible creek within the LMRWD, as the majority of the creek itself is located within the MnDNR Aquatic Management Area. The creation of the AMA has allowed the MnDNR to acquire lands for conservation and public recreation (**Figure 21**), whereas numerous local parks and the Minnesota Valley National Wildlife Refuge within the watershed also offer additional protection from urbanization (**Figure 25**).

Since the early 1900s, Eagle Creek has faced enormous pressure from anglers (**Figure 30**), leading to rainbow and brown trout stocking and ultimately to the creation of the AMA. Given the small resident brown trout population, the creek is currently a catch-and-release only, meaning fish may not be harvested, to protect the existing population. The demand from anglers may need to be monitored to protect the fishery from overuse.

Figure 30. 1947 Minnesota trout opener on Eagle Creek (Minneapolis Star Tribune 1947).

5.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4, the following tables highlight the data gaps needed to determine the quality of the trout habitat in Eagle Creek. The minimum and optimal criteria are shown in the following tables.

Table 7. Eagle Creek spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Adult Access: Jump Height < 1 ft	**Unknown**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**Unknown**
Constant Baseflow	**Yes**
Gravel Substrate	**No**
Protection from Flooding	**Partial**

Table 8. Eagle Creek summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Min. Water Temperatures < 72°F	**Yes**
Optimal Dissolved Oxygen ≥ 9 mg/L	**Partial**
Optimal Water Temperatures < 57°F	**Partial**
Healthy Macroinvertebrate Population	**Unknown**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Unknown**
Cover > 6 in	**Unknown**

Table 9. Eagle Creek overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Constant Baseflow or Deep Pools	**Yes**
Cover ≥ 15% of Total Stream Area	**Yes**
Healthy Macroinvertebrate Population	**Unknown**
Juvenile Access: Jump Height < 1 ft	**Unknown**
Juvenile Access: Velocity < 0.3 fps	**Unknown**
Juvenile Access: Cover > 6 in	**Unknown**

Eagle Creek meets the minimum criteria for trout habitat and some of the optimal criteria as well. Data gaps exist to determine whether the creek meets all the optimal criteria. For example, stream velocities and channel depths throughout the reaches are not known to adequately assess access conditions or total cover areas. Detailed channel surveys and either monitoring of flows or predictive modeling would be beneficial in determining whether the creek meets access and cover criteria. Also, Eagle Creek's baseflow and susceptibility to groundwater withdrawals and contamination is poorly understood. A review of groundwater recharge areas within the LMRWD may be beneficial in determining water supply to the creek and the potential for contamination.

Limited information is available regarding macroinvertebrate populations in Eagle Creek, and most data are limited to general statements like "poor conditions for macroinvertebrate production" (Willey 2003). Just like trout, aquatic insects require an optimal thermal regime; temperatures outside this optimal range will produce smaller and less proliferating adult macroinvertebrates and less food for trout (Anderson et al. 2016). The Metropolitan Council has been collecting macroinvertebrate population data at the WOMP station most years since 2001 and shows the annual Macroinvertebrate Index of Biological Integrity (M-IBI) score has generally exceeded the threshold of impairment, however this data should be consulted prior to future macroinvertebrate data collection efforts elsewhere in the creek (Metropolitan Council, 2014).

5.9 Management Strategies

Although Eagle Creek has all the necessary characteristics of a trout water—the presence of trout; cold, clean, well-oxygenated water; and defined channel banks—the resident trout population may still be limited by two major factors: habitat and the overall size of the stream itself.

1. **Spawning Habitat:** The underlying soils in the Eagle Creek watershed are very sandy and highly erodible, resulting in fine sediments entering the creek and covering potential gravel spawning areas. The lack of gravel spawning beds means fish cannot successfully reproduce in the wild, and a large trout fishery would remain dependent on stocking efforts. Improving spawning habitat could be completed by reducing sediment inflows into the system by addressing upstream erosion concerns, in addition to reach-specific habitat restoration projects. A potential source of sediment in the West Branch, may be erosion caused by groundwater seeps.
2. **Overwintering Habitat and Access:** Trout require flowing water, pools, and overhead cover. Due to the abundance of springs in the area, Eagle Creek is likely to flow year-round, providing adequate flows; however, the overwintering habitat may be inaccessible. Deep pools, especially in the upper reaches, are often disconnected, and trout may be unable to migrate to these areas for overwintering. Deep pools exist near the Minnesota River, but culvert barriers, such as the Highway 101 culvert, may prevent fish from migrating to overwinter in these locations. Winter habitats could be improved by improving overhead cover conditions to protect fish from predators and removing the barriers that would allow fish free migration.
3. **Creek Size:** Eagle Creek by nature is a small stream and will never support a large population of big game fish, such as rainbow trout, but it has a long history of supporting the smaller brown and brook trout. The natural size limitations of this creek suggest it may be best suited for a small resident population of brook trout.

Eagle Creek is already a state-designated trout stream and a designated AMA; thus, it should continue to be protected and managed as such. Based on the data reviewed, the following management strategies are recommended for Eagle Creek and summarized in **Table 10**:

- **EC-0:** Continue monitoring activities and implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek.

- **EC-1:** Detailed Survey and Sediment Sampling: Work with the MnDNR to expand on the 2019 Geomorphic and Habitat Assessment recommendations for Eagle Creek to better understand the causes of the over-widened channel and mid-channel bars, including an investigation into the causes of the aggradation problem in the restored reach and throughout the system. This work should include a topographic survey and a Level III Rosgen analysis to collect sediment samples from the creek and monitor bank erosion to calculate erosion rates in critical reaches.
- **EC-2:** Using the City of Savage's upcoming Eagle Creek Sub-Watershed Assessment Stormwater Study, evaluate sediment transport within the Eagle Creek watershed to determine how best to manage the fine sediment inflows and protect trout spawning habitats, using the data previously collected in EC-1. Determine the likelihood of a system reaching equilibrium and make recommendations for future restoration projects.
- **EC-3:** Conduct a feasibility study on the eroding bank at the Town and Country Campground to determine how much sediment is contributing to the stream and what stabilization options may be feasible.
- **EC-4:** Continue to coordinate with the MnDNR for future stream re-surveys of Eagle Creek.
- **EC-5:** Continue to coordinate with the MCES for future water quality sampling and monitoring of Eagle Creek, with particular emphasis on bacteria.
- **EC-6:** Establishment of a real-time flow and temperature gage to better monitor and track changes in stream flow conditions in the potentially viable sections of the creek throughout the year. The MCES has had real-time flow and temperature data at the WOMP station since 1999 and can share this data with the LMRWD to aid in tracking changes.
- **EC-7:** Establish a protocol for macroinvertebrate surveys, including identifying potential project partners, such as the MCES which is already collecting this data at the WOMP station and may be willing to partner on future efforts.
- **EC-8:** Given the small nature of the creek, coordinate with the MnDNR to evaluate the potential to establish a native brook trout population in the creek. Based on the literature reviewed, the east branch historically has been able to support a more-reliable brown trout population while also having some of the worst habitat conditions in the watershed. This reach may be suitable for the further study of habitat improvements and restoration projects.
- **EC-9:** Work with the MnDNR to expand on the 2019 Geomorphic and Habitat Assessment to review and understand the causes of the over-widened channel and mid-channel bars.
- **EC-10:** Based on the recommendations from EC-1, EC-2, EC-4, and EC-9, as well as the City of Savage's Eagle Creek Sub-Watershed Stormwater Study, embark on a capital improvement project to improve the trout habitat within Eagle Creek.
- **EC-11:** Continuing beaver management practices and the management of invasive species, especially on the restored reaches, will be critical to the long-term success of the fishery.

Table 10. Eagle Creek management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
EC-1	Eagle Creek Detailed Survey and Sediment Sampling	Data Collection	2022
EC-2	Sediment Transport Study	Study	2023
EC-3	Town & Country RV Park Bank Restoration Feasibility Study	Study	2022
EC-4	MnDNR Stream Re-Surveys	Data Collection	2022
EC-5	MCES Water Quality Sampling	Data Collection	2022
EC-6	Real-Time Flow Monitoring (Annual)	Data Collection	2022
EC-7	Macroinvertebrate Monitoring (Bi-Annual)	Data Collection	2022
EC-8	Brook Trout Stocking Feasibility Study	Study	2025
EC-9	Geomorphic Assessment Update	Study	2026
EC-10	Habitat Improvements	Capital Improvement	2027
EC-11	Beaver and Vegetation Management	Maintenance	As Needed

6.0 IKE'S CREEK

Ike's Creek (Tributary Number M-55-2-1) is less than a mile-long stream located in Hennepin County within the City of Bloomington (**Figure 31**). It is passively managed for brook trout, and does not have any fishing access easements. It is situated on the north side of the Minnesota River Valley and flows southeast into Long Meadow Lake, which drains into the Minnesota River.

Ike's Creek has a watershed area of 87 acres and an estimated length of 3,238 feet, all of which are considered suitable for stream trout (Nemeth 2020b). Ike's Creek is not officially designated as a trout stream and has no official name, but it was named after the Izaak Walton League conservation group, which raised fish in nearby ponds in the early 1900s. Many other entities have also worked to improve its habitat, including Trout Unlimited, which successfully lobbied to get it stocked with brook trout. Some entities are advocating to have the stream officially designated as a trout stream, however when the MnDNR tried to designate it as such, public comment supported water quality management without the formal designation (Nemeth 2022). It was reported that the stream historically had a native trout population that inexplicably disappeared (Niskanen 2007a).

6.1 Watershed History and Land Uses

Ike's Creek watershed was surrounded primarily by agricultural land since early European settlement in the 1850s (Bloomington Historical Society 1987). By 1896, the USGS historic topographic maps show the Bloomington city grid taking shape, including present-day Old Shakopee Road and 24th Avenue at the headwaters of Ike's Creek (**Figure 32**). Analysis of the 1896 topographic maps indicate the watershed area may have exceeded 600 acres before development and was fed from upstream wetlands that have since been developed.

Aerial photographs show the shift to residential and suburban development began in the late 1950s, which accelerated in the early 1960s, including the opening of the Metropolitan Stadium in 1967. In 1994, the Metropolitan Stadium was demolished to make way for the new Mall of America, IKEA, and parking lots (Gonzales 2016). Most of the urban development around Ike's Creek watershed is diverted away from the creek via a storm sewer, treated in a regional detention pond, then discharged into the Minnesota River. By diverting urban stormwater runoff and despite the reduced watershed size, Ike's Creek has a "very stable hydrology" (Ellison 2007).

The Ike's Creek watershed is surrounded by fully developed lands for retail, commercial, and light industrial purposes. Land use within the watershed is predominately agricultural, with the large Kelly Farm occupying half of the watershed itself. The lower half of the watershed is within the Minnesota Valley National Wildlife Refuge. In 2016, there were approximately 9 acres of remaining undeveloped land in the watershed; however, this area is currently under development, as shown in the 2020 Hennepin County aerial images (Metropolitan Council 2016; **Figure 33**).

Land use within the watershed could substantially change in the future, with the sale of the 35-acre Kelly Farm. Based on the projected 2040 land use, this area is proposed to be a future innovation and technology center, likely creating a large amount of impervious surfaces, similar to the existing developments in the area, and, if improperly designed, could adversely affect the existing trout population and habitat quality (Metropolitan Council 2020; **Figure 33**; **Table 11**).

Table 11. 2016 and future generalized land uses within the Ike's Creek watershed (Metropolitan Council 2016, 2020).

	2016 Area (ac)	Future Area (ac)	Change (ac)
Agricultural	35	0	-35
Park, Recreational, or Preserve	15	17	2
Undeveloped	9	0	-9
Mixed Use/Commercial/Industrial	2	43	41

Figure 31: Ike's Creek Watershed

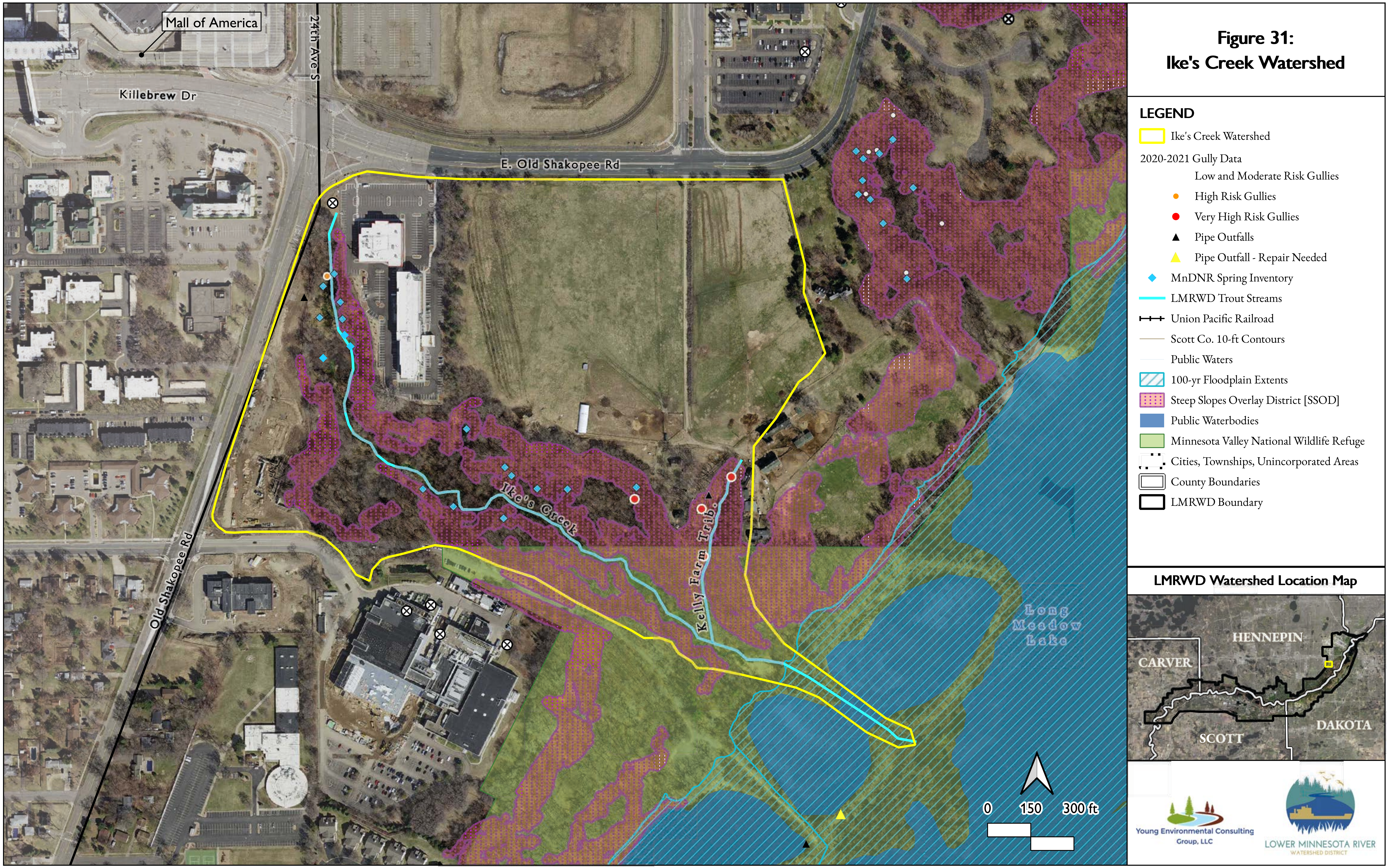
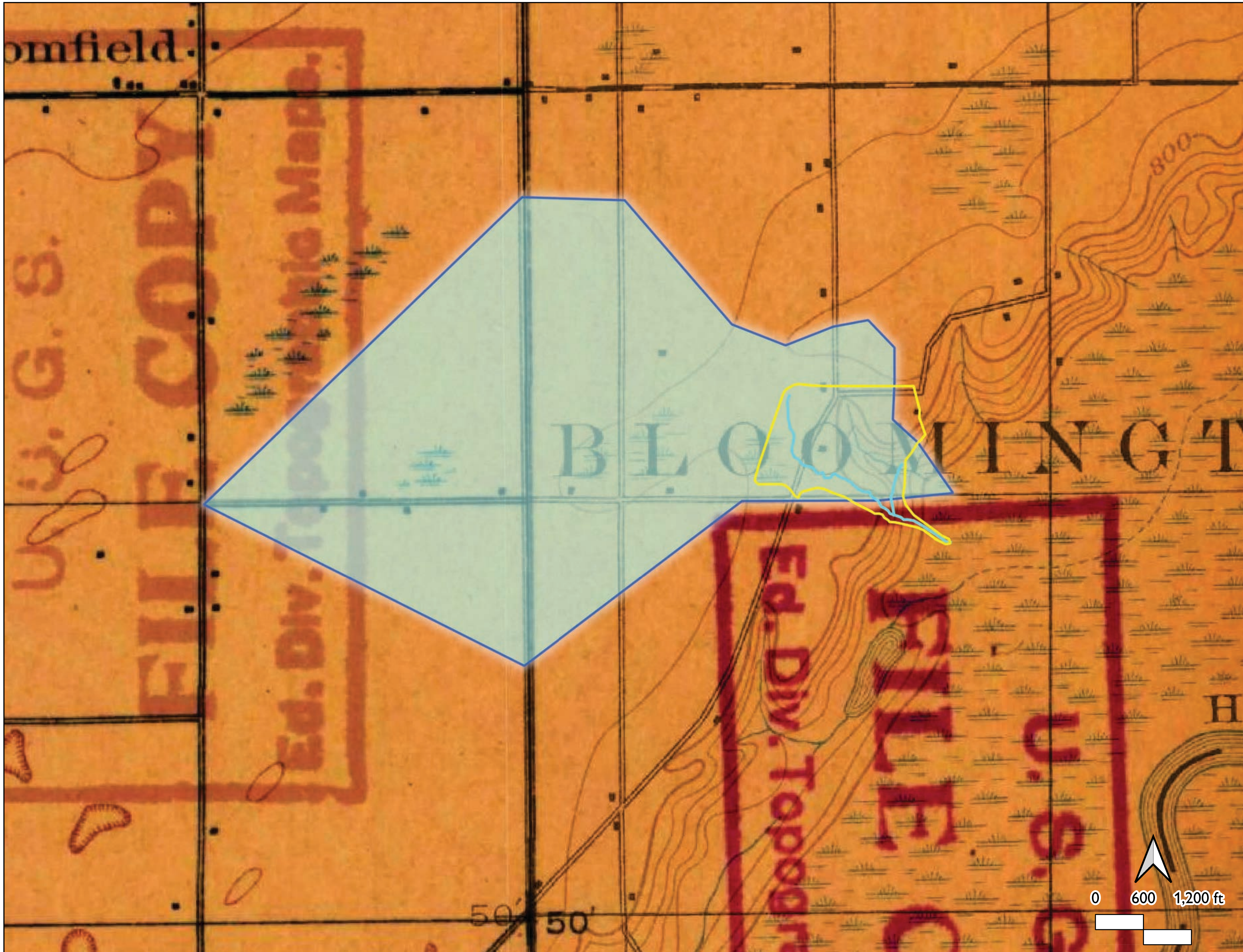


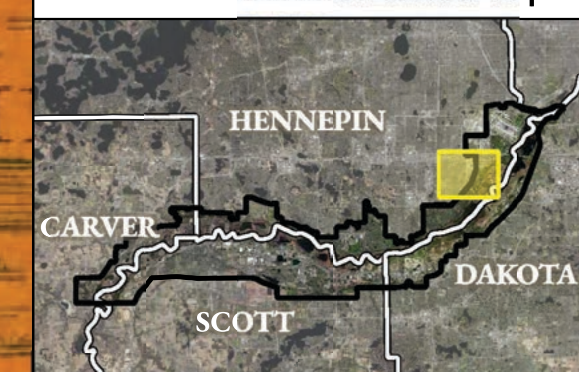
Figure 32:
Ike's Creek
Historic Watershed



LEGEND

- Ike's Creek (Present Day)
- Ike's Creek Present Day Watershed
- Ike's Creek 1896 Watershed
- Historic USGS Quad Sheets (1896)

LMRWD Watershed Location Map



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LOWER MINNESOTA RIVER WATERSHED DISTRICT

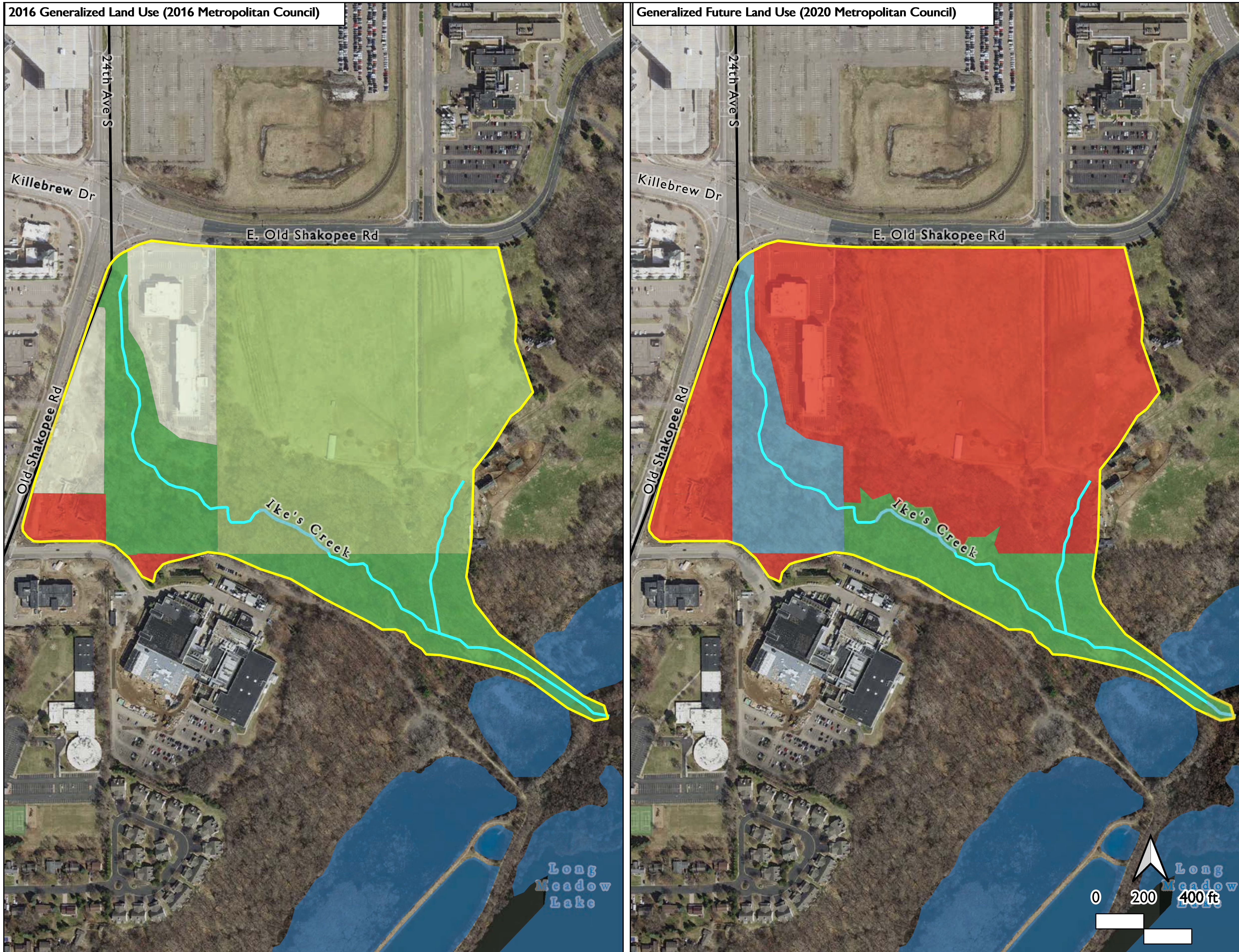
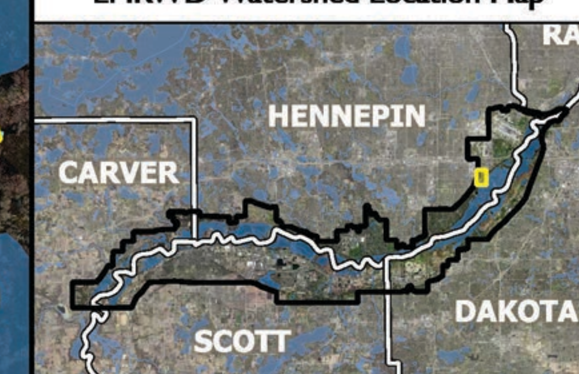


Figure 33: Ike's Creek Watershed Land Uses

LEGEND

- LMRWD Trout Streams
- Ike's Creek Watershed
- Generalized Land Use:
  - Agricultural
  - Mixed Use/Commercial/Industrial
  - Residential
  - Public / Quasi-Public
  - Park, Recreational, or Preserve
  - Transportation
  - Undeveloped
  - Open Water
- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map



Young Environmental Consulting Group, LLC

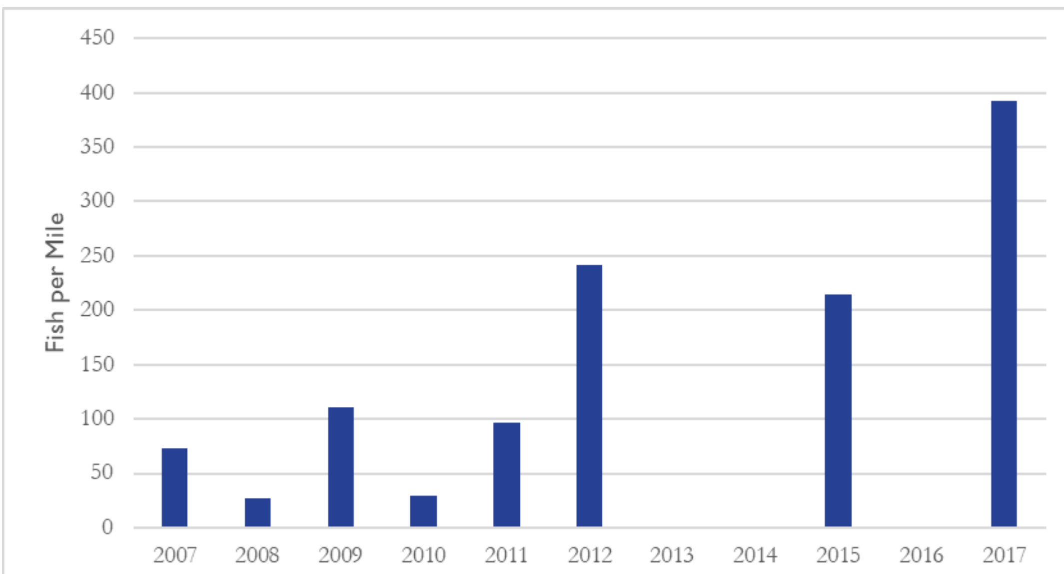
LOWER MINNESOTA RIVER WATERSHED DISTRICT

6.2 Fisheries

The MnDNR had previously stocked Ike's Creek in 1993; however, records prior to that are unclear. Records from the Isaak Walton League of America indicate an abundant brook trout population at that time, but that population died out for unknown reasons (J. Harris 2017; Niskanen 2007a).

In 2007, brook trout were reintroduced to Ike's Creek by stocking the creek with 1,450 fingerling heritage brook trout, of which approximately 200 survived (Nerbonne 2007). The creek has been sampled regularly since reintroduction, with the goal of establishing a population of 500 brook trout per mile, which was achieved for the first time in 2017 (J. Harris 2017). A summary of the MnDNR fish counts is provided in **Figure 34**. It should be noted that while the figure does not show 500 fish per mile, the surveys may estimate the number of trout in the stream and, if expanded to trout per mile, would be close to or exceed the 500 trout per mile goal (Nemeth 2022).

Figure 34. Ike's Creek MnDNR brook trout counts 2007–2017.



Ike's Creek is small, and it is likely the trout population will always be small as a result. A danger of a smaller population in streams is that they will be more susceptible to overharvesting and genetic bottlenecks (Nerbonne 2007), even if fishing is not allowed in Ike's Creek.

6.3 In-Stream Habitat

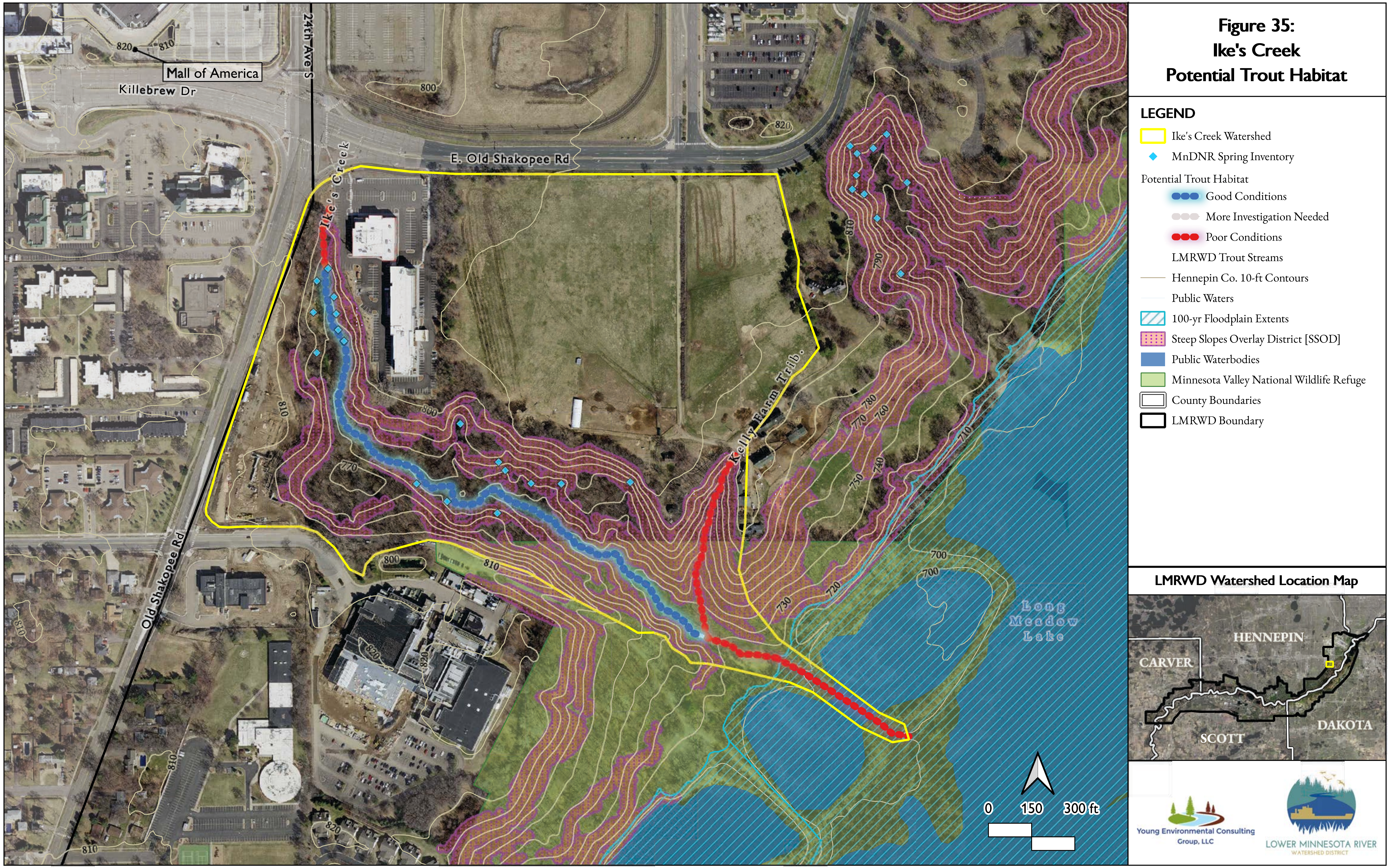
Ike's Creek substrate is a mix of gravel and sand, with a moderate amount of silt deposited in the pools and runs of the creek. The lower portion of Ike's Creek is occasionally inundated with floodwaters, causing silt deposition, which can be harmful to trout. Upstream, the creek is nearly silt-free. Riparian vegetation along Ike's Creek is variable, with wetlands in some areas and forests in others. In-stream habitat includes logs, in-stream vegetation, woody debris, root wads, deep pools, and overhanging vegetation. Sparse in-stream vegetation is found on the lower portion of Ike's Creek, but upstream areas have prolific in-stream vegetation, with some portions completely covered in watercress. Although watercress is a known indicator of cold, clean water, neither of these conditions are ideal for trout, as the excess vegetation could present a blockage to fish, while the lack of vegetation downstream can make them vulnerable to predation. The creek has one good bend, with a consistent current creating a good drift for trout, near the western portion along with fair channel pool/riffle sequence development, which is preferred by trout (Berg et al. 2019).

Sediment inflows from gully formation along the Kelly Farm tributaries and the steep banks of the lower reaches are of concern. Noted in 2007, in addition to causing sedimentation in Ike's Creek, the tributary carries manure, which, when deposited downstream in Ike's Creek, can lower dissolved oxygen levels to lethal levels (Nerbonne 2007).

Moderate bank erosion was intermittently observed in 2019, as well as what may be multiple knickpoints, which could indicate channel downcutting and instability. It is unclear if the identified knickpoints are in fact accumulated marl on debris in the creek. Marl is a calcium carbonate deposit and can deposit on organic material in the creek. The MnDNR has observed several marl deposits on fallen trees, and they speculate it could be mistaken for a knickpoint. If true knickpoints were identified, then it is a significant stability concern; however, if instead they are naturally occurring marl deposits, then the creek may be relatively stable (Barr Engineering Co. 2019).

A fish migration project was completed in 2012 to remove the Izaak Walton dam, reconstructed with a series of small, less than 6-inch, weirs, to re-meander the stream to provide a better habitat and restore streambank vegetation with native plants (Sparrow 2013). A small impoundment still exists near the upstream origins of the creek and is the only remaining fish barrier on the creek (J. Harris 2017). A summary of the trout habitat conditions on Ike's Creek is provided in **Figure 35**.

Figure 35: Ike's Creek Potential Trout Habitat

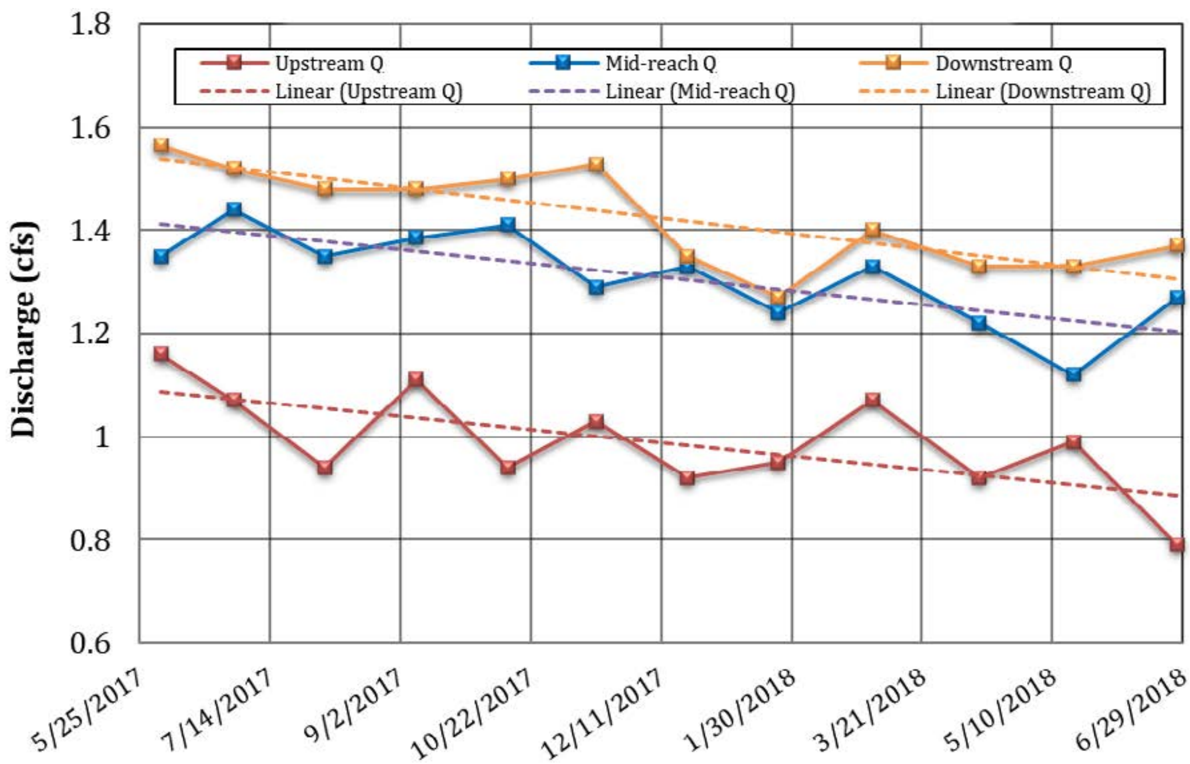


6.4 Streamflow

The creek is fed primarily through the discharge of cold groundwater and presently receives negligible surface inflow (**Figure 31**). Many of the surface discharges have been diverted elsewhere to protect the integrity of the creek and reduce the possibility of warm water entering the creek, which could adversely affect trout habitat. While most surface water discharges have been diverted, there remains at least one culvert that discharges parking lot drainage directly to the creek (Nemeth 2022). Trinity School at River Ridge had been collecting stream water data for years before the Minnesota Valley National Wildlife Refuge discovered it could support trout in 2005 (Niskanen 2007b).

Streamflow estimates from 2017 describe that the streamflow was about 1.0 cubic feet per second (cfs) upstream and ranged from 1.27 to 1.56 cfs downstream. A monthly flow measurement study was done in 2018 and noted an apparent downward trend in total discharge (**Figure 34**). This study concluded that, because there are no permanent stream gages located on Ike's Creek, a long-term monitoring station is needed to determine whether the 2018 observations were a true trend (Kiefer 2018).

Figure 36. Ike's Creek 2017–2018 monthly measured flows (Kiefer 2018).



Surface water conditions were measured in 2019 at Ike's Creek throughout its stream length until the creek flowed into Long Meadow Lake. Surface water temperatures remained relatively constant throughout the creek's length and were consistent with the temperature of groundwater inflow throughout the creek. Due to this, the measurements show Ike's Creek is a gaining stream throughout its entire length until it enters Long Meadow Lake (Berg et al. 2019).

Temperature measurements of Ike's Creek suggest its waters are well within the optimal range of temperatures needed for trout. Temperature monitors deployed during June through November 2008 provided values that ranged from 55 to 65° Fahrenheit (F) and usually were below 60°F (Nemeth 2020a).

6.5 Groundwater

At least 17 springs have been identified along Ike's Creek and were surveyed in 1983 by the MnDNR. Combined, they provide an estimated baseflow of 0.5 cfs to Ike's Creek and have an average temperature of 50 degrees Fahrenheit. Many of these springs were visited again in February 2016 and confirmed to still be flowing (Minnesota Department of Natural Resources 2020e).

Nyquist et al. (2020) studied the macroinvertebrate population in Ike's Creek and noted it originates from springs of upwelling groundwater. It is assumed that this water is from a surficial aquifer in the glaciofluvial deposits, which might be warmer than water from deeper aquifers. Surficial aquifers are more susceptible to contamination from land uses above the aquifer than deeper aquifers. The bedrock geology suggests that, as the creek flows downhill, it intersects with deeper aquifers in the dolomitic Prairie du Chien Group, which may be a source of calcium carbonate deposits observed in the creek. This research also shows that winter creek temperatures averaged about 53.6°F near the creek origin to about 41.9°F in the lower reaches, suggesting a changing dominance from warmer surficial groundwater to colder, deeper groundwater.

From follow-up discussions with Dr. Ferrington, knowing the thermal regime along the creek can help identify where groundwater has the most profound impact and can help create better trout habitat projects. Brook trout were found congregating in areas that had winter temperatures between 46 and 54°F, near where the warmer surficial groundwater entered the channel. In the summer, trout migrated to the colder springs in the lower reaches. The surficial aquifer, especially given the heavily urbanized landscape above it, should be investigated further to protect this source of baseflow into Ike's Creek.

6.6 Geochemistry and Water Quality

The MnDNR Spring Inventory measured the dissolved oxygen of the springs that feed Ike's Creek in 1983, showing a range from 2 to 10 mg/L, with an average pH of 7.5, spanning the range of ideal trout habitat. The 2016 site visits provide more information on many of the springs, including documenting several calcite and iron deposits (Minnesota Department of Natural Resources 2020e). Because of the suspected marl deposits observed in the creek, it can be assumed that creek waters usually are nearly saturated with respect to calcium carbonate.

Ike's Creek has been experiencing an influx of chloride and has been sampled for chloride since 2017, and despite much of the surface drainage having been directed away from the creek, the suspected cause of the chloride concentrations in the stream are from road salt application and contributions from the Kelly Farm tributary, which continues to supply some runoff to the creek. Researchers have expressed concern that it may contribute runoff harmful to the creek (Nerbonne 2007).

The MCES has collected samples from two sites on Ike's Creek on behalf of the USFWS, the LMRWD, and other stakeholders and analyzed them for select major ions and related water quality indicators. The samples were collected on the same date at stream miles 0.6 and 0.2 miles upstream of the mouth from late March to late June 2021 and December 2021 through April 2022, and most samples were analyzed for the same suite of constituents. This sampling is an ongoing effort and is summarized in **Table 12**.

Table 12 is organized in a downstream order, Mile 0.6 to Mile 0.2, suggesting how the stream quality might change along its course. As the water flows downstream, the temperature gets colder while the dissolved oxygen increases, both of which are more conducive to trout habitat. The pH goes from neutral to slightly alkaline. For many constituents, there is a dilution effect that may be from the tributary streams or inflow from various springs encountered as the stream flows to its mouth. The chloride concentration is notably high, well above the 230 mg/L standard for the protection of aquatic life (MPCA 2018). Chloride and other constituents often are associated with runoff from urban areas, which may suggest the vulnerability of Ike's Creek to contamination from urban runoff.

It is expected that this sampling will continue providing additional data that could be used to identify trends. It may be important to assess whether the concentration of chloride or other constituents needs to be reduced in Ike's Creek to maintain a healthy habitat for trout and other coldwater organisms.

Table 12. Summary of MCES samples collected from Ike's Creek 2021–2022.

	Mile 0.6				Mile 0.2			
	Count	Mean	Max	Min	Count	Mean	Max	Min
Water Temperature (°C)	17	12.9	12.2	13.7	17	9.6	5.1	15.7
Dissolved Oxygen (mg/L)	17	6.3	4.8	7.3	17	11.0	8.8	12.6
pH[1]	16	7.1	6.9	7.2	17	7.8	7.6	8.0
Conductivity (µS/cm)	17	2,381	2,267	2,464	17	1,895	1,841	1,938
Alkalinity (mg/L as $CaCO_3$)	17	353	185	399	17	319	171	357
Calcium (mg/L)	16	167	151	177	16	135	123	147
Chloride (mg/L)	17	578	549	634	17	422	383	466
Magnesium (mg/L)	16	42	39.4	44.5	16	38	35.3	39
Sulfate (mg/L)[2]	8	52	48	54.8	8	47	38.7	54
Hardness (mg/L as $CaCO_3$)	16	591	550	620	16	493	460	527

[1] The "mean" pH in this table is the average of the pH readings, not the mathematical average of the actual pH.
[2] Eight sulfate samples from Mile 0.6 were summarized.

6.7 Public Access

The Minnesota Valley Wildlife Refuge provides limited access to lower portions of Ike's Creek via the Bass Pond Trail. Other access points are not well documented but may have been identified during a geomorphic assessment that was conducted during 2019. The U.S. Fish and Wildlife Service, the City of Bloomington, and a private landowner each own different parts of Ike's Creek; however, there are public trails along part of the stream, which provide accessibility (Berg et al. 2019).

Fishing is prohibited on Ike's Creek, making it unlikely the MnDNR would consider designation of Ike's Creek as a state trout water. While limiting to anglers, this prohibition ensures the newly stocked trout population can become established. However, awareness of this resource is growing, and consideration may need to be given in the future to allowing catch-and-release fishing, should both the demand and trout population be sufficient.

Illegal watercress harvests within the creek area have been noted to be a problem (Nerbonne 2007) because the harvesting damages the stream and its banks. Watercress provides a habitat and food source for macroinvertebrates, as well as cover for stream trout.

6.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4, the following tables highlight the data gaps needed to determine the quality of trout habitat in Ike's Creek. The minimum and optimal criteria are shown in the following tables.

Table 13. Ike's Creek spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Partial**
Adult Access: Jump Height < 1 ft	**Partial**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**Unknown**
Constant Baseflow	**Yes**
Gravel Substrate	**Yes**
Protection from Flooding	**Partial**

Table 14. Ike's Creek summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Min. Water Temperatures < 72°F	**Yes**
Optimal Dissolved Oxygen ≥ 9 mg/L	**Partial**
Optimal Water Temperatures < 57°F	**Partial**
Healthy Macroinvertebrate Population	**Partial**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Unknown**
Cover > 6 in	**Unknown**

Table 15. Ike's Creek overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Constant Baseflow or Deep Pools	**Yes**
Cover ≥ 15% of Total Stream Area	**Yes**
Healthy Macroinvertebrate Population	**Yes**
Juvenile Access: Jump Height < 1 ft	**Partial**
Juvenile Access: Velocity < 0.3 fps	**Unknown**
Juvenile Access: Cover > 6 in	**Unknown**

Based on the information presented and wealth of data in terms of groundwater inflows, optimal temperature regimes, and vegetative cover, Ike's Creek contains all the necessary characteristics of a trout water. It meets the minimum criteria for trout habitat, and many of the optimal criteria as well; however, some of the necessary data to evaluate the optimal criteria have not been collected to date. For example, stream velocities and channel depths throughout the reaches are not known to adequately determine whether trout access and migration is possible. Detailed channel surveys and either monitoring of flows or predictive modeling would be beneficial for determining whether trout can freely migrate up and down the creek.

Streamflow information in Ike's Creek is limited to measurements or estimates made during stream surveys. Without a continuous record of flow or monitoring data, it is difficult to determine whether any trends are occurring. In addition, understanding the winter baseflow of Ike's Creek may be critical because of the importance of winter habitats for trout and their food sources, which often rely on the warmer waters during their life cycle.

Ike's Creek overall is a good habitat for trout, but it is unclear why the native fish population disappeared from the creek. Habitat conditions are suitable, so it is possible a catastrophic event may have wiped out the native population, with no means of replenishment. Runoff from Kelly Farm may include manure, which could lower dissolved oxygen to lethal levels and increase sediment deposits, which could alter the habitat.

6.9 Management Strategies

As an existing trout water with the potential for the resident brook trout population to thrive, Ike's Creek is a preservable trout water. Management strategies should be geared toward managing it as a trout water to preserve it for future generations. The following are the major concerns for Ike's Creek:

1. **Groundwater:** Little is known about the variability and reliability of the groundwater springs and seeps that are the primary source of flow to the creek. The areas of recharge that supply water to the creek are poorly identified, so their susceptibility to contamination is poorly understood. Competing withdrawals of groundwater from aquifers that discharge to the creek also could have an adverse effect on streamflow. Temperature probes and water chemistry sampling can help indicate the age of groundwater discharging to the stream and add to the understanding of the aquifers supplying water to the creek.

2. **Channel Stability:** The data review indicates many concerns regarding the stability of the streambanks, as well as recommendations to investigate knickpoints/marl issues to determine whether a stability issue is present and develop a definitive conclusion regarding channel stability in the creek, as well as recommendations to stabilize the banks with shrubs or trees, if necessary.

3. **Sediment Inflows:** Several areas of bank erosion, severe gully erosion, and pipe outfalls have been identified by the LMRWD that could be contributing to sedimentation in the lower reaches. The Kelly Farm tributaries have also been a continued source of concern for the viability of the brook trout population.

Based on the data reviewed, the following specific strategies are recommended for Ike's Creek and summarized in **Table 16**:

- **IC-0:** Continue to implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek as the watershed develops in the future.
- **IC-1:** Gully and Channel Restoration Feasibility Study: The 2019 Geomorphic Study identified potential channel downcutting and bank erosion locations, and the 2020 Gully Inventory and Condition Assessment project identified three pipe outfalls and five gully locations within the Ike's Creek watershed. The LMRWD, City of Bloomington, and USFWS should continue to work together to prioritize and restore these sources of sediment entering Ike's Creek.

- **IC-2:** Establish a real-time, long-term flow monitoring gage on Ike's Creek to determine whether the creek is experiencing a decline in base flows.
- **IC-3:** Continue to coordinate with the MnDNR for future stream re-surveys of Ike's Creek.
- **IC-4:** Continue to coordinate with the USFWS and MCES on the future chloride monitoring of Ike's Creek.
- **IC-5:** Develop a groundwater monitoring plan for Ike's Creek.
- **IC-6:** Establish a protocol for macroinvertebrate surveys, including identifying potential project partners.
- **IC-7:** Given the small nature of the creek and growing popularity, coordinate with the MnDNR and USFWS to evaluate the need for additional regulations to protect the trout fishery.
- **IC-8:** Reassess the 2019 Geomorphic and Habitat Assessment and 2020 Gully Inventory sites to evaluate changes over time.
- **IC-9:** Based on the outcomes from IC-1 implement restoration projects on the Kelly Farm tributaries.

Table 16. Ike's Creek management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
IC-1	Gully and Channel Restoration Feasibility Study	Study	2022
IC-2	Real-Time Flow Monitoring	Data Collection	2022
IC-3	MnDNR Stream Re-Surveys	Data Collection	2022
IC-4	Chloride Monitoring	Data Collection	2022
IC-5	Groundwater Monitoring Plan	Data Collection	2023
IC-6	Macroinvertebrate Monitoring	Data Collection	2024
IC-7	Review Fishing Demand	Study	2025
IC-8	Geomorphic Assessment and Gully Inventory Condition Assessment Update	Study	2026
IC-9	Kelly Farm Tributary Restoration	Capital Improvement	2027

7.0 KENNALEY'S CREEK

Kennaley's Creek (Tributary Number M-55-4-0.5) is a less than a mile-long stream located in Dakota County within the City of Eagan (**Figure 37**). It is an MnDNR-designated trout water, is not actively managed, and does not have any fishing access easements. Kennaley's Creek has a relatively large watershed of 419 acres, with 660 feet of length considered suitable for trout habitat, and about 15 percent of the watershed is developed. Unnamed 1 enters Kennaley's Creek before just upstream of its confluence with the Minnesota River. The Nicols Meadow fen complex is in the middle of the Kennaley's Creek watershed.

Kennaley's Creek originates from a series of springs and seeps south of the Union Pacific railroad and passes under the railbed via a 5-foot metal culvert, constructed in 1993, which replaced the original bridge crossing (WSB & Associates 2008). It was named after the property owner, Thomas Kenneally, whose surname and creek has been subject to various misspellings, since before his death in 1861 (Burnsville Historical Society 1903). Ultimately the family name was established as Kennealy, whereas the creek was named in state statute as Kennaley's.

7.1 Watershed History and Land Uses

The watershed was at one time much larger and outlet directly into Black Dog Creek, but major changes in the landscape, including the construction of Cedar Avenue (TH77) and channel straightening have reduced the watershed area to only a fraction of what it was in 1896 (**Figure 38**). The watershed is relatively flat, especially near the mouth, and is primarily surrounded by wetlands. The creek channel is subject to flooding almost annually after it emerges from beneath the Union Pacific railroad to its confluence with the Minnesota River.

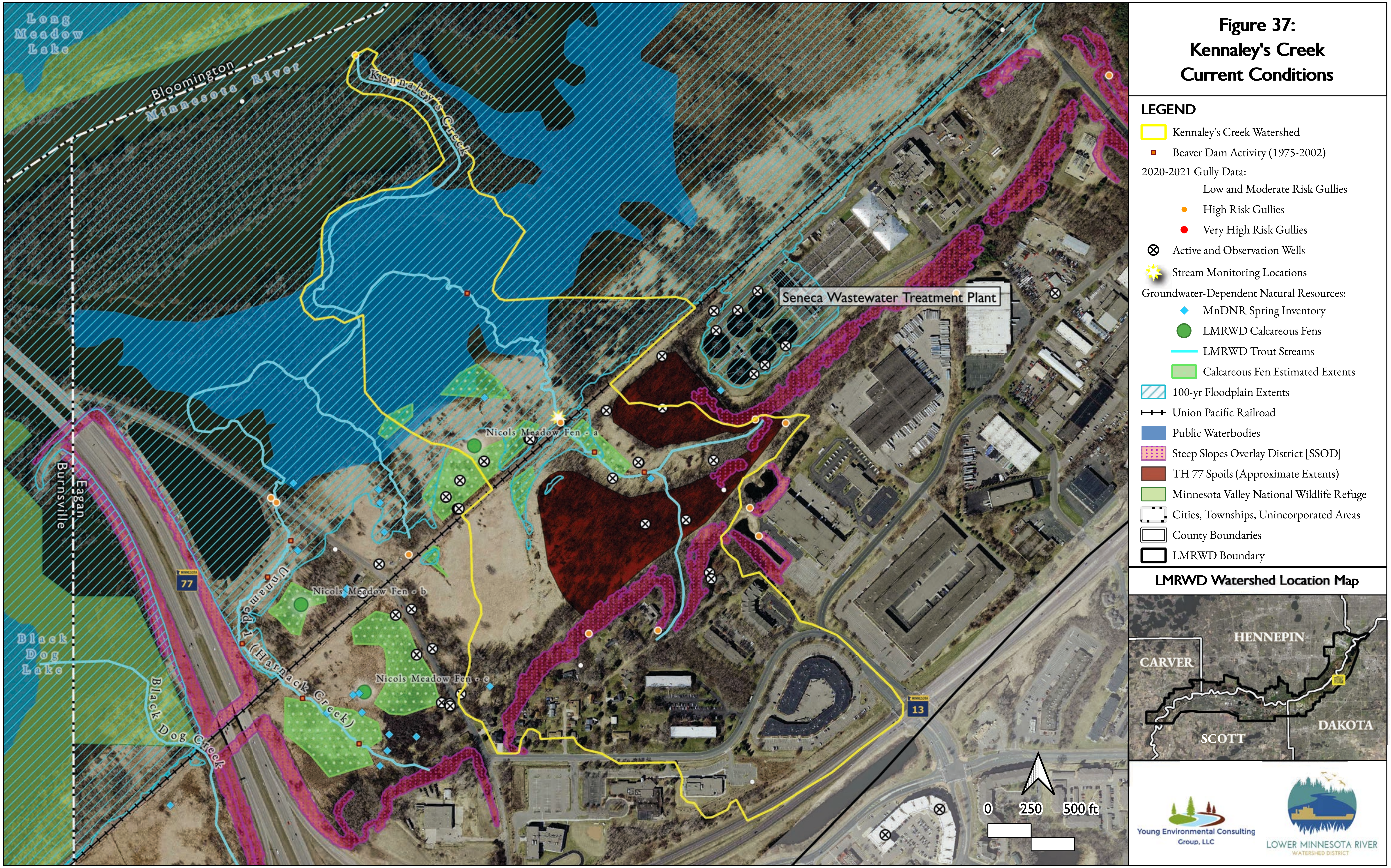


Figure 37:
Kennaley's Creek
Current Conditions
LEGEND
Kennaley's Creek Watershed
Beaver Dam Activity (1975-2002)
2020-2021 Gully Data:
Low and Moderate Risk Gullies
High Risk Gullies
Very High Risk Gullies
Active and Observation Wells
Stream Monitoring Locations
Groundwater-Dependent Natural Resources:
MnDNR Spring Inventory
LMRWD Calcareous Fens
LMRWD Trout Streams
Calcareous Fen Estimated Extents
100-yr Floodplain Extents
Union Pacific Railroad
Public Waterbodies
Steep Slopes Overlay District [SSOD]
TH 77 Spoils (Approximate Extents)
Minnesota Valley National Wildlife Refuge
Cities, Townships, Unincorporated Areas
County Boundaries
LMRWD Boundary
LMRWD Watershed Location Map
HENNEPIN
CARVER
SCOTT
DAKOTA
Long Meadow Lake
Bloomington
Minnesota River
Kennaley's Creek
Seneca Wastewater Treatment Plant
Nicols Meadow Fen - a
Nicols Meadow Fen - b
Nicols Meadow Fen - c
Unnamed 1 (Harnack Creek)
Black Dog Lake
Black Dog Creek
Eagan
Burnsville
77
13
0
250
500 ft
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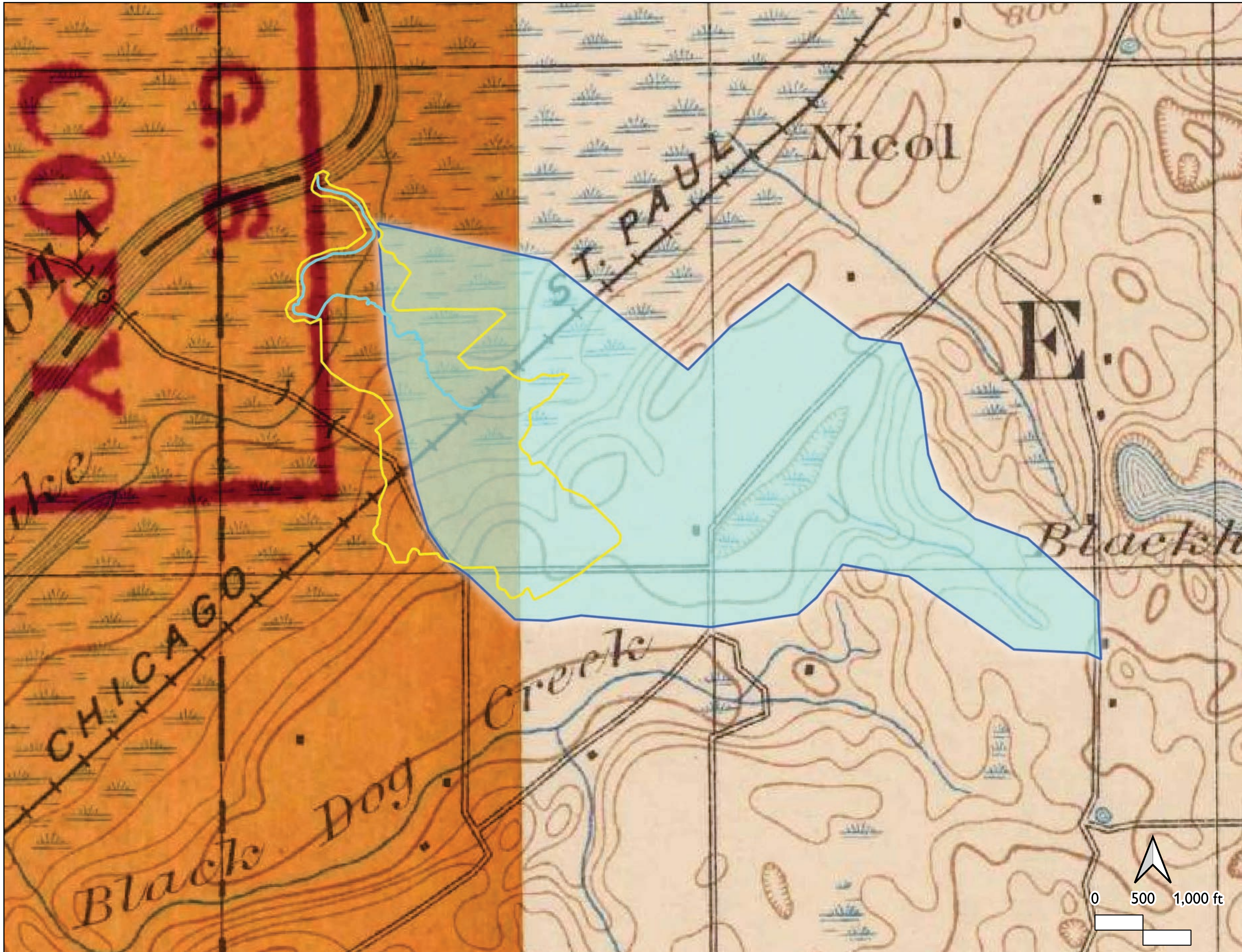
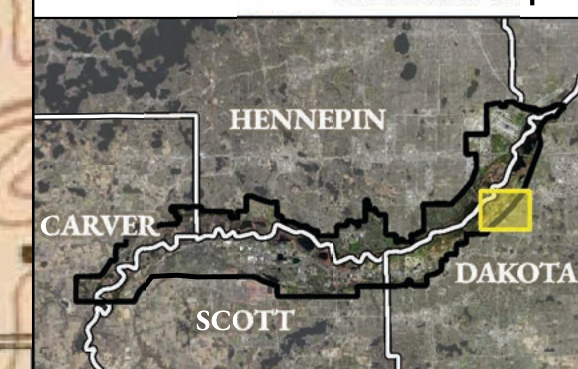


Figure 38: Kennaley's Creek Historic Watershed

LEGEND

- Kennaley's Creek (Present Day)
- Kennaley's Creek Present Day Watershed
- Kennaley's Creek 1896 Watershed
- Historic USGS Quad Sheets (1896)

LMRWD Watershed Location Map



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The Chicago St. Paul Railroad (now Union Pacific) has bisected the Kennaley's Creek watershed since the late 1800s (Gannet and Renshawe 1896; Mills 1919). The small community of Nicols Station, named for the Nicols flag station constructed in 1867, grew as part of the Minnesota River Valley onion farming boom. In 1890, the Old Cedar Avenue Bridge was constructed west of Kennaley's Creek to connect Dakota County to the City of Bloomington on the north side of the Minnesota River (Eagan Historical Society 1998). By the early 1900s, Nicols became known as the "Onion Shipping Capital of America." Around this time, Nicols also became well-known for its molding sand, a rare, naturally occurring combination of silica sand and clay, used by metal foundries until the 1950s. The onion and sand industries supported this small but thriving town. Due to the town's renown, this area and the nearby Nicols Fen became popular fishing and recreation sites (Dakota County Historical Society 1989). A 2001 interview with the then current landowner, Joe Kennealy, provides a background on the history of Kennaley's Creek. In the 1920s and 1930s, residents from St. Paul and Minneapolis traveled to Nicols to fish the creek during trout season (Callahan 2015b). During the Great Depression, Thomas Kennealy, Joe's father, accepted an offer to dam Kennaley's Creek to create trout rearing ponds. The ponds were constructed, but this venture ultimately proved to be unsuccessful (WSB & Associates 2008). In 2002, it was noted that Kennaley's Creek still contains remnants of the constructed dams (Moeckel 2002).

The stream continued to support a lightly fished and naturally reproducing brook trout population, but that began to decline in the 1960s. With the diminishment of brook trout, the MnDNR began to annually stock the stream with rainbow trout as a "put-and-take trout fishery" (Stewart 2004).

In 1977, Old Cedar Avenue was replaced with the construction of the TH 77 Bridge and roadway, removing the connection between Kennaley's Creek and Black Dog Creek (WSB & Associates 2008). In addition to permanently altering the alignment of many creeks, the TH 77 project also introduced stormwater runoff into the creek watershed from the highway and altered the upper reaches of the Kennaley's Creek watershed. Several communications discussed the importance of reducing the effects of storm drainage to the creek to sustain trout habitat. Severe habitat degradation occurred when spoils from the construction of the TH 77 project were "dumped in a horseshoe pattern around the headwater area of its watershed" (Gilbertson and Ramsell 1994).

Today, Kennaley's Creek watershed is primarily undeveloped or part of the Fort Snelling State Park. Land use could change in the upper undeveloped reaches, with the City of Eagan's projected 2030 land uses, including an expansion of the existing commercial and industrial developments, though the special waters protection afforded by nearby Nicols Fen may affect the development potential. (Metropolitan Council 2016, 2020; **Figure 39; Table 17**).

Table 17. 2016 and future generalized land uses within the Kennaley's Creek watershed (Metropolitan Council 2016, 2020).

	2016 Area (ac)	Future Area (ac)	Change (ac)
Park, Recreational, or Preserve	47	47	0
Undeveloped	52	0	-52
Mixed Use/Commercial/Industrial	10	57	47
Transportation	4	3	-1
Residential	24	30	6

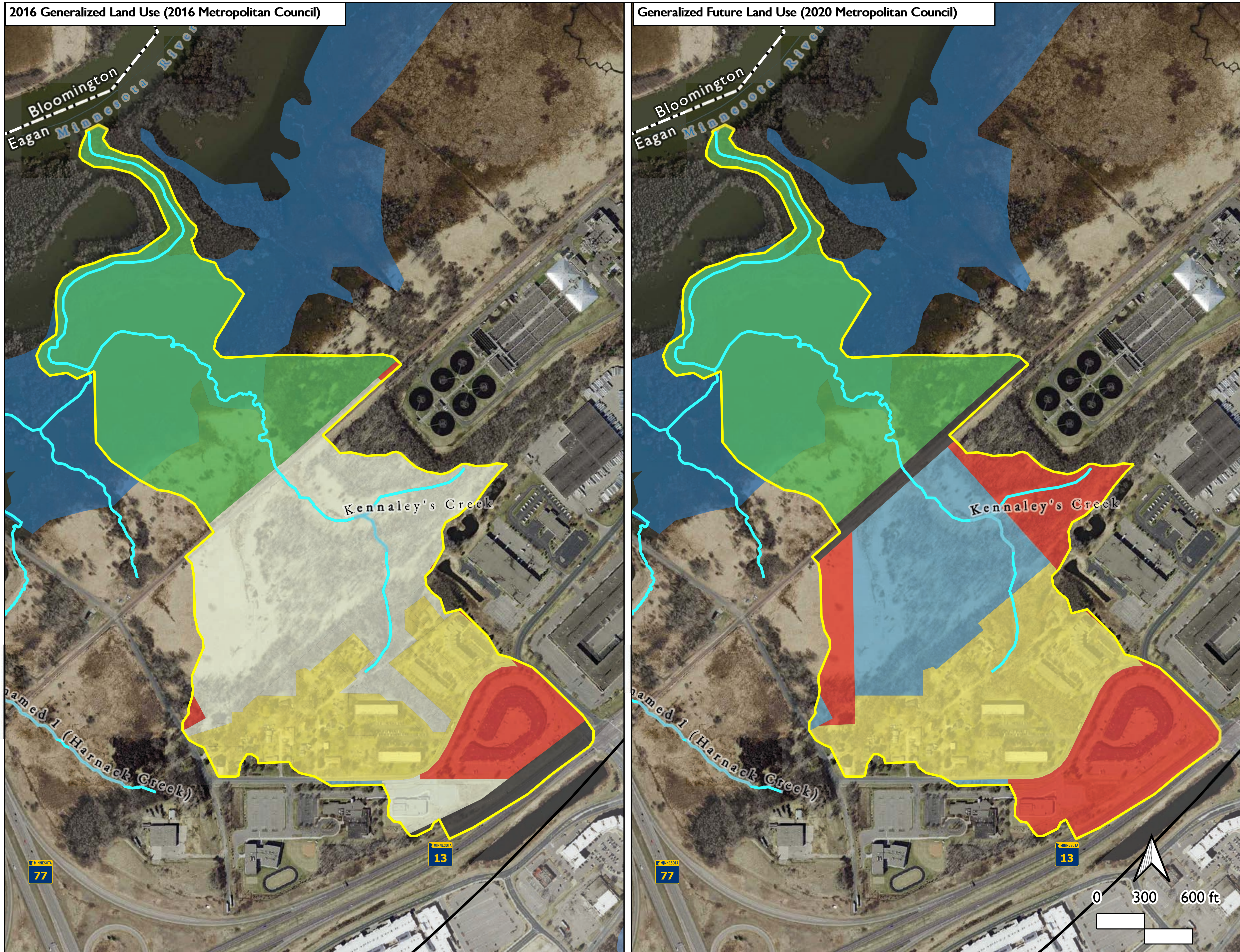
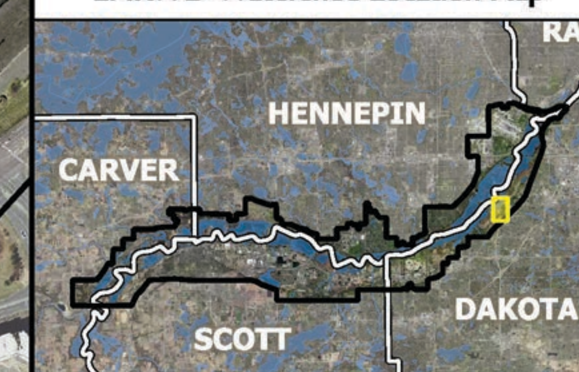


Figure 39: Kennaley's Creek Watershed Land Uses

LEGEND

- LMRWD Trout Streams
- Kennaley's Creek Watershed
- Generalized Land Use:
  - Agricultural
  - Mixed Use/Commercial/Industrial
  - Residential
  - Public / Quasi-Public
  - Park, Recreational, or Preserve
  - Transportation
  - Undeveloped
  - Open Water
- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map



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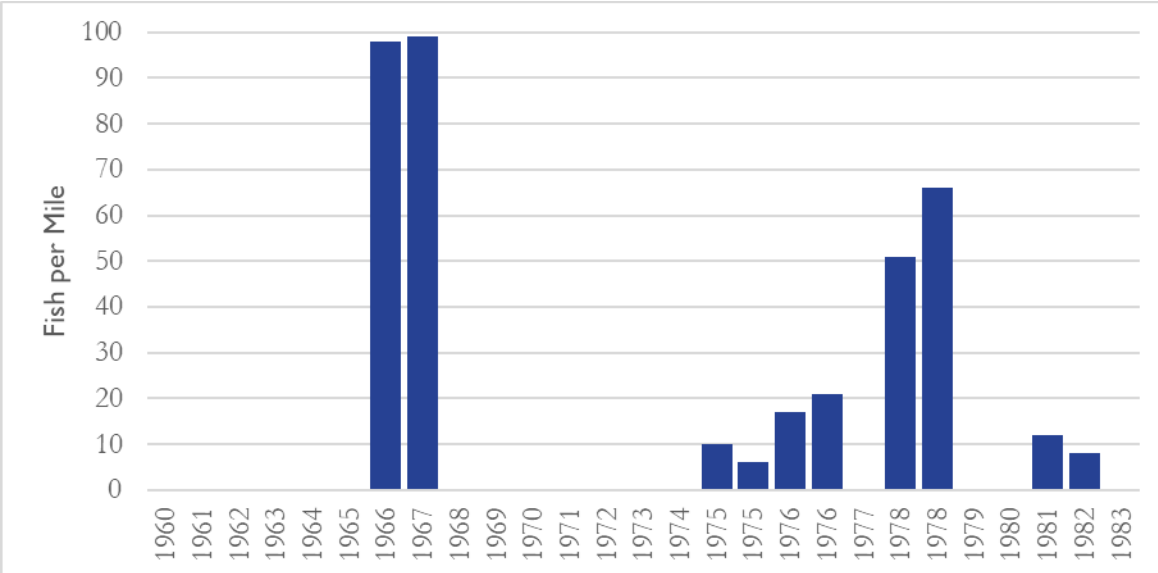
7.2 Fisheries

Kennaley's Creek supported a naturally reproducing brook trout population; however, the MnDNR began stocking the creek with 498 rainbow trout in 1947 when it was determined the creek had the potential to support a "small trout population and limited fishing pressure." The creek was stocked annually with rainbow trout as a put-and-take fishery starting in 1947, and it was recommended that brook trout also be stocked in 1962 up to three times a year to keep up with the heavy fishing demand (Huber 1962).

The MnDNR began stocking brook trout in 1963, with 152 yearling trout, but due to the significant lack of "good pools for supporting catchable size trout," the MnDNR recommended resuming rainbow trout stocking and holding off on future brook trout stocking until the habitat was improved (Minnesota Department of Conservation 1968). Records from the MnDNR show that the stream was stocked with rainbow trout until 1974.

During the MnDNR stream assessments that were conducted over several decades, it was suggested that, in its present state, the stream did not have a habitat robust enough to maintain a self-sustaining fishery, and that a managed fishery would be unlikely to provide a justifiable return on the invested resources. It was suggested that efforts could be made to improve the stream habitat, including increasing baseflow, adding structures to enhance the complexity of the stream bottom, and enhancing riparian vegetation. According to the MnDNR, no trout have been captured in Kennaley's Creek since 1982 (**Figure 40**; Nemeth and DeBates, 2020).

Figure 40. Summary of MnDNR fish counts on Kennaley's Creek (1960–1983).

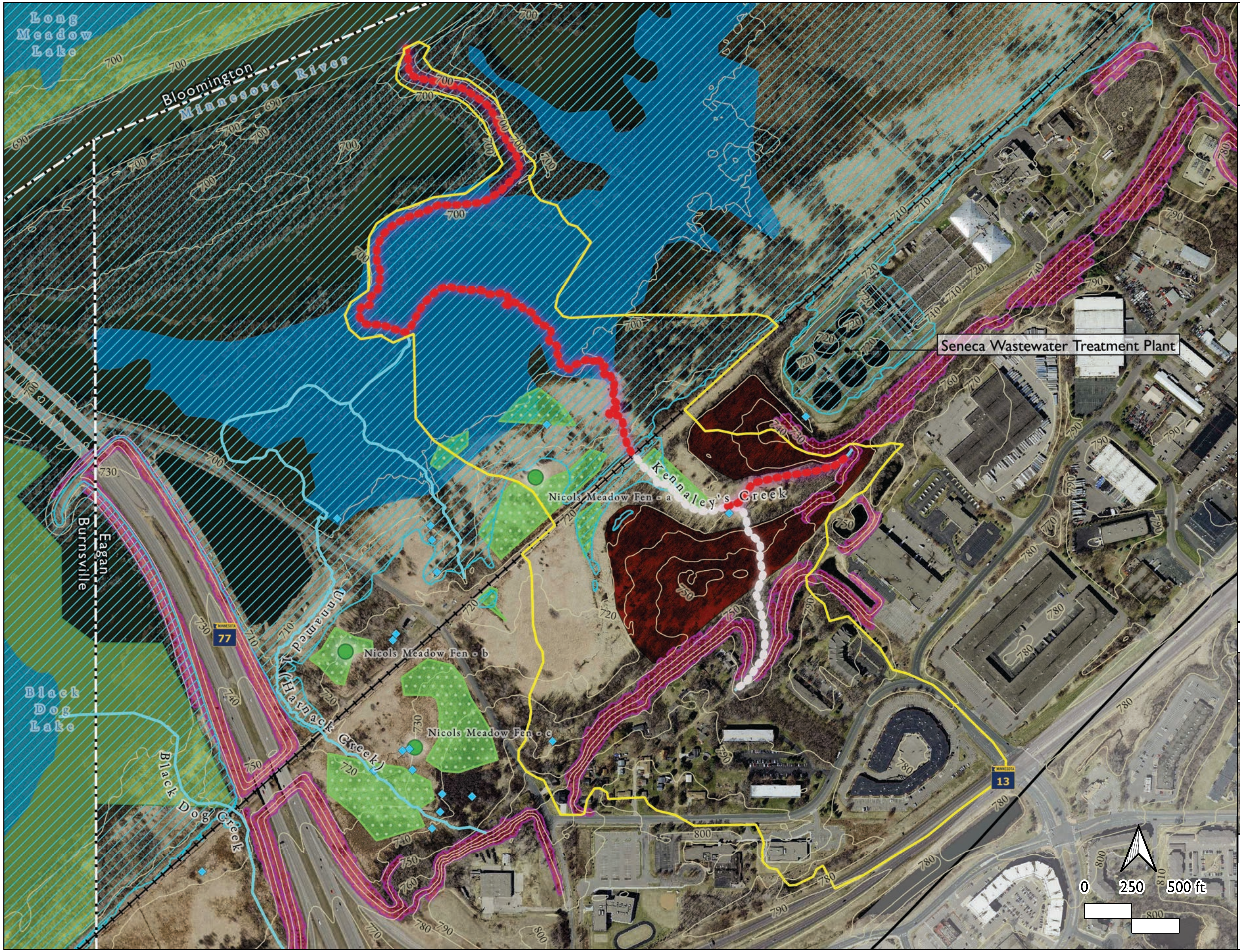


7.3 In-Stream Habitat

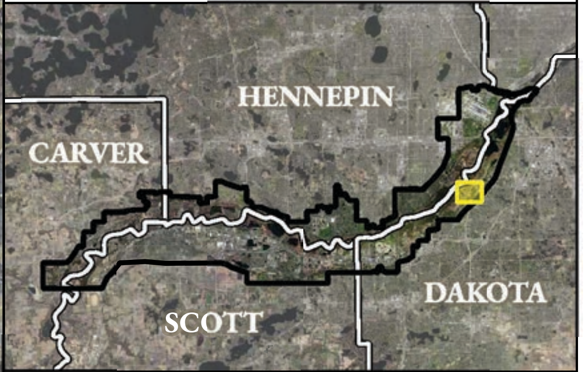
In 1960, Kennaley's Creek was surveyed, and, from the data at the time, we met the majority of the trout habitat criteria presented in Sections 1.3 and 1.4. At the time, it was determined the creek had "the characteristics of a small, moderately good trout stream" (Huber 1962). In 2003, when the MnDNR resurveyed the creek, it had adequate temperatures and dissolved oxygen; however, very little flow was present in any of the reaches. The survey stated there was no suitable reaches for brook trout on Kennaley's Creek due to low flow and the limited habitat (Stewart 2004).

In 2002, the MnDNR identified the reach with the highest potential for trout habitat was in the 1,200-foot reach downstream of the railroad tracks, as this reach had more gravel in the channel bed and deeper pools and riffles. Additionally, it was unaltered from its original stream path over the years (Moeckel 2002). In 2003, it was also observed that the bottom substrate was inadequate for redd building—and that "These habitat limitations have occurred because of the inadequate stream flow to develop and maintain stream morphology suitable for trout" (Stewart 2004). Unfortunately, this reach of suitable trout habitat is also partially affected by flooding from the Minnesota River, which may be subject to the accumulation of fine sediments during flood events that can smother and deprive trout eggs of oxygen in their redds (**Figure 41**).

Figure 41:
Kennaley's Creek
Potential Trout Habitat



LMRWD Watershed Location Map



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The 2019, a geomorphic assessment noted channel instability, including large knickpoints and channel incisement, but that further observations and data were needed to determine whether Kennaley's Creek had a suitable trout habitat (Berg et al. 2019). This report did not offer where these specific locations of channel instability were located on Kennaley's Creek.

The LMRWD *2021 Gully Inventory and Condition Assessment* field work identified several gullies in the upper watershed that may be contributing to sediment in the channel (**Figure 37**), including a large gully behind Wuthering Heights Road. Residents have observed that portions of the gully have filled in with three feet of sediment over the past 30 years, but other areas are actively eroding (**Figure 42**). Residents have attempted to slow down the erosion by dumping brush, logs, boulders, and concrete in this area (**Figure 43**). Continued erosion in the upper reaches of the watershed may degrade in-stream habitat by covering spawning areas and creating blockages to fish passage.

The Union Pacific culvert also presents a major blockage to fish migration. As observed on October 13, 2020, it was significantly higher than the channel thalweg and would likely present an insurmountable jump for trout species (**Figure 44**).

Figure 42. Gully behind Wuthering Heights Road and private residents' efforts to prevent erosion.

Figure 43. Gully stabilization attempt behind Wuthering Heights Road.

Figure 44. Kennaley's Creek downstream of the Union Pacific culvert, October 13, 2020.

7.4 Streamflow

Kennaley's Creek was never a large stream; going back to 1960, the total flow was only 1.25 cfs (Huber 1962). By 1990, the creek was nearly dry, and the resident brook trout population had disappeared. The disappearance of the brook trout has been assumed to be due to the dewatering activities caused by the expansion of the Seneca Wastewater Treatment Plant (WWTP; Gilbertson and Ramsell 1994). Due to the WWTP's proximity to Kennaley's Creek and 30 wells of various types on its property, this assumption has been has become a widely held belief, but more data are needed to identify all of the potential impacts that may have led to the loss of brook trout, including construction dewatering and stormwater infrastructure, before determining whether there is a causal relationship between the loss of brook trout in Kennaley's Creek and Seneca WWTP groundwater pumping.

Stream flows and temperature have been monitored since 1998, including bimonthly monitoring from the MCES. The highest temperature recorded in Kennaley's Creek was 65 degrees, and, in many years, the flow in the creek dropped below 0.5 cfs, including August 2004, when there was no flow in the creek (WSB & Associates 2008).

Streamflow and groundwater measurements have been collected for decades in the Nicols Fen, including sporadic monitoring of Kennaley's Creek itself. In 2002, stream flows were characterized as "predominantly cold, clean groundwater capable of sustaining a trout fishery," but that the Seneca WWTP was suspected of diverting groundwater away from the creek (Moeckel 2002). Since that time, there have been ongoing concerns that the stream flows have been affected by the Seneca WWTP operations.

The MnDNR confirmed that flows in Kennaley's Creek since the 1980s have been "somewhat tenuous for trout," including that the MnDNR has estimated the 2018 winter baseflow at about 0.5 cfs (Minnesota Department of Natural Resources 2020).

Stream surveys provide some information on the occurrence of macroinvertebrates in the stream, but there is no information on seasonal populations. On a stream of this relatively small size, characterization of macroinvertebrate populations during winter baseflow may be critical to determine whether trout can survive the winter. The iron flocculants used by the Seneca Plant may also limit invertebrate production and limit food sources (Gilbertson and Ramsell 1994).

On October 13, 2020, staff from Young Environmental, the LMRWD, and the MnDNR met on-site to review the current stream conditions. At the time of the visit, the creek was experiencing high flows; however, the MnDNR stated that typical winter flows are approximately half of what was observed. Watercress and healthy ferns observed also indicated clear, cold water in the channel (**Figure 44**).

7.5 Groundwater

Groundwater discharge has been identified as the primary source of water to Kennaley's Creek. The Seneca WWTP operates at least one 16-inch groundwater well that, as of February 2020, is actively pumped for dewatering the plant. Several of the stream surveys specifically identify dewatering at the plant as the cause for reduced baseflow in Kennaley's Creek, negatively affecting trout habitat; however, a hydrogeologic study has not been conducted.

A stream survey of Kennaley's Creek by the MnDNR noted, "The fen area from which the creek originates from was completely dry, as was the creek on Jul 31, 1990, due to the de-watering process the Seneca Treatment Plant employed during its expansion," and, in 1994, the MnDNR concluded that the brook trout population had been devastated (Bell 1991a; Gilbertson and Ramsell 1994). In 2002, an examination of pumping records at the Seneca WWTP documented that groundwater had been diverted away from Kennaley's Creek and may have been limiting the potential to support the trout population (Moeckel 2002).

It has been suggested that pumped water could be directed to the headwaters of the creek, thus sustaining the streams' flow, but concerns over chloride levels in the pumped water affecting Nicols Meadow Fen resulted in the pumped water being discharged to the Minnesota River instead (WSB & Associates 2002). It is unclear why the groundwater pumped from beneath the plant has elevated chloride concentrations.

If dewatering pumping rates are reduced in the future, then it may be possible to restore base flow levels to sustain the trout population. As it is, the groundwater inputs are not enough to keep the stream cool in the summer and warm in the winter.

It should be noted that the 1990 and 2003 MnDNR stream surveys implied that groundwater recharge activities have been attempted, including noting that "groundwater reinjection attempts have failed to reestablish adequate flow from springs and fens in the area," but both fail to detail when and who attempted to revive groundwater elevations (Bell 1991b; Stewart 2004). As part of the review of the Seneca WTP dewatering alternatives, any past attempts to reestablish groundwater elevations should also be evaluated.

7.6 Geochemistry and Water Quality

No geochemistry data were found for Kennaley's Creek itself, but stream surveys from 2003 confirm the dissolved oxygen levels meet trout requirements, at 7.5 ppm (Stewart 2004).

Groundwater samples from Nicols Fen, near the creek, have been and may provide an estimate for the underlying groundwater conditions. These samples showed that groundwater in the fen contain high concentrations of iron, which may negatively affect macroinvertebrate populations, which are a major food source for trout (Young Environmental 2020b).

The construction of TH 77 in the 1980s affected water quality in Kennaley's Creek during construction and for decades afterwards. The underlying soils were peat and heavily organic material, unsuitable for the new Cedar Avenue roadway and bridge, so MnDOT excavated these soils and placed them in spoil piles in the upper reaches of Kennaley's Creek (**Figure 37**). Monitoring of the creek following the placement of the spoil pile showed increased levels of turbidity and suspended solids in the creek, reducing the water quality in Kennaley's Creek (WSB & Associates 2008). Discussions with the MnDNR on October 13, 2020, confirmed that the spoil piles have continued to erode, despite efforts to contain the material, and they remain an ongoing threat to the water quality in the creek (Nemeth 2020c).

7.7 Public Access

The Minnesota Valley Wildlife Refuge provides limited access to Kennaley's Creek. The accessible part of the stream is located near Nicols Road and is surrounded by wetlands. Most of the southern area is privately owned, including the nearby Black Dog Power Plant owned by Xcel Energy. The land is owned by the MnDNR and the Union Pacific Railroad, as well as other government entities. The MnDNR provides guidance to would-be anglers on how to access Kennaley's Creek but also notes that this access requires criminal trespass of private railroad property (Minnesota Department of Natural Resources n.d.).

7.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4, the following highlights the data gaps needed to determine the quality of trout habitat in Kennaley's Creek. The minimum and optimal criteria are shown in the following tables.

Table 18. Kennaley's Creek spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Adult Access: Jump Height < 1 ft	**No**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**No**
Constant Baseflow	**No**
Gravel Substrate	**Yes**
Protection from Flooding	**No**

Table 19. Kennaley's Creek summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Min. Water Temperatures < 72°F	**Yes**
Optimal Dissolved Oxygen ≥ 9 mg/L	**No**
Optimal Water Temperatures < 57°F	**Yes**
Healthy Macroinvertebrate Population	**Unknown**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Unknown**
Cover > 6 in	**No**

Table 20. Kennaley's Creek overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	Yes
Optimal Dissolved Oxygen ≥ 7 mg/L	Yes
Constant Baseflow or Deep Pools	No
Cover ≥ 15% of Total Stream Area	Unknown
Healthy Macroinvertebrate Population	Unknown
Juvenile Access: Jump Height < 1 ft	No
Juvenile Access: Velocity < 0.3 fps	Unknown
Juvenile Access: Cover > 6 in	No

Kennaley's Creek meets the minimum criteria for trout habitat, but no brook trout have been found in the channel during any of the stream surveys since 1982. The creek lacks adequate baseflow and depths to support trout.

7.9 Management Strategies

Based on the information presented and wealth of data in terms of groundwater inflows, optimal temperature regimes, and vegetative cover, Kennaley's Creek does not have the necessary characteristics of a trout water. Although it once supported a self-sustaining brook trout population, lack of adequate baseflow in the channel limits the potential for this creek. The following highlights the major challenges facing Kennaley's Creek:

1. **Hydrogeologic Uncertainty:** Further study is needed to determine how domestic and municipal wells, as well as dewatering activities, within the Kennaley's Creek watershed affect groundwater elevations and stream baseflows. This information is needed to determine what can be done to protect Nicols Meadow Fen groundwater elevations and Kennaley's Creek baseflows.
2. **Streamflow Monitoring:** Continuous monitoring of Kennaley's Creek streamflow for multiple years would provide the hydrologic characteristics, including extreme and normal stream flows. This gage also could record stream temperatures and other important measurements such as specific conductance or chloride. A staff gage was observed and installed in the stream during a site visit on October 13, 2020, but it was not in a location that would provide a stable relationship between the stage of the creek and its streamflow, and it is not evident who installed or read the gage.

3. **Geomorphic Assessment Update:** Kennaley's Creek was not surveyed in detail in 2019 due to high floodwaters on the Minnesota River, and there is no recent evidence to support whether the ideal trout habitat upstream of the railroad still exists. An additional survey could confirm the suitability of this habitat.

Until a better understanding of the hydrogeology is established, Kennaley's Creek should be managed as a potentially restorable trout water. Based on the data reviewed, the following management strategies are recommended for Kennaley's Creek and summarized in **Table 21**:

- **KC-0:** Continue to implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek as the watershed develops in the future.
- **KC-1:** Hydrogeologic investigation of Nicols Meadow fen: Due to the proximity of several groundwater-dependent resources, it is recommended the LMRWD conduct a review of the groundwater observation wells and approved appropriations permits to determine whether there is an adequate groundwater supply to support Nicols Meadow fen, Kennaley's Creek, and Unnamed 1. An outcome of this evaluation should include mapping of the local water table, evaluation of permitted dewatering activities, and active well depths to determine how disconnected the creek is from its groundwater sources.
- **KC-2:** Evaluate the current HVRA boundary around Kennaley's Creek and work with the City of Eagan to confirm the direct runoff boundary and identify stormwater inputs.
- **KC-3:** Based on the results from the 2021 Gully Inventory, conduct a feasibility study to evaluate restoration opportunities to mitigate the continued erosion.
- **KC-4:** Together with KC-1, establish a real-time, long-term flow monitoring gage on Kennaley's Creek to determine whether the creek has adequate baseflows for trout.
- **KC-5:** The 2019 Geomorphic Study was unable to access the western branch of Kennaley's Creek. Given the habitat degradation concerns, it is recommended that a geomorphology of the creek be reevaluated to determine the sources of channel instability leading to loss of viable habitat. This work should also include topographic survey data to document alignment and profile of the channel for future evaluations.

Table 21. Kennaley's Creek management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
KC-1	Hydrogeologic Investigation of Nicols Meadow Fen Area	Study	2022
KC-2	HVRA and Stormwater Inputs Reevaluation	Study	2022
KC-3	Kennaley's Creek Gully Restoration Feasibility Study	Study	2023
KC-4	Real-Time Flow Monitoring	Data Collection	2022
KC-5	Geomorphic Assessment	Study	2026

8.0 UNNAMED #1 (HARNACK CREEK)

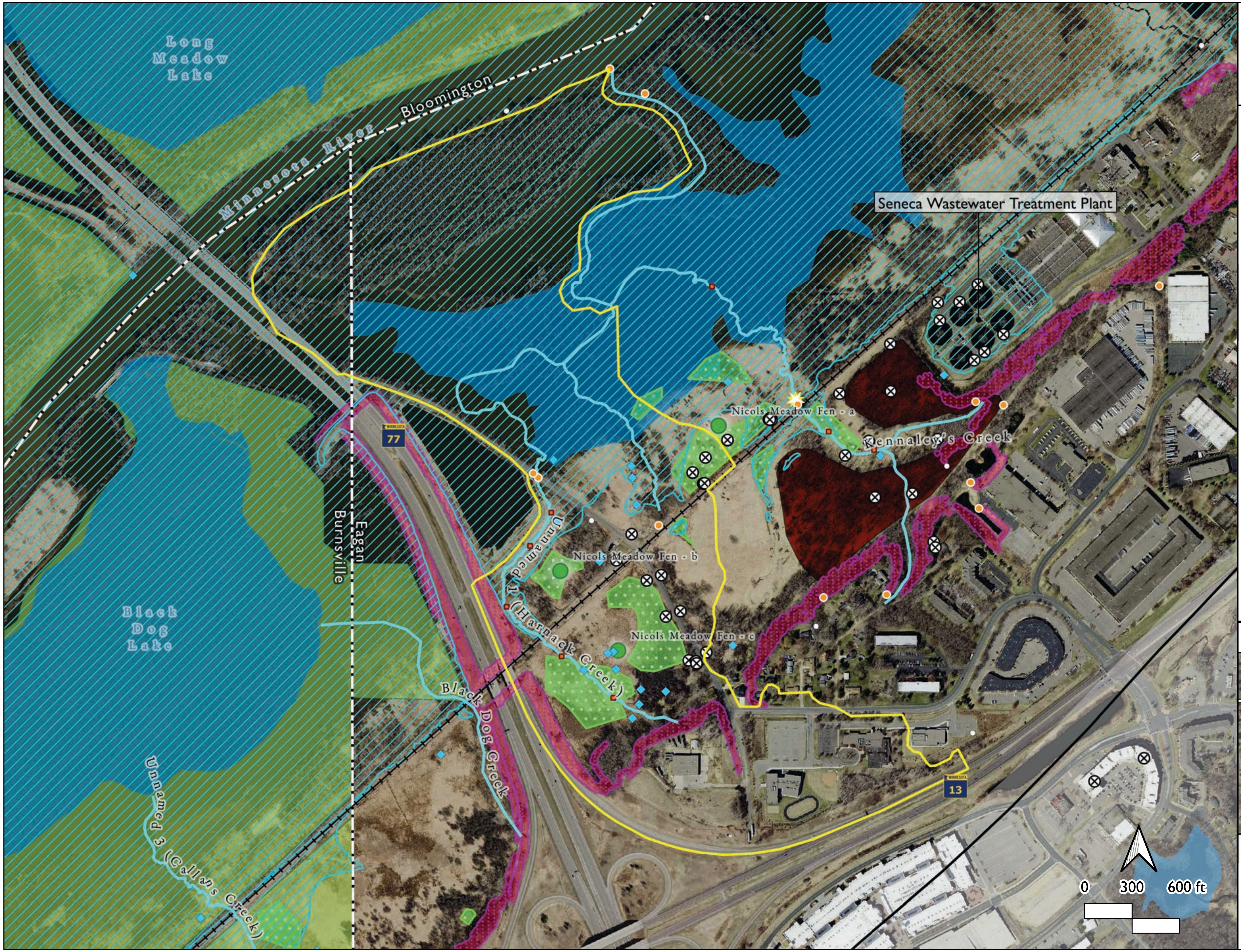
This stream, variously called Harnack Creek or One Mile Creek, is officially known as Dakota County Unnamed 1 (Tributary Number M-55-4-1). Unnamed 1 is a 0.16-mile stream located in Dakota County within the City of Eagan (**Figure 42**). It is an MnDNR-designated trout water but is not actively managed. Dakota County Unnamed 1 is thought to be named after Ron Harnack, who was the MnDNR regional hydrologist in 1976 when the stream was first discovered to support trout (Nemeth 2020c).

Unnamed 1 historically discharged into Black Dog Lake and was a tributary of Black Dog Creek upstream of Black Dog Lake, prior to the construction of TH 77 (**Figure 18**). With the construction of the TH 77 Bridge, roadway, and stormwater pond, the alignment of Unnamed 1 was altered, and its connection to Black Dog Creek was severed (WSB & Associates 2008). Today, Unnamed 1 now outlets directly into Kennaley's Creek, which also was once a tributary to Black Dog Creek.

In 2015, the MnDNR proposed removing Unnamed #1 from the designated trout streams list, removing the special waters protections because the streams no longer contain trout. However, due to overwhelming support from the community, the MnDNR withdrew their proposal to delist Unnamed 1 in 2016 (Callahan 2016b, 2016c).

It has a watershed area of about 66 acres and a length of more than 6,900 feet, about 1,700 feet of which are considered suitable habitat for trout (Nemeth 2020b). About 15 percent of the watershed is considered developed. Unnamed 1 originates from a series of springs and seeps associated with the Nicols Meadow fen complex. The area is relatively flat, mostly wetlands.

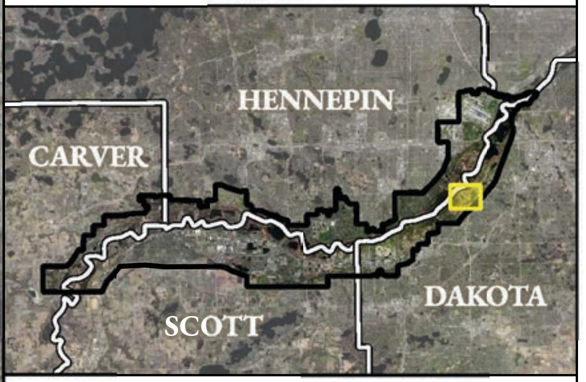
Figure 45: Unnamed 1 Current Conditions



LEGEND

- Unnamed 1 Watershed
- Beaver Dam Activity (1975-2002)
- 2020-2021 Gully Data:
  - Low and Moderate Risk Gullies
  - High Risk Gullies
  - Very High Risk Gullies
- Active and Observation Wells
- Stream Monitoring Locations
- Groundwater-Dependent Natural Resources:
  - MnDNR Spring Inventory
  - LMRWD Calcareous Fens
  - LMRWD Trout Streams
  - Calcareous Fen Estimated Extents
- Union Pacific Railroad
- 100-yr Floodplain Extents
- Public Waterbodies
- Steep Slopes Overlay District [SSOD]
- TH 77 Spoils (Approximate Extents)
- Minnesota Valley National Wildlife Refuge
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map



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8.1 Watershed History and Land Uses

Historically, the Unnamed 1 watershed was part of the overall Black Dog Creek watershed and has been altered by the construction of the railroad, Old Cedar Avenue, and the TH 77 Bridge and roadway (**Figure 46**).

The small community of Nicols Station, named for the Nicols flag station constructed in 1867, grew as part of the Minnesota River Valley onion farming boom. In 1890, the Old Cedar Avenue Bridge was constructed west of Kennaley's Creek to connect Dakota County to the City of Bloomington on the north side of the Minnesota River (Eagan Historical Society 1998). By the early 1900s, Nicols became known as the "Onion Shipping Capital of America." Around this time, Nicols also became well-known for its molding sand, a rare, naturally occurring combination of silica sand and clay, used by metal foundries until the 1950s. The onion and sand industries supported this small but thriving town. Due to the town's renown, Black Dog, Kennaley's, and other spring-fed creeks, such as Unnamed 1, became popular fishing and recreation sites for residents and tourists (Dakota County Historical Society 1989).

Aerial photographs from 1937 show mostly undeveloped land adjacent to the creek. The creek appears to emerge at springs near the northeast to southwest aligned railroad, where the railroad intersects old Cedar Avenue. A small community of structures at the Nicols flag station is evident southwest of this location. Structures from this community were still evident in 1971 aerial photographs but are no longer present.

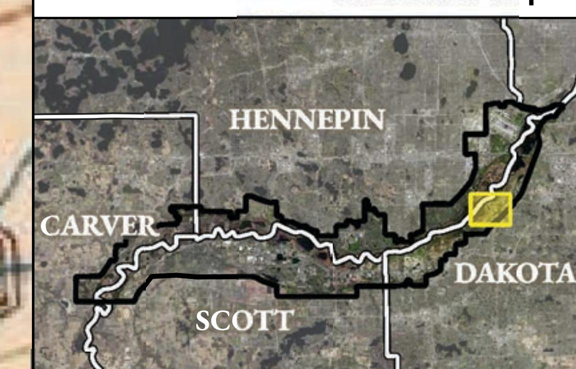
During the planning and design of the Cedar Avenue/TH 77 highway project in the 1970s, it was discovered that Unnamed 1 was home to a naturally reproducing brown trout population. A letter from Ron Harnack, MnDNR Regional Hydrologist, to Duane Shodeen, Regional Fisheries Manager, dated June 8, 1976, discussed the state's desire to protect the Unnamed 1 fishery and the newly discovered Nicols Fen calcareous fen community from the highway project, but there was "little that can be done to retain the stream in its present condition," particularly because the new roadway would be burying the headwater springs and filling in the existing channel (Shodeen 1976). Ultimately, the alignment for Unnamed 1 was moved, and the historical connection to Black Dog Creek was permanently severed.

Figure 46: Unnamed 1 Historic Watershed

LEGEND

- Unnamed 1 Creek (Present Day)
- Unnamed 1 Present Day Watershed
- Unnamed 1 1896 Watershed
- Historic USGS Quad Sheets (1896)

LMRWD Watershed Location Map



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Today, the Unnamed 1 watershed is primarily undeveloped, under public ownership, or part of the Fort Snelling State Park. Land use may change in the upper watershed, with the City of Eagan's projected 2030 land uses indicating an expansion of existing commercial and industrial developments. Of concern is the undeveloped area, south of the MnDOT stormwater pond and north of the Union Pacific railroad, that is home to a one-acre calcareous fen community, which is part of the larger Nicols Meadow fen complex. Portions of this area are under state ownership; however, it is slated to become a future mixed-use development (Metropolitan Council 2016, 2020; **Figure 47; Table 22**). Although the special waters protection afforded by Nicols Meadow Fen and the trout water designation may affect the development potential of this land, it may be worth considering making a strategic acquisition to protect this land in perpetuity.

Table 22. 2016 and future generalized land uses within the Unnamed 1 watershed (Metropolitan Council 2016, 2020).

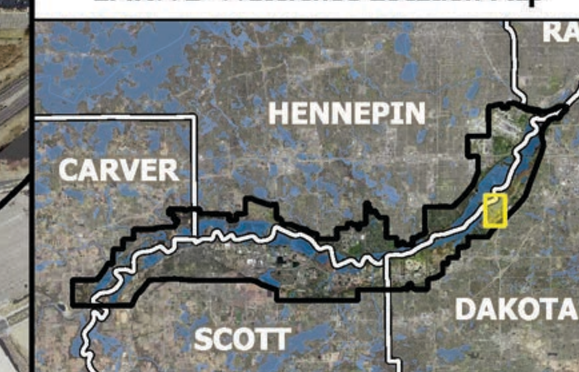
	2016 Area (ac)	Future Area (ac)	Change (ac)
Park, Recreational, or Preserve	123	110	-13
Undeveloped	20	0	-20
Mixed Use/Commercial/Industrial	5	33	28
Transportation	16	22	6
Residential	4	2	-2
Institutional	14	14	0

Figure 47: Unnamed 1 Watershed Land Uses

LEGEND

- LMRWD Trout Streams
- Unnamed 1 Watershed
- Generalized Land Use:
  - Agricultural
  - Mixed Use/Commercial/Industrial
  - Residential
  - Public / Quasi-Public
  - Park, Recreational, or Preserve
  - Transportation
  - Undeveloped
  - Open Water
- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map



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The *2021 Gully Inventory and Condition Assessment* identified some erosion near Nicols Road; however, no gullies were observed in the field, as access to the upper watershed was difficult and should be reevaluated the next time gullies are surveyed by the LMRWD (Young Environmental 2021).

8.2 Fisheries

In 1976, during the planning and design of the TH 77 Bridge and roadway project, Unnamed 1 was discovered to have a naturally reproducing brown trout population, but that little could be done to protect the creek from the highway project (Shodeen 1976). The initial stream survey in 1976 indicated that the stream could support a small brook trout population, and, in 1980, the MnDNR stocked the creek with 3,900 brook trout fry and has been surveying the stream since that time (Gilbertson 1981a). A summary of the subsequent fish counts are provided in **Table 23**.

Table 23. Unnamed 1 fish counts from MnDNR surveys (1976 to 2005).

Year	Brook Trout	Brown Trout	Total Trout
1976	17	1	18
1980	0	20	20
1982	0	0	0
1985	0	2	2
1990	0	0	0
2000	0	0	0
2005	0	0	0

A beaver dam in the headwaters was removed in 1981, causing a flood downstream that resulted in "substantial degradation of the existing habitat." It was recommended that brook trout be stocked again to reestablish the population (Gilbertson 1983a). By 2000, the steam was determined to have "very limited potential for establishment of a permanent trout population," and it was advised not to stock again. The MnDNR determined the costs outweighed the benefits to continue stocking Unnamed 1 due to low base flows, high flooding potential, stormwater intrusions, degraded trout habitat, and beaver dams that make it difficult for trout to thrive. The stream was suggested to be left as part of the protected Nicols Meadow fen and has not been actively managed since 2000 (Stewart 2001a, 2006a).

Today, the MnDNR's website states that the Unnamed 1 "has little potential for anglers. It may yield an occasional small brook trout, but little else should be expected" (Minnesota Department of Natural Resources 2020h).

8.3 In-Stream Habitat

An MnDNR stream survey from 1980 discussed the stream channel alterations caused by the TH 77 construction, confirming that the final roadway design resulted in Unnamed 1 being "diverted down a ditch and into the old Black Dog Creek channel on the east side of the old Cedar Ave." The remaining channel had gravel substrate in the upper reach, which became predominantly silt and clay near the mouth (Gilbertson 1981a).

The improper removal of the beaver dam in 1981 resulted in a flood that "destroyed most undercut banks and silted in most pools," decimating the existing trout habitat in Unnamed 1 (Gilbertson 1983a). The July 2000 flood also caused significant scour and damage to in-stream habitat on Unnamed 1 (Stewart 2006a).

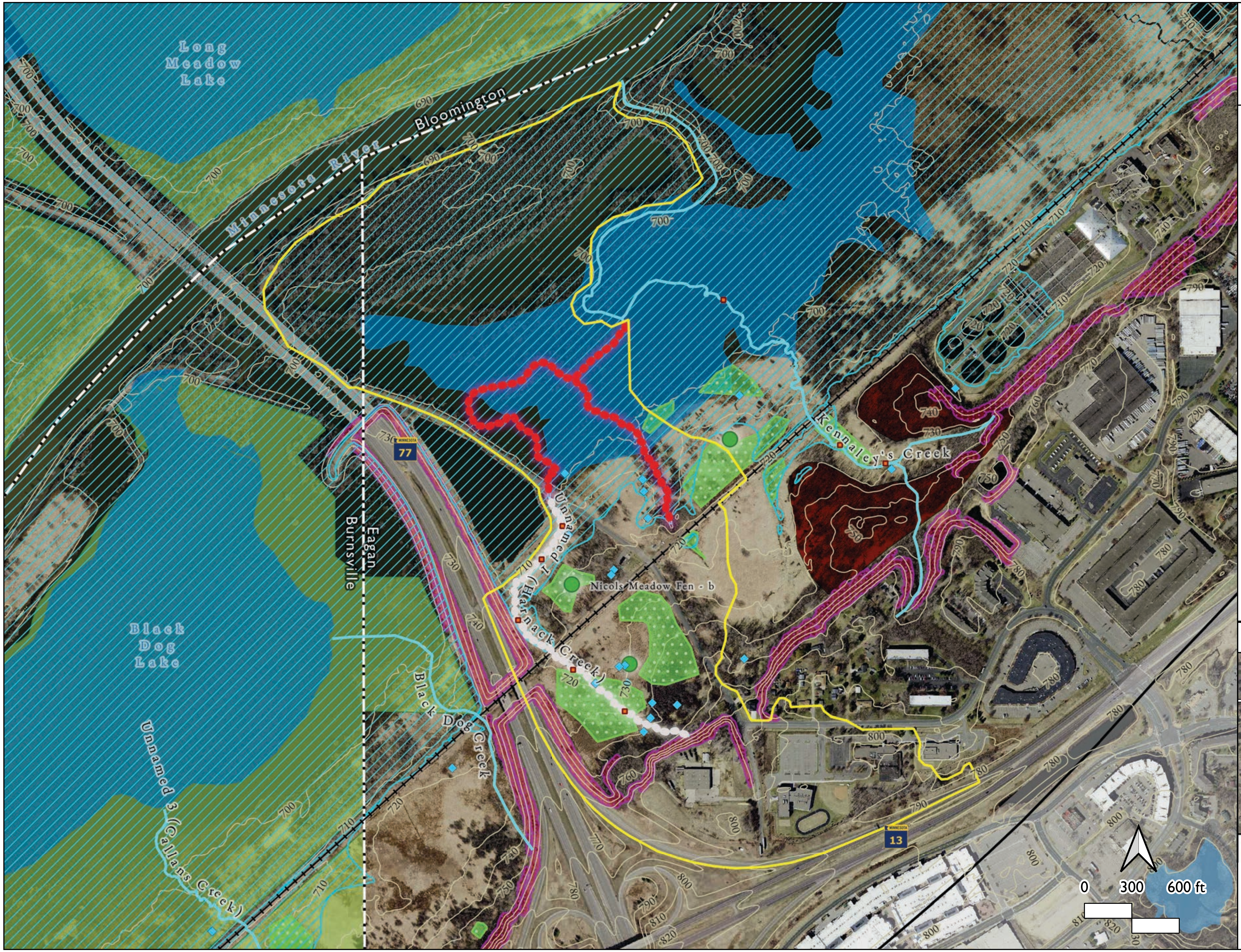
In the 2019 survey, most of Kennaley's Creek and Unnamed 1 were inaccessible because of overgrown vegetation and intense flooding, and, because of confusion over the creek names, Unnamed 1 was surveyed and mislabeled as Kennaley's Creek. On Unnamed 1, different types of substrate were present in the channel, including coarse and fine gravel, sand, and silt and muck. The cover in the stream for trout is extensive, including undercut banks, overhanging vegetation, woody debris, and root mats. The stream became more incised as it progressed past Nicols Fen, showing signs of erosion. There is little to no degree of stream meandering, and moderate adjustments are needed for channel stability (Berg et al. 2019).

Several of the MnDNR stream surveys describe considerable head cutting and other erosion along the banks of Unnamed 1 since 1981. Later surveys suggest the addition of stormwater discharges into the creek could be the cause of bank instability, resulting in a flashy hydrology from the increased impervious surface in the upper watershed (Stewart 2001a). During the site visit on October 13, 2020, heavy vegetation made it difficult to determine whether any erosion was occurring (**Figures 48** and **49**). Additional surveys should be completed to document the specific locations of streambank and gully erosion, specifically in the areas that may be suitable for trout habitats (**Figure 50**).

Figure 48. Unnamed 1 looking upstream from Union Pacific crossing on October 13, 2020.

Figure 49. Unnamed 1 Looking downstream from Union Pacific crossing on October 13, 2020.

Figure 50: Unnamed 1 Potential Trout Habitat



LEGEND

Unnamed 1 Watershed

Potential Trout Habitat
- Good Conditions
- More Investigation Needed
- Poor Conditions

Groundwater-Dependent Natural Resources:
- MnDNR Spring Inventory
- LMRWD Calcareous Fens
- LMRWD Trout Streams
- Calcareous Fen Estimated Extents

100-yr Floodplain Extents

Union Pacific Railroad

Dakota Co. 10-ft Contours

Public Waterbodies

Steep Slopes Overlay District [SSOD]

TH 77 Spoils (Approximate Extents)

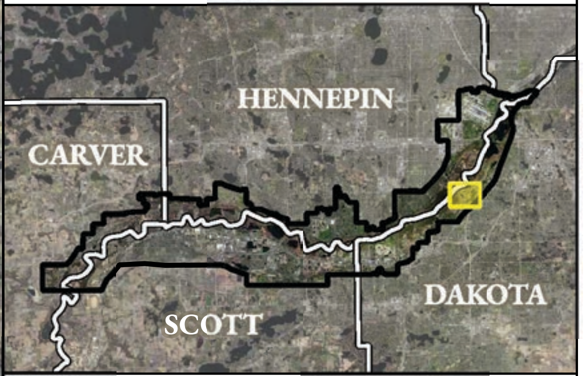
Minnesota Valley National Wildlife Refuge

Cities, Townships, Unincorporated Areas

County Boundaries

LMRWD Boundary

LMRWD Watershed Location Map



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8.4 Stream Flow

There are no established stream gages on Unnamed 1; however, most of the MnDNR stream surveys estimated stream flows at the time of survey. Those surveys that included stream flows consistently estimated the flow at the mouth to be around 1 cfs, but with a range between 0.23 and 2.3 cfs.

Winter baseflow may be critical, especially in smaller streams because macroinvertebrate populations, which trout need for survival, often rely on sustained winter baseflow to complete their life cycle stages (French et al. 2017).

The thermal regime of Unnamed 1 suggests it would support a trout fishery. One reported water temperature of 79°F may have been an outlier and appears to be associated with a beaver dam. Other water temperature readings were in the 50s F, with one 62°F reading noted. Winter water temperature readings were not found.

A culvert was also identified as a source of water in 1985 (Ebbers 1985), and later surveys from the MnDNR noted concerns that stormwater discharges into the creek were degrading the habitat by warming the creek temperatures (Stewart 2001a).

8.5 Groundwater

Unnamed 1 receives its baseflow from "springs and seeps too numerous and diffuse to catalog," flowing in from gentle slopes of the Minnesota River Valley (Stewart 2001a). From the MnDNR Springs Inventory, a few springs were identified near the creek, but none of them had information that could help with understanding the groundwater contribution to the creek.

The 2020 *Fens Sustainability Gaps Analysis for Carver, Dakota, and Scott Counties, Minnesota* noted concerns that groundwater elevations in the Nicols Meadow fen complex may have been artificially lowered because of nearby groundwater appropriations from the Seneca WWTP. These pumping activities could also be affecting the groundwater contribution in Unnamed 1's baseflow, leading to lower water levels and warmer temperatures in the creek.

8.6 Geochemistry and Water Quality

No information on the geochemistry of the creek or the groundwater feeding the stream was found. However, some geochemical data collected from Nicols Meadow Fen during 1989 (Almendinger and Leete 1998a, 1998b) may provide some insight into the quality of the water adjacent to the creek.

Surface water quality samples were collected by the MnDNR in 1981, 1990, and 2000 that tested the creek waters for pH, total alkalinity, and total phosphorus, which indicated that the Unnamed 1 had clean, clear water suitable for trout.

8.7 Public Access

Most of the lower reaches of Unnamed 1 are within the Fort Snelling State Park and accessible to the public. In the upper reaches, much like Kennaley's Creek, most access to Unnamed 1 is by walking along the private Union Pacific railroad tracks. The stream does pass under Nicols Road and is accessible at that crossing, but the surrounding area is mostly wetland. The western reaches of the stream would be accessible for fishing if proper safety measures were taken for walking on marshy ground (Berg et al. 2019).

8.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4, the following highlights the data gaps needed to determine the quality of trout habitat in Unnamed 1. The minimum and optimal criteria are shown in the following tables.

Table 24. Unnamed 1 spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Adult Access: Jump Height < 1 ft	**No – Nicols Road**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**Unknown**
Constant Baseflow	**Yes**
Gravel Substrate	**Yes**
Protection from Flooding	**Partial**

Table 25. Unnamed 1 summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Min. Water Temperatures < 72°F	**Yes**
Optimal Dissolved Oxygen ≥ 9 mg/L	**No – 8.3 in upper reach**
Optimal Water Temperatures < 57°F	**Yes**
Healthy Macroinvertebrate Population	**Unknown**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Yes**
Cover > 6 in	**Unknown**

Table 26. Unnamed 1 overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Constant Baseflow or Deep Pools	**No**
Cover ≥ 15% of Total Stream Area	**Yes**
Healthy Macroinvertebrate Population	**Unknown**
Juvenile Access: Jump Height < 1 ft	**No – Nicols Road**
Juvenile Access: Velocity < 0.3 fps	**Unknown**
Juvenile Access: Cover > 6 in	**Unknown**

Although Unnamed 1 meets the minimum criteria for trout habitat, no trout have been found in the stream since 1985. The creek has good cover, water temperatures, and water quality, but several other factors may be limiting trout populations:

- There is a scarcity of complex in-stream habitat such as deep pools.
- With the prevalence of springs in the watershed, baseflows appear to be adequate, but have not been consistently monitored.
- Beaver dams have been noted to be a concern to management in the past and appear to recur in the same locations from year to year.
- Catastrophic flooding on the Minnesota River can affect the geomorphology of the creek and wipe out entire populations.
- Channel degradation from flooding and bank erosion occurs from stormwater inputs.

Unnamed 1 is supplied mostly by groundwater that keeps water temperatures cool, with sufficient water to maintain a trout habitat and create an environment suitable for a thriving macroinvertebrate community. However, the degraded stream channel and beaver activity make the sustainability of that community uncertain. It was noted "there is not enough existing information to make a positive or negative determination on the long-term viability of the Nicols Meadow area to exist as a calcareous fen and trout streams" (WSB & Associates 2002). Similarly, limited information on the macroinvertebrate populations was available to determine whether an adequate food supply exists for trout.

8.9 Management Strategies

Based on the information presented and fair amount of data in terms of temperature regimes, dissolved oxygen, and vegetative cover, Unnamed 1 does meet the minimum characteristics of a trout water. Although it once supported a self-sustaining brown and brook trout population, flood events from the Minnesota River and improper beaver dam removals appear to have wiped out these populations. The following highlight the major challenges Unnamed 1 faces:

1. **Geomorphology:** Since only one survey site was accessible in the 2019 Geomorphic Assessment, there is not adequate evidence to support or reject the claims that a trout habitat exists on Unnamed 1. Additional surveys should be conducted to identify gullies and ravines that may be contributing to the fine sediments found in the channel, and they could provide additional insight into the stream and its morphology.

2. **Stormwater Discharges:** Stormwater intrusions into the creek are thought to have caused channel instability and warming temperatures. Further investigation into the actual contribution from roadways, developed surfaces, and storm sewer in coordination with the City of Eagan is recommended.

3. **Consistent Baseflows:** Unnamed 1 has not been monitored consistently to determine whether adequate baseflow in the creek exists to support trout, yet this has been cited as a reason for delisting the creek. Monitoring of flows in the creek and groundwater contributions, including extreme and normal stream flows, would provide this information to definitively state if the creek has enough depth and flow to support trout. As discussed with Kennaley's Creek, further study is needed to determine how or whether dewatering at the Seneca WWTP may be affecting the groundwater table in the area.

4. **Catastrophic Flooding:** Flooding from the Minnesota River, specifically the severe 2000 Minnesota River flooding, is another reason the MnDNR has not actively managed this trout water. From the data reviewed, the best trout habitat is located in the upper reaches, above Nicols Road and the Union Pacific railroad. Because of the rail and roadway construction Unnamed 1 is nearly leveed off from the Minnesota River, except for culvert crossings. Further study should be conducted to determine whether installation of a flap gate or backflow preventor could protect Unnamed 1 from future catastrophic flood events on the Minnesota River.

Until more is known about the reasons the existing trout population died off and a better understanding of the hydrogeology is established, Unnamed 1 should be considered and managed as a restorable trout water. It is a valuable resource to the District, especially as part of the larger Nicols Meadow fen complex. It may be best managed as part of the fen, rather than a stand-alone resource. Based on the data reviewed, the following management strategies are recommended for Unnamed 1 and summarized in **Table 27**:

- **U1-0:** Continue to implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek as the watershed develops in the future.
- **U1-1:** Given the proximity of Unnamed 1 to Nicols Meadow fen, it is recommended this groundwater investigation include Unnamed 1 to determine the hydrogeologic conditions of the fen and surrounding area. The outcomes from this study will inform whether the creek has the potential to become a viable trout stream in the future.
- **U1-2:** Evaluate the current HVRA boundary around Unnamed 1 and work with the cities of Burnsville and Eagan to confirm the direct runoff boundary and identify any stormwater inputs.
- **U1-3:** Together with U1-1, establish a real-time, long-term flow monitoring gage on Unnamed 1 to determine whether the creek has year-round adequate baseflows to support trout.
- **U1-4:** Using the outcomes from U1-1, implement a groundwater monitoring plan for Nicols Meadow fen and Unnamed 1.
- **U1-5:** The 2019 Geomorphic Study was unable to access most of Unnamed 1. Given the habitat degradation concerns, it is recommended that a geomorphology of the creek be reevaluated to determine the sources of channel instability leading to loss of viable habitat. This work should also include topographic survey data to document alignment and profile of the channel for future evaluations.
- **U1-6:** As discussed in Section 8.1, the land between Nicols Road and Union Pacific Railroad is owned by a private entity. For the protection of Nicols Meadow fen and Unnamed 1 from future commercial development, serious consideration should be given to acquiring the land for future conservation and protection.

Table 27. Unnamed 1 management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
U1-1	Hydrogeologic Investigation of Nicols Meadow Fen Area	Study	2022
U1-2	HVRA and Stormwater Inputs Reevaluation	Study	2022
U1-3	Real-Time Flow Monitoring	Data Collection	2022
U1-4	Groundwater Monitoring Plan	Study	2024
U1-5	Geomorphic Assessment	Study	2026
U1-6	Conservation Land Acquisition	Capital Improvement	2030

9.0 UNNAMED #4 (NAAS CREEK)

This stream, variously called Callans Creek, One Mile Creek, Naas Creek, or Nass Creek, is officially known as Unnamed 4 (Tributary Number M-55-4-4). It is an MnDNR-designated trout water but is not actively managed and is in Dakota County within the City of Burnsville (**Figure 51**).

The Unnamed 4 watershed has changed drastically since the late 1800s. It was once part of the Black Dog Creek watershed; however, due to stream straightening, alterations at railroad crossings and development in the upper watershed have reduced the watershed by over 90 percent (**Figure 52**).

Like Unnamed 1, the MnDNR proposed delisting Unnamed 4 in 2015 (Harper 2016), but they withdrew their proposal to delist Unnamed 4 in 2016 (Callahan 2016b).

9.1 Watershed History and Land Uses

Anecdotally, the MnDNR said that land around Unnamed 4 was heavily farmed for onion production during the drier years of the 1930s (Nemeth 2020c). In the 1950s, the landowner, David Naas, created Cedar Hills Farm and dammed Unnamed 4 to create trout ponds stocked with brook and rainbow trout for a fee-fishing operation (Callahan 2015b; Stewart 1981).

Aerial photographs from 1937 show mostly undeveloped land, with some agricultural land adjacent to the origin of the stream. In 1956, Black Dog Lake Power Plant can be seen in the aerial photographs. By 1957, the private Cedar Hills Farm had completed construction of the trout ponds on Unnamed 4, and these ponds could still be seen in the landscape in 2020. The upper watershed began increasing in development in the 1970s.

Today, the Unnamed 4 watershed is primarily developed, with residential subdivisions in the upper watershed, whereas the lower reach is primarily undeveloped and protected as part of the Minnesota River Wildlife Refuge. Land use may slightly change in the upper watershed, with the City of Burnsville's projected 2040 land uses indicating an expansion of existing residential development (Metropolitan Council 2016, 2020; **Figure 53; Table 28**).

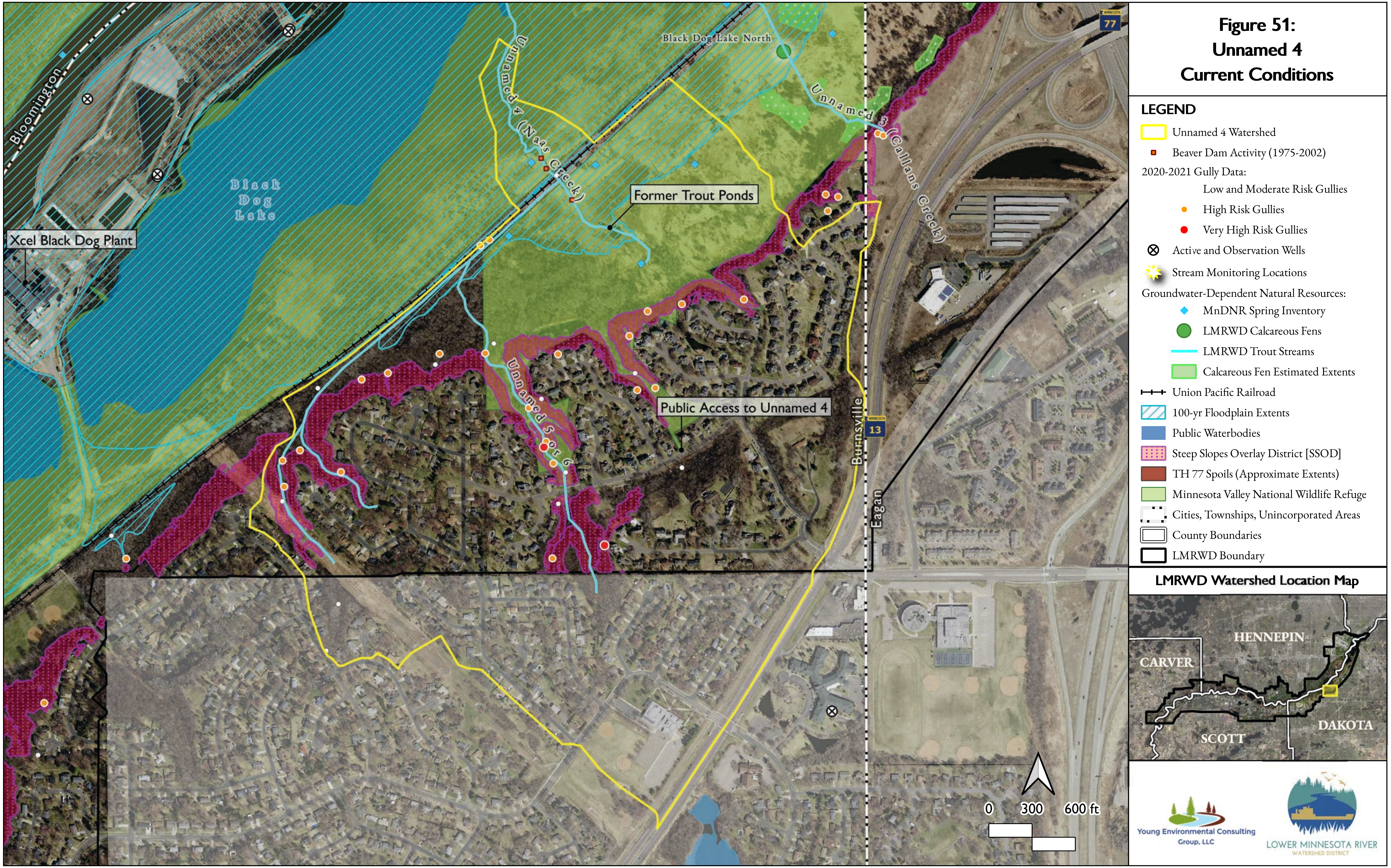
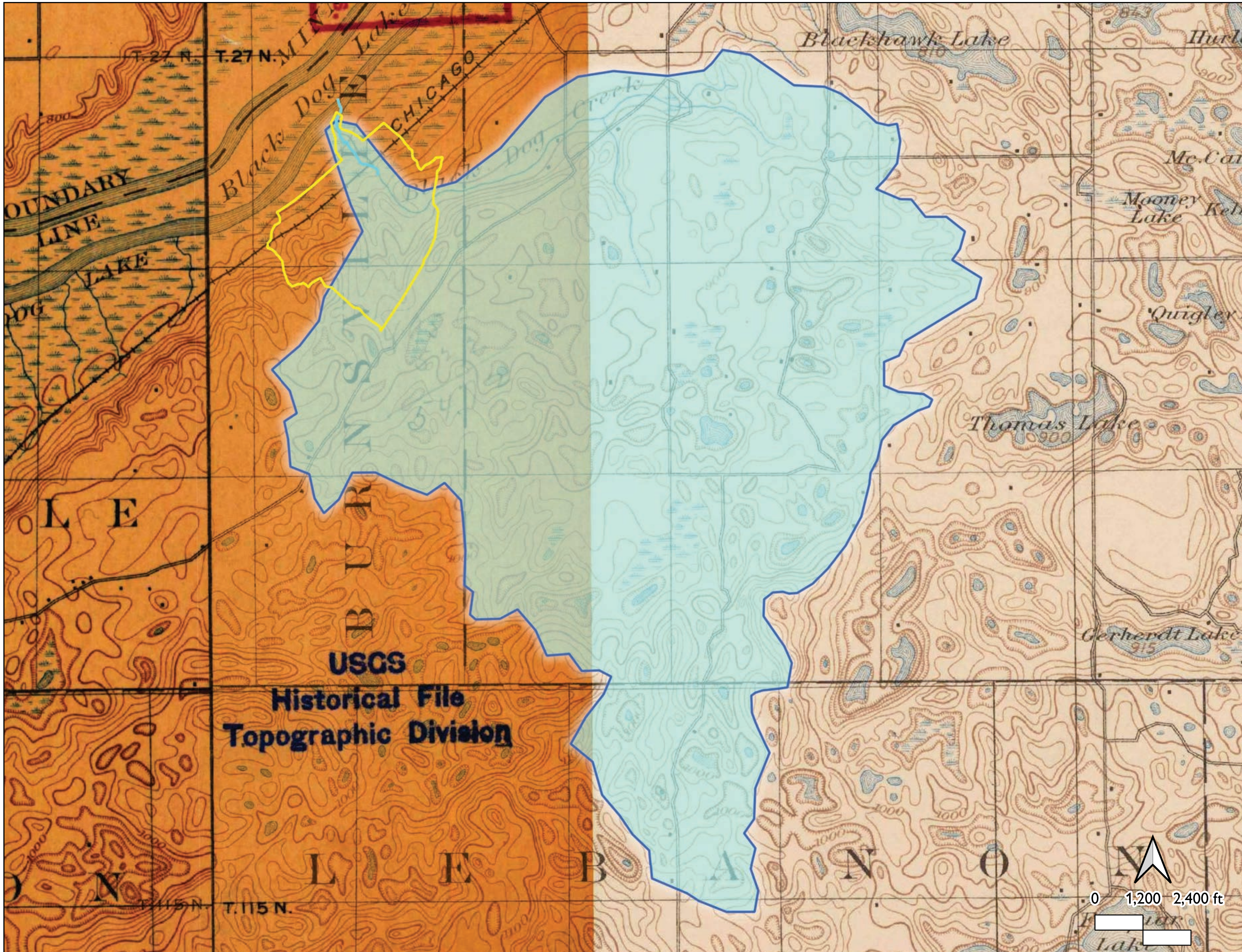


Figure 51: Unnamed 4 Current Conditions

Figure 52:
Unnamed 4
Historic Watershed



LEGEND

- Unnamed 4 (Present Day)
- Unnamed 4 Present Day Watershed
- Unnamed 4 1896 Watershed
- Historic USGS Quad Sheets (1896)

LMRWD Watershed Location Map

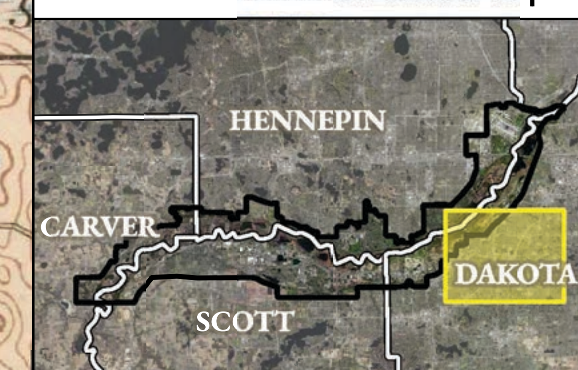


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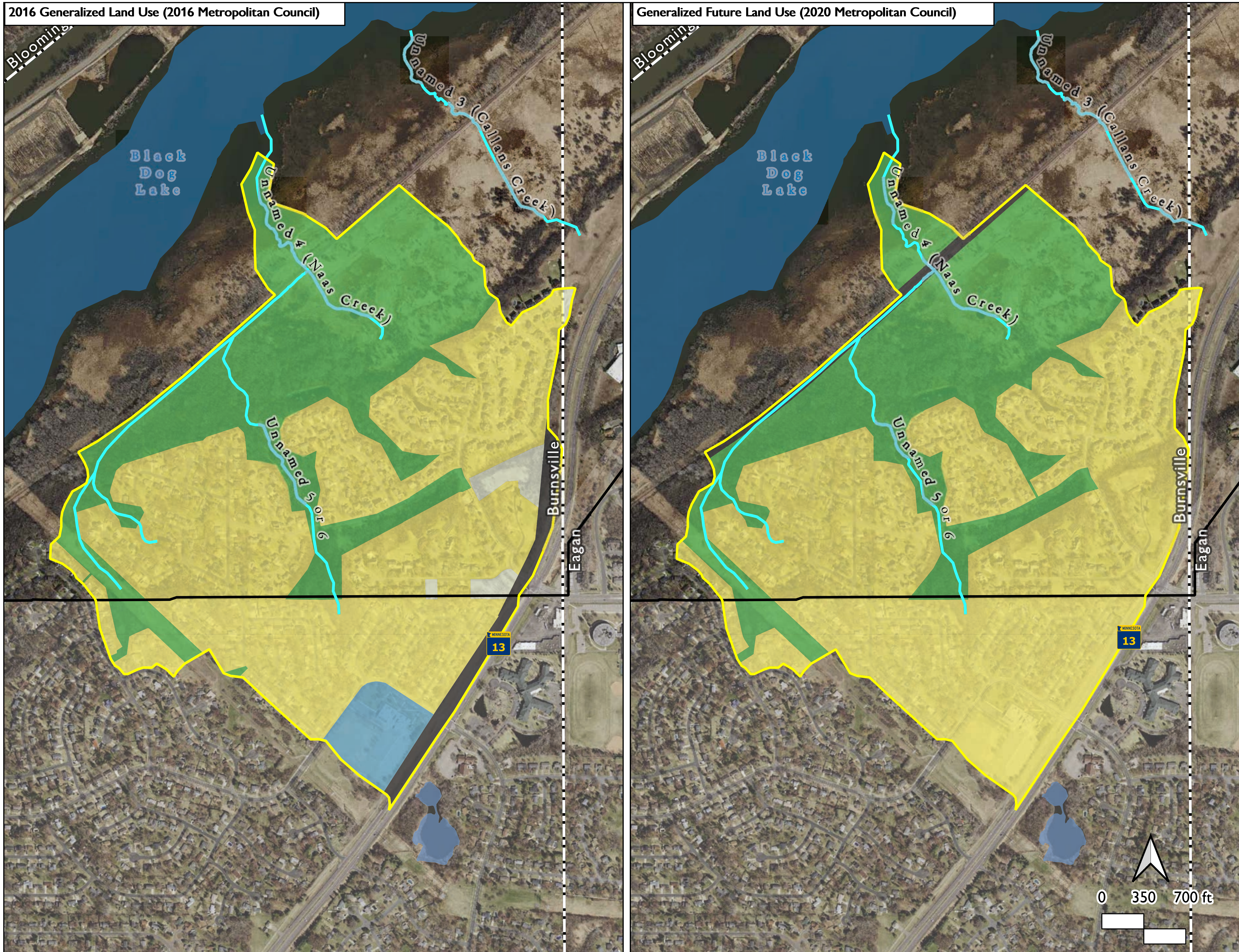
Figure 53: Unnamed 4 Watershed Land Uses



LEGEND

- LMRWD Trout Streams
- Unnamed 4 Watershed
- Generalized Land Use:
  - Agricultural
  - Mixed Use/Commercial/Industrial
  - Residential
  - Public / Quasi-Public
  - Park, Recreational, or Preserve
  - Transportation
  - Undeveloped
  - Open Water
- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map

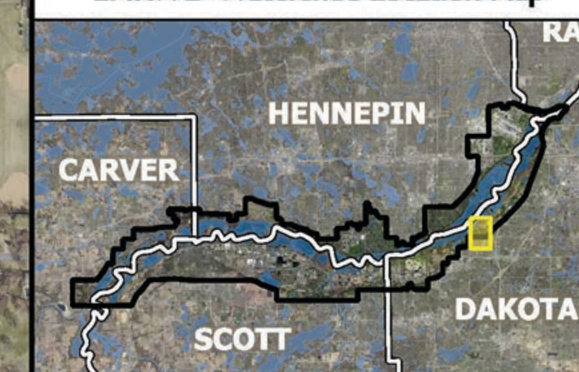


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Table 28. 2016 and future generalized land uses within the Unnamed 4 watershed (Metropolitan Council 2016, 2020).

	2016 Area (ac)	Future Area (ac)	Change (ac)
Park, Recreational, or Preserve	109	104	-5
Undeveloped	6	0	-6
Transportation	10	5	-5
Residential	170	196	26
Institutional	11	0	-11

The LMRWD 2021 *Gully Inventory and Condition Assessment* found several gullies in the upper watershed of Unnamed 4 and Unnamed 5/6. The assessment found evidence of stormwater runoff contributing to erosion in the upper watershed (**Figure 54**), including previous repairs (**Figure 55**), deposition of eroded sediments (**Figure 56**), and dumping activities (**Figure 57;** Young Environmental 2021). Erosion in the upper watershed can contribute to poor water quality downstream, and dumping grass clippings and brush can increase phosphorus downstream, leading to excess nutrients and algal blooms; both detrimental to trout habitat.

Figure 54. Gully erosion in upper Unnamed 4 watershed from stormwater outfall near 10805 Chatham Court.

Figure 55. Gully and restoration in upper Unnamed 4 watershed (behind 10700 Cambridge Court).

Figure 56. Gully erosion and sedimentation in upper Unnamed 4 watershed (behind 3101 Chandler Court).

Figure 57. Evidence of dumping (brush and grass clippings) in upper Unnamed 4 watershed behind 10809 Chatham Court.

9.2 Fisheries

The Cedar Hills Farm fishing operation started in 1957 and ended in the 1970s, when the owner could no longer keep poachers out of the area. The ponds were stocked primarily with rainbow trout, but they also tried stocking brown and rainbow trout (Stewart 1981).

The MnDNR has been monitoring Unnamed 4 since 1976 and stocked it with 8,300 brook trout fry in 1979. The stream had adequate flow, food organisms, and cover to support a trout population in 1980; however, only two brook trout were found during the fish survey. No trout remained in the creek by 1985. At the time, several persistent beaver dams and stormwater inputs were thought to be driving temperatures to lethal levels (Ebbers 1986). Unnamed 4 was sampled in 1985, 1990, 2000, and 2005, without finding any trout (Stewart 2006b).

In 2001, a Stream Management Plan was created for Unnamed 4. The long-range goal of the plan was to maintain a brook trout population of 250 and install a catch-and-release program (Minnesota Department of Natural Resources 2001b). Recent assessments by the MnDNR suggest that Unnamed 4 no longer should be managed as a trout stream. Although brook trout have historically been observed in the stream, there are concerns the stream may also be too small to maintain a significant trout habitat through winter and support the macroinvertebrate populations required. The continued stormwater discharges and beaver activity are also a concern for future trout fisheries (Stewart 2006b).

9.3 In-Stream Habitat

The Unnamed 4 stream habitat has commonly been described by stream-survey professionals as being adversely affected by stormwater runoff, beaver dams, and low baseflows. They also have questioned whether this stream should be managed as a fishery because of the unstable trout habitat.

In 1980, MnDNR surveys noted the channel substrate consisted of sand and gravel overlain with peat, but overall the creek had a marginal trout habitat due to warm stream temperatures caused by stormwater runoff (Gilbertson 1981c). The July 7, 2000, flood event caused severe bank erosion, bed scour, and incision; altered the stream course; and caused a significant loss of cover vegetation. However, because of the deepening of the channel, it was hoped that the habitat for trout would actually be improved (Stewart 2000).

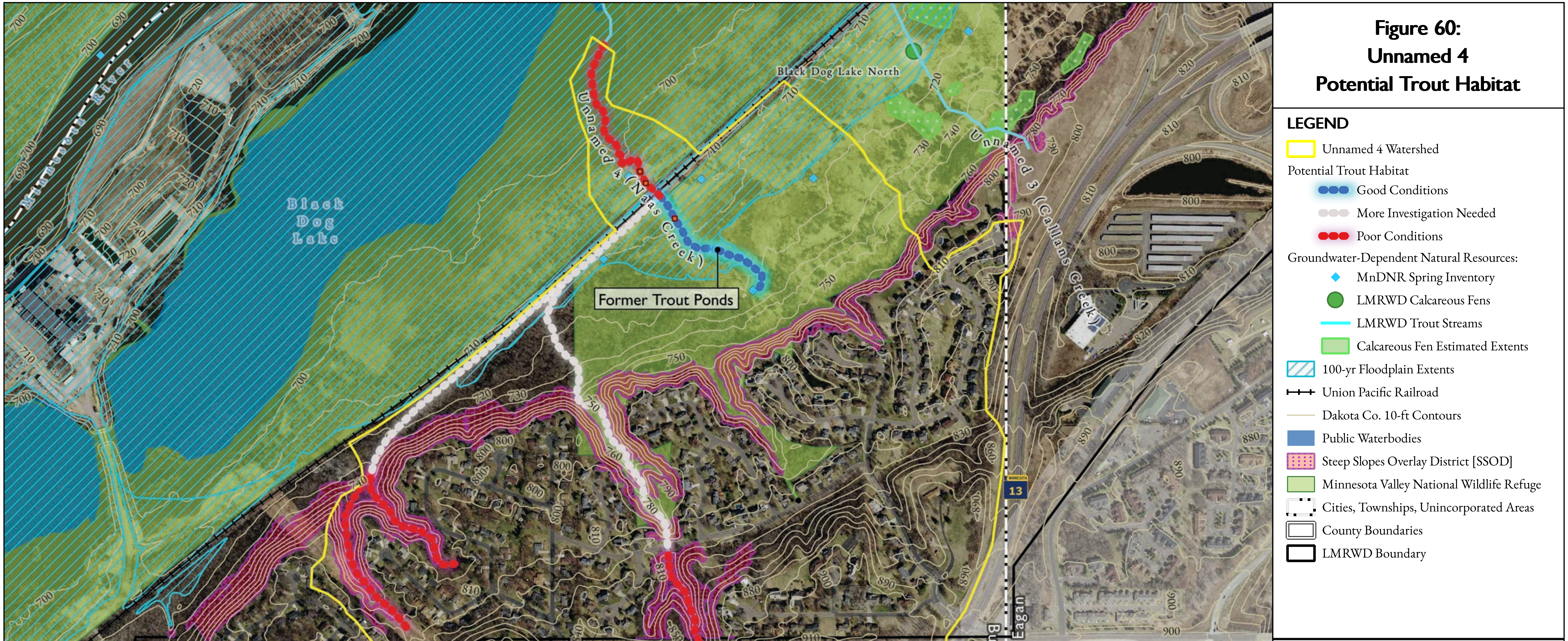
In 2019, Unnamed 4 had almost no tree cover in the lower reaches, but the stream was shaded with large amounts of overgrown bank vegetation. The creek was fairly straight, with a few pools but not many run-riffle-pool sequences for trout habitat. Gravel and sand were the most common channel substrates found (Berg et al. 2019).

During the October 13, 2020, site visit, the water in the creek was clear and had a high flow with good substrate, including small boulders in the channel (**Figures 58** and **59**). Based on the information reviewed, the best trout habitat on Unnamed 4 appears to be upstream of the Union Pacific railroad (**Figure 60**).

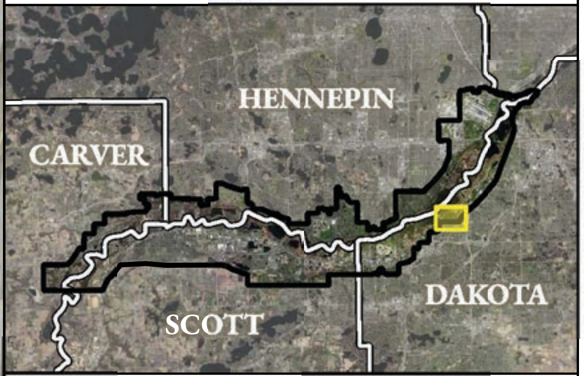
Figure 58. Unnamed 4 looking upstream from Union Pacific Bridge on October 13, 2020.

Figure 59. Unnamed 4 looking downstream from Union Pacific Bridge on October 13, 2020.

Figure 60: Unnamed 4 Potential Trout Habitat



LMRWD Watershed Location Map



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9.4 Stream Flow

There are no stream gages located on Unnamed 4; however, the MnDNR has estimated flows during their survey work around 2 to 3 cfs. These surveys have noted that the creek may have low baseflows; however, extensive measurements have not been conducted.

Stormwater inputs to the creek have been an ongoing concern since the 1980s, and a large stormwater outfall pipe is located near the Unnamed 5/6 tributary just upstream of the railroad (Gilbertson 1981c). This stormwater runoff has changed Unnamed 4's natural hydrology, as rainfall runoff now occurs more quickly and intensely from the upper developed areas, leading to downcutting of the channel and bank erosion, as well as increasing water temperatures (Stewart 2000).

During the site walk on October 13, 2020, the team noticed several storm sewer pipes discharging into the floodplain near Unnamed 4 (**Figure 61**), and the MnDNR noted that Trout Unlimited has suggested that, at some point, the railroad had plugged the crossing under the railbed near Unnamed 5/6 because increased flow from storm sewer discharges up the bluff had been washing out the rail embankment. At the time of visit, heavy armoring along the railbed was noted, supporting this theory (**Figure 62**).

Figure 61. Stormwater outfall observed on October 13, 2020, on Unnamed 5/6.

Figure 62. Union Pacific railbed armoring opposite stormwater outfall on October 13, 2020.

9.5 Groundwater

The Minnesota Springs Inventory identified five springs in the Unnamed 4 watershed. The MnDNR has determined the creek is primarily fed by four seeps and springs located along its length (Stewart 2006b).

The 2020 *Fens Sustainability Gaps Analysis for Carver, Dakota, and Scott Counties, Minnesota* noted concerns that groundwater elevations in the Black Dog Lake fen complex may have been artificially lowered due to nearby groundwater appropriations. These pumping activities could also be affecting the groundwater contribution in Unnamed 4's baseflow, leading to lower water levels and warmer temperatures in the creek.

9.6 Geochemistry and Water Quality

The creek was sampled on July 13, 1980. It had a pH of 7.3, total alkalinity of 265 mg/L, total dissolved solids of 314 mg/L, and a total phosphorus concentration of 0.125 mg/L (Gilbertson 1981c).

The watershed experienced intense urbanization beginning in the 1990s, which led to concerns regarding the stream's water quality; unfortunately, no water quality sampling has occurred since 1980 to verify the impact of development on water quality (Stewart 2000).

9.7 Public Access

The MnDNR owns most of the surrounding area, but private landowners, the City of Burnsville, Xcel Energy, and adjacent businesses also own portions of the watershed. Near the Minnesota River, Unnamed 4 is inaccessible to the public without trespassing on the adjacent Union Pacific property, but various easement corridors exist close to the stream (Berg et al. 2019; **Figure 51**). There is legal access through an easement to the Minnesota Valley Wildlife Refuge at 3104 Hayes Drive in Burnsville (Callahan 2016a).

9.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4, the following highlights the data gaps needed to determine the quality of trout habitat in Unnamed 4. The minimum and optimal criteria are shown in the following tables.

Table 29. Unnamed 4 spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Adult Access: Jump Height < 1 ft	**No – Trout Ponds**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**Unknown**
Constant Baseflow	**Yes**
Gravel Substrate	**Yes**
Protection from Flooding	**Partial**

Table 30. Unnamed 4 summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Min. Water Temperatures < 72°F	**Yes**
Optimal Dissolved Oxygen ≥ 9 mg/L	**No**
Optimal Water Temperatures < 57°F	**No**
Healthy Macroinvertebrate Population	**Unknown**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Yes**
Cover > 6 in	**Unknown**

Table 31. Unnamed 4 overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Constant Baseflow or Deep Pools	**Yes – 2 cfs**
Cover ≥ 15% of Total Stream Area	**Yes**
Healthy Macroinvertebrate Population	**Unknown**
Juvenile Access: Jump Height < 1 ft	**No – Trout Ponds**
Juvenile Access: Velocity < 0.3 fps	**Unknown**
Juvenile Access: Cover > 6 in	**Unknown**

While Unnamed 4 meets the minimum criteria for trout habitat, no trout have been found in the stream since 1982. The creek has good baseflow; however, increased water temperatures from stormwater discharges and beaver dams are thought to have decimated the stocked trout population. The MnDNR and Minnesota Trout Unlimited have considered stream restoration projects on Unnamed 4; however, city storm sewer and drainage improvements are necessary for any restoration attempts to be successful.

Information about macroinvertebrate populations on Unnamed 4 was not found, so the availability of food sources can only be inferred from information on similar streams. Winter baseflow, estimated to be about 0.5 cfs, may not be adequate to support the life stages of important trout-food life stages.

The sources of pollution have not been well-documented but have remained an ongoing concern for the viability of the creek. This should be verified through water quality sampling.

9.9 Management Strategies

Based on the information presented, and a fair amount of data describing temperature regimes, dissolved oxygen, and vegetative cover, Unnamed 4 meets the minimum characteristics of a trout water. Although it once supported a stocked trout population, no trout have been observed since 1982. The following highlights the major challenges Unnamed 4 faces:

1. **Stormwater:** Stormwater discharges into Unnamed 4 have been a concern for many years; however, no study has been conducted to determine the total amount of stormwater runoff entering the creek, or the impacts it may have on temperatures and water quality.
2. **Barriers:** The remnant trout ponds and recurrent beaver dams present barriers to trout migration, especially during the summer when fish may move to the upper reaches of the system to seek refuge from the sun.
3. **Erosion:** Streambank erosion and instability in the channel may be releasing fine sediments into the Unnamed 4 system and burying potential spawning grounds.

Until more is known about the effects of stormwater runoff on the creek, Unnamed 4 should be considered and managed as a restorable trout water. It is a valuable resource to the District, especially as part of the larger Black Dog fen complex. It may be best managed as part of the fen, rather than a stand-alone resource until the above major challenges can be addressed. Based on the data reviewed, the following management strategies are recommended for Unnamed 4 and summarized in **Table 32**:

- **U4-0:** Continue to implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek as the watershed develops in the future.
- **U4-1:** Evaluate the current HVRA boundary around Unnamed 4 and work with the City of Burnsville to confirm the direct runoff boundary, identify any stormwater inputs, and quantify the flows and potential pollutant loading to prevent further habitat degradation.
- **U4-2:** Based on the results from the 2021 Gully Inventory, conduct a feasibility study to evaluate restoration opportunities to mitigate the continued erosion in the upper watershed.
- **U4-3:** Establish a real-time, long-term flow monitoring gage on Unnamed 4 to determine whether the creek has adequate baseflows year-round to support trout.
- **U4-4:** Black Dog Fen Hydrogeologic Investigation: Due to concerns surrounding groundwater appropriations and low baseflows, a hydrogeologic investigation would be beneficial to determine whether the creek's subsurface hydrology can be restored. This work could be done as part of a larger review of the stormwater inputs to the Black Dog fen complex, including Black Dog Creek discussed in **Section 4**, and as part of the Black Dog Fen Management Study recommended in the *2020 Fens Sustainability and Gaps Analysis* report.
- **U4-5:** The 2019 Geomorphic Study was unable to access most of Unnamed 4. A creek survey to determine geomorphic features and identify erosion concerns, stormwater inputs, and fish blockages is needed to determine whether a viable trout habitat exists.
- **U4-6:** If determined to have sufficient baseflow and stream temperatures, work with Trout Unlimited to implement habitat restoration projects, including improving fish passage by removing the former trout ponds and beaver dams.

Table 32. Unnamed 4 management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
U4-1	Unnamed 4 Stormwater Inputs Study	Study	2022
U4-2	Unnamed 4 Gully Restoration Feasibility Study	Study	2023
U4-3	Real-Time Flow Monitoring	Data Collection	2023
U4-4	Black Dog Fen Hydrogeologic Investigation	Study	2026
U4-5	Geomorphic Assessment	Study	2026
U4-6	Habitat Restoration	Capital Improvement	2030

10.0 UNNAMED #7

Unnamed #7 (Tributary Number M-55-4.3), also sometimes known as One Mile Creek, is a 0.18-mile stream located in Dakota County within the City of Burnsville (**Figure 63**). Not much is known about Unnamed 7; however, it was once a designated trout stream and presumably at that time was able to support trout. Today it is no longer a designated trout water and is not actively managed by the MnDNR, but is within the Black Dog Fen complex and flows through remnants of the fen.

10.1 Watershed History Land Uses

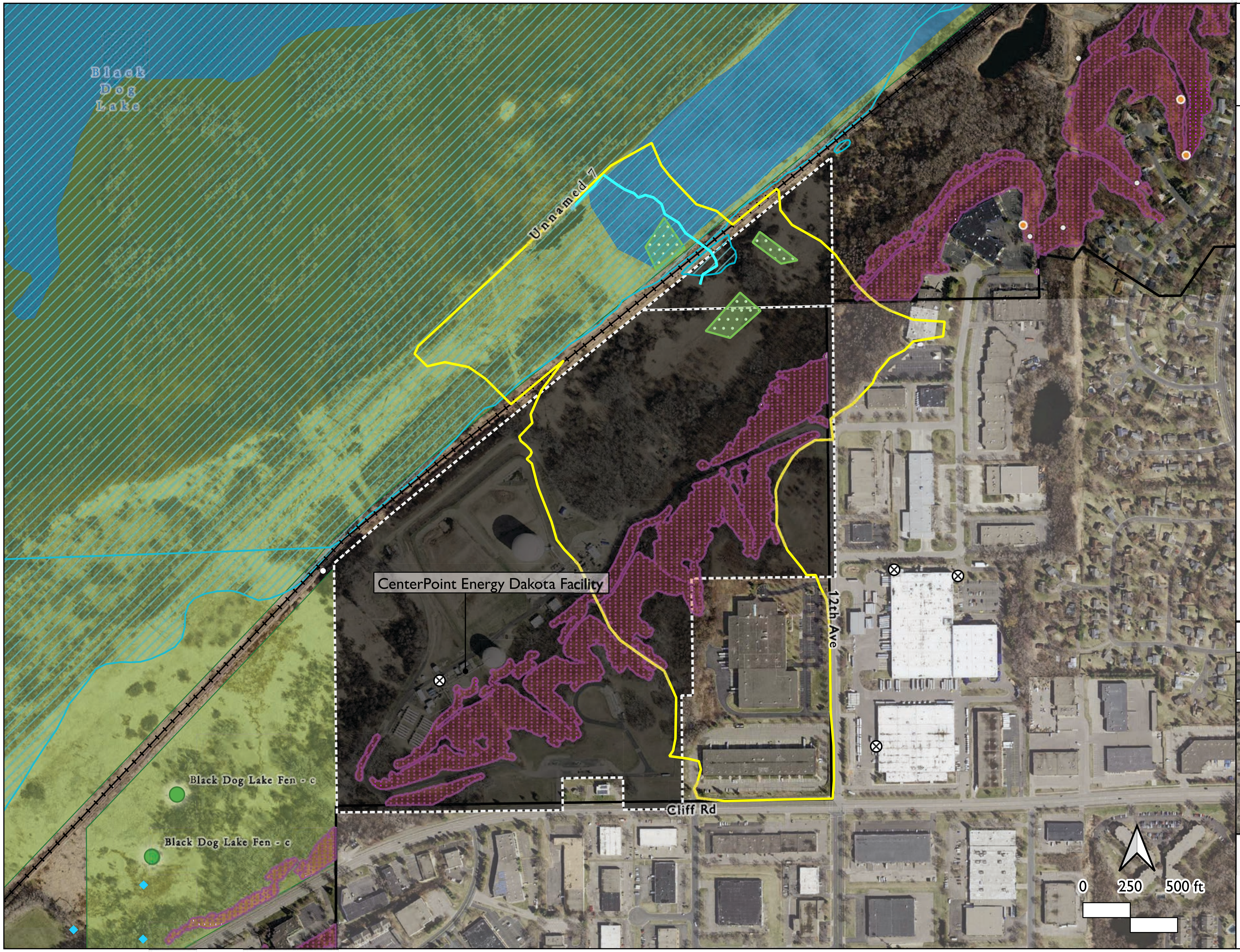
Unlike many of the other trout streams, information on the history of the creek or historical watershed uses is not available. Like much of the Minnesota River Valley, the Dakota people were an active presence in the area until the 1860s (Shakopee Mdewakanton Sioux Community 2002). The USGS topographic maps from 1896 show that Unnamed 7, much like many of the Dakota County trout streams, was part of the larger Black Dog Creek watershed, with a contributing drainage area of approximately 12 acres (**Figure 64**). Aerial photographs from 1937 show a dry Black Dog Lake and all but the steep bluff slopes in production, primarily hay. In 1956, the Black Dog Lake Power Plant can be seen. From 1967 to 1971, large residential developments are seen directly north and south of Black Dog Lake.

Today, the Unnamed 7 watershed is slightly smaller at 9.6 acres but is still primarily open space, with commercial lands in the upper watershed, whereas the lower reach is primarily undeveloped and owned by Xcel Energy. Land use is expected to change upstream of the railroad, with the City of Burnsville's projected 2040 land uses indicating an expansion of existing commercial development (Metropolitan Council 2016, 2020; **Figure 65; Table 33**). Stormwater management from this future development, if improperly managed, could have a detrimental impact on Unnamed 7 in terms of increased temperatures and erosion and decreased water quality.

Table 33. 2016 and future generalized land uses within the Unnamed 7 watershed (Metropolitan Council 2016, 2020).

	2016 Area (ac)	Future Area (ac)	Change (ac)
Park, Recreational, or Preserve	7.6	2.1	-5.5
Mixed Use/Commercial/Industrial	1.9	7.1	5.2
Transportation	0	0.3	0.3

Figure 63: Unnamed 7 Current Conditions



LEGEND

- Unnamed 4 Watershed
- 2020-2021 Gully Data:
  - Low and Moderate Risk Gullies
  - High Risk Gullies
  - Very High Risk Gullies
- Active and Observation Wells
- Groundwater-Dependent Natural Resources:
  - MnDNR Spring Inventory
  - LMRWD Calcareous Fens
  - LMRWD Trout Streams
  - Calcareous Fen Estimated Extents
- Union Pacific Railroad
- 100-yr Floodplain Extents
- Public Waterbodies
- Steep Slopes Overlay District [SSOD]
- CenterPoint Energy Property
- Minnesota Valley National Wildlife Refuge
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map

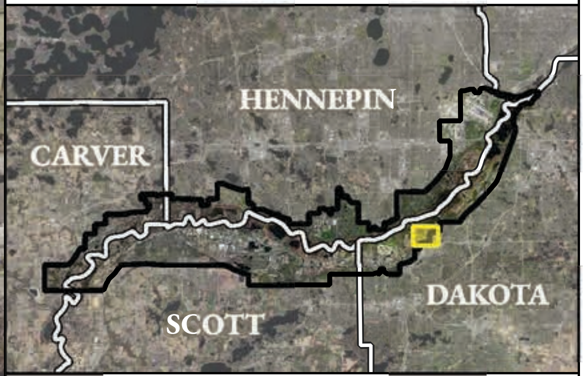


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Figure 64: Unnamed 7 Historic Watershed

LEGEND

- Unnamed 7 (Present Day)
- Unnamed 7 Present Day Watershed
- Unnamed 7 1896 Watershed
- Historic USGS Quad Sheets (1896)

LMRWD Watershed Location Map

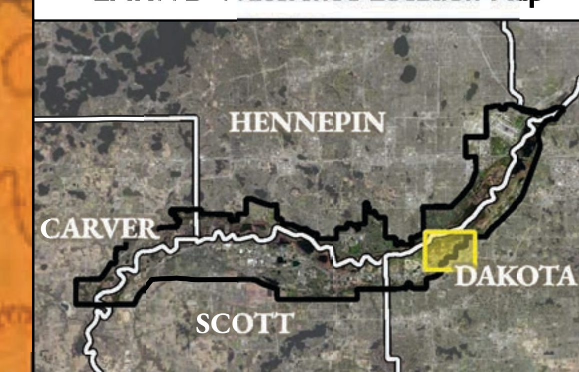

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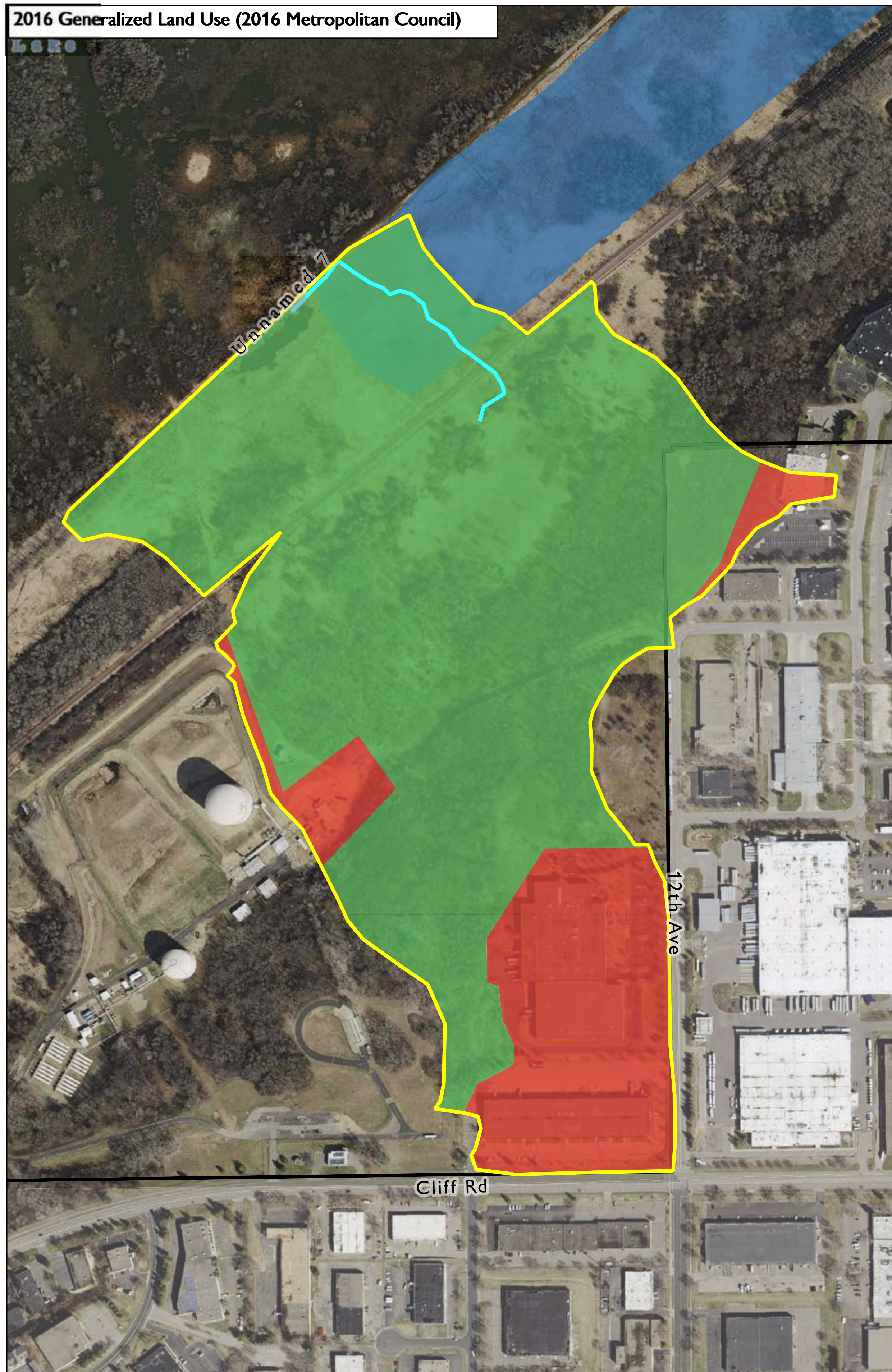
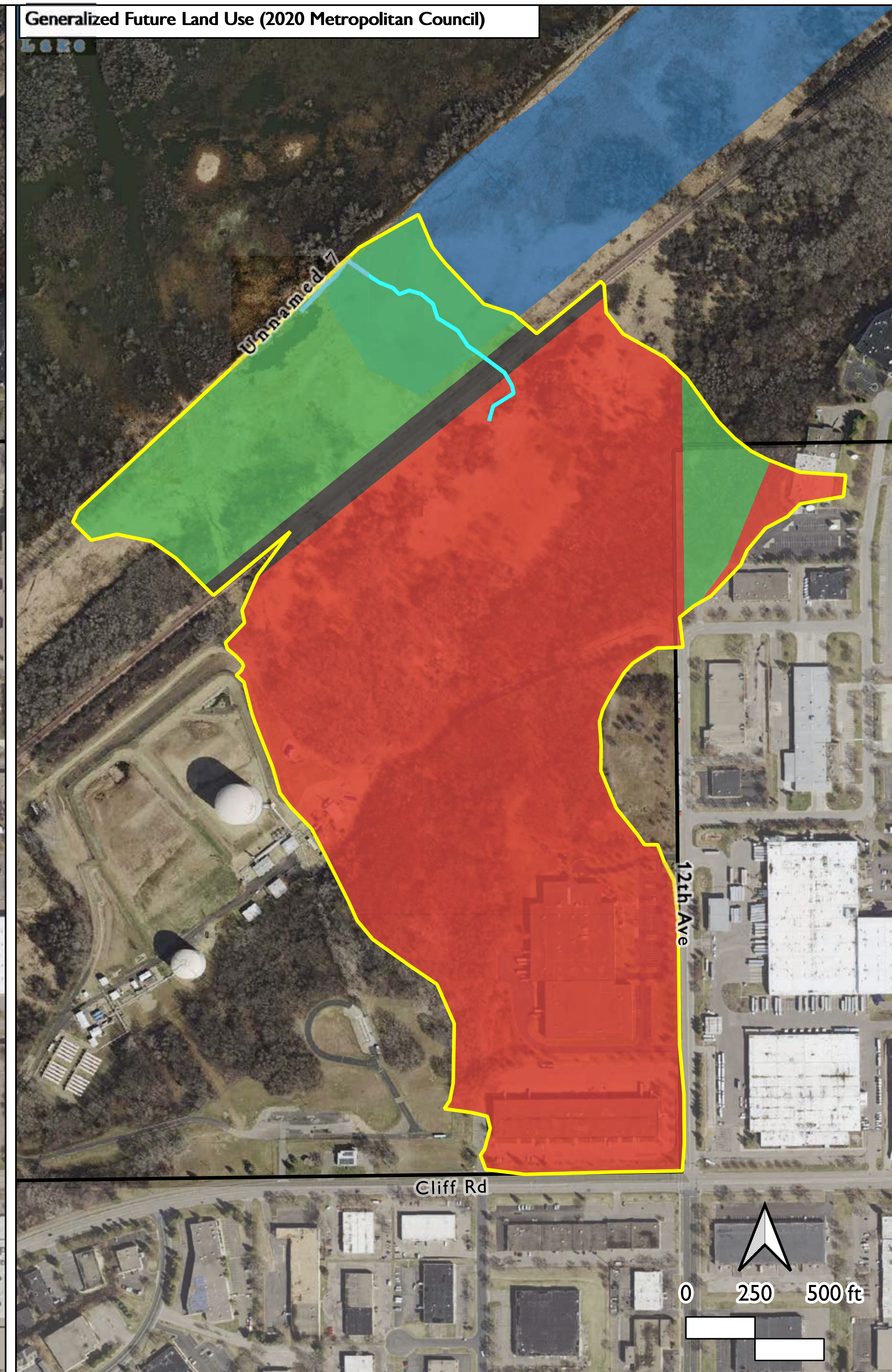
Figure 65: Unnamed 7 Watershed Land Uses





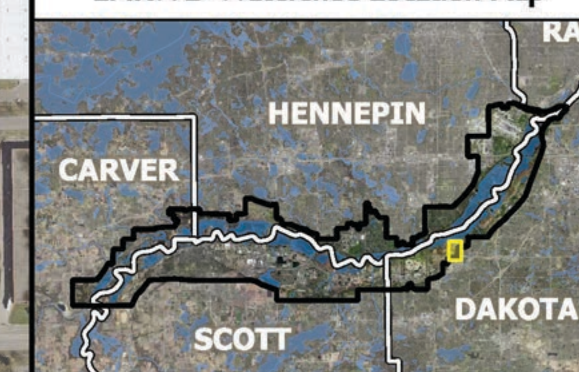
LEGEND

- Unnamed 7
- Unnamed 7 Watershed

Generalized Land Use:

- Agricultural
- Mixed Use/Commercial/Industrial
- Residential
- Public / Quasi-Public
- Park, Recreational, or Preserve
- Transportation
- Undeveloped
- Open Water
- Public Waters
- Public Waterbodies
- Cities, Townships, Unincorporated Areas
- County Boundaries
- LMRWD Boundary

LMRWD Watershed Location Map



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The *2021 Gully Inventory and Condition Assessment* was unable to access this area to determine whether gullies or erosion exist within the watershed due to security fencing around CenterPoint Energy. Given the steep slopes in the area, it is likely that gully formation is occurring, and this area should be surveyed in the future (Young Environmental 2021).

10.2 Fisheries

The MnDNR first investigated Unnamed 7 in 1980; however, the field team noted that "despite our efforts, no fish were found" in the stream. The team recommended retaining the creek on the designated list and consider stocking brook trout, if surplus fish were available in the future (Gilbertson 1981d). The creek was not resurveyed until 2000, when the MnDNR was updating area stream files. Although eight fish were found, none were trout, and the MnDNR determined that the stream may not be able to support trout and that stocking was not justified at that time (Stewart 2001b). A stream management plan was developed in 2001, with the long-range goal of eventually supporting brook trout stocking operations and a catch and release fishery (Minnesota Department of Natural Resources 2001a).

10.3 In-Stream Habitat

The major substrate types making up Unnamed 7 are silt, muck, and gravel. In 1980, the stream bottom consisted almost entirely of soil and muck, with only a 20-foot stretch of gravel; however, water temperatures were determined to be suitable for trout (Gilbertson 1981d). The lower vegetation includes cattails, floodplain forest, shrubs, overhanging banks, and tall grasses, ideal cover for trout; but it has a scarcity of pool and in-stream cover. A 100-year flood on July 7, 2000, blew out the banks, causing channel depth changes in the stream and severe scouring after the 2000 MnDNR resurvey (Stewart 2001b).

The 2001 stream management plan identified storm sewer inflows as a major concern and detriment to in-stream habitats. It recommended consistent monitoring, and potential stream and habitat restorations were needed prior to any stocking (Minnesota Department of Natural Resources 2001a).

By 2020, of the total estimated length of 2,269 feet, none of Unnamed 7 was considered suitable for stream trout due to size and limited flows (Nemeth 2020b; **Figure 66**).

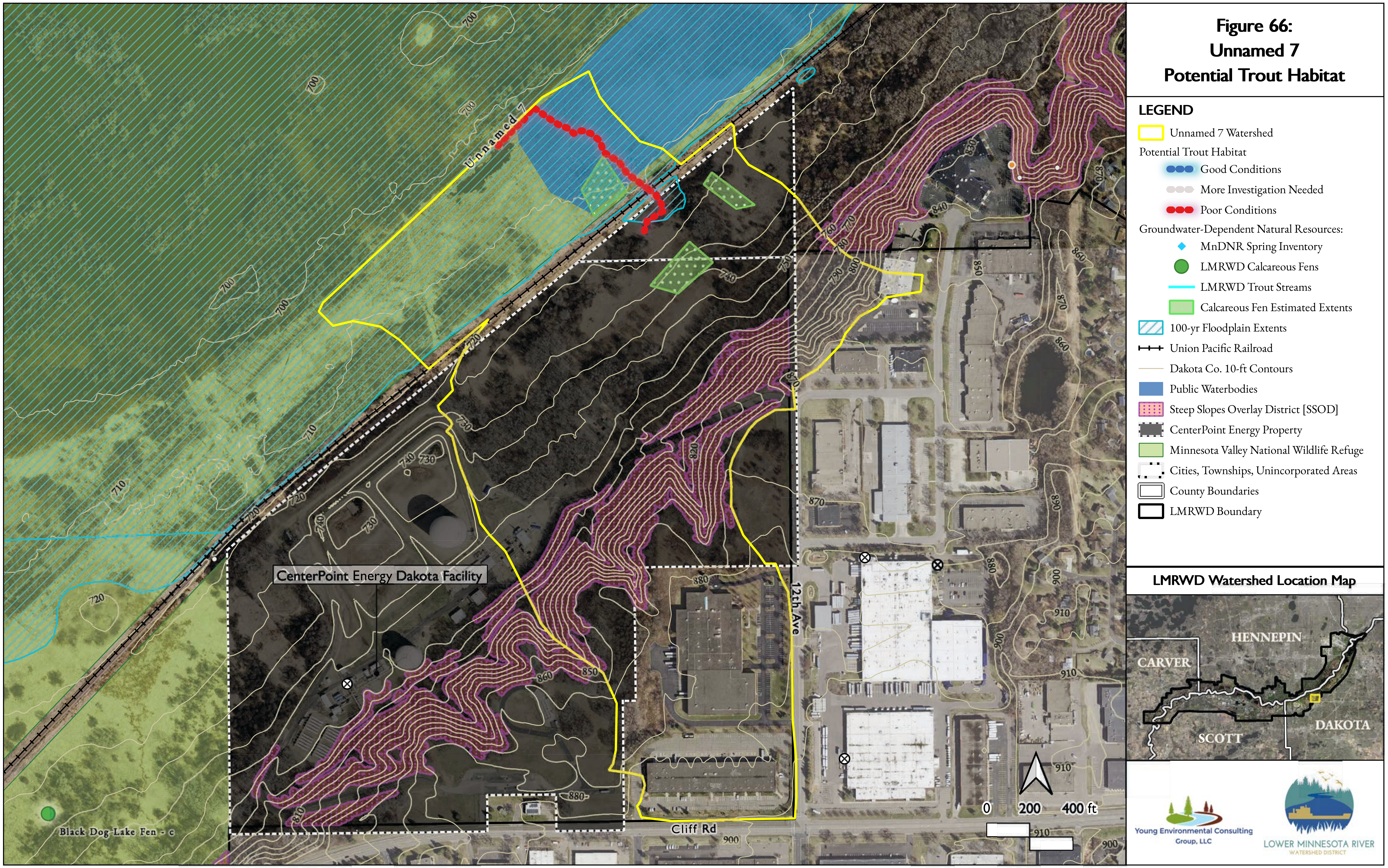

Figure 66: Unnamed 7 Potential Trout Habitat

10.4 Stream Flow

In the initial survey, the MnDNR noted the stream flows for Unnamed 7 may be variable, especially in the fall and winter, potentially causing low water conditions detrimental to trout (Gilbertson 1981d). Both the MnDNR surveys in 1980 and 2000 reported flows of 0.2 cfs, and it was estimated to be 0.15 cfs in fall 2015 (Nemeth 2020b).

In 2015, the MnDNR monitored stream temperatures downstream of the railroad tracks with a level logger. When the instrument was placed in the channel thalweg, in April 2015, it was covered by 6 to 8 inches of water. When the team collected the level logger in August, the water depth was only 1 inch deep (Nemeth 2017), confirming the low and variable nature of flows in Unnamed 7, as well as the consistently cool stream temperatures within trout tolerances.

The Cliff Road storm sewer system also collects water from the headwater spring. Before the spring water enters Unnamed 7, it is piped under Cliff Road and a large parking lot. Also arising in the headwater springs is the west tributary, which has been straightened along the southern side of the Union Pacific railroad embankment to Cliff Road (Stewart 2001b).

10.5 Groundwater

In 2001, the MnDNR assumed that spring water from the rock terraces provided the baseflow in Unnamed 7; however, the MnDNR Minnesota Spring Inventory does not have a record of these springs (Stewart 2001b).

The 2020 *Fens Sustainability Gaps Analysis for Carver, Dakota, and Scott Counties, Minnesota* noted concerns that groundwater elevations in the Black Dog fen complex may have been artificially lowered due to nearby groundwater appropriations. These pumping activities could also be affecting the groundwater contribution in Unnamed 7's baseflow, leading to lower water levels and warmer temperatures in the creek.

10.6 Geochemistry and Water Quality

The water chemistry of the stream was sampled by the MnDNR on July 13, 1981. It had a pH of 7.0, total alkalinity of 278 mg/L, a total phosphorus concentration of 0.035 mg/L, and total dissolved solids of 333 mg/L (Oie and Berowski 1981). The occurrence of marl deposits in the stream were noted during a site visit on July 29, 1980 (Gilbertson 1981d).

The notes from a site visit on June 27, 2000, describe the results of water chemistry samples of the stream. The results were reported as downstream/upstream of the railroad bridge: pH 7.9/7.9, total alkalinity 308/307 ppm, conductivity 780/800 µS/cm, total phosphorus 0.021/0.025 ppm, chloride 41.4/45.3 ppm, and total dissolved solids 536/516 ppm (Stewart 2001b).

The watershed has experienced intense development beginning in the 1990s, and stormwater discharges are an ongoing concern, not only because of increased stream temperatures but also in terms of water quality. However, the effects have not been confirmed by any sampling.

10.7 Public Access

Much of the watershed is in private ownership, with limited access only available via Union Pacific railroad right-of-way. A small portion of the eastern watershed is owned by the City of Burnsville.

10.8 Data Gaps and Resource Concerns

Using the minimum and optimal criteria established in Sections 1.3 and 1.4, the following highlights the data gaps needed to determine the quality of trout habitat in Unnamed 7 based on the information reviewed. The minimum and optimal criteria are shown in the following tables.

Table 34. Unnamed 7 spawning habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Adult Access: Jump Height < 1 ft	**Yes**
Adult Access: Velocity < 0.5 fps	**Unknown**
Adult Access: Cover > 6 in	**No**
Constant Baseflow	**No**
Gravel Substrate	**No**
Protection from Flooding	**No**

Table 35. Unnamed 7 summer habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Min. Water Temperatures < 72°F	**Yes**
Optimal Dissolved Oxygen ≥ 9 mg/L	**No**
Optimal Water Temperatures < 57°F	**No**
Healthy Macroinvertebrate Population	**Unknown**
Velocity < 0.3 fps	**Unknown**
Undercut Banks/LWD	**Yes**
Cover > 6 in	**No**

Table 36. Unnamed 7 overwintering habitat summary (minimum criteria are highlighted in light blue).

Criteria	Meets Requirements
Min. Dissolved Oxygen ≥ 5 mg/L	**Yes**
Optimal Dissolved Oxygen ≥ 7 mg/L	**Yes**
Constant Baseflow or Deep Pools	**No**
Cover ≥ 15% of Total Stream Area	**Yes**
Healthy Macroinvertebrate Population	**Unknown**
Juvenile Access: Jump Height < 1 ft	**Yes**
Juvenile Access: Velocity < 0.3 fps	**Unknown**
Juvenile Access: Cover > 6 in	**No**

Although Unnamed 7 meets the minimum criteria for trout habitat, no trout have been found in the stream during any of the surveys since 1980. The creek lacks adequate baseflow and depths to support trout. Stormwater discharges from upstream may be contributing to increased water temperatures as well.

10.9 Management Strategies

Based on the information presented, although Unnamed 7 does meet the minimum characteristics of a trout water, no trout have been observed in the creek. The following highlight the major challenges Unnamed 7 faces:

1. **Baseflow:** The Unnamed 7 watershed is small and subject to urbanized runoff in the upper reaches. It may never support a fishery due to the inconsistent flows in the creek and lack of cover depth in the channel.

2. **Stormwater:** Stormwater discharges into Unnamed 7 are a concern; however, no study has been conducted to determine the total amount of stormwater runoff entering the creek and the impacts it may have on temperatures, water quality, and erosion potential.
3. **In-Stream Habitat:** The channel bottom is primarily silt and muck, not ideal habitat for trout. Unnamed 7 also does not provide adequate pool refuges or in-stream cover for fish.

Given the small watershed size, it is unlikely Unnamed 7 will be able to support a trout fishery and should not be managed as a trout water. However, it is a valuable resource to the District, especially as part of the larger Black Dog fen complex. It may be best managed as part of the fen, rather than a stand-alone resource. Based on the data reviewed, the following management strategies are recommended for Unnamed 7 and summarized in **Table 37**:

- **U7-0:** Continue to implement the HVRA restrictions to minimize future stormwater runoff inputs into the creek as the watershed develops in the future.
- **U7-1:** Evaluate the current HVRA boundary around Unnamed 7 and work with the City of Burnsville to confirm the direct runoff boundary, identify any stormwater inputs, and quantify the flows and potential pollutant loading.
- **U7-2:** The 2021 Gully Inventory was unable to gain access to the Unnamed 7 watershed and document site conditions; this area should be included the next time the study is conducted.

Table 37. Unnamed 7 management strategies, 2022–2030.

ID	MANAGEMENT STRATEGY	TYPE	YEAR
U7-1	Unnamed 7 Stormwater Inputs Study	Study	2026
U7-2	Unnamed 7 Gully Inventory and Assessment	Data Collection	2030

11.0 RECOMMENDATIONS

Following the detailed review of the trout streams within the LMRWD, three different categories were established: Trout Stream, Restorable Trout Stream, and Fen.

11.1 Trout Streams

Trout Streams are creeks that have an active trout fishery or resident trout population. Two of the streams evaluated for this study have characteristics that make them primary candidates for continued management as trout streams: Eagle Creek and Ike's Creek.

Both have reliable baseflow and groundwater connections providing cool temperatures in the summer and sustained ice-free conditions through the winter that should support an abundant macroinvertebrate food supply and provide adequate cover for trout. Both streams are generally protected from the detrimental effects of excessive runoff due to their reduced watersheds. Based on the habitat preferences of brook trout for smaller, headwater streams, Ike's Creek may be best managed as a brook trout stream, whereas Eagle Creek may be more suited to support a brown trout fishery.

Whether those management plans include recreational fishing is beyond the scope of this assessment, but it is understood that the opportunity to catch trout in these streams will considerably increase the value of those resources. It is recommended the LMRWD continue working with the MnDNR and USFWS to manage these resources and combine monitoring efforts.

11.2 Restorable Trout Streams

Most other streams considered in this analysis have many of the individual characteristics of high-quality trout habitat and have supported limited trout populations in the past. However, most are unable to sustain adequate baseflows that could make this habitat reliable and suitable in some warm, dry years. Although they can no longer support trout, if flows in these streams could be augmented by increasing the supply of groundwater discharging to the streams, they likely could be productive trout streams. Four creeks in this study were classified as Restorable Trout Streams: Kennaley's Creek, Unnamed 1, Unnamed 4, and Unnamed 7.

11.3 Fens

Trout streams, like calcareous fens in the LMRWD, rely heavily on the discharge of cold, clean groundwater. Black Dog Creek was once a large creek with a healthy trout population; however, it no longer has the watershed area or groundwater supply to support trout. It has similar issues as Black Dog Fen and should be managed in tandem.

Understanding the groundwater hydrology as it relates to natural resources in the LMRWD and determining whether the supply of groundwater discharging to streams and fens has changed over time would add greatly to our understanding of whether reclamation of these trout streams is achievable. It can be speculated that the appropriation and diversion of groundwater that once sustained trout streams has resulted in the decline of reliable trout habitats. It could further be speculated that, if those appropriations and diversions were reversed or reduced, it might allow many of those LMRWD resources to return to something approaching their original, productive condition. The outcomes from the District's Groundwater Recharge Value Engineering Workshop will provide additional information on current state of the LMRWD groundwater and how to proceed for future studies. Continued coordination with the MnDNR and USFWS to monitor these streams is recommended as well.

11.4 Long-Term Management Plan

The recommendations from each of the trout streams have been compiled into a comprehensive management plan (**Table 38**). Many of the management strategies have already been initiated, including the groundwater recharge value engineering, ongoing monitoring activities, and 2021 gully inventory; however, some may require modifications based on the recommendations in this report. Specific tasks from this study will be incorporated into the LMRWD's capital improvement plan to reflect the current priorities, begin long-term budgeting needs, and begin coordinating with potential project partners and stakeholders to continue to protect these valuable resources for future generations.

Table 38. Long-term management plan for LMRWD trout streams (2022–2030).

No.	ID	CREEK	MANAGEMENT STRATEGY	TYPE	YEAR	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	BD-1	Black Dog Creek	Black Dog Fen Management Study	Study	2024			x						$10,000
2	BD-2 U4-4	Black Dog Creek, Unnamed 4	Black Dog Fen Hydrogeologic Investigation	Study	2026					$20,000				
3	EC-1	Eagle Creek	Detailed Survey and Sediment Sampling	Data Collection	2022	$30,000								$30,000
4	EC-2	Eagle Creek	Eagle Creek Sediment Transport Study	Study	2023		$60,000							
5	EC-3	Eagle Creek	Town & Country RV Park Bank Restoration Feasibility Study	Study	2022	$30,000								
6	EC-4	Eagle Creek	MnDNR Stream Re-Surveys	Data Collection	2022	x			X			X		
7	EC-5	Eagle Creek	MCES Water Quality Sampling	Data Collection	2022	x					x			
8	EC-6	Eagle Creek	Real-Time Flow Monitoring	Data Collection	2022	$20,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
9	EC-7	Eagle Creek	Macroinvertebrate Monitoring	Data Collection	2023		x		x		x		x	
10	EC-8	Eagle Creek	Brook Trout Stocking Feasibility Study	Study	2025				$40,000					
11	EC-9	Eagle Creek	Geomorphic Assessment Update	Study	2026					$30,000				
12	EC-10	Eagle Creek	Eagle Creek Habitat Improvements	Capital Improvement	2027						$10,000	$20,000	$40,000	$100,000
13	EC-11	Eagle Creek	Beaver and Vegetation Management	Maintenance	As Needed	x		x		x		x		x
14	IC-1	Ike's Creek	Gully and Channel Restoration Feasibility Study	Study	2022	$10,000	$20,000	$40,000	$100,000					$10,000
15	IC-2	Ike's Creek	Real-Time Flow Monitoring	Data Collection	2022	$20,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
16	IC-3	Ike's Creek	MnDNR Stream Re-Surveys	Data Collection	2022	X			X			X		
17	IC-4	Ike's Creek	Chloride Monitoring	Data Collection	2022	x	x	x	x	x	x			
18	IC-5	Ike's Creek	Groundwater Monitoring Plan	Study	2022	$30,000								
19	IC-6	Ike's Creek	Macroinvertebrate Monitoring	Data Collection	2023		x		x		x		x	
20	IC-7	Ike's Creek	Review Fishing Demand	Study	2025				x					
21	IC-8	Ike's Creek	Geomorphic Assessment Update	Study	2026					$30,000				
22	IC-9	Ike's Creek	Kelly Farm Tributary Restoration	Capital Improvement	2027						$10,000	$20,000	$40,000	$100,000
23	KC-1 U1-1	Kennaley's Creek Unnamed 1	Hydrogeologic Investigation of Nicols Meadow Fen Area	Study	2022	x								
24	KC-2	Kennaley's Creek	HVRA and Stormwater Inputs Reevaluation	Study	2022	$20,000								
25	KC-3	Kennaley's Creek	Kennaley's Creek Gully Restoration Feasibility Study	Study	2023		$40,000							$10,000
26	KC-4	Kennaley's Creek	Real-Time Flow Monitoring	Data Collection	2022	$20,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
27	KC-5	Kennaley's Creek	Geomorphic Assessment	Study	2026					$30,000				
28	U1-2	Unnamed 1	HVRA and Stormwater Inputs Reevaluation	Study	2022	$20,000								
29	U1-3	Unnamed 1	Real-Time Flow Monitoring	Data Collection	2022	$20,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
30	U1-4	Unnamed 1	Groundwater Monitoring	Study	2024			$30,000						

No.	ID	CREEK	MANAGEMENT STRATEGY	TYPE	YEAR	2022	2023	2024	2025	2026	2027	2028	2029	2030
31	U1-5	Unnamed 1	Geomorphic Assessment	Study	2026					$100,000				
32	U1-6	Unnamed 1	Parcel Acquisition for Conservation	Capital Improvement	2030									x
33	U4-1	Unnamed 4	Unnamed 4 Stormwater Inputs Reevaluation	Study	2022	$20,000								
34	U4-2	Unnamed 4	Unnamed 4 Gully Restoration Feasibility Study	Study			$40,000							$10,000
35	U4-3	Unnamed 4	Real-Time Flow Monitoring	Data Collection	2022	$20,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
36	U4-5	Unnamed 4	Geomorphic Assessment	Study	2026					$30,000				
37	U4-6	Unnamed 4	Habitat Restoration	Capital Improvement	2030									$100,000
38	U7-1	Unnamed 7	Unnamed 7 Stormwater Inputs Study	Study	2026					$30,000				
39	U7-2	Unnamed 7	2021 Gully Inventory	Data Collection	2030									$10,000

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APPENDIX A - PARTNER DATA RECEIVED

LMRWD TROUT STREAMS GAPS ANALYSIS - PARTNER DATA RECEIVED

ID	DATA TITLE	FILE NAME	AUTHOR	DATA AUTHOR	DATA DATE	DATA SOURCE
1	Minnesota Department of Natural Resources Stream Survey Site Code: 310	Kennealy's 2004.pdf	MN DNR	Jim Stewart	Mar-03	MN DNR
2	Minnesota Department of Natural Resources River or Stream Survey	Kennealy's Creek Resurvey 1990.pdf	MN DNR	Craig W. Bell, Bruce Gilbertson, Scott Craig	Jul-90	MN DNR
3	Minnesota Department of Natural Resources Stream Survery Summary	Kennealy's Creek Stream Survey 1982.pdf	MN DNR	Gilbertson, Gorton Adams	Jul-82	MN DNR
4	Trout Water Census Form	Kennealy's Creek Creel 1967.pdf	MN DNR	M. Haugsted	Apr-67	MN DNR
5	Species and Numbers of Fish in Length Groups	Kennealy's Creek EF Survey 1975 1.pdf	MN DNR	Tureson, Gilbertson	Sep-75	MN DNR
6	Species and Numbers of FIsh in Length Groups	Kennealy's Creek EF Survey 1975 2.pdf	MN DNR	Tureson and Bathel	Oct-75	MN DNR
7	Minnesota Department of Natural Resources Division of Game & Fish, Section of Fisheries	Kennealy's Creek EF Survey 1976 1.pdf	MN DNR	Tureson, Pederson	May-76	MN DNR
8	Minnesota Department of Natural Resources Division of Game & Fish, Section of Fisheries	Kennealy's Creek EF Survey 1976 2.pdf	MN DNR	Tureson, Pederson	Oct-76	MN DNR
9	Electrofishing Survery Form	Kennealy's Creek EF Survey 1978 1.pdf	MN DNR	Tureson and Johnson	Mar-78	MN DNR
10	Electrofishing Survery Form	Kennealy's Creek EF Survey 1978 2.pdf	MN DNR	Tureson and Kirch	Jul-78	MN DNR
11	Electrofishing Survery Form Trout Streams	Kennealy's Creek EF Survey 1981.pdf	MN DNR	B. Gilbertson, D. Mach	Jun-81	MN DNR
12	Electrofishing Survery Form Trout Streams	Kennealy's Creek EF Survey 1983.pdf	MN DNR	B. Gilbertson, D. Baker	Oct-83	MN DNR
12	Fish Inventory and Other Information	Kennealy's Creek Fish Inventory and Creel 1967.pdf	MN Division of Game and Fish Section of Fisheries	M. C. Haugsted	Apr-67	MN DNR
13	Fish Population Survey Streams	Kennealy's Creek Fish Population 1966.pdf	MN Conservation Department	-	Sep-66	MN DNR
14	Kenaleys Creek, Storm Sewer	Kennealy's Creek Letter City of Eagan 1977.pdf	MN DNR	Bob Rosene	Oct-77	MN DNR
15	Kennaleys Creek	Kennealy's Creek Map 1.pdf	-	-	-	MN DNR
16	River or Stream Survey, Electrofishing Survey Form - Trout Streams	Kennealy's Creek Resurvey 1994.pdf	MN DNR	B. Gilbertson, R. Ramsell	Oct-94	MN DNR
17	Kenaleys Creek	Kennealy's Creek Site Visit 1976.pdf	-	Tureson and Gilbertson	Jun-76	MN DNR
18	Stream Summary Card	Kennealy's Creek Stocking History.pdf	MN Division of Game and Fish	-	-	MN DNR
19	Trout quota, Kenaley Creek	Kennealy's Creek Stocking Request 1962.pdf	Minnesota Conservation - Game and Fish, Section of Research and Planning	From: R. E. Schumacher, To: Fred Miller From: Henry Swanson, To: Fred Miller	10/15/62 10/9/62 09/28/62	MN DNR
20	Stream Survey Data Summary	Kennealy's Creek Stream Survey 1960.pdf	Game and Fish, Section of Research and Planning	Fred Miller	Oct-62	MN DNR
21	Stream and River Survey Reports	Kennealy's Creek	State of Minnesota Conservation- Game and Fish	From: Fred Miller, To: Henry Swanson	Oct-62	MN DNR
22	Park Construction, Kenaleys Creek, Dakota County	Kennealy's Letter to Construction 1977 2.pdf	MN DNR	Ronald D. Harnack	Mar-77	MN DNR
23	Park Construction, Kenaleys Creek, Dakota County	Kennealy's Letter to Construction 1977 1.pdf	MN DNR	Ronald D. Harnack	Jan-77	MN DNR
24	Kenaley's (Kennealy's) Creek	Kennealy's Map 1960.pdf	State of Minnesota Conservation- Game and Fish Research of Planning Section	E.H, R.W.B.	Mar-62	MN DNR
25	Change of Stream Managment Recommendations	Kennealy's Stream Recommendation 1968.pdf	Minnesota Conservation Section of Fisheries	-	May-68	MN DNR
27	Stream and River Survey Reports	Kennealy's Creek Stream Survey 2003.pdf	MNDNR	-	Mar-04	MN DNR
28	Letter to Donn Dexter from the Kennealy family	Letter from Kennealy 1978.pdf	-	Joseph Kennealy, Elisabeth Kennealy	Feb-78	MN DNR

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ID	DATA TITLE	FILE NAME	AUTHOR	DATA AUTHOR	DATA DATE	DATA SOURCE
29	Nicols Fen, Kennealy and Harnack Project Metro Greenways Planning Grant #01-13	Nicols Fen.pdf	Prepared by WSB & Associates, Inc.	Submitted by Gun Club Lake Watershed Management Organization	Jul-02	MN DNR
30	Dakota County Unnamed Streams Temperature Monitoring 2015	F313 Dakota Co Streams Temp Monitor 2015.pdf	MN DNR	Mark Nemeth	May-17	MN DNR
31	Harnack and Kennealy Creeks: Summary of stream channel assessments	Harnack and Kennealy Creeks.doc	-	Jason B. Moeckel	Jun-02	MN DNR
32	Unnamed #1 Tributary Number M-55-3-4	Unnamed 1 and Black Dog Creek Map.pdf	-	-	-	MN DNR
33	Unnamed 1 and Black Dog Creek Map	Unnamed 1 and Black Dog Creek Map 2.pdf	-	-	-	MN DNR
34	Stream Survey Summary Data Pertaining to Entire Stream	Unnamed 1 Intital Survey 1980.pdf	MN DNR	B. Gilbertson, R. Berowski, D. Schrader	Jul-80	MN DNR
35	River or Stream Survey	Unnamed 1 Population Assessment 1985.pdf	MN DNR	Mark Ebbers, Lee Sundmark	Jul-85	MN DNR
36	River or Stream Survey	Unnamed 1 Population Assessment 1990.pdf	MN DNR	Craig Bell, Scott Craig, Jim Stewart	Aug-90	MN DNR
37	River or Stream Survey, Electrofishing Survey Form - Trout Streams, Fisheries Recommendations for Stream Managment	Unnamed 1 Resurveyed 1982.pdf	MN DNR	B. Gilbertson, J. Gorton, Tom Adams	May-82	MN DNR
38	River or Stream Survey Site Code: 610	Unnamed 1 Resurvery 2000.pdf	MN DNR	Jim Stewart, Pete Carlson, Dan Wilfond	Aug-00	MN DNR
39	Stream Summary Card	Unnamed 1 Stocking History.pdf	MN Division of Game and Fish	-	Feb-80	MN DNR
40	Stream Survery	Unnamed 1 Stream Survey 2005.pdf	MN DNR	Jim Stewart	Mar-05	MN DNR
41	Unamed Tributary to Blackdog Creek	Unnamed 1 Trib to Black Dog Description 1976.pdf	-	Tureson and Hannay	Jun-76	MN DNR
42	Electrofishing Survery Form	Unnamed 1 Trib to Black Dog EF 1976.pdf	MN Division of Game and Fish Section of Fisheries	Fred Tureson, Kit Nelson	May-76	MN DNR
43	Unamed Tributary to Blackdog Creek, Dakota County	Unnamed 1 Trib to Black Dog Letter 1976.pdf	Natural Resources, Metro Region	Ronald D. Harnack	Jun-76	MN DNR
44	Water Analysis Report	Unnamed 1 Water Quality 1981.pdf	MN DNR Division of Fish and Wildlife, Ecological Services Section	S. Oie, R. Berowski	Jul-76	MN DNR
45	Natural Spawning Program - One Mile Creek & Callane Creek	Unnamed 4 and One Mile Spawning Report 1966.pdf	MN Conservation Department Division of Game and Fish, Section Fisheries	-	Jun-66	MN DNR
46	Electrofishing Survery Form	Unnamed 4 EF Survery 1976.pdf	-	Tureson and Hannay	May-76	MN DNR
47	Stream #4, West of Cedar Avenue	Unnamed 4 Flows 1976.pdf	-	Tureson and Jacobson	Jun-76	MN DNR
48	Stream Survey Summary, Data Pertaining to Entire Stream	Unnamed 4 Initial Survey 1980.pdf	MN DNR	B. Gilbertson, R. Berowski, D. Schrader, R. Nelson	Jul-80	MN DNR
49	Callans Creek	Unnamed 4 Map (Callans Creek).pdf	-	-	-	MN DNR
50	River or Stream Survey	Unnamed 4 Population Assessment 1981.pdf	MN DNR	S. Oie, R. Berowski	Jul-81	MN DNR
51	River or Stream Survey	Unnamed 4 Population Assessment 1985.pdf	MN DNR	Mark Ebbers, Lee Sundmark	Jul-85	MN DNR
52	River or Stream Survey	Unnamed 4 Resurvey 2000.pdf	MN DNR	Jim Stewart, Pete Carlson, Dan Wilfond	Aug-00	MN DNR
53	Stream Management Plan 2001	Unnamed 4 Stream Mgmt Plan 2001.pdf	-	-	Apr-01	MN DNR
54	Stream Survery	Unnamed 4 Stream Syrvery 2005.pdf	Mn DNR	James I. Stewart, Nora Helf	Mar-05	MN DNR
55	Water Analysis Report	Unnamed 4 Water Quality 1981.pdf	MN DNR Division of Fish and Wildlife, Ecological	S. Oie, R. Berowski	Jul-81	MN DNR
56	River or Stream Survey	Unnamed 7 2000.pdf	Mn DNR	Jim Stewart, Pete Carlson, Dan Wilfond	Jun-00	MN DNR
57	River or Stream Survey	Unnamed 7 Initial Survey 1980.pdf	Mn DNR	B. Gilbertson, R. Berowski, R. Nelson	Jul-80	MN DNR
58	Stream	Unnamed 7 Initial Survey Summary 1980.pdf	MN DNR	-	Jul-80	MN DNR
59	Unnamed 7 Map (1)	Unnamed 7 Map 1.pdf	-	-	-	MN DNR
60	Unnamed 7 Map (2)	Unnamed 7 Map 2.pdf	-	-	-	MN DNR
61	Stream Management Plan 2001	Unnamed 7 Stream Mgmt Plan 2001.pdf	-	-	Apr-01	MN DNR
62	Water Analysis Report	Unnamed 7 Water Quality 1981.pdf	MN DNR Division of Fish and Wildlife, Ecological Services Section	S. Oie, R. Berowski	Jul-81	MN DNR
63	River or Stream Survey	Unnamed 7 Water Quality Field Sheet 1981.pdf	MN DNR	Steve Oie, Richard Berowski	Jul-81	MN DNR

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ID	DATA TITLE	FILE NAME	AUTHOR	DATA AUTHOR	DATA DATE	DATA SOURCE
64	River Survery	Ike's Creek Report 2017 55-002-001.pdf	MNDNR	Jason Harris and others	9/9/17 & 9/10/17	MN DNR
65	Ike's Creek Monitoring Summary	Ike's Creek Summary_2018.docx	MNDNR	Ben Kiefer	6/29/2018	MN DNR
66	River Survey	M-55-2-1 2007 PA.pdf	MNDNR	Brian Nerbonne and others	9/27-9/28/2007	MN DNR
67	River Survey	M-55-2-1 2008 PA.pdf	MNDNR	Brian Nerbonne and others	9/10/2008 & 9/12/2008	MN DNR
68	River Survey	M-55-2-1 2009 PA.pdf	MNDNR	Mark Nemeth and others	9/9/2009 & 9/11/2009	MN DNR
69	River Survey	M-55-2-1 2010 PA.pdf	MNDNR	Mark Nemeth and others	9/8/2010 & 9/10/2010	MN DNR
70	River Survey	M-55-2-1 2011 PA.pdf	MNDNR	Mark Nemeth and others	9/7/2011 & 9/9/2011	MN DNR
71	River Survery	M-55-2-1 2012 PA.pdf	MNDNR	BJ Bauer and others	9/17/2012 & 9/19/2012	MN DNR
72	River Survey	M-55-2-1 2015 PA Draft.pdf	MNDNR	Kristan Maccaroni and others	9/9/2015 & 9/10/2015	MN DNR
73	Stream Management Plan	M-55-2-1 Stream Mgmt Plan.pdf	MNDNR	-	5/27/2007	MN DNR
74	Temp Data, Waste Creek Pool	M-55-2-1 Temp Data 2006 and 2008.xlsm	-	-	9/13/2006 - 12/10/2006	MN DNR
75	Habitat Suitability Index Models: Brook Trout	Raleigh_1982_BrookTroutHSI.pdf	USFWS	Robert F. Raleigh	Sep-82	Online
76	Habitat Suitability Information: Rainbow Trout	Raleigh_etal1984_RainbowTroutHSI.pdf	USFWS	Robert F. Raleigh, Terry Hickman, R. Charles Solomon, Patrick C. Nelson	Jan-84	Online
77	Habitat Suitability Index Models and Instream Flow Suitability Curves: Brown Trout	Raleigh_etal1986_BrownTroutHSI.pdf	USFWS	Robert F. Raleigh, Laurence D. Zuckerman, Patrick C. Nelson	Sep-86	Online
78	Environmental and Natural Resources Trust Fund (ENRTF) M.L. 2015 Work Plan Final Report	ML2015 Chp 76 Sec 2 Subd 08a Prioritizing Future Management_workplan 1-31-2018_amendment (1).docx	NRRI			NRRI
79	Long Range Plan for Trout Stream Resource Management in SE Minnesota 2010-2015	Fisheries Long-Range Plan for Trout Stream Resource Management in Southeast Minnesota 2010-2015 and Progress Rep.pdf	MnDNR			Email
80	LMRWD Trout Stream Geomorphology Assessment	LMRWD Trout Stream Geomorphology Assessment.pdf	LMRWD			Internal
81	LMRWD Fen Gaps Analyses		LMRWD		5/4/2020	Internal
82	Draft Brickyard Clayhole Lake Sustainable Lake Management Pln		LMRWD		1/9/2020	Internal
83	Plan		LMRWD		12/30/2019	Internal
84	Draft Quarry Lake Sustainable Lake Management Plan		LMRWD		12/30/2019	Internal
85	Habitat Suitability Index Model for Brook Trout in Streams of the Southern Blue Ridge Province: Surrogate Variables, Model Evaluation, and Suggested Improvements	ja_schmitt001_BrookTroutHSI_SouthernBlueRidge.pdf	USFWS		1983	Online
86	Strategic Plan for Coldwater Resources Management in Southeast Minnesota 2004-2015		MNDNR		2003	Online