# Feasibility Report for Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvement Projects

## *Plymouth, Minnesota*

Prepared for
Bassett Creek Watershed Management Commission

June 2020

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# Feasibility Report for Mt. Olivet Stream Stabilization Project and Parkers Lake Drainage Improvement Project

## June 2020

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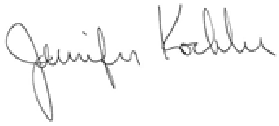
# Certifications

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



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PE #: 47500

6/1/2020
Date

# 1.0 Executive Summary

## 1.1 Background

The Mount Olivet Stream Stabilization Project in the City of Plymouth will reduce erosion, total suspended solids, and phosphorous loading to Medicine Lake. The lake is a state-listed impaired water for excess nutrients, with an approved total maximum daily load (TMDL) plan, and a Priority-1 water body of the Bassett Creek Watershed.

This project meets two gatekeeper criteria (as defined in the BCWMC Watershed Management Plan, Reference (1)), including improving/protecting water quality in a priority water body and addressing an approved TMDL. In addition to gatekeeper criteria, this project also protects previous Commission investments in Medicine Lake, addresses erosion and sedimentation issues, and addresses Commission goals of improved water quality, aesthetics, and wildlife habitat.

The Parkers Lake Drainage Improvement Project in the City of Plymouth will reduce erosion, total suspended solids, and phosphorous loading to Parkers Lake, a Priority-1 water body of the Bassett Creek Watershed. Additionally, the project may reduce chloride loads to Parkers Lake, a state-listed impaired water for chlorides with an approved TMDL.

This project meets the gatekeeper criteria of improving/protecting water quality in a priority water body and addressing an approved TMDL. In addition to gatekeeper criteria, this project also enhances previous Commission investments intended to protect Parkers Lake and addresses erosion/sedimentation issues and the Commission goals of improved water quality, aesthetics, and wildlife habitat.

## 1.2 Project Definition and Site Characteristics

This feasibility report includes proposed projects at two separate locations within the Bassett Creek Watershed. The Mount Olivet Stream Stabilization Project is located adjacent to Mount Olivet Lutheran Church in Plymouth, MN. This project site will be called the Mount Olivet Stream Stabilization project area throughout this text.

The Parkers Lake Drainage Improvement project is located within the Parkers Lake Community Playfields in Plymouth, MN. This project includes two subprojects involving the restoration of the stream and implementation of stormwater water quality improvement projects. The stormwater water quality improvement projects are further divided into the implementation of physical best management practices and strategies for chloride reduction in the contributing watershed. The two primary project components will be called the Parkers Lake Stream Stabilization and Parkers Lake Water Quality improvements throughout this text.

See Table 1-1 for a summary of the project area definitions.

**Table 1-1 Feasibility Study Project Area Definitions**

| Project Definitions |
|---|
| **Mount Olivet Stream Stabilization Project** |
| Mount Olivet Stream Stabilization—Restoration of eroding stream features |
| **Parkers Lake Drainage Improvement Project** |
| Parkers Lake Stream Stabilization—Restoration of eroding stream features<br>Parkers Lake Water Quality Improvements—Improvements to stormwater water quality<br>1) Best management practices<br>2) Chloride reduction strategies |

### 1.2.1 Mount Olivet Stream Stabilization Project Area

The Mount Olivet Stream Stabilization Project area is located in and along an unnamed stream in the City of Plymouth. The project area borders Mount Olivet Lutheran Church to the west, Old Rockford Road to the north, an apartment complex to the east, and a pond in Clifton E. French Regional Park of Three Rivers Park District (TRPD) to the south. The stream feeds into wetland areas upstream of Medicine Lake. During the non-winter months, the naturally ephemeral stream generally has fairly consistent, low flows with high, flashy flows during rain events due to the steep slopes in the ravine, minimal access to a floodplain, and receiving significant amounts of stormwater runoff; in the winter, the stream freezes over. The Mount Olivet Stream Stabilization Project area extends just over 1,000 feet south along the stream from Mount Olivet Lutheran Church. Erosion of the channel banks is moderate-to-high and primarily confined to isolated sections with 4- to 5-foot-high vertical eroding faces. This feasibility study identifies four reaches for evaluation, based on physical and geomorphic distinguishing features.

### 1.2.2 Parkers Lake Stream Stabilization and Water Quality Improvements Project Area

The Parkers Lake Stream Stabilization Project area is located within Parkers Lake Community Playfields, upstream of Parkers Lake. This feasibility study evaluates the restoration of stream features and reviews alternatives for improving the water quality of runoff from the park and contributing watershed.

The stream has experienced significant erosion along most of the reach. The channel bed has lowered by approximately 2 to 3 feet since the contributing storm sewer was installed. The stream exhibits limited geomorphic features that are characteristic of healthy streams and riparian habitat, such as riffles, runs, and pools. Similar to the stream Mount Olivet at the Stream Stabilization Project area, this naturally ephemeral stream generally has fairly consistent, low flows with high, flashy flows during rain events due to the minimal access to a floodplain and receiving a significant amount of stormwater runoff during non-winter months; in the winter, the stream freezes over.

Parkers Lake Community Playfields has open space available for the implementation of projects that would improve the water quality of stormwater leaving the site. The implementation of physical best management projects within these open-space areas would reduce the total phosphorus (TP) and total suspended solids (TSS) reaching Parkers Lake.

Additionally, Parkers Lake is listed as impaired for chlorides. TRPD, in partnership with the City of Plymouth, collected monitoring data at two stations within the Parkers Lake watershed. The monitoring data shows that the northern watershed tributary to Parkers Lake is the primary source of chlorides to the lake. This feasibility study identifies and evaluates a chloride-reduction demonstration project to help reduce chloride loads to Parkers Lake.

## 1.3 Project Alternatives

This feasibility study evaluates alternatives for the stabilization of the Mount Olivet Stream Stabilization Project area, the stabilization of the Parkers Lake Stream Stabilization Project area, and improved stormwater management in the Parkers Lake tributary area within the Parkers Lake Community Playfields (including chloride management in the larger tributary watershed north of Parkers Lake).

The measures considered for potential stream stabilization improvements include the following:

- Re-meandering the stream channel
- Restoring the vegetative buffer
- Restoring existing wetlands
- Grading stream banks and opening the tree canopy
- Installing a variety of stream stabilization measures, including riprap, root wads and toe wood, vegetated reinforced soil stabilization (VRSS), rock or log vanes, and stone toe protection
- Removing debris
- Replacing stream with storm sewer

The measures considered for improved stormwater management include a variety of best management practices (BMPs):

- Bioretention with iron-enhanced filtration media
- Wet retention ponds
- Chloride management opportunities

A summary of alternatives is provided in Table 1-2.

**Table 1-2 Feasibility Study Alternative Summary**

| Alternative | Description |
|---|---|
| **Mount Olivet Stream Stabilization Project** | |
| **Alternative 1** | Stream stabilization utilizing bio-engineering techniques, wetland restoration, and installation of a manhole drop structure at the Mount Olivet Church parking lot |
| **Alternative 2** | Stream stabilization utilizing bio-engineering techniques, stream re-meandering, and installation of hard armoring/riprap at the Mount Olivet Church parking lot |
| **Parkers Lake Drainage Improvement Project** | |
| **Alternative 1** | Stream stabilization by conveying flow through a pipe rather than through the stream channel |
| **Alternative 2** | Stream stabilization utilizing a standard hard-armoring approach |
| **Alternative 3** | Stream stabilization utilizing bio-engineering techniques |
| **Alternative 4** | Diversion of low flows from the existing storm sewer system to an iron-enhanced bioretention filtration system |
| **Alternative 5a/5b** | Opportunities for a wet retention pond in open space along the existing stream alignment through the Parkers Lake Community Playfields site |
| **Alternative 6** | Chloride demonstration projects in the northern watershed tributary to Parkers Lake to reduce salt usage and chloride loads to the lake |

Sections 5.0 and 6.0 provide more detailed discussion of the measures considered and alternatives evaluated.

## 1.4 Relationship to Watershed Management Plan

The Bassett Creek Watershed Management Commission (BCWMC) included the Mount Olivet Stream Stabilization Project and the Parkers Lake Drainage Improvement Project in its Capital Improvement Plan (CIP), based on the following "gatekeeper" policy from the BCWMC Plan. The items in bold italics directly apply to these projects.

110. The BCWMC will consider including projects in the CIP that meet one or more of the following "gatekeeper" criteria.

- Project is part of the BCWMC trunk system (see Section 2.8.1, Figure 2-14 and Figure 2-15 of the report)
- ***Project improves or protects water quality in a priority waterbody***
- ***Project addresses an approved TMDL or watershed restoration and protection strategy (WRAPS)***
- Project addresses flooding concern

The BCWMC will use the following criteria, in addition to those listed above, to aid in the prioritization of projects:

- Project protects or restores previous Commission investments in infrastructure
- Project addresses intercommunity drainage issues
- ***Project addresses erosion and sedimentation issues***
- ***Project will address multiple Commission goals (e.g., water quality, runoff volume, aesthetics, wildlife habitat, recreation, etc.)***
- Subwatershed draining to project includes more than one community
- Addresses significant infrastructure or property damage concerns

The BCWMC will place a higher priority on projects that incorporate multiple benefits and will seek opportunities to incorporate multiple benefits into BCWMC projects, as opportunities allow.

This project meets several gatekeeper criteria—the project will improve water quality as its primary goal by reducing the amount of sediment and pollutants (including chlorides) that enter Medicine Lake and Parkers Lake. This project will also help address multiple BCWMC goals by enhancing water quality and improving wildlife habitat.

## 1.5 Project Impacts

Section 7.0 and Section 8.0 discuss the potential impacts resulting from the stabilization and stormwater management projects, which include tree removals and temporary wetland impacts. Tree removal will be limited to only those necessary to complete the project, and trees will be replaced as appropriate. For the streambank stabilization projects, the removed trees will be re-used as part of the project's stabilization features.

The proposed stream stabilization projects will result in reduced stream bank erosion and, therefore, reduced sediment and phosphorus loading to the downstream wetland, pond, and lakes. The water quality improvement project in the Parkers Lake watershed will reduce sediment loads, phosphorus loads, and/or chloride loads to Parkers Lake. Section 8.0 presents the estimated existing erosion rates and pollutant loading and the pollutant load reductions. The estimated pollutant load reductions for the recommended projects are summarized in the following section.

## 1.6 Recommendations

Based on review of the project impacts; feedback from residents, representatives of the City of Plymouth, and regulators; the overall project costs and benefits; and existing water quality improvement needs; the BCWMC Engineer recommends the following projects:

- Alternative 1 for the Mount Olivet Stream Stabilization (stream stabilization with bioengineering wetland restoration, and manhole structure)
- Alternative 3 for the Parkers Lake Stream Stabilization (stream stabilization with bioengineering)
- Alternative 6 for the Parkers Lake Water Quality Improvements (chloride reduction demonstration project for the northern tributary watershed)

Table 1-3, below, shows the planning-level estimated costs for the recommended alternatives. We recommend that the BCWMC use the opinion of cost identified in this study to develop a levy request for the recommended combination of projects and that it proceed to design and construction. The BCWMC CIP funding (ad valorem tax levied by Hennepin County on behalf of the BCWMC) will be the sole source of funding for these projects.

**Table 1-3 Recommended Stream Stabilization and Water Quality Improvement Project Alternatives Cost Summary**

| Alternative Description | Project Cost Estimate[(1)] | Annualized Cost[(2)] | Total Phosphorus (TP) Loading | | Total Suspended Sediment (TSS) Loading | |
|---|---|---|---|---|---|---|
| | | | Load Reduction (lb/yr) | Cost/lb/yr Reduced[(3)] | Load Reduction (lb/yr) | Cost/lb/yr Reduced[(3)] |
| **Mount Olivet Stream Stabilization Alternative 1.** Bio-engineering, wetland restoration, and manhole structure | $134,000 ($107,000–$174,000) | $10,000 | 5.3 | $1,892 | 10,560 | $0.95 |
| **Parkers Lake Stream Stabilization Alternative 3.** Bio-engineering | $113,000 ($90,000–$147,000) | $8,000 | 20.1 | $399 | 40,140 | $0.20 |
| **Parkers Lake Water Quality Alternative 6.** Chloride management | $300,000 | Chloride reduction strategies may have limited impact on TP and TSS load reductions; however, data compiled from the MPCA suggests that implementation of smart salting recommendations can result in 30–70% reductions in chloride use. Although chloride usage can vary significantly from year to year based on the climatic conditions, based on the monitoring data from TRPD, this could reduce chloride loading to Parkers Lake on average by 163 – 380 lbs chloride per acre of watershed per year. | | | | |

(1) A Class 4 screening-level opinion of probable cost, as defined by the American Association of Cost Engineers International (AACI International), has been prepared for these alternatives. The opinion of probable construction cost provided in this table is based on the Commission Engineer's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. The cost opinion is based on project-related information available to the Commission Engineer at this time and includes a conceptual-level design of the project. It includes 20% project contingency and 30% for planning, engineering, design, and construction administration. Lower bound assumed at -20% and upper bound assumed at +30%.

(2) Assumed to be 15% of the total project cost for annual maintenance plus replacement cost associated with major repairs and the initial project cost distributed evenly over a 30-year project lifespan.

(3) Annualized cost divided by estimated annual pollution load reduction.

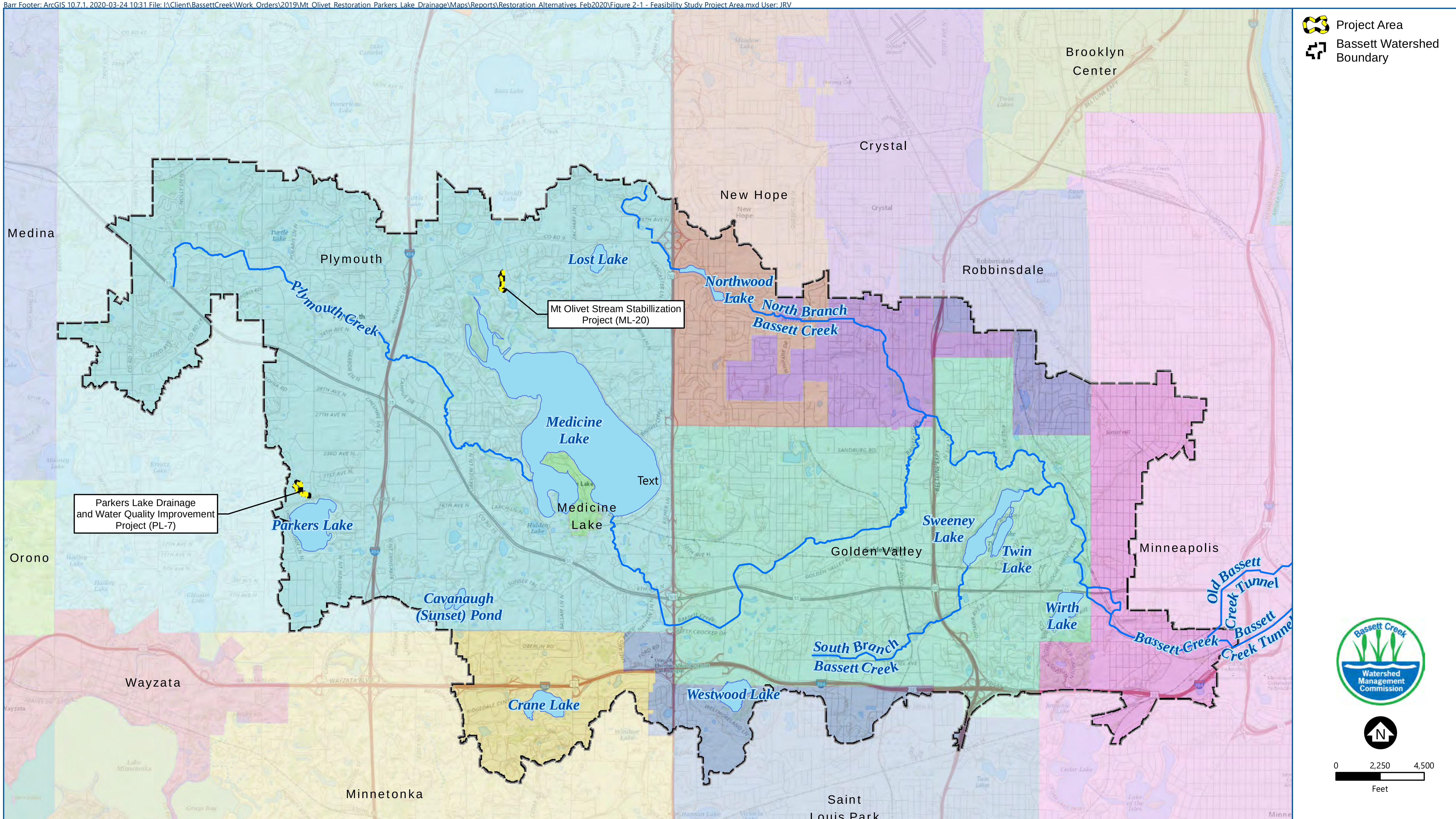
# 2.0 Background and Objectives

Medicine Lake is included on the Minnesota Pollution Control Agency's (MPCA) 303d list for mercury, chlorides, and excess nutrient (e.g., total phosphorus) impairments. The United States Environmental Protection Agency (EPA) approved a TMDL for the excess nutrients impairment in 2011. The City of Plymouth identified an eroding channel near Mount Olivet Lutheran Church as contributing sediment and nutrient loads to Medicine Lake.

Parkers Lake is included on the MPCA's 303d list for mercury and chloride impairments. The EPA approved a TMDL for the chloride impairments in 2016 as part of the Twin Cities Metropolitan Area Chloride TMDL. Although Parkers Lake currently meets the MPCA eutrophication (i.e., excess nutrients) criteria for the North Central Hardwood Forest ecoregion, the City of Plymouth identified an eroding stream through the Parkers Lake Community Playfields area as contributing sediment and nutrient loads to Parkers Lake.

This feasibility study evaluates the potential restoration of two streams: one located within the City of Plymouth's Parkers Lake Community Playfields and the second located near Mount Olivet Lutheran Church. These projects are included in the BCWMC's current CIP (as amended in 2018) and listed as PL-7 and ML-20, respectively. At its April 18, 2019, meeting, the Commission approved the 5-year (working) CIP, which included both projects, scheduled for construction in 2022 and 2021, respectively. Due to the concerns about elevated chloride levels in Parkers Lake and the proximity of the Parkers Lake Drainage Improvement project area to the watersheds identified as significant sources of chlorides to the lake, the feasibility study also evaluates opportunities to reduce chloride usage and loads to Parkers Lake.

This study was developed with input from the City of Plymouth, which owns or maintains easements to nearly all property adjacent to the streams. Figure 2-1 provides an overview of the project locations.




FEASIBILITY STUDY PROJECT AREA
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 2-1

## 2.1 Past Documents and Activities Addressing the Project Areas

### 2.1.1 BCWMC Watershed Management Plan (2015)

The *2015-2025 BCWMC Watershed Management Plan* (Plan, Reference (1)) identifies improving and protecting water quality as a primary focus of the BCWMC and also addresses the need to restore stream reaches damaged by erosion or affected by sedimentation. Section 3.1 of the Plan describes water quality issues and Section 4.2.1 outlines the Commission's policies related to water quality. Section 3.4 of the Plan describes the issue and the benefits of stream restoration, and Section 4.2.5 describes the Commission's policies related to streambank restoration and stabilization. The Plan's 10-year CIP includes a variety of water quality and streambank restoration and stabilization projects.

### 2.1.2 Medicine Lake Excess Nutrients TMDL (2011)

Medicine Lake, the downstream receiving water body for the Mount Olivet Stream Stabilization Project, is listed as impaired for excess nutrients (Reference (2)). The BCWMC and the MPCA prepared a TMDL study and implementation plan for the lake in 2010, which the EPA approved in 2011 (References (3) and (4)).

The TMDL implementation plan (Reference (4)) estimated that a load reduction of 1,287 pounds of TP per year (28 percent) from the Medicine Lake watershed is necessary to meet the nutrient waste load allocation for the lake.

### 2.1.3 Parkers Lake Excess Chlorides (2016)

Parkers Lake is included on the MPCA 303d list as impaired for chlorides, with the chloride concentrations for many of the recent monitoring years exceeding the MPCA chronic chloride standard. The EPA approved a TMDL for the chloride impairments in 2016 as part of the Twin Cities Metropolitan Area Chloride TMDL (Reference (5)). The TMDL did not identify numeric load reductions for specific waterbodies in the study.

### 2.1.4 Parkers Lake 2018 Water Quality Monitoring Report (2018)

In 2018, the BCWMC compiled a water quality monitoring summary report for Parkers Lake, including review of 2018 water chemistry, clarity, microbiology (zooplankton/phytoplankton), and aquatic plants (macrophytes) (Reference (6)). The report also summarizes runoff chloride data collected at two stations within the Parkers Lake watershed (see Figure 2-3). TRPD collected the monitoring data in partnership with the City of Plymouth. Station PL1 monitors a southern watershed tributary to Parkers Lake that is primarily single-family residential. Station PL2 monitors a portion of the northern tributary watershed that includes multifamily residential and office/industrial land use. Table 2-1 summarizes the 2013–2017 monitored chloride loads at each monitoring station, as summarized by TRPD. Runoff from the northern tributary watershed through station PL2 provides significantly more chloride load per acre of watershed than from the southern tributary watershed.

**Table 2-1 Parkers Lake Watershed Chloride Loading**

| Year | PL1<br>Chloride Load (lbs/acre) | PL2<br>Chloride Load (lbs/acre) |
|---|---|---|
| 2013 | 12.6 | 561 |
| 2014 | 4.5 | 294 |
| 2015 | 4.1 | 856 |
| 2016 | 7.0 | 354 |
| 2017 | 19.0 | 648 |
| ***Average (2013–2017)*** | ***9.4*** | ***543*** |

## 2.2 Project Area Description

### 2.2.1 Mount Olivet Stream Stabilization

The Mount Olivet Stream Stabilization area is located in the City of Plymouth in and along an unnamed, naturally ephemeral stream with frequently low flows and flashy high flows during rain events (Figure 2-2). The project area of the stream borders Mount Olivet Lutheran Church to the west, a single-family private property on Old Rockford Road to the north, an apartment complex to the east, and a pond in Clifton E. French Regional Park of TRPD to the south. The stream feeds into a wetland area north of the large pond upstream of Medicine Lake.

The Mount Olivet Stream Stabilization area extends just over 1,000 feet south along the stream. This feasibility study identifies four reaches for evaluation, based on physical and geomorphic distinguishing features as shown on Figure 2-2.

Reach 1 begins at the north/upstream section of the project area near residential private property just south of Old Rockford Road and runs through a historically channelized area with access to a floodplain in a densely wooded area. Reach 1 then turns into Reach 2, which is a very steep ravine that historically was not a stream. Reach 2 is densely wooded and is fairly straight with some meandering. The Mount Olivet Lutheran Church parking lot drains into this section of the stream along with other stormwater pipe outlets. These stormwater sources contribute to the instability of the stream banks along this reach, which is evident in the amount of moderate stream bank erosion seen. Reach 2 is representative of approximately two-thirds of the project area.

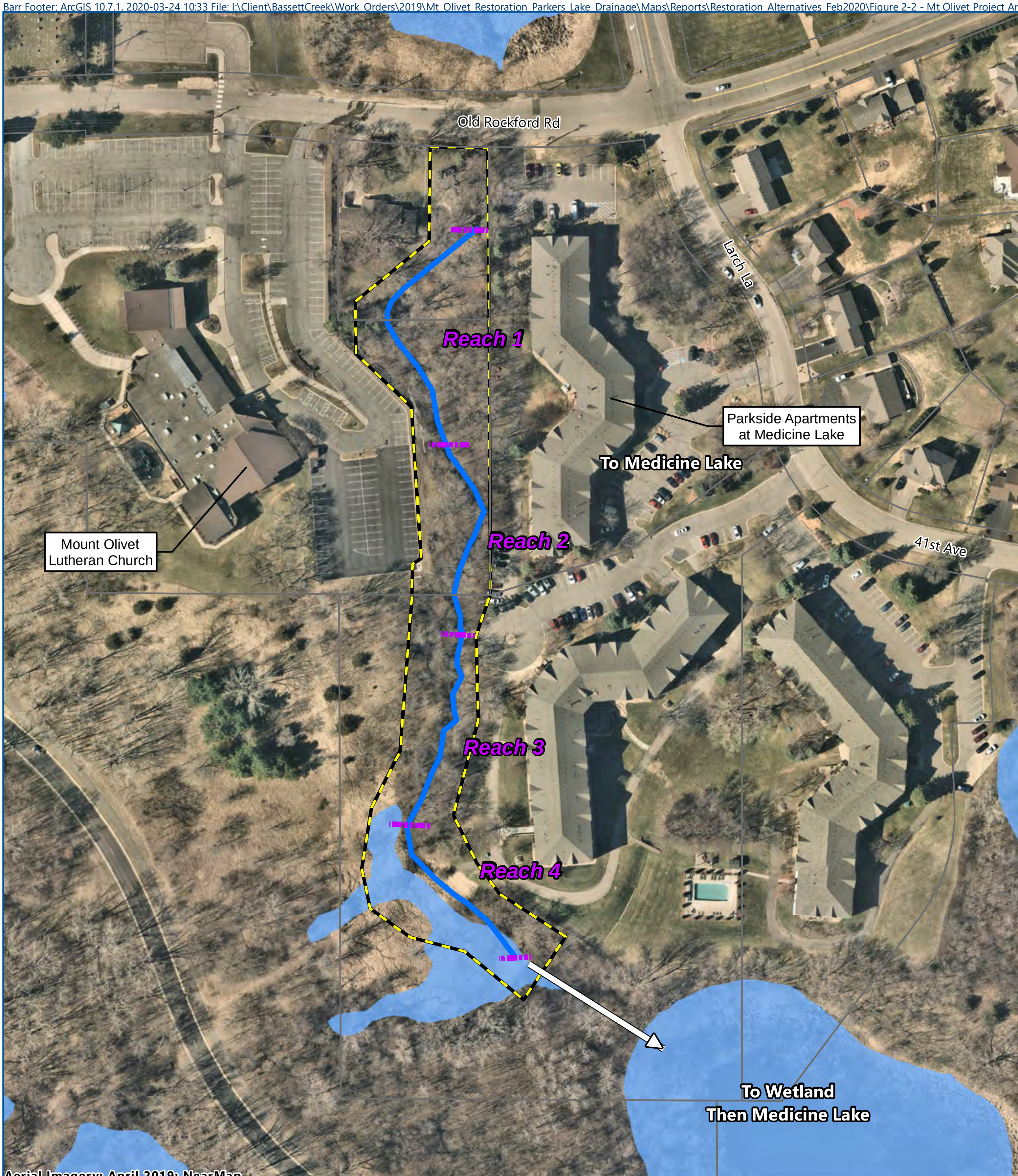
Further downstream in Reach 3, the stream continues to be fairy straight with some meandering and is in a semi-wooded area. This reach has less steep banks, is no longer in a very steep ravine, and has access to a floodplain before flowing into Reach 4. Reach 4 is an existing wetland area with very few trees. Part of the water in Reach 4 flows into the wetland and the other part continues in a shallow stream channel into a wooded area before returning to the wetland.

The Commission Engineer and City of Plymouth staff walked the entire project area in August 2019 and identified preliminary areas with bank erosion, scour, and/or bank failure. The Commission Engineer conducted additional site visits and surveys in November 2019 (after leaf-off) to verify erosion locations, identify conceptual stabilization alternatives, and perform a site evaluation. Photos of identified bank erosion locations are included in Appendix A.

Stream bank erosion is a natural process that occurs at some rate on all stream channels. However, the natural erosion rate can be accelerated by local and regional changes in land use and hydrology. The bank erosion and bank failures present throughout the project area appear to be caused by a combination of natural stream erosion processes, problems associated with changing watershed hydrology, direct historical impacts to the stream channel, and effects of riparian land use. Of the approximately 1,000 feet of stream bank in the project area, approximately 720 feet showed some degree of erosion. The sediment load from the erosion and scour increases phosphorus loads to downstream water bodies, decreases the clarity of water in the stream, impacts aquatic habitat, and causes sedimentation in downstream wetlands.

Stable stream channels are often said to be in a state of "dynamic equilibrium" with their watersheds, adjusting to changes in the watershed hydrology. It may take many years or decades for a stream to fully adjust to a rapid change in watershed hydrology. The use of stormwater BMPs helps reduce the impact of development projects on streams. Nonetheless, development and land-use changes fundamentally change the hydrology of the watershed. These changes to hydrology often include increased magnitude and frequency of high-flow events, which subsequently increases erosion rates. In addition, the heavy impact of stormwater (especially from the southeast corner of the Mount Olivet Church parking lot) in the riparian area of Reaches 2 and 3 has increased the sediment load to the stream. The steep banks and heavily wooded area also prevents the growth of more groundcover on the stream banks, increasing the erosion potential.

Barr Footer: ArcGIS 10.7.1, 2020-03-24 10:33 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 2-2 - Mt Olivet Project Area.mxd




- Stream Path
- Reach Boundary
- Project Area
- Ponds and Wetlands
- Parcels

N

0 150 300
Feet

Bassett Creek Watershed Management Commission

MT. OLIVET PROJECT AREA
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 2-2

### 2.2.2 Parkers Lake Drainage Improvements

#### 2.2.2.1 Parkers Lake Stream Stabilization

The Parkers Lake Stream Stabilization is located in the City of Plymouth along an unnamed, naturally ephemeral stream with frequently low flows and flashy high flows during rain events (Figure 2-3 and Figure 2-4). The project area of the stream is in the eastern area of Parkers Lake Community Playfields, north of County Road 6. To the east of the stream, outside of park boundaries, there is a large apartment complex. The stream receives stormwater from the surrounding area, including the watershed that extends north to 28$^{th}$ Avenue North/Highway 55, Parkers Lake Park, and the adjacent apartment complex. The stream begins near 18$^{th}$ Avenue North, flowing along the eastern area of the park, before flowing through approximately 300 feet of storm sewer (bypassing a stormwater retention pond) and returning to a stream channel downstream before flowing through a culvert to Parkers Lake.

The Parkers Lake Stream Stabilization extends approximately 1,150 feet (850 feet of stream, 300 feet of pipe) and receives the local stormwater from Parkers Lake Community Playfields, the adjacent apartment complex, and from the contributing watershed north of the park. Two reaches were identified for evaluation in this feasibility study, based on physical and geomorphic distinguishing features, and are shown on Figure 2-3.

Reach 1 begins at the upstream section of the project area, near 18$^{th}$ Avenue North, and runs through a historically channelized area with minimal access to a floodplain in a densely wooded area. The area surrounding the stream includes 18$^{th}$ Avenue North to the north, a large apartment complex to the east, and tennis courts to the west. After approximately 500 feet of Reach 1, the water flows through approximately 300 feet of pipe (bypassing the stormwater retention pond) before flowing into Reach 2. Reach 2 is approximately 350 feet long and flows alongside a small wetland and through a historically channelized area with moderate access to a floodplain before flowing through a culvert to Parkers Lake. The area surrounding the stream includes residential housing to the east, County Road 6 and Parkers Lake to the south, and a small wetland and a large parking lot to the west. The inflowing stormwater contributes to the instability of the stream banks along this reach, which is evident in the moderate stream bank erosion present.

The Commission Engineer and City of Plymouth staff walked the entire project area in August 2019 and identified preliminary areas with bank erosion, scour, and/or bank failure. The Commission Engineer conducted additional site visits and surveys in November 2019 (after leaf-off) to verify erosion locations, identify conceptual stabilization alternatives, and perform a site evaluation. Photos of identified bank erosion locations are included in Appendix A.

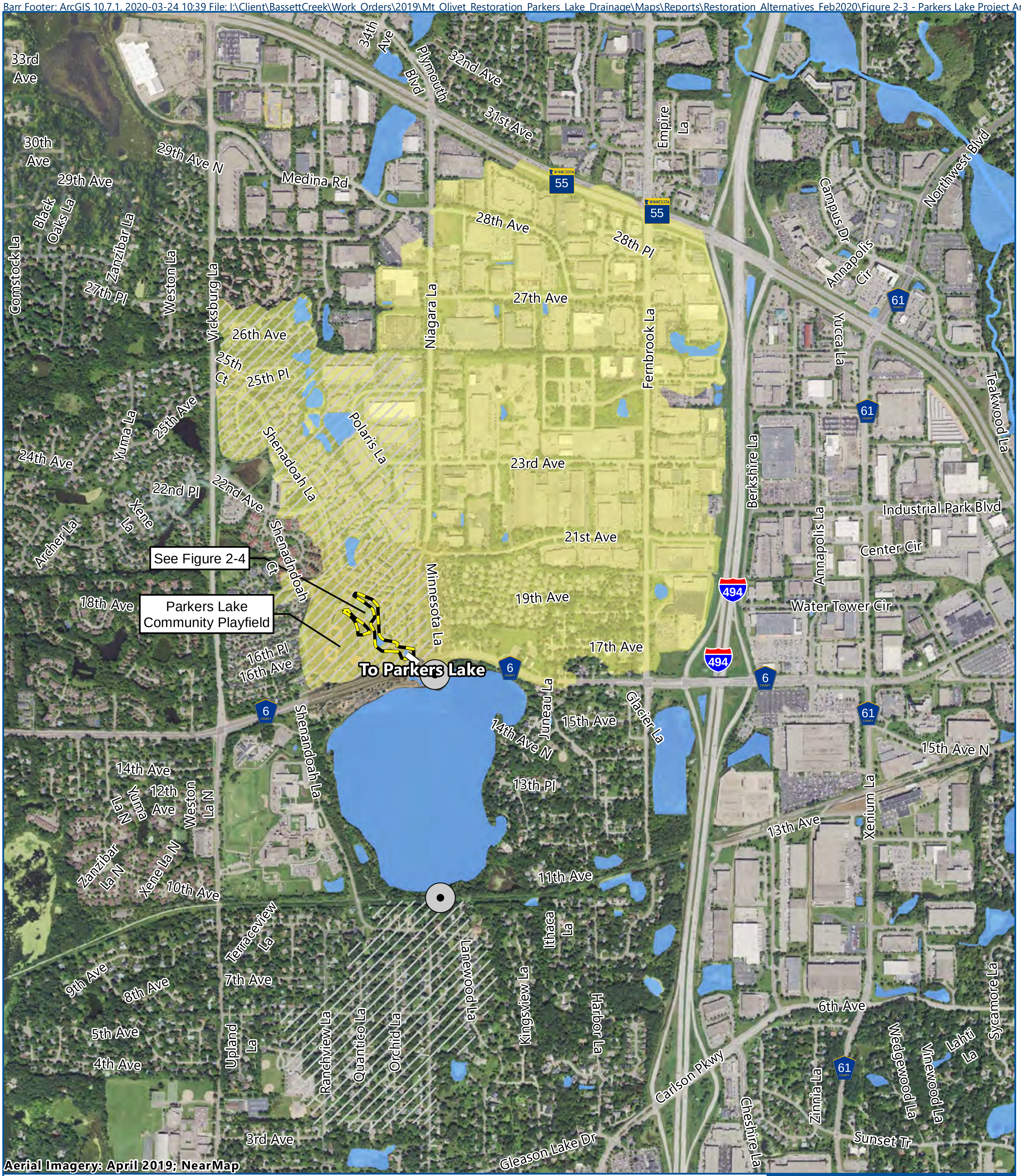
Stream bank erosion is a natural process that occurs at some rate on all stream channels. However, the natural erosion rate can be accelerated by local and regional changes in land use and hydrology. The bank erosion and bank failures present throughout the project area appear to be caused by a combination of natural stream erosion processes, problems associated with changing watershed hydrology, direct historical impacts to the stream channel, and effects of riparian land use. Of the approximately 1,150 feet of stream bank in the project area, approximately 830 feet showed some degree of erosion. The sediment load from the erosion and scour increases phosphorus loads to downstream water bodies, decreases the clarity of water in the stream, impacts aquatic habitat, and increases sediment loading to downstream wetlands.

#### 2.2.2.2 Parkers Lake Water Quality Improvement

Although there are some stormwater management practices in the larger watershed to Parkers Lake, we evaluated other opportunities to increase sediment and phosphorus removals from stormwater runoff within the Parkers Lake Community Playfields area. Given the fully developed nature of the watershed, the park land provides a potential opportunity to provide more stormwater treatment in addition to the stream stabilization measures. The park contains ballfields and sport courts, a playground area, walking trails, and parking lots; the unprogrammed open space is primarily mowed turf.  Two stormwater ponds within the Parkers Lake Community Playfields are located adjacent to the stream, but do not receive/treat upstream flows from the stream. The northern pond treats runoff from the central park area and the apartment complex directly east of the park. The southern pond primarily treats runoff from the southern portion of the park and the southern parking lot.

We considered BMPs for the removal of additional sediments and total phosphorus (TP) including enhanced filtration, wet detention, and stormwater reuse for irrigation, taking into account the context of existing topography, open space, and drainage infrastructure.

Because of the significant chloride concerns in Parkers Lake and the clear evidence in the TRPD monitoring data that the northern watersheds tributary to Parkers Lake are the main source of the chloride loads to the lake, the feasibility study also considered opportunities to reduce chloride use in this area.




- Project Area (Stream/BMPs)
- Ponds and Wetlands
- Open Channel
- Culvert or Bridge
- Watershed to Project Area/ TRPD Monitoring Stations
- TRPD Monitoring Stations
- Chloride Management Watershed to Parkers Lake

N

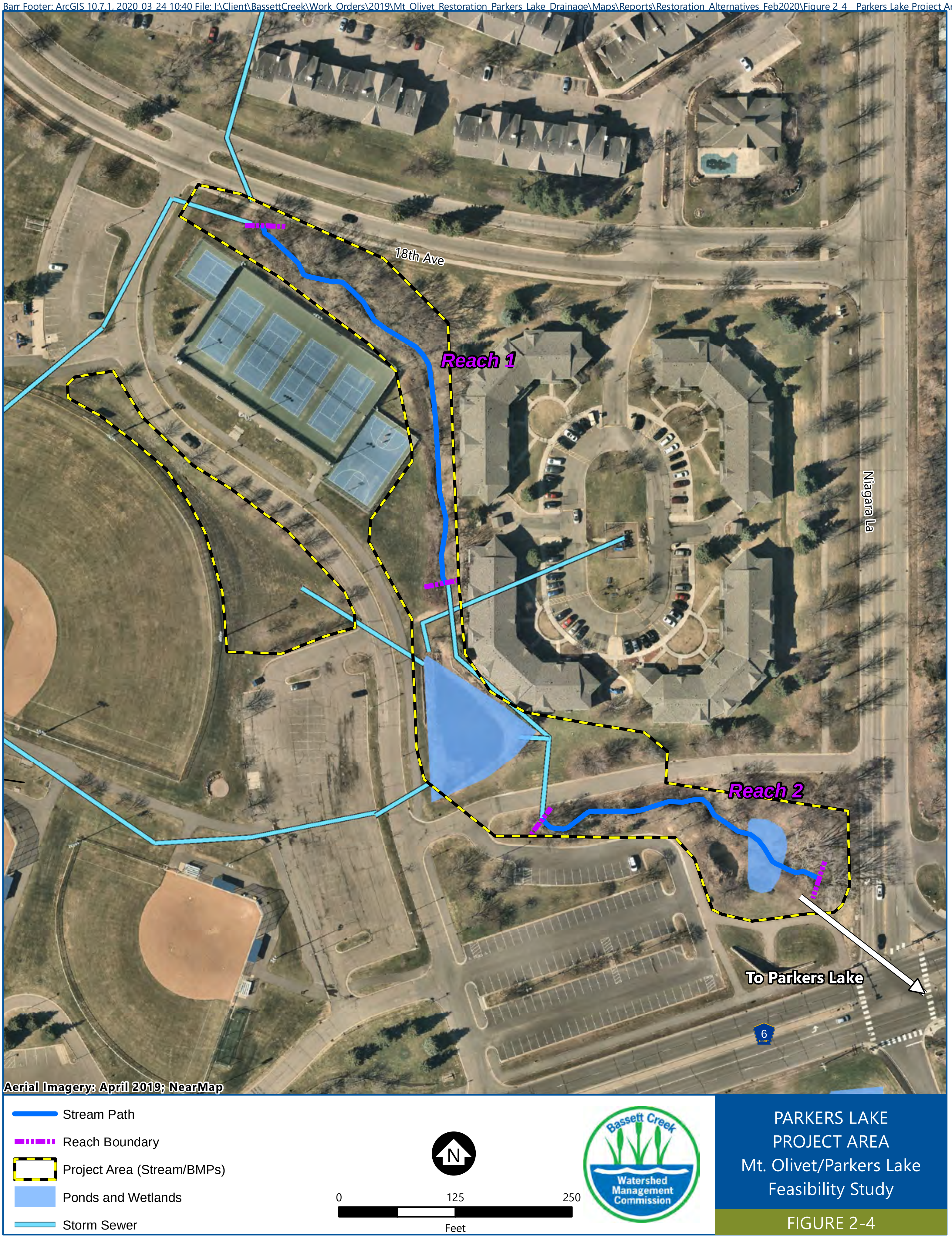
0 1,500 3,000
Feet

Bassett Creek Watershed Management Commission

PARKERS LAKE PROJECT AREA
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 2-3

Barr Footer: ArcGIS 10.7.1, 2020-03-24 10:40 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 2-4 - Parkers Lake Project Area.m




PARKERS LAKE PROJECT AREA
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 2-4

## 2.3 Goals and Objectives

The goals of the feasibility study are to:

1. Review feasibility of projects that will protect and/or improve water quality in the downstream receiving water bodies (Medicine Lake and Parkers Lake, respectively) through the development of two conceptual layouts for the Mount Olivet stream, three concepts for the Parkers Lake stream site, and four concepts for the Parkers Lake water quality improvements. These projects include:
    a. Stabilizing the eroding streams near Mount Olivet Lutheran Church and Parkers Lake Community Playfields.
    b. Providing additional water quality treatment of stormwater runoff at the Parkers Lake Community Playfields to protect water quality in Parkers Lake.
    c. Identifying opportunities to reduce chloride loads reaching Parkers Lake.
2. Provide a planning-level opinion of cost for design and construction of the alternatives.
3. Identify potential project impacts and permitting requirements.
4. Develop visual representations of the alternatives for public input.
5. Identify recommended projects for implementation.

The conceptual designs for the stream restoration projects will:

1. Identify feasible stream bank stabilization measures to reduce total suspended solids (TSS) and TP loading and re-establish desirable vegetation within the project area along the streams near Mount Olivet Lutheran Church and Parkers Lake Community Playfields.
2. Preserve natural beauty along the streams (including minimizing tree removal), enhance vegetation, and contribute to natural habitat quality and species diversification by planting eroded areas with native vegetation.
3. Prevent future channel erosion along the streams and subsequent degradation of water quality downstream by establishing a stable channel dimension, pattern, and profile.

The conceptual designs for the stormwater water quality improvement project are to:

1. Identify feasible practices that will reduce TSS, TP and chlorides loading to Parkers Lake.
2. Enhance vegetation and contribute to natural habitat quality and species diversification with the restoration practices.

### 2.3.1 Scope

The City of Plymouth identified the portion of the stream near Mount Olivet Lutheran Church and at the Parkers Lake Community Playfields as suffering from stream bank and channel erosion. As a result, the BCWMC included these two project areas in its current CIP—projects ML-20 and PL-7, respectively. These projects are consistent with the goals (Section 4.1) and policies (Sections 4.2.1, 4.2.5, 4.2.8, and 4.2.10) in the 2015–2025 Plan.

In 2009, the BCWMC completed a Resource Management Plan (RMP) in which the U.S. Army Corps of Engineers (USACE) and the BCWMC agreed on a series of steps, work items, and deliverables (called "protocols") that must be accomplished and submitted to complete the RMP process and USACE review/approval process. Although these projects (ML-20 and PL-7) were not included in the RMP, the USACE has allowed the RMP protocols to be applied to other projects not specifically included in the RMP. With the completion of the protocols, we expect the USACE permit application process to move more quickly than it would otherwise. Most of the protocols must be addressed as part of the feasibility study, in addition to the usual tasks that would be performed as part of any feasibility study under the criteria adopted by the BCWMC in October 2013. In general, the protocols require compliance with Section 106 of the National Historic Preservation Act, compliance with Section 404 of the Clean Water Act, and Clean Water Act Section 401 Water Quality Certification. Compliance with Section 106 typically requires a cultural resources inventory.

As required for BCWMC CIP projects, a feasibility study must be completed prior to the BCWMC holding a hearing and ordering the project. This feasibility study is prepared to address both projects. The feasibility study estimates the amount of erosion taking place within each study area and discusses the feasibility of different options to stabilize each reach. For the Parkers Lake project, the feasibility study discusses options to improve drainage, reduce chloride loading, and improve the water quality treatment in the watershed (e.g., improvements to the existing stormwater pond or upstream water quality improvements). The study also reviews the permitting requirements and develops a concept plan and cost estimate for each project.

### 2.3.2 Considerations

Key considerations for project alternatives included:

- Maximizing the stability of the streams to reduce long-term erosion concerns.
- Providing solutions that minimize long-term maintenance requirements.
- Providing in-stream habitat improvements for aquatic vegetation and organisms.
- Providing visually appealing stream corridors for park patrons, adjacent landowners, and adjacent multi-family housing.
- Minimizing tree loss where possible.
- Minimizing the permitting required to construct the project.
- Minimizing wetland impacts.
- Reviewing a possible access location to church grounds and Clifton E. French Regional Park across the Mount Olivet stream.
- Incorporating ecological improvements consistent with TRPD's goals for adjacent Clifton E. French Regional Park.
- Minimizing impacts to Clifton E. French Regional Park during construction (possible access location).

The considerations listed above played a key role in determining final recommendations and will continue to play a key role through final design.

# 3.0 Site Characteristics

## 3.1 Mount Olivet Stream Stabilization Project and Parkers Lake Drainage Improvement Project Watersheds

The watershed area tributary to the Mount Olivet project area is approximately 211 acres and drains portions of the City of Plymouth (Figure 3-1). The watershed is nearly fully developed; existing land use includes single-family residential, roadway, parks and undeveloped land, multi-family residential, and open water. Exact percentages for land-use type in this subwatershed have not been determined.

The watershed area tributary to the Parkers Lake project area is approximately 175 acres and drains portions of the City of Plymouth (Figure 3-1). The watershed is nearly fully developed; existing land use includes commercial/industrial, multi-family residential, roadway, parks and undeveloped land, and open water. Exact percentages for land-use type in this subwatershed have not been determined. The entire northern watershed to Parkers Lake, which is being considered for chloride reduction opportunities, is approximately 652 acres.

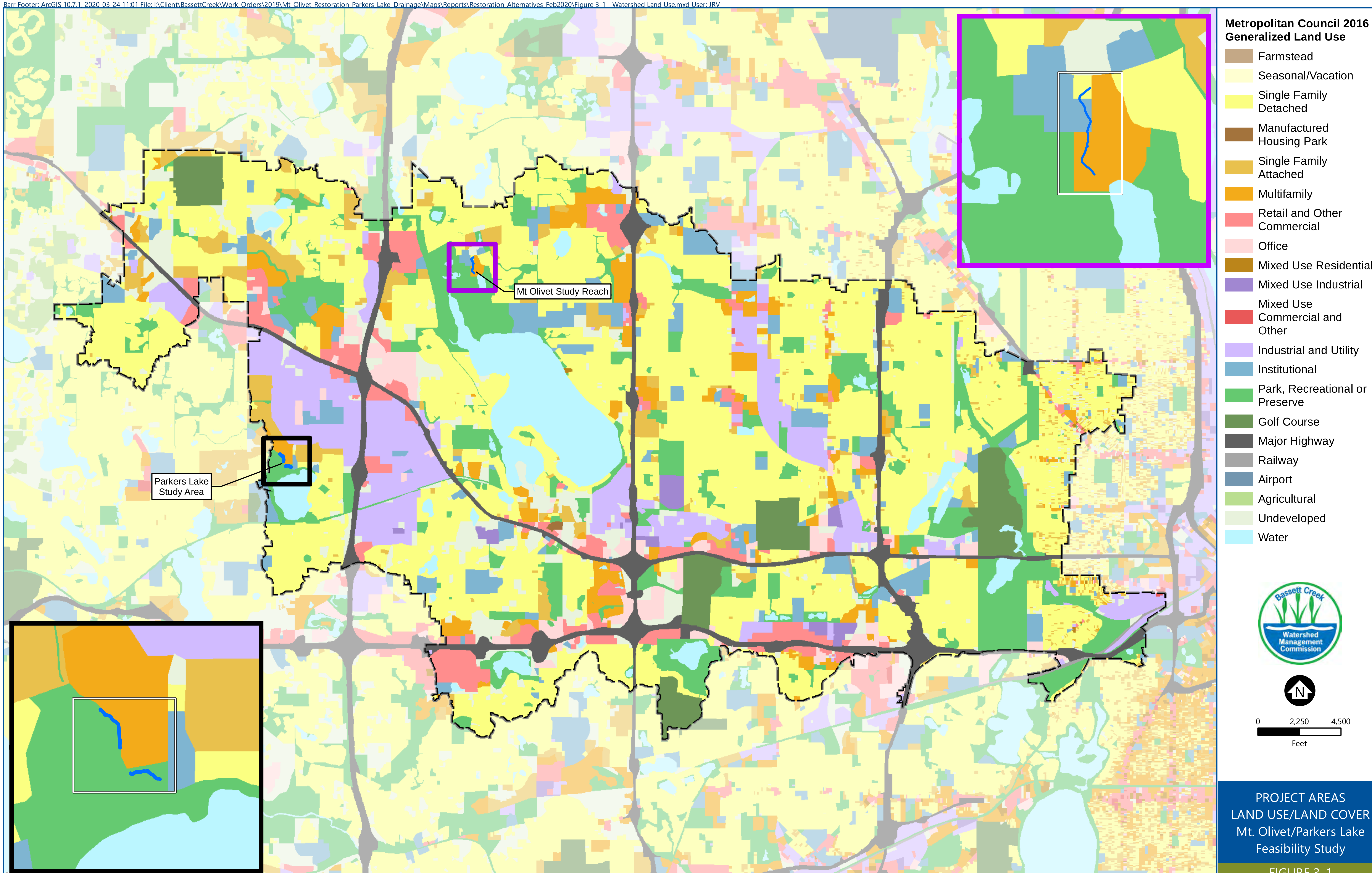
### 3.1.1 Surrounding Land Use

#### 3.1.1.1 Mount Olivet Stream Stabilization

Reaches 1 through 4 at the Mount Olivet stream site are adjacent to land with a variety of uses, and the reaches are primarily forested or with wetlands, as shown in Figure 3-1. Upstream of Reach 1, water flows through undeveloped land. Reach 1 flows through single-family and institutional (church) land, which includes mainly residential yards and a variety of understory vegetation (mature trees, young trees, shrubs, and shade-tolerant grasses and forbs). Reach 2 flows adjacent to institutional (church) land and multi-family residential land, which contributes runoff to the stream. This area of the stream has a variety of understory vegetation (mature trees, young trees, shrubs, and some grasses). Reaches 3 and 4 comprise multi-family residential land and park land, which includes mainly wetland vegetation (grasses and shrubs) and some understory vegetation (young trees, shrubs, and some grasses and forbs).

#### 3.1.1.2 Parkers Lake Stream

Reaches 1 and 2 are within Parkers Lake Community Playfields, a City park that includes ballfields, tennis courts, and parking lots adjacent to the creek. The stream flows from the north to southeast. Land use in the area surrounding the park is primarily single- and multi-family residential on the north and east, and parks and recreation on the west and south. In Reach 1, the tennis courts to the west and apartment complex to the east are immediately adjacent to and have a direct impact on the creek. In Reach 2, parking lots and streets surround the stream area. Relatively mature trees are adjacent to the creek, with typical understory vegetation (young trees, shrubs, and shade-tolerant grasses and forbs). For Reaches 1 and 2, there is a wooded and vegetated buffer between the stream and the impervious surfaces (tennis courts, apartment complex, parking lots, and streets).




PROJECT AREAS
LAND USE/LAND COVER
Mt. Olivet/Parkers Lake
Feasibility Study

FIGURE 3-1

### 3.1.2 Stream Geomorphic Assessment

#### 3.1.2.1 Mount Olivet Stream Stabilization

Within the project area, the creek at the Mount Olivet Stream Stabilization is a mid-gradient stream with limited sinuosity and channel development (riffle/run/pool sequences). The channel bed and banks are primarily silty sand with some loam. For approximately half of the upstream reach, the channel is confined by two adjacent parking lots and tall, steep banks. The project area is bounded on the upstream end by a culvert that contributes flow to the creek under Old Rockford Road. In the center and at the downstream end of the project area, the stream flows into a broad meadow with pockets of wetlands before eventually discharging into a more substantial wetland complex.

The Commission Engineer performed a qualitative geomorphic assessment for the entire project area during a field visit, including an erosion inventory and topographical survey. Within the project area, the stream has an approximate average bankfull depth of 1 foot and an approximate bankfull width of 2 to 4.5 feet.

Within Reach 1 the stream is relatively straight—in part a result of historical channelization or ditching. The channel appears to have a very mild slope through Reach 1 with little apparent elevation change. With banks approximately 3 feet high, the stream does not appear to be incised in this reach and has access to the floodplain.

In Reaches 2 and 3, the stream meanders through a ravine area (with stream banks ranging from approximately 10 to 30 feet on either side) and is densely forested. The channel is moderately incised and may not access the floodplain with appropriate frequency. In addition, pockets of granular soils have facilitated bank erosion in some areas of Reach 2. The presence of large woody debris, which directs flows towards the banks, is also causing stream bank erosion.

Reach 4 is primarily composed of a large wetland, with good access to the floodplain before discharging into a forested area, which is a large, flat floodplain area with little-to-no bank height.

Figures 3-2 through 3-5 show a few erosion examples along the stream site.

**Figure 3-2 Mount Olivet Erosion Example (broken concrete causing stream to erode bank at left)**

**Figure 3-3 Mount Olivet Erosion Example (bank erosion)**

**Figure 3-4 Mount Olivet Erosion Example (bank erosion)**

**Figure 3-5 Mount Olivet Erosion Example 4 (bank erosion)**

#### 3.1.2.2 Parkers Lake Stream Stabilization

The creek at Parkers Lake Community Playfields is a low-gradient stream with limited sinuosity and channel development (riffle/run/pool sequences). The channel banks are primarily loam or clay loam while the channel bed includes some sand and cobbles. The project area is bounded on the upstream end by two culverts that contribute flow to the creek from 18th Avenue N. and from the park roads. The stream flows are conveyed via storm sewer around the existing stormwater pond and daylight downstream of the park road for a short open channel segment before discharging via storm sewer into Parkers Lake. The stream is confined by park features (tennis courts, roadways, parking lots) and by the Lakeview Commons Apartments (east side of stream). A number of storm sewer inlets to the stream convey flow from the adjacent roadways, parking areas, tennis courts, stormwater ponds, and the apartment complex roof drains.

The Commission Engineer performed a qualitative geomorphic assessment for the entire project area during a field visit, including an erosion inventory and topographical survey. Within the project area, the stream has an approximate average bankfull depth of 1.5 feet and an approximate bankfull width of 7 feet.

Within Reach 1, the stream is relatively straight—in part a result of historical channelization or ditching. The channel appears to have a very mild slope through Reach 1, with little apparent elevation change. Reach 2 is relatively straight, with a floodplain and a small wetland in its proximity. With banks approximately 6 to 8 feet high, the stream does not appear to be incised in this reach and has access to the floodplain.

Figures 3-6 through 3-9 demonstrate a few erosion examples along the stream site.

**Figure 3-6 Parkers Lake Erosion Example**

**Figure 3-7 Parkers Lake Erosion Example**

**Figure 3-8 Parkers Lake Erosion Example**

**Figure 3-9 Parkers Lake Erosion Example**

### 3.1.3 Historical Channel Alignments

The stream alignment at the Mount Olivet Stream Stabilization has been re-aligned since the land use changed from agricultural to residential from 1940 to the present. The crossing under Old Rockford Road appears to have moved to the east and the middle of the stream has shifted towards the west. The stream has maintained a similar planform with limited sinuosity. The riparian area around the stream has become more forested since the conversion from agricultural land use to residential. Figure 3-10 provides a comparison between the 1940s stream alignment (Reference (7)) and the current stream alignment (Reference (8)).

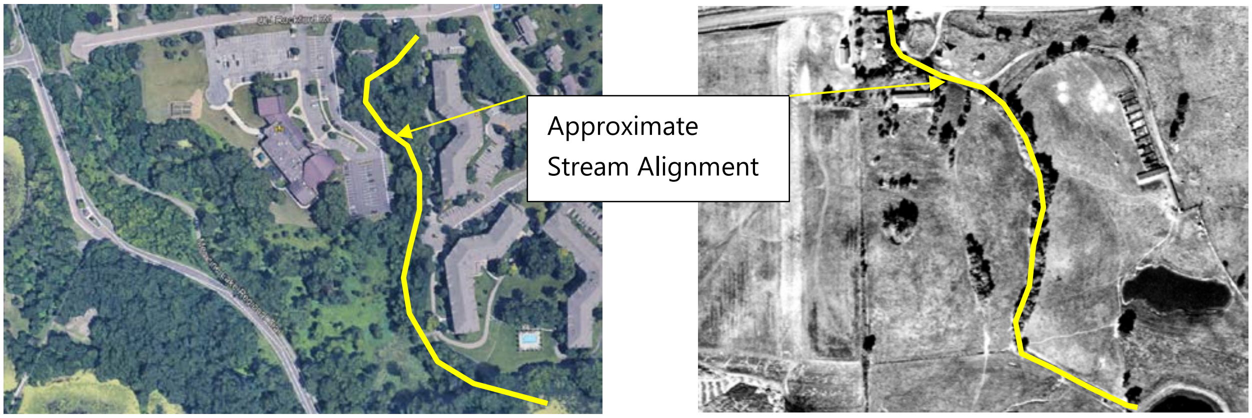



**Figure 3-10 Mount Olivet Historical Channel Alignment (current vs 1940)**

The development of the Parkers Lake Community Playfields and neighboring apartments resulted in changes to the stream alignment at the Parkers Lake Stream Stabilization. This area changed from primarily agricultural to residential and park land since the 1940s (Reference (7)), as compared with the current land use (Reference (8)). The historic stream planform remained similar with limited sinuosity. The stream appears to function primarily as a roadway ditch in the aerial imagery from 1940 shown in Figure 3-11, below.

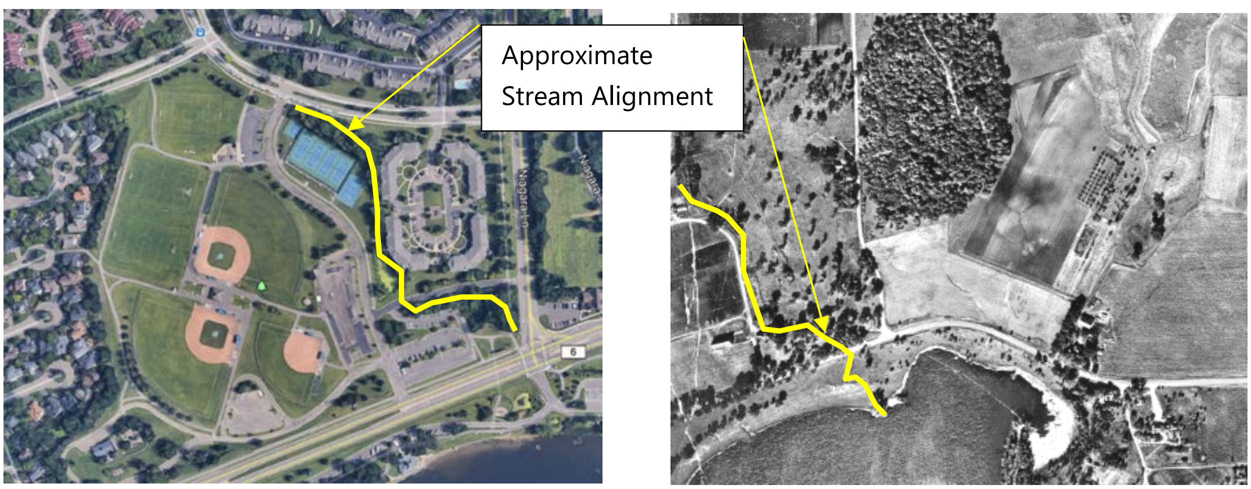



**Figure 3-11 Parkers Lake Historical Channel Alignment (current vs 1940)**

## 3.2 Site Access

The Mount Olivet Stream Stabilization has sections with tall, steep banks, which will make access to the upstream end challenging. We assume the primary access route for construction will be from the Clifton E. French Regional Park (TRPD) thoroughfare and over park land. Construction crews and equipment will need to traverse up the channel to conduct the project work. Easements will be necessary from TRPD, Parkside Apartments, the single-family home at the upstream end, and Mount Olivet Lutheran Church to access the ravine.

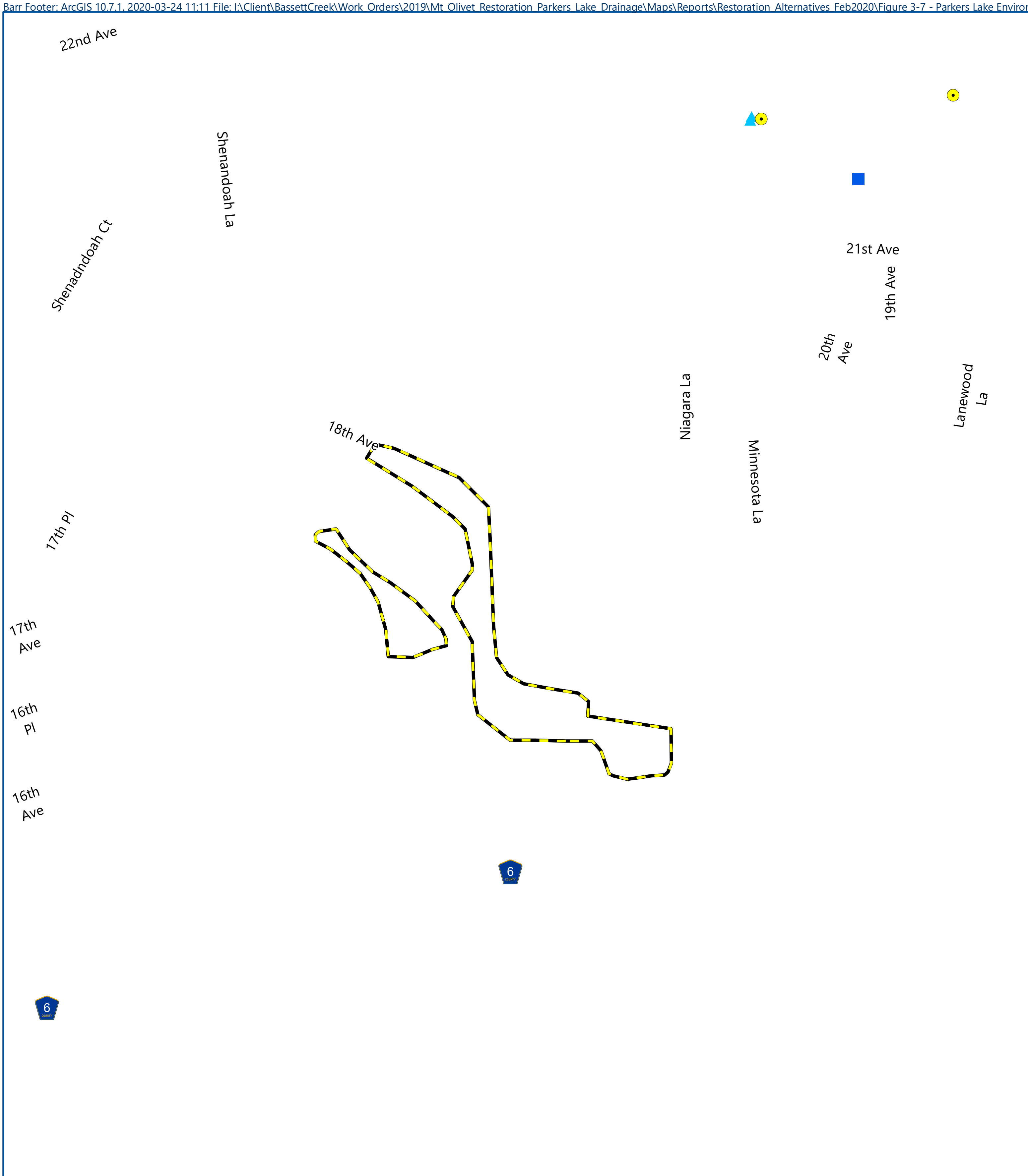
Because the stream reach at the Parkers Lake project area is on public property (Parkers Lake Community Playfields), construction access will be fairly straightforward. Construction access from private property (i.e., Lakeview Commons Apartments) will not be necessary. However, the work must avoid existing infrastructure including park amenities, stormwater ponds, storm sewer, and sanitary sewer. Potential site access locations and staging areas are presented in the figures in Section 6.0.

## 3.3 Environmental Site Investigation

Review of the MPCA's "What's in my Neighborhood?" database indicated no active environmental concerns within the project footprint or on adjacent properties. The Parkers Lake stream and water quality site has historic and permitted industrial activities within the project's vicinity. These activities have industrial stormwater and hazardous waste permits. Figure 3-12 and Figure 3-13 show the locations of all identified environmental activities within approximately 1,000 feet of the two proposed projects.

Barr Footer: ArcGIS 10.7.1, 2020-03-24 11:08 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 3-6 - Mt Olivet Environmental R

Barr Footer: ArcGIS 10.7.1, 2020-03-24 11:11 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 3-7 - Parkers Lake Environmenta




Aerial Imagery: April 2019; NearMap

What's in my Neighborhood (MPCA)

- Hazardous Waste
- Water Quality
- Multiple Activities
- Project Area

0 300 600
Feet

PARKERS LAKE ENVIRONMENTAL REVIEW
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 3-13

## 3.4 Topographic, Utility, and Tree Surveys

The Commission Engineer performed a topographic, utility, and tree survey in the fall of 2019 to develop the existing-conditions base map and to develop and evaluate concepts. The existing-conditions topographic, storm sewer/culvert, and tree survey results. This information is included in the report appendices.

A Topcon GR VRS Receiver, Topcon PS Robotic Total Station, and RTK Survey Grade GPS were used to gather topographic and utility information within the project extents. Topographic information was collected in Hennepin County NAD83 horizontal datum and NAVD88 vertical datum. A survey of the inlet and outlet structures in both project areas was completed. Topographic survey information was imported into AutoCAD Civil 3D to create an existing-conditions base map for this feasibility study.

The Commission Engineer conducted a tree survey, where they collected species, condition, and diameter data for trees greater than 4 inches in diameter. A summary of the tree survey including species and count within the immediate project area (approximately 20 to 40 feet on either side of the stream channel, depending on the terrain) is shown in Table 3-1. Dominant species surveyed include ash, box elder, buckthorn, cherry, elm, hackberry. The full topographic, utility, and tree survey results can be found in Appendix B. For details on the proposed number of removed trees, refer to Section 6.

**Table 3-1 Tree Survey Summary by Project Area**

| Species Name | Count | |
|---|---|---|
| | Mount Olivet | Parkers Lake |
| Apple | 1 | 1 |
| Ash (Green) | 10 | 21 |
| Aspen (Bigtooth) | 1 | - |
| Basswood (American) | 5 | 1 |
| Beech | 3 | - |
| Box Elder | 97 | 81 |
| Buckthorn | 31 | - |
| Cedar (Northern White) | 4 | 1 |
| Cherry (Black) | 38 | - |
| Cherry (Pin) | 2 | - |
| Cottonwood (Eastern) | 12 | 6 |
| Elm (American) | 10 | 3 |
| Elm (Siberian) | 35 | 9 |
| Hackberry | 22 | 1 |
| Hawthorn | 2 | - |
| Hophornbeam / Ironwood (Eastern) | 6 | - |
| Maple (Amur) | 1 | - |
| Maple (Norway) | 1 | - |
| Maple (Red) | 8 | 1 |
| Oak (Bur) | 2 | - |
| Spruce (Norway) | 1 | - |
| Walnut (Black) | 6 | - |
| Willow (Black) | 1 | 9 |
| **Total** | **299** | **134** |

## 3.5 Wetlands

The Commission Engineer performed a field wetland delineation in the two project areas on August 29, 2019, to identify wetlands that may be directly impacted by the Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvements projects. Two wetlands were delineated within the project areas.

The Commission Engineer prepared a Wetland Delineation Report in accordance with the USACE *1987 Wetland Delineation Manual* (Reference (9)), the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region* (Reference (10)) and the requirements of the Minnesota Wetland Conservation Act (WCA) of 1991.

The Commission Engineer submitted a Wetland Delineation Report to the local government unit (LGU) (the City of Plymouth). The City issued a Notice of Decision (NOD) approving the wetland boundary on December 10, 2019. The NOD is included in Appendix C.

Table 3-2 summarizes the wetlands delineated in the two project areas.

**Table 3-2 Wetland Summary by Project Area**

| Wetland Number | Circular 39 | Cowardin Classification | Eggers and Reed | Wetland Area (ac) |
|---|---|---|---|---|
| **Mount Olivet Stream Stabilization Project** | | | | |
| Wetland 1 | Type 2 | PEMB | Fresh (wet) meadow | 0.04 |
| **Parkers Lake Drainage Improvement Project** | | | | |
| Wetland 2 | Type 3 | PEMC | Shallow marsh | 0.02 |
| Wetland 3 | Type 4 | PABHx | Deep marsh | 0.19 |

The wetland delineation report includes general environmental information (Section 2.0), descriptions of the delineated wetlands (Section 3.0), and a discussion of regulations and the administering authorities (Section 4.0). The Tables section includes antecedent precipitation data. The Figures section includes the Project Location Map, Topography Map, National Wetland Inventory (NWI), Public Waters Inventory (PWI), Hydric Soils Map, and the Wetland Boundary Map (Appendix C).

## 3.6 Threatened and Endangered Species

The Commission Engineer completed a desktop review for federal and state-listed species and associated habitats that may be found in the Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvements project sites to evaluate potential impacts on listed species (Figure 3-14). The federal government protects federally listed species under the Endangered Species Act and requires consideration of the impacts on these species for projects involving federal permits. State-listed species are only protected under Minnesota's Endangered and Threatened Species Law and the impacts on these species must be considered for state-level permitting requirements. We completed the desktop review in November 2019 using a combination of data available from the United States Fish and Wildlife Service (USFWS) and the Minnesota Department of Natural Resources (MDNR), as further described below.

### 3.6.1 Federally Listed Species

The USFWS Information, Planning, and Conservation System (IPaC) website shows the northern long-eared bat (*Myotis septentrionalis*) and the Rusty Patch Bumblebee (RPBB; *Bombus affinis*) as being listed in the proposed project areas. No designated critical habitat for any federally listed species is located within the project areas.

The northern long-eared bat inhabits caves, mines, and forests. The project areas are centered along a riparian corridor dominated by woody vegetation. According to the MDNR, the nearest hibernacula is over 22 miles southeast of the proposed project areas, and no maternity roost trees have been identified within the vicinity of the proposed project areas. Therefore, it is unlikely the proposed projects would have a significant impact on federally listed species.

The Rusty Patch Bumblebee (RPBB) is an endangered insect that utilizes different habitat types during different times of the year. Woodland and woodland edge habitats in uplands are used for overwintering and early season foraging, while herbaceous wetlands and grassland habitats provide foraging habitat from the late spring season through the fall. The USFWS RPBB High Potential Zone (HPZ) is a geographic area were the RPBB is likely to be present. The Mt. Olivet project area is located within this designated HPZ; while the Parkers lake project area is not.

Based on this desktop review, we conclude that the project is unlikely to impact suitable overwintering habitat within the HPZ. As indicated, the RPBB is believed to overwinter in upland woodland and woodland edge habitat types. A majority of the project disturbance would occur within the stream channel. It is unlikely for the RPBB to use the project area for overwintering habitat due to the saturation of the soil. However, the herbaceous wetlands, grasslands, and wooded areas have the potential to provide RPBB with foraging habitat during the spring, summer and fall months. RPBB utilizes a variety of flowering plant species throughout the year depending on the blooming period for each species.

It is unlikely for the RPBB to utilize the project areas for overwintering habitat due to the project work being conducted within a stream channel. Therefore, It is unlikely the proposed project would have an adverse impact on the RPBB due to the degraded quality of the surrounding habitat. If the project has a federal nexus, consultation with USFWS or the action agency should occur. Additional habitat assessment may be required to obtain a no effect determination for the species from the action agency.

### 3.6.2 State-Listed Species

The Commission Engineer has a license agreement (LA-898) with the MDNR for access to the Natural Heritage Information System (NHIS) database, which we queried in March 2020 to determine if any rare species could potentially be affected by the proposed projects. No state-listed species have been previously recorded within the project areas. However, the NHIS database identified two sensitive species and one sensitive plant community within 1 mile of the Mount Olivet Stream Stabilization project site (Table 3-3). No state-listed species were identified within 1 mile of the Parkers Lake Drainage Improvements project site.

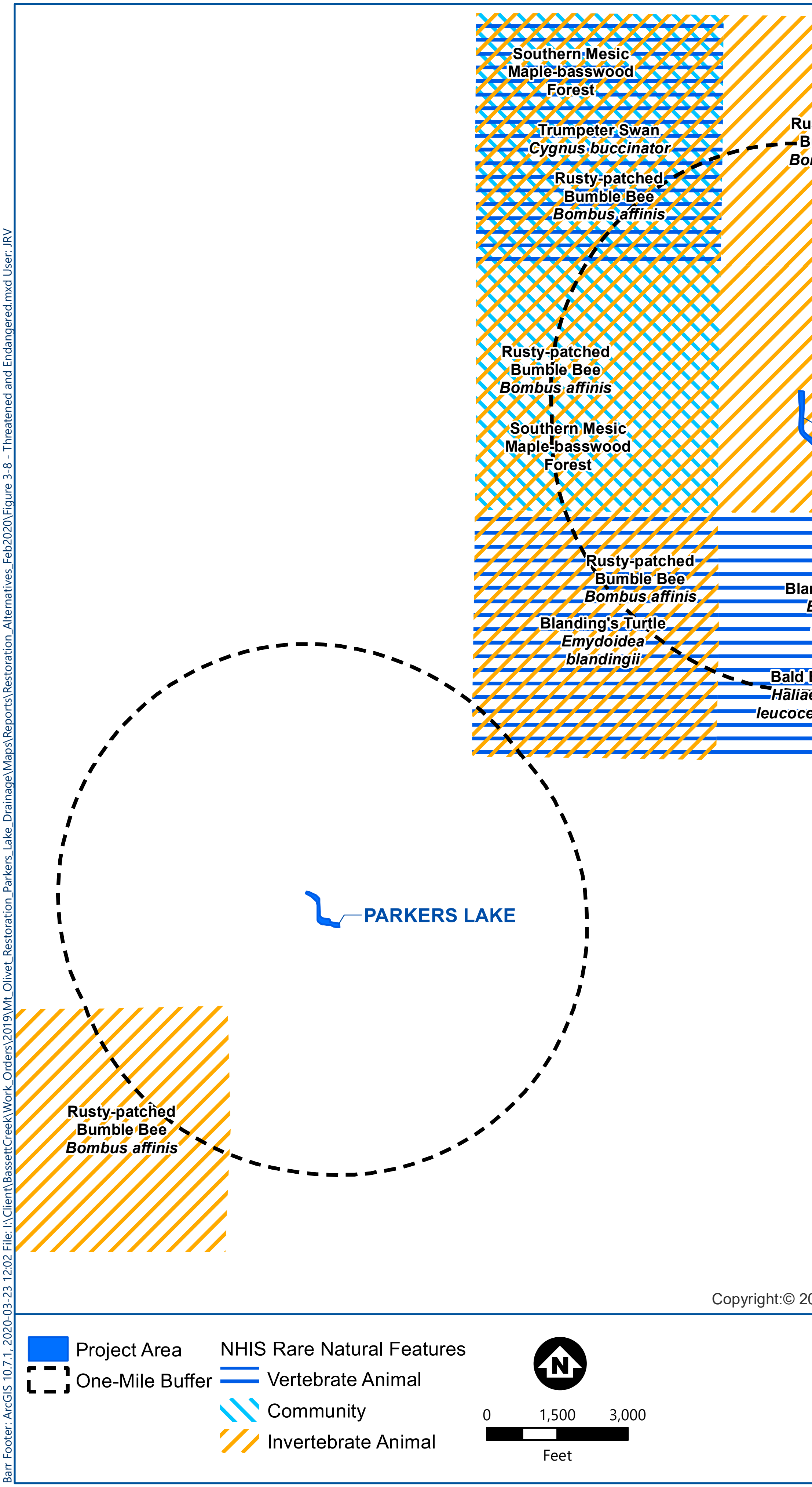
**Table 3-3 Rare Species Documented within 1 mile of Proposed Mount Olivet Stream Stabilization Project Site According to MDNR NHIS**

| Common Name | Scientific Name | Federal Status | State Status | Habitat[1] |
|---|---|---|---|---|
| Blanding's turtle | *Emydoidea blandingii* | None | Threatened | Wetland complexes and adjacent sandy uplands including calm, shallow waters and wetlands associated with rivers and streams with rich aquatic vegetation |
| Southern mesic maple-basswood forest class | *N/A* | None | None | Minnesota native plant community |
| Bald eagle | *Haliaeetus leucocephalus* | None | Delisted | Nests in mature trees near bodies of water |

1: Habitat information obtained from MDNR Rare Species Guide: https://www.dnr.state.mn.us/rsg/index.html

The Blanding's turtle uses a variety of aquatic habitats, including marshes, bays of lakes, slow-moving waters with areas of submergent and emergent vegetation, and wet meadows near these habitats. There is suitable Blanding's turtle habitat in the immediate vicinity of the project and Blanding's turtles have been recorded within 1 mile of the Mount Olivet Stream Stabilization Project site. During the active season (considered March–November), this species spends a large majority of its time on land. Nesting typically occurs May–June and their nesting sites are in sandy soil within 300 meters (984 feet) of a wetland. The primary measure to avoid direct impacts to this species is to install exclusion fencing around the entire work area during the turtle's non-nesting period (November–March). Fencing should be installed during the non-nesting period because Blanding's turtles have not yet traveled to and settled in their nesting locations. Blanding's turtles would be excluded from the project area prior to carrying out construction. Work can then be conducted any time of year as long as fencing is maintained. If a Blanding's turtle is observed in the work area, work would cease and the MDNR notified. It is expected that work could resume once the turtle is removed from the construction area.

The Mount Olivet Stream Stabilization Project site is located in the vicinity of suitable habitat for the federally protected bald eagle. If work will occur between January 15 and July 31, an eagle nest survey should be completed. If a nest is identified, the contractor should maintain a buffer of at least 660 feet between the project activities and the nest. If the activity is closer than the 660 feet restriction, all clearing, external construction, and landscaping activities within 660 feet of the nest need to occur outside the nesting season.




THREATENED & ENDANGERED SPECIES
Mount Olivet/Parkers Lake Feasibility Study

FIGURE 3-14

## 3.7 Cultural and Historical Resources

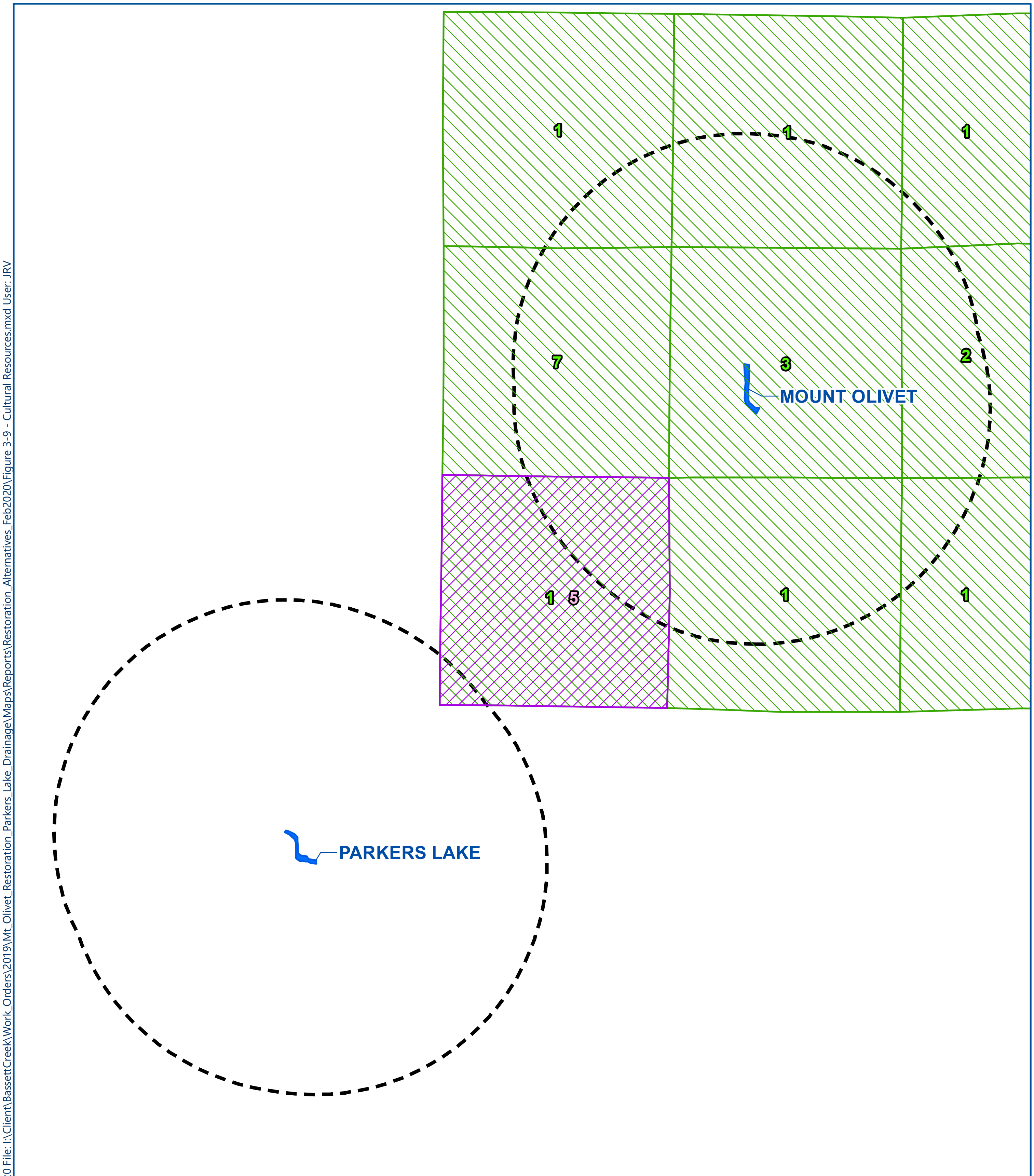
The Commissioned Engineers completed a Phase Ia cultural resource literature review for the proposed Parkers Lake Drainage Improvement project in October 2019, which resulted in the identification of no archaeological sites and 16 historical sites within 1 mile of the project area (Figure 3-15). Of the historical sites, none have been evaluated for inclusion on the National Register of Historic Places (NRHP).

The results of the literature review, the scope of the project, and the MnModel Phase 4 survey implementation model (MM4) survey implementation model suggest the proposed Parkers Lake Drainage Improvements project site generally has low-to-no potential for intact pre-European contact archaeological resources. Pre-European contact resources means resources that were in place prior to Europeans traveling to North and South America. Additional investigation is recommended if project boundaries are changed. Additional evaluation may be required under 36 CFR 800.4 to determine the project's potential to have direct or indirect effects to Historic Properties.

The Commission Engineer also completed a Phase Ia cultural resource literature review for the proposed Mount Olivet Stream Stabilization project site in October 2019, which resulted in the identification of five archaeological sites and 18 historical sites within 1 mile of the Mount Olivet Stream Stabilization project site. Of these resources, none have been evaluated for inclusion on the NRHP.

The results of the literature review, the scope of the project, and the MM4 survey implementation model suggest the proposed Mount Olivet Stream Stabilization project site generally has low-to-no potential for intact pre-European contact archaeological resources. Additional investigation is recommended if project boundaries are changed. Additional evaluation may be required under 36 CFR 800.4 to determine the Mount Olivet Stream Stabilization project site's potential to have direct or indirect effects to Historic Properties.

Technical memos of the archeological reconnaissance survey are included as Appendix D.




**Data Source: Statewide inventories.**
**Minnesota State Historical Preservation Office.**



- Project
- One-Mile Buffer
- Section Contains Archaeological Inventory Record(s)
- Section Contains Historical Inventory Record(s)

0 1,500 3,000
Feet

CULTURAL RESOURCES
Mount Olivet/Parkers Lake
Feasibility Study

FIGURE 3-15

# 4.0 Stakeholder Input

## 4.1 Project Kickoff Meeting with BCWMC Staff and City of Plymouth Representatives

A project kickoff meeting with BCWMC (administrator, commissioner, alternate commissioner), TRPD, and City of Plymouth staff was conducted on September 13, 2019, at Plymouth City Hall. At this meeting, we reviewed the project scope and schedule, reviewed key tasks, and identified data needs. Discussions also included preferences regarding preliminary stream stabilization and water quality concepts.

## 4.2 Technical Stakeholder/Agency Meeting

A technical stakeholder meeting was held at Plymouth City Hall on December 16, 2019. Attendees included representatives from the City of Plymouth, BCWMC (administrator, commissioner, alternate commissioner), TRPD, USACE, MPCA, and the Commission Engineers. The attendees reviewed the design concepts at the Parkers Lake Drainage Improvements and Mount Olivet Stream Stabilization project sites and provided technical and permitting feedback. Items discussed included:

- Review of the project schedule and meeting objectives.
- Review of the erosion sites and other creek deficiencies.
- Review of water quality issues
- Review and discussion of the design concepts.
- Discussion of permit requirements for potential wetland and stream impacts.
- Discussion of potential habitat improvements.

The meeting provided an opportunity to review the project site and discuss options, considering ideal restoration scenarios and practical aspects of maintenance and construction. The USACE expressed their preference for bioengineering techniques whenever possible and the need to limit wetland impacts and/or changes in stream length. Additional specific outcomes of the discussion are incorporated into the appropriate sections below.

## 4.3 Public Meeting

A public stakeholder meeting was held at Plymouth City Hall on February 12, 2020 with 10 members of the public attending the meeting. During the meeting, preliminary design concepts for both project areas were presented to local residents and users of the Parkers Lake Community Playfields. Attendees asked questions and provided some of their observations of the creeks and general project areas. There were no significant concerns raised about either of the projects. General discussions included tree removal and habitat improvements, water quality benefits, and project cost.

One long-time resident, who lives adjacent to the creek near Mount Olivet Lutheran Church, indicated previous projects along the creek were not successful in establishing native vegetation. This resident would like to see this project succeed in establishing vegetation.

A representative of Mount Olivet Lutheran Church was present and indicated support for the project. This representative noted discussions with past City staff of a possible pedestrian bridge or culvert crossing of the stream for residents in the adjacent apartments to access the Church grounds and Clifton E. French Regional Park, which the church would support. A follow-up email received by City staff from a church representative, dated 3/23/2020, indicated that church leadership is interested in supporting the project via the following:

- Holding future planning of public meetings at the church facilities
- Using the parking lot during construction
- Assisting in site clean-up, reseeding, etc.

Several residents expressed interest in the water quality components of the Parkers Lake Drainage Improvements project, especially regarding the potential reduction in chloride loading to Parkers Lake. The meeting included informative discussions regarding chlorides in Parkers Lake and support for the improvements presented, but also acknowledged the challenges of chloride management.

### 4.3.1 Public Meeting Follow-up

A meeting was held at Plymouth City Hall on March 4, 2020, with representatives from the City of Plymouth, BCWMC, and the Commission Engineer. This meeting reviewed the concepts, the feedback heard at the public meeting, discussion of the alternatives, and agreement on the recommended alternatives emerging from this feasibility study.

# 5.0 Potential Improvement Methods and Techniques

This section provides a summary of the alternatives for stabilization of the stream sites and water quality improvements at the Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvements project sites. Section 5.1 includes a general description of the stabilization alternatives and techniques evaluated and Section 5.2 discusses the water quality alternatives evaluated.

## 5.1 Description of Stream Stabilization Alternatives

There are a large number of possible combinations of alternatives that would provide stabilization benefits throughout the entire project area. This section provides an overview of the stabilization concepts reviewed by the project stakeholders in this feasibility study. Detailed design efforts may identify and include stabilization techniques or combinations of techniques that are not specifically included in this feasibility study.

### 5.1.1 Hard Armoring and Bioengineering Stream Stabilization Techniques

Techniques for stream stabilization generally fall into two categories: hard armoring and bioengineering (also known as soft armoring). Hard armoring techniques include the use of engineered materials such as stone (riprap or boulders), gabions, and concrete to stabilize slopes and prevent erosion. Bioengineering techniques employ biological and ecological concepts to control erosion, using vegetation or a combination of vegetation and construction materials, including logs and boulders. Techniques that do not use vegetative material but are intended to achieve stabilization of natural flow patterns and create in-stream habitat, such as boulder or log vanes, are generally included under the umbrella of bioengineering.

Hard armoring and bioengineering techniques present different challenges, costs, and benefits for stream stabilization design. Hard armoring methods are viewed as standard and time-tested and typically have a longer life span due to the permanence of the materials used. Hard armoring is usually effective in preventing erosion where it is installed; however, placement must consider downstream impacts, understanding that the armoring may push the erosive stresses downstream. Hard armoring typically requires little maintenance; however, if the armoring fails, maintenance or replacement can be expensive, particularly if the armoring materials need to be removed from the site.

Bioengineering techniques maintain more of a stream's natural function and provide better habitat and a more natural appearance than hard armoring. If vegetation is well-established this approach can also be self-maintaining. Due to biodegradation of construction materials and variable vegetation establishment success, it is typically assumed that bioengineering installations have a shorter life span and may need more frequent (if less expensive) maintenance, particularly as the vegetation is becoming established. Compared to hard armoring, the success of bioengineering techniques is more dependent on the skill of the designer and installer—sometimes making bioengineering construction more expensive.

Technical stakeholders for this feasibility study, including the USACE, expressed a preference for bioengineering over hard armoring for stream stabilization where possible. In addition, the current

*BCWMC Watershed Management Plan* (see Section 4.2.5 of Reference (1)) states: "recognizing their benefits to biodiversity and more natural appearance, the BCWMC will strive to implement stream and streambank restoration and stabilization projects that use soft armoring techniques (e.g., plants, logs, vegetative mats) as much as possible and wherever feasible."

### 5.1.2 Stream Stabilization Techniques Evaluated

We evaluated several techniques for stabilizing the streams within the project areas. Rock riffles or boulder cross vanes could be used to stabilize the channel bed and introduce flow variability and an improved riffle/pool sequence. The use of grading, root wads, and installation of live stakes on eroding banks will stabilize these areas from further sediment loss and improve habitat within the pools that have become overly shallow. The deeper pools will improve habitat, especially during winter months. Vegetation establishment in the overbanks will include enhanced buffers with native vegetation that have deeper roots for improved sediment-loss reduction and new riparian habitat. Table 5-1 summarizes the project restoration techniques evaluated for this feasibility study.

**Table 5-1 Project Design Elements**

| Design Element | Purpose | Ecological Benefit |
|---|---|---|
| **Rock Riffles**<br> | Gravel or cobble-sized material installed in the stream bed to create natural flow patterns and to control stream bed elevations | The variety in flow and channel substrate size provides habitat diversity for aquatic species. |
| **Cross Vanes**<br> | Boulders buried in the stream bed and extending partially ("vanes") or entirely across the stream ("cross vanes") to achieve one or more of the following goals: re-direct flows away from banks, encourage sediment deposition in selected areas, and control stream bed elevations | Scour pools develop over time near the vane, which provide habitat diversity for species that prefer pools to faster flowing in-channel habitat. |
| **Root Wads**<br> | Tree trunks with the root ball attached, installed either singly (root wads) or in conjunction with additional large woody debris and toe wood to Increase bank roughness and resistance to erosion, re-direct flows away from banks, and provide a bench for establishment of riparian vegetation | Creates undercut/overhanging bank habitat features |
| **VRSS/Toe Wood Bank Stabilization**<br> | Soil lifts created with a combination of root wads and long-lasting, biodegradable fabric and vegetated to stabilize steep slopes and encourage establishment of root systems for further stabilization | Creates undercut/overhanging bank habitat features |

| Design Element | Purpose | Ecological Benefit |
|---|---|---|
| **Vegetation/Buffer**  | Established along a stream bank or overbank area to stabilize bare soils and increase resistance to fluvial erosion | Using trees, shrubs, and a seed mix of grass and forbs provides a diverse array of vegetation strata and habitat types. Allows for more naturalized aesthetics, with emphasis on native species. |

## 5.2 Description of Water Quality Alternatives

Examples of the stormwater BMPs that can be used for sediment and phosphorus removal, and in some cases runoff volume reduction, included the following:

- Filtration/Infiltration practices
- Enhanced filtration practices to target soluble phosphorus
- Bioretention
- Wet retention ponds
- Permeable pavements
- Stormwater reuse for irrigation

Working with City of Plymouth staff, we selected stormwater management practices based on the existing topography, existing drainage infrastructure, available open space, and hydraulic loading and conditions.

City of Plymouth staff were very interested in evaluating opportunities to reuse water for irrigation at the Parkers Lake Community Playfields. However, the TRPD data indicated elevated chloride levels persisted well into the summer months, and the chloride concentrations were often well above recommended thresholds for irrigation of turf (100 mg/L) and ornamental plantings (70 mg/L). As a result, we did not further pursue reuse for irrigation as part of this feasibility study.

Because chlorides dissolve in stormwater runoff, typical structural stormwater BMPs, such as those listed above, are not effective in removing chlorides. The main method to reduce chloride loads in the Parkers Lake watershed is to reduce the application of deicing salts, specifically in the northern tributary watersheds. Given the land use is primarily multifamily residential and office/industrial, the property owners of these sites often rely on property managers and/or hired private contractors for snow management and deicing efforts and over-salting is often an issue.

The City of Plymouth has greatly reduced the amount of salt it uses in deicing City streets and facilities and is committed to salt reduction efforts citywide. As part of its MS4 permit implementation efforts and as outlined in its stormwater pollution prevention plan (SWPPP), the City of Plymouth has aggressively pursued improving salt management and reducing salt usage including the following:

- Covering the salt storage at its public works facility
- Annual calibration of spreaders
- Utilization of the Road Weather Information Service (RWIS)
- Upgrading to brining equipment
- Implementing prewetting and anti-icing practices
- Utilizing liquid deicing practices to reduce chloride application rates per lane mile

This feasibility study has considered ways to help promote reduced salt usage on the private properties in the northern watershed tributary to Parkers Lake.

# 6.0 Project Concepts

This section provides a summary of the two conceptual designs developed and evaluated for the Mount Olivet stormwater improvement project and seven conceptual designs for the Parkers Lake project.

Table 6-1 provides a summary of the alternatives evaluated and further discussed in the following sections.

**Table 6-1 Feasibility Study Alternatives Summary**

| Alternative | Description |
|---|---|
| **Mount Olivet Stream Stabilization Project** | |
| **Alternative 1** | Stream stabilization utilizing bio-engineering techniques, wetland restoration, and installation of a manhole drop structure at the Mount Olivet Church parking lot |
| **Alternative 2** | Stream stabilization utilizing bio-engineering techniques, stream re-meandering, and installation of hard armoring/riprap at the Mount Olivet Church parking lot |
| **Parkers Lake Drainage Improvement Project** | |
| **Alternative 1** | Stream stabilization by conveying flow through a pipe rather than through the stream channel |
| **Alternative 2** | Stream stabilization utilizing a standard hard-armoring approach |
| **Alternative 3** | Stream stabilization utilizing bio-engineering techniques |
| **Alternative 4** | Diversion of low flows from the existing storm sewer system to an iron-enhanced bioretention filtration system |
| **Alternative 5a/5b** | Opportunities for a wet retention pond in open space along the existing stream alignment through the Parkers Lake Community Playfields site |
| **Alternative 6** | Chloride demonstration projects in the northern watershed tributary to Parkers Lake to reduce salt usage and chloride loads to the lake |

Section 7.0 summarizes the impacts of the conceptual designs, Section 8.0 summarizes the project modeling and estimated water quality improvements, and Section 9.0 provides a summary of the cost for each alternative.

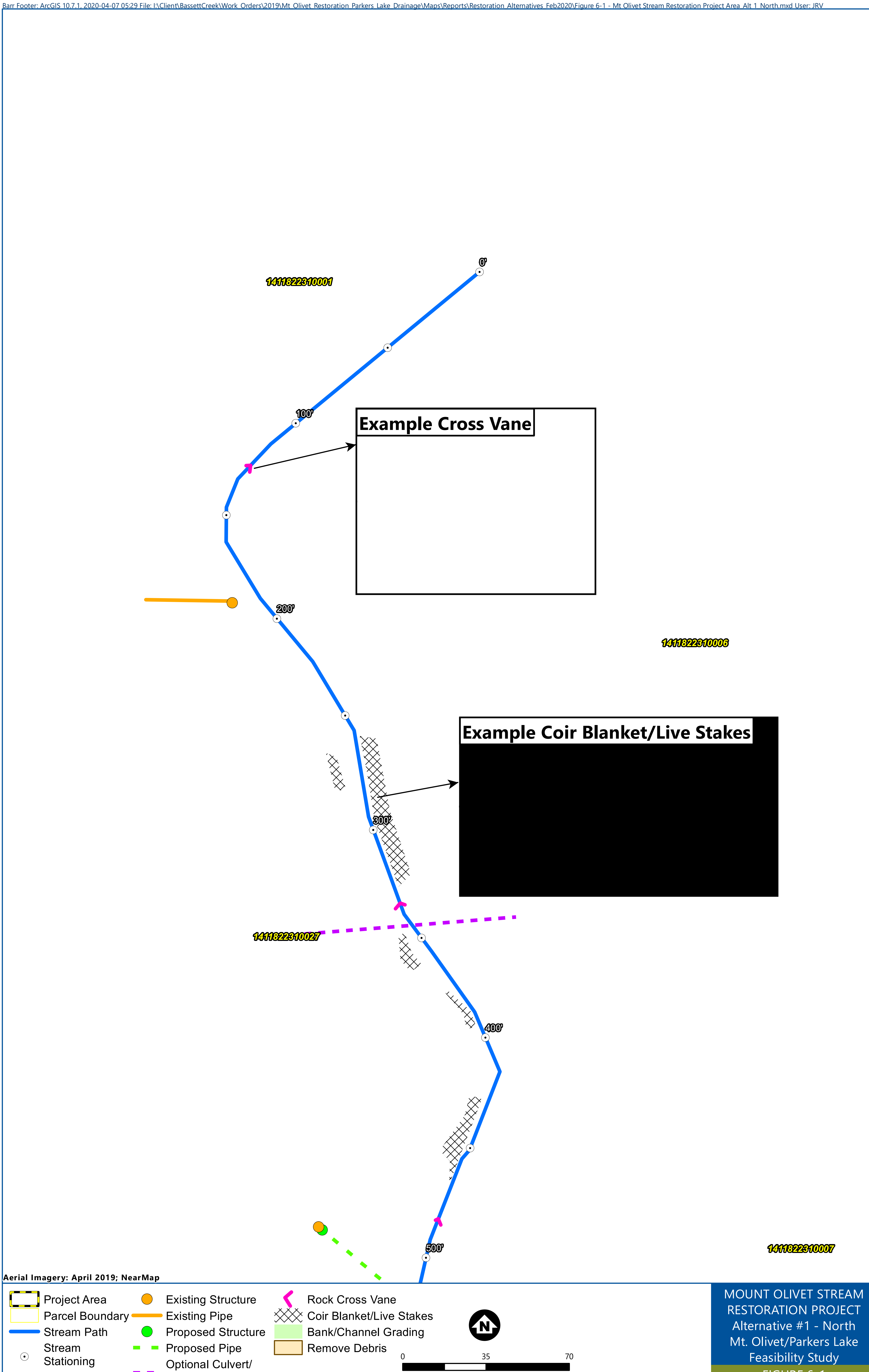
## 6.1 Analyzed Alternatives for Mount Olivet Stream Restoration Project

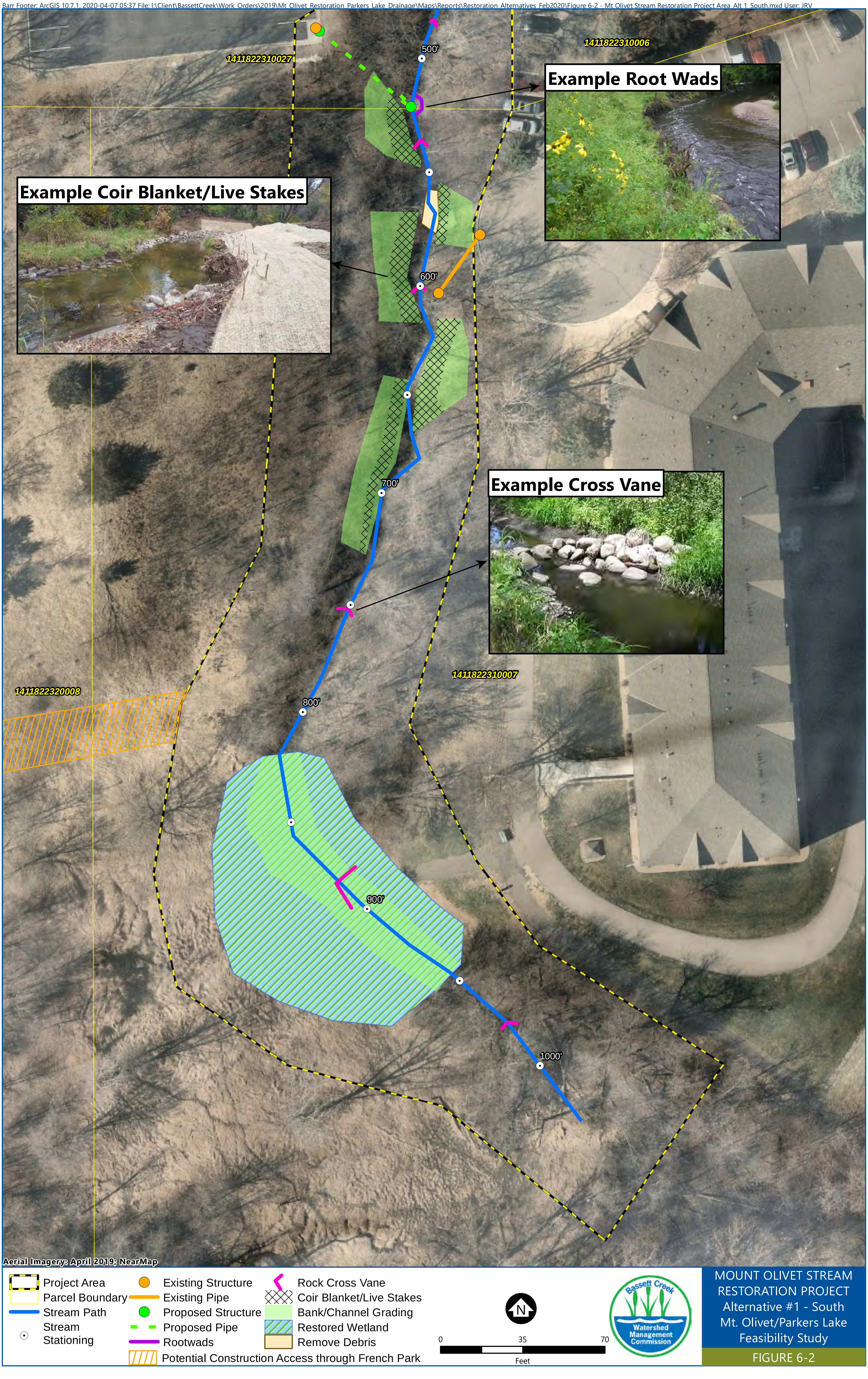
### 6.1.1 Alternative 1— Mount Olivet Stream Stabilization

The primary focus of the Alternative 1 design is stabilizing the stream, which will decrease erosion and total suspended solids (TSS) loading, improve water quality, and improve stream and downstream wetland habitat. Figure 6-1 and Figure 6-2 show a representation of the proposed features of Alternative 1. This alternative includes the following design components:

- Installing cross vanes to limit erosion of the channel bed and create flow diversity.
- Grading and placing coir blankets with live stakes to improve stream bank stability and decrease erosion.
- Restoring approximately 0.15 acres of the existing wetland. This restoration will allow for the creation of habitat for wildlife, waterfowl, fish, macroinvertebrates, and macrophytes and installation of habitat features, such as turtle logs and waterfowl nesting boxes.
- Removing and replanting (if necessary) 39 trees. Details of replanting trees and other restoration will be determined during the final design process. Most of the removed trees will be re-used and installed as large woody debris in the stream. Removed species (with range of diameters in inches) include box elder (4- to 16-inch), buckthorn (4- to 10-inch), black cherry (4- to 13-inch), Siberian elm (6- to 13-inch), red maple (4-inch), and bur oak (9-inch). The majority of these removed trees are less than 12 inches in diameter.
- Installing a manhole drop structure to prevent further slope erosion. There is moderate-to-severe erosion from the southeastern corner of Mount Olivet Lutheran Church's parking lot down to the stream channel.
- Removing large debris from the stream channel, which will decrease localized erosion.
- Considering installation of a pedestrian crossing over the northern section of the stream, per discussions between representatives of the adjacent apartment complex and Mount Olivet Lutheran Church. Both entities want to collaborate to allow the apartment complex residents access to Mount Olivet Lutheran Church's trails and access to Three Rivers' Clifton E. French Regional Park trails. The pedestrian crossing will be built above a 54-inch diameter reinforced concrete pipe culvert, which is sized to handle a 25-year rain event with a portion of the pipe being buried to provide a natural channel bottom.

Barr Footer: ArcGIS 10.7.1, 2020-04-07 05:29 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 6-1 - Mt Olivet Stream Restoration Project Area_Alt_1_North.mxd User: JRV



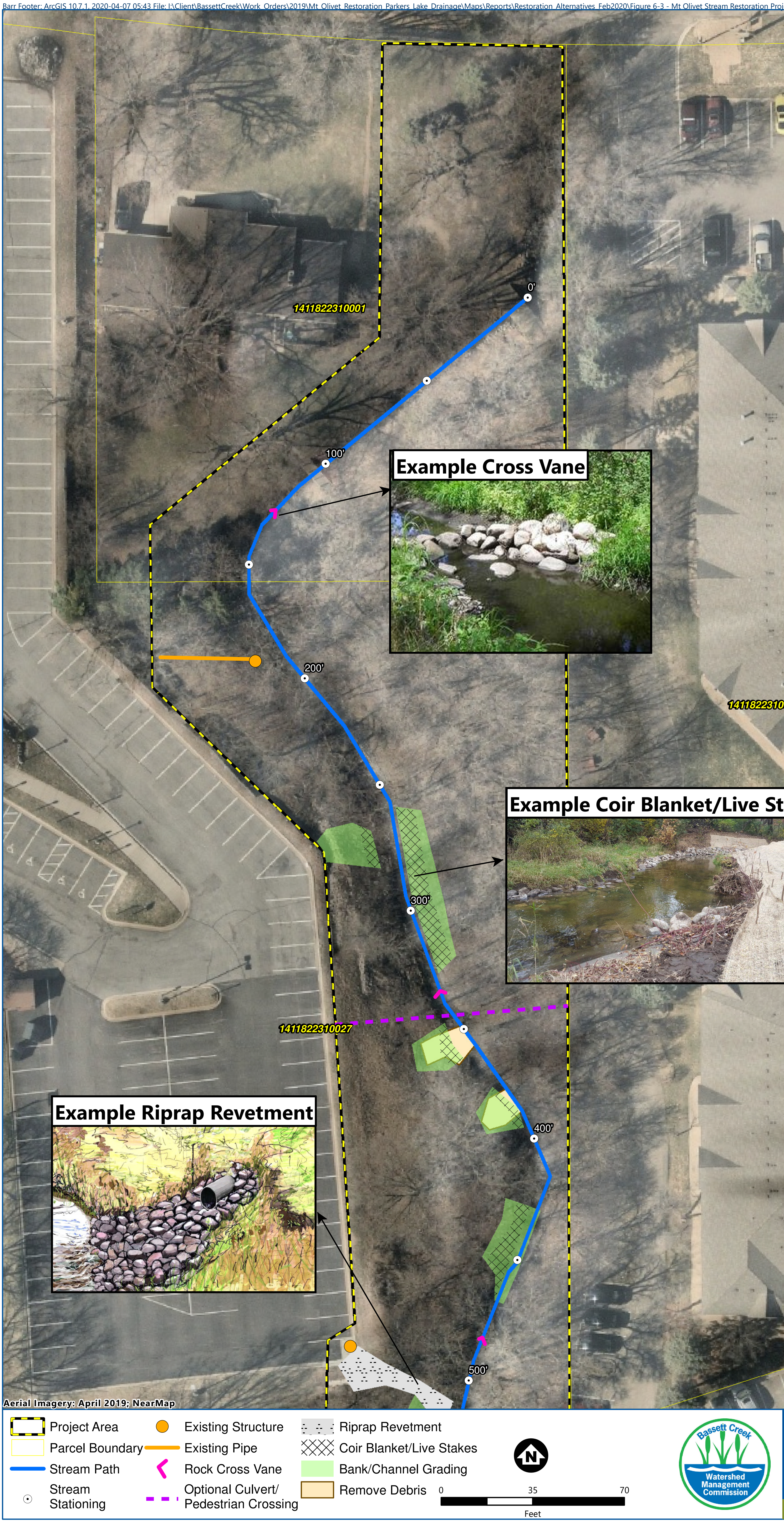

1411822310027
1411822310006
500'
Example Root Wads
Example Coir Blanket/Live Stakes
600'
700'
Example Cross Vane
1411822310007
1411822320008
800'
900'
1000'
Aerial Imagery: April 2019; NearMap
Project Area
Parcel Boundary
Stream Path
Stream Stationing
Existing Structure
Existing Pipe
Proposed Structure
Proposed Pipe
Rootwads
Potential Construction Access through French Park
Rock Cross Vane
Coir Blanket/Live Stakes
Bank/Channel Grading
Restored Wetland
Remove Debris
N
0
35
70
Feet
Bassett Creek Watershed Management Commission
MOUNT OLIVET STREAM RESTORATION PROJECT
Alternative #1 - South
Mt. Olivet/Parkers Lake Feasibility Study
FIGURE 6-2

### 6.1.2 Alternative 2— Mount Olivet Stream Stabilization

The primary focus of the Alternative 2 design is stabilization of the stream, which will decrease erosion and TSS, improve water quality, and improve stream habitat. Figure 6-3 and Figure 6-4 show a representation of the proposed features of Alternative 2. This alternative includes the design components of Alternative 1, with these changes:

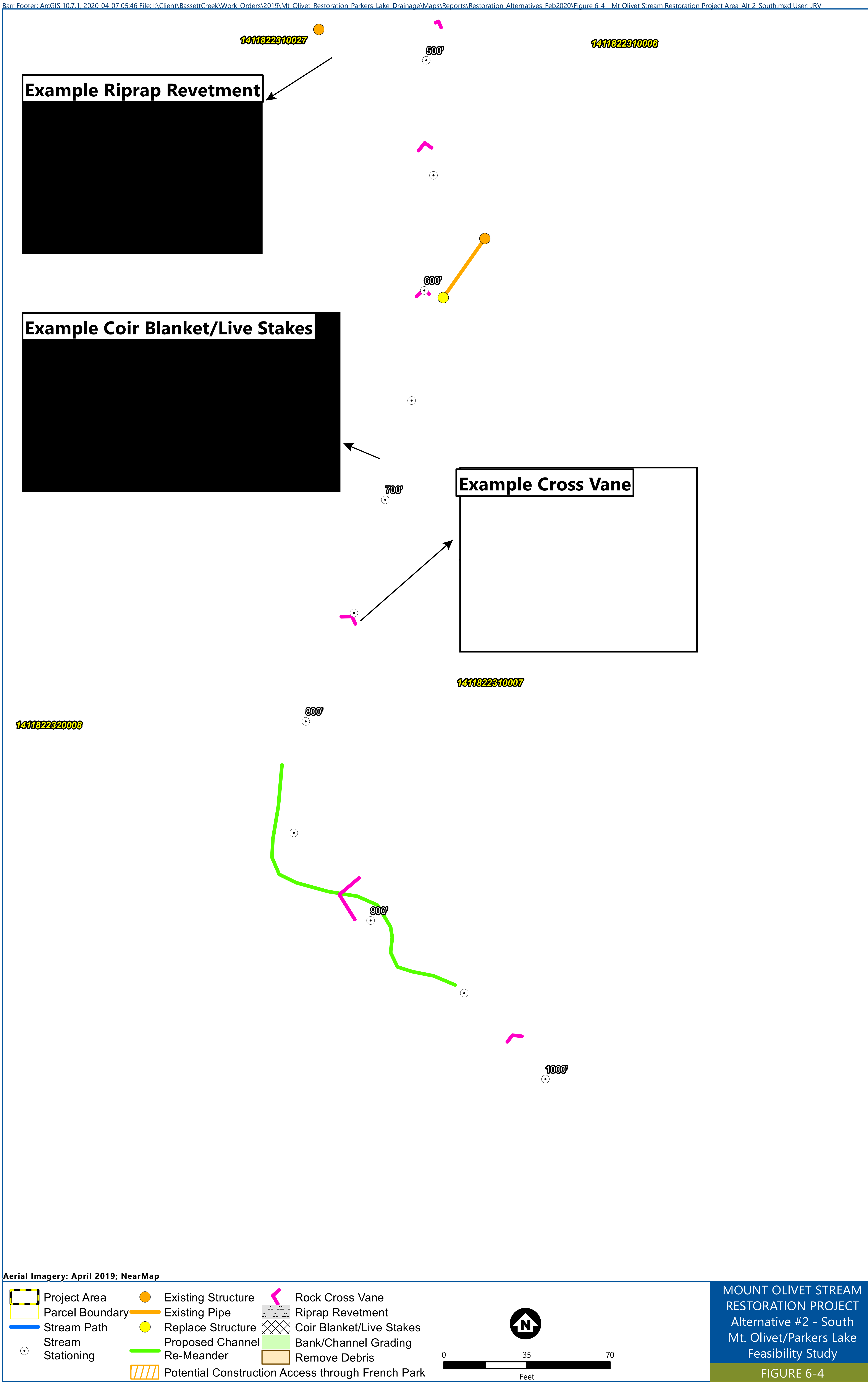
- Re-meandering the stream path in the wetland area to increase stream path sinuosity and provide additional habitat and flow diversity instead of restoring the wetland area as in Alternative 1.
- Installing riprap revetment to prevent further slope erosion instead of installing a manhole drop structure as in Alternative 1. There is moderate-to-severe erosion from the southeastern corner of Mount Olivet Lutheran Church's parking lot down to the stream channel.
- Removing large debris from the stream channel, which will decrease the current localized erosion.

Barr Footer: ArcGIS 10.7.1, 2020-04-07 05:43 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 6-3 - Mt Olivet Stream Restoration Project Area_Alt 2_North.mxd User: JRV




MOUNT OLIVET STREAM RESTORATION PROJECT
Alternative #2 - North
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 6-3



1411822310027
1411822310006
500'
Example Riprap Revetment
600'
Example Coir Blanket/Live Stakes
700'
Example Cross Vane
1411822310007
800'
1411822320008
900'
1000'
Aerial Imagery: April 2019; NearMap
Project Area
Parcel Boundary
Stream Path
Stream Stationing
Existing Structure
Existing Pipe
Replace Structure
Proposed Channel Re-Meander
Rock Cross Vane
Riprap Revetment
Coir Blanket/Live Stakes
Bank/Channel Grading
Remove Debris
Potential Construction Access through French Park
N
0
35
70
Feet
MOUNT OLIVET STREAM RESTORATION PROJECT
Alternative #2 - South
Mt. Olivet/Parkers Lake Feasibility Study
FIGURE 6-4

## 6.2 Analyzed Alternatives for Parkers Lake Drainage and Water Quality Improvement Project

### 6.2.1 Alternative 1— Parkers Lake Stream Stabilization

The primary focus of the Alternative 1 design is stabilizing the stream by conveying flow through a pipe rather than through the stream channel. This will decrease erosion and TSS loading, improve water quality, and improve stream habitat. Figure 6-5 and Figure 6-6 show a representation of the proposed features of Alternative 1. This alternative includes the following design components:

- Installing approximately 850 feet of reinforced-concrete pipe below the stream channel and installing nine new stormwater manhole structures in the northern and southern areas of the project site. After construction of these improvements, most of the stormwater will flow through the area via the pipe, which will prevent erosion of the stream channel.
- Removing and replanting (if necessary) 16 trees. Details of replanting trees and other restoration will be determined during the final design process. Removed species (with range of diameters in inches) include box elder (5- to 14-inch) and black willow (7- to 10-inch). The majority of these removed trees are less than 12 inches in diameter.


PARKERS LAKE DRAINAGE IMPROVEMENTS PROJECT AREA
Alternative #1 North
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 6-5

Barr Footer: ArcGIS 10.7.1, 2020-03-24 11:36 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 6-6 - Parkers Lake Stream Restoration Project Area_Alt 1_South.mxd User: JRV

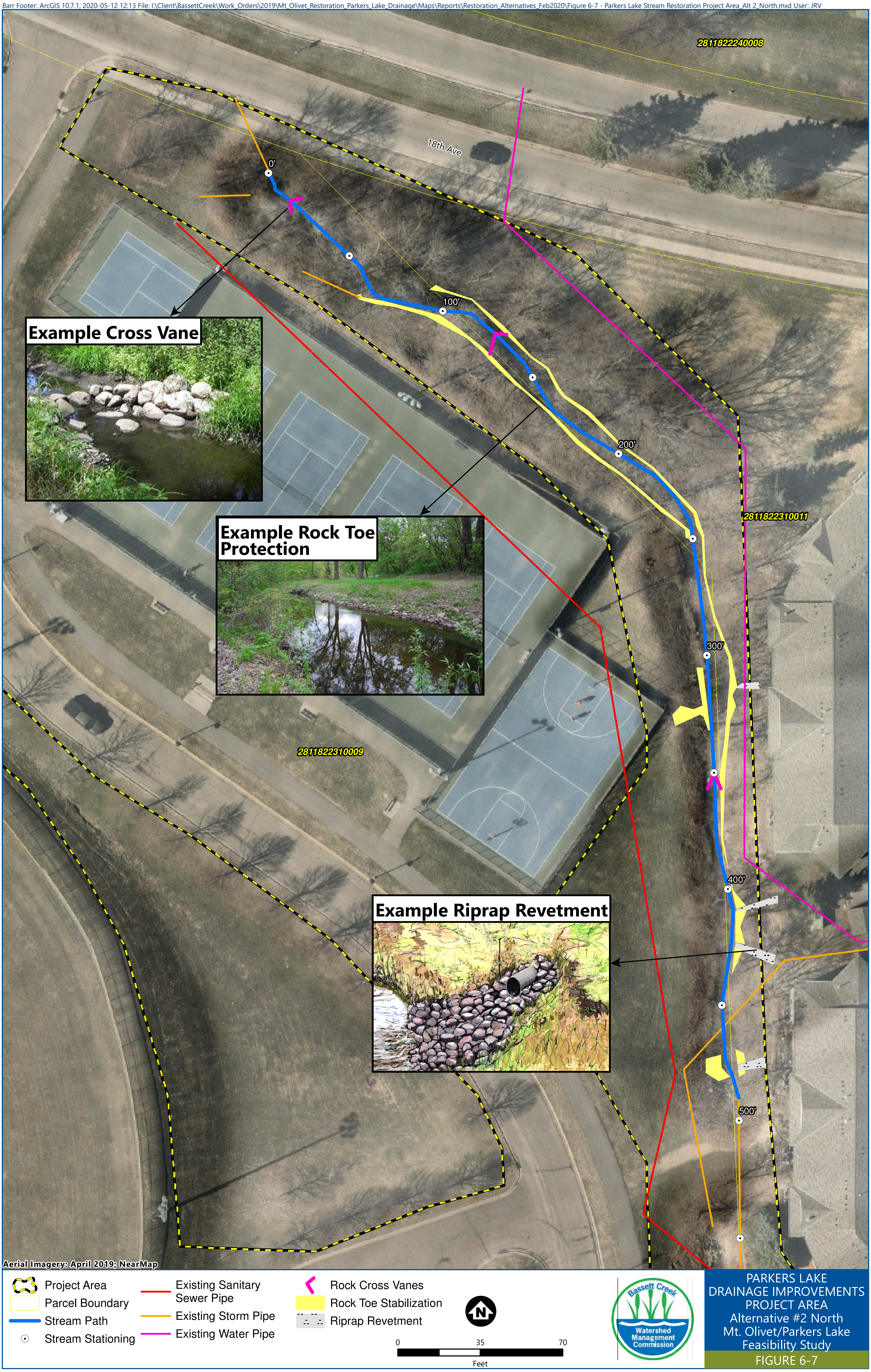

PARKERS LAKE
DRAINAGE IMPROVEMENTS
PROJECT AREA
Alternative #1 South
Mt. Olivet/Parkers Lake
Feasibility Study

FIGURE 6-6

### 6.2.2 Alternative 2 — Parkers Lake Stream Stabilization

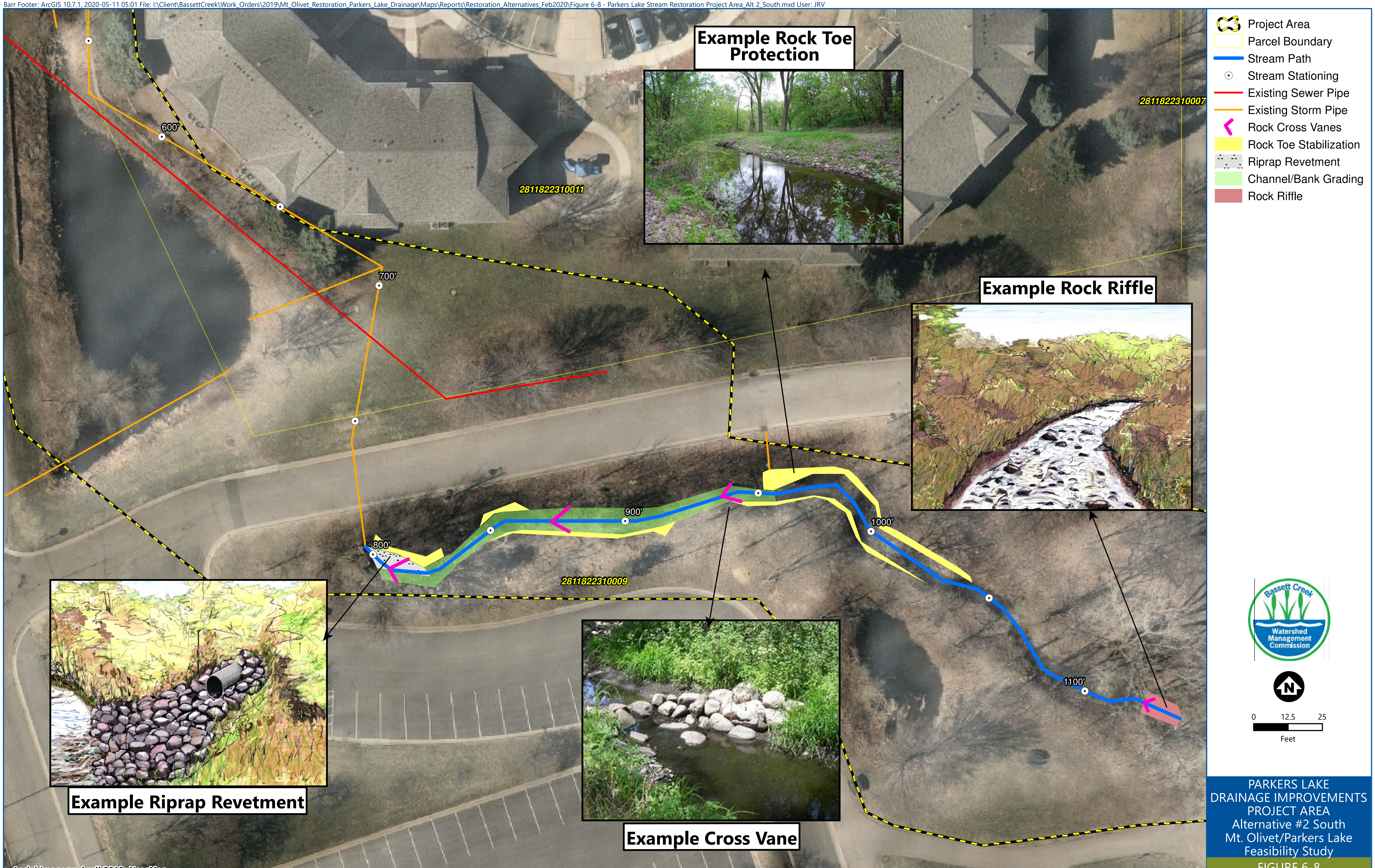
The primary focus of the Alternative 2 design is stabilizing the stream through the use of hard-armoring approaches. This will decrease erosion and TSS loading, improve water quality, and improve stream habitat. Figure 6-7 and Figure 6-8 show a representation of the proposed features of Alternative 2. This alternative includes the following design components:

- Installing cross vanes to limit erosion of the channel bed and create flow diversity.
- Installing rock toe protection along sections of the stream banks to decrease bank erosion and improve the stream stabilization.
- Installing riprap revetment along areas of the stream banks to decrease the erosion caused by the runoff from apartment complex roof drainpipes.
- Installing some riprap revetment in the southern section of the stream at culvert outlets and regrading portions of the stream channel in the same section.
- Installing a rock riffle at the downstream outlet to add flow diversity and limit erosion of the channel bed.
- Removing and replanting (if necessary) 20 trees. Details of replanting trees and other restoration will be determined during the final design process. Removed species (with range of diameters in inches) include green ash (5- to 9-inch) and box elder (6- to 15-inch). The majority of these removed trees are less than 12 inches in diameter, and several of the large box elder trees (10- to 15-inch) are already dead.




PARKERS LAKE DRAINAGE IMPROVEMENTS PROJECT AREA
Alternative #2 North
Mt. Olivet/Parkers Lake Feasibility Study

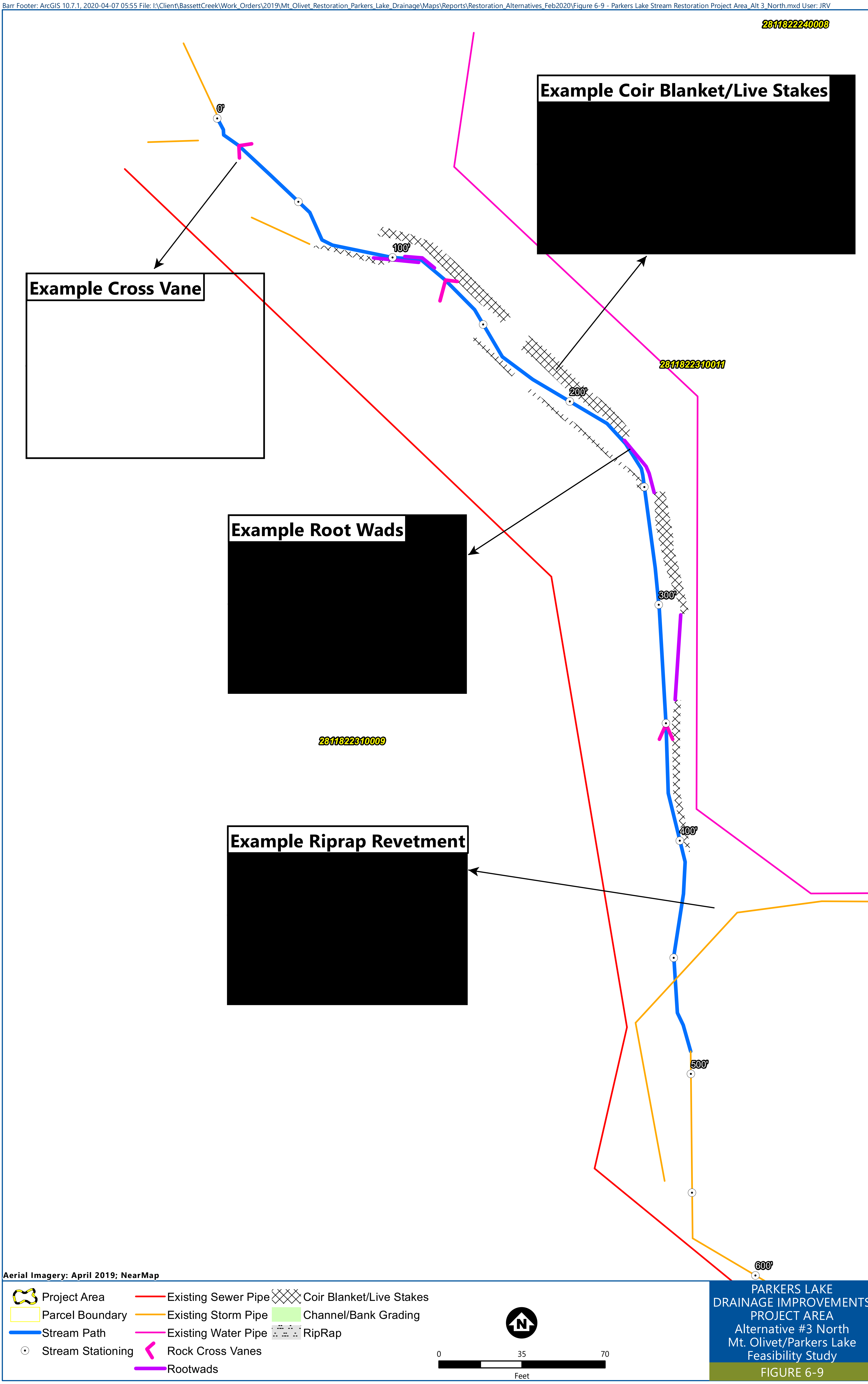
FIGURE 6-7


Example Rock Toe Protection
Example Rock Riffle
Example Riprap Revetment
Example Cross Vane
600'
700'
800'
900'
1000'
1100'
2811822310011
2811822310007
2811822310009
Aerial Imagery: April 2019; NearMap
Project Area
Parcel Boundary
Stream Path
Stream Stationing
Existing Sewer Pipe
Existing Storm Pipe
Rock Cross Vanes
Rock Toe Stabilization
Riprap Revetment
Channel/Bank Grading
Rock Riffle
Bassett Creek Watershed Management Commission
0
12.5
25
Feet
PARKERS LAKE
DRAINAGE IMPROVEMENTS
PROJECT AREA
Alternative #2 South
Mt. Olivet/Parkers Lake
Feasibility Study
FIGURE 6-8

### 6.2.3 Alternative 3 — Parkers Lake Stream Stabilization

The primary focus of the Alternative 3 design is stabilizing the stream through the use bio-engineering principles. This will decrease erosion and TSS loading, improve water quality, and improve stream habitat. Figure 6-9 and Figure 6-10 show a representation of the proposed features of Alternative 3. This alternative includes the following design components:

- Installing cross vanes to limit erosion of the channel bed and create flow diversity.
- Grading and installing coir blankets with live stakes to improve stream bank stability and decrease erosion.
- Installing riprap revetment along areas of the stream banks to decrease the erosion caused by the runoff from the apartment complex drainpipes.
- Installing some riprap revetment in the southern section of the stream at culvert outlets where velocities exceed stability thresholds for native materials and regrading portions of the stream channel in the same section.
- Installing a rock riffle at the downstream outlet to add flow diversity and limit erosion of the channel bed.
- Removing 14 trees and reusing/installing them as large woody debris in the stream and importing and installing an additional 16 trees as large woody debris. Details of replanting trees and other restoration will be determined during the final design process. Removed species (with range of diameters in inches) include green ash (5- to 9-inch), box elder (6- to 16-inch), and red maple (5-inch). The majority of these removed trees are less than 12 inches in diameter


2811822240008
Example Coir Blanket/Live Stakes
0'
100'
200'
300'
400'
500'
600'
Example Cross Vane
2811822310011
Example Root Wads
2811822310009
Example Riprap Revetment
Aerial Imagery: April 2019; NearMap
Project Area
Parcel Boundary
Stream Path
Stream Stationing
Existing Sewer Pipe
Existing Storm Pipe
Existing Water Pipe
Rock Cross Vanes
Rootwads
Coir Blanket/Live Stakes
Channel/Bank Grading
RipRap
N
0
35
70
Feet
PARKERS LAKE
DRAINAGE IMPROVEMENTS
PROJECT AREA
Alternative #3 North
Mt. Olivet/Parkers Lake
Feasibility Study
FIGURE 6-9


PARKERS LAKE DRAINAGE IMPROVEMENTS PROJECT AREA
Alternative #3 South
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 6-10

### 6.2.4 Alternative 4 — Water Quality Improvement (Iron-Enhanced Bioretention Filtration System)

The primary focus of Alternative 4 is to treat stormwater runoff from the Parkers Lake Community Playfields that currently discharges, untreated, into the stream on the property. The proposed treatment would remove TSS and TP (including soluble phosphorus). Alternative 4 includes the diversion of low flows from the existing storm sewer system to an iron-enhanced bioretention filtration system. Figure 6-11 shows the conceptual layout of Alternative 4. This alternative includes the following design components:

- Converting an existing low, turfed area to a bioretention basin with iron-enhanced media and an underdrain system.
- Modifying the existing drainage structure to allow for filtration of 1.5 feet of stored water within the basin.
- Diverting low flows from the existing storm sewer system in the northern parking lot to the filtration basin.
- Restoring the area, creating 0.3 acres of native and pollinator-friendly habitat.
- Providing opportunities for outreach and education due to the proximity to trails and other recreation features.
- No tree removal is anticipated, as the existing area is primarily managed turf.


PARKERS LAKE
WATER QUALITY
Alternative #4
Mt. Olivet/Parkers Lake
Feasibility Study

FIGURE 6-11

### 6.2.5 Alternatives 5a and 5b — Water Quality Improvement (Wet Retention Ponds)

Alternatives 5a and 5b are two separate wet retention project locations along the existing stream through the Parkers Lake Community Playfields; however, it was assumed that if these projects were one of the preferred, only one project location would be selected and implemented. The intent of project 5a and 5b is to treat stormwater runoff from the watershed upstream of the Parkers Lake Community Playfields using a wet retention pond to remove TSS and TP. These wet retention ponds would be located in open space along the existing stream alignment through the Parkers Lake Community Playfields site. Either retention project could be paired with any of the stream stabilization concepts. Figure 6-12 shows the conceptual location of Alternatives 5a and 5b.

Alternative 5a includes the following design components:

- Excavating a wet retention pond, providing 0.34 acre-feet of water quality treatment volume and 0.14 acres of open water in the open space south of the basketball and tennis courts.
- Restoring the upland slopes of the project with native and pollinator-friendly habitat.
- Providing opportunities for outreach and education due to the proximity of trails and other recreation features.
- Removing an estimated six trees and replanting (as necessary). Removed species (with range of diameters in inches) include Siberian Elm (9- to 14-inch), box elder (7- to 11-inch), and black willow (10- to 15-inch). Details of replanting trees and other restoration will be determined during the final design process.

Alternative 5b includes the following design components:

- Excavating a wet retention pond, providing 0.71 acre-feet of water quality treatment volume and 0.28 acres of open water in the wooded wetland and stream space east of the southern parking lot where the farmers' market is held.
- Restoring the upland slopes of the project with native and pollinator-friendly habitat.
- Providing opportunities for outreach and education due to the proximity of trails and other recreation features.
- Removing an estimated 35 trees and replanting (as necessary). Removed species (with range of diameters in inches) include, but are not limited to, apple (10-inch), green ash (10- to 11-inch), box elder (4- to 32-inch), and eastern cottonwood (13- to 28-inch). Details of replanting trees and other restoration will be determined during the final design process.

Barr Footer: ArcGIS 10.7.1, 2020-03-24 12:05 File: I:\Client\BassettCreek\Work_Orders\2019\Mt_Olivet_Restoration_Parkers_Lake_Drainage\Maps\Reports\Restoration_Alternatives_Feb2020\Figure 6-12 - Parkers Lake Alt5a5b_WetRetention.mxd User: JRV


Project Area
Ponds and Wetlands
Subwatersheds
Storm Sewer
WQ Alternative - Open Water
WQ Alternative - Grading

N

0 150 300
Feet

Bassett Creek Watershed Management Commission

PARKERS LAKE WATER QUALITY
Alternatives 5a & 5b
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 6-12

### 6.2.6 Alternative 6 — Water Quality Improvement (Chloride Management)

Unlike all of the other alternatives, where very specific practices can be implemented to reduce pollutant loads, chlorides are challenging to remove because they dissolve in water. Reverse osmosis is a common method for removal of dissolved constituents, such as chlorides, in drinking water, wastewater, and some industrial process systems. However, due to the variability in flows and potential extremes in magnitude of chloride concentration, it is not energy efficient, cost effective, or generally feasibility to use this method to treat stormwater runoff at Parkers Lake. Ultimately, reducing the use of chlorides in the watershed will be the most effective approach.

The BCWMC recognizes the importance of reducing chloride loading to Parkers Lake and the complexity of this issue. Although many private applicators acknowledge they are over-salting, they are often pressured into over-applying salt by the property owners/managers for fear of potential litigation. If enacted, limited liability legislation at the state level could potentially reduce or eliminate this driver for over-application of salts.

Additionally, the City of Plymouth and the BCWMC have partnered in the promotion of Smart Salt training for property managers and private applicators. Continued support for these trainings is important. These recent trainings have been successful; however, until chloride reductions are observed in the watershed monitoring data, it is hard to measure the impact that the training is having on reductions in salt usage.

Watersheds in Hennepin County, including the BCWMC, are working in partnership with Hennepin County and the University of Minnesota on the Hennepin County Chloride Initiative to combat the overuse of salt and understand the barriers that are preventing reductions in salt application. The initiative is using funds from the Minnesota Board of Water and Soil Resources' (BWSR) Watershed-Based Implementation Funding program (through the BWSR Clean Water Fund grant program). Based on project research, surveys, and conversations, one key takeaway is that there is a significant difference between what we know and what we do. There is also an opportunity for more hands-on/specialized training and an opportunity for education on the level of service that property managers can provide related to deicing efforts (e.g. educating that ice-free roads/walks is not always possible). This effort can help people change their behavior/expectations to support chloride reduction efforts.

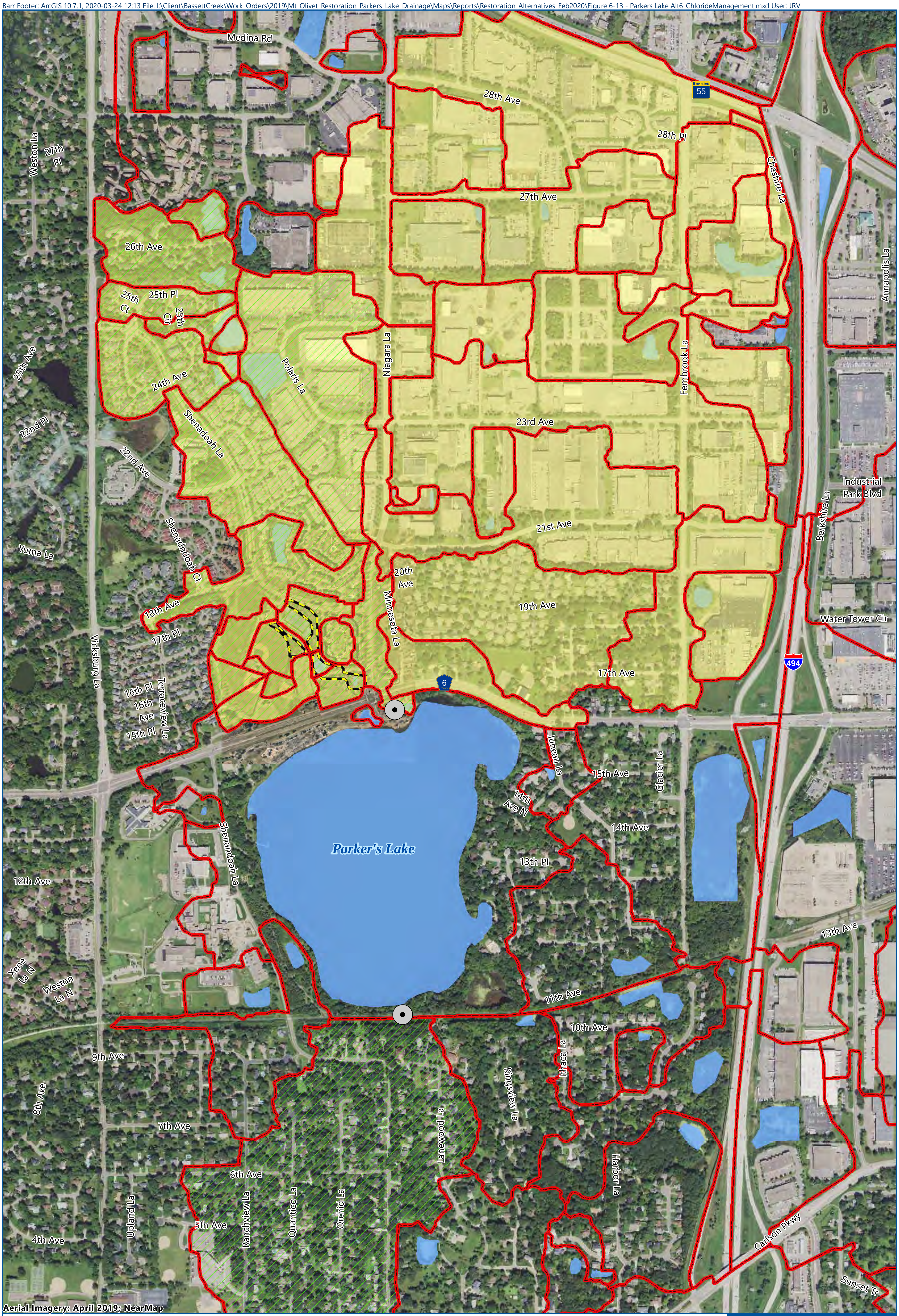
Data compiled from the MPCA suggests that implementation of smart salting recommendations and other salt reducing practices can result in 30–70% reductions in chloride use.

This alternative includes implementation of a chloride-reduction demonstration project(s) within the Parkers Lake northern tributary watershed that will include working with willing property owners to reduce their chloride usage. The City of Plymouth is taking the lead on reaching out to all multi-family residential and office/industrial property owners in the northern watershed to Parkers Lake to identify willing project partners that are interested in working with the City and the BCWMC on proactively reducing their use of chlorides on their property.

Depending on the interest of property owners, this demonstration effort could include projects implemented at multiple sites and would include pre- and post-chloride reduction monitoring to quantify the change in chloride use.

Although the specifics of each project will be dependent on the site and property, the reduction efforts could include:

- Working closely with the partners (the property owners/property managers/private applicators) on smart salting and improved deicing methods.
- Upgrading plowing and deicing equipment used at the site, such as segmented plow blades and transitioning to use of brining equipment.
- Installing automated or remote-controlled pavement anti-icing systems integrated into the pavement surfaces, that proactively treat pavement surfaces with anti-icing liquids that prevent the formation of ice or bonded snow. These systems are commonly used in highway and bridges.
- Installation of snowmelt systems to create heated walks and drives in high-use areas that can typically eliminate the need for de-icing salts.
- Converting impervious to permeable surfaces to allow for melting and infiltrating of snow/ice.
- Educating residents of multi-family units and employees at participating businesses about the project, the reason for reducing salt use, and the methods used to ensure continued safety in order to change expectations and recognize the amount of salt that's truly needed to reduce ice levels.




Ponds and Wetlands
Project Area
Subwatersheds
Chloride Management Area
TRPD Monitoring Station Watersheds
TRPD Monitoring Stations

N

0 750 1,500
Feet

Bassett Creek Watershed Management Commission

PARKERS LAKE WATER QUALITY
Alternative #6
Mt. Olivet/Parkers Lake Feasibility Study

FIGURE 6-13

# 7.0 Project Impacts

This section discusses the impacts of each project, including the land ownership and permitting requirements for each alternative. Section 8.0 summarizes the estimated pollution reduction of each alternative.

## 7.1 Easement Acquisition

For the Mount Olivet Stream Stabilization, the proposed construction access is through Clifton E. French Regional Park and onto property owned by Parkside Apartments, requiring easements. Easements may also be necessary for work on Mount Olivet Lutheran Church property and at the single-family residence at 12135 Old Rockford Road. The single-family home property owner attended the public stakeholder meeting and expressed support for the project; we assume this owner will be willing to work with the City on an easement agreement.

Nearly all of the proposed work for the Parkers Lake Drainage Improvement Project is on City of Plymouth property, or within existing easements. Some work may be necessary on property owned by Lakeview Commons Apartments, but no staging or access through the property will be necessary.

## 7.2 Permits Required for the Project

Table 7-1 shows the list of expected permitting agencies for each site. This list is only an estimate; each project site should be evaluated for required permits as the site construction details are developed.

**Table 7-1 Potential Permit Requirements by Work Site**

| Project Site | Agencies Who May Require Permits |
|---|---|
| Mount Olivet | City of Plymouth, MPCA, USACE, TRPD |
| Parkers Lake | City of Plymouth, MPCA, USACE |

The proposed projects will require 1) a Clean Water Act Section 404 permit from the USACE or Letter of Permission under a General Permit and Section 401 certification from the Minnesota Pollution Control Agency (MPCA), 2) compliance with the Minnesota Wetland Conservation Act, 3) a Construction Stormwater General Permit from the MPCA and compliance with the MPCA's guidance for managing dredged materials, 4) compliance with Minnesota environmental review rules, and 5) local permits from the City of Plymouth. Additionally, the Mount Olivet project will likely require written permission from the TRPD for access to the project site through park district property.

### 7.2.1 Section 404 Permit

According to Section 404 of the Clean Water Act (CWA), the USACE regulates the placement of fill into wetlands if they are hydrologically connected to a Water of the United States. In addition, the USACE may regulate all proposed wetland alterations if any wetland fill is proposed. The MPCA may be involved in wetland mitigation requirements as part of the CWA Section 401 water quality certification process for the 404 Permit.

The BCWMC developed its Resource Management Plan (RMP), with the goal of completing a conceptual-level USACE permitting process for proposed projects. The RMP was submitted to the USACE in April 2009 and revised in July 2009. This feasibility study follows the protocols for projects within the BCWMC RMP.

The USACE 404 permit requires a Section 106 review for historic and cultural resources. The results of the archeological reconnaissance study are included as Appendix D. If the State Historic Preservation Office (SHPO) requests more detailed information, a Phase I Archaeological Survey may need to be completed. A Phase I Archaeological Survey can be completed in 45 days or less during a frost-free period. The USACE staff anticipates that the 404 permit review and approval process could require 120 days to complete. These projects may fit under the USACE Nationwide Permit 13. Verification of the USACE Nationwide Permit 13 requirements and comparison to the proposed project features/impacts will be necessary during the project design phase to determine whether this permit or another will be most relevant.

### 7.2.2 Minnesota Pollution Control Agency (MPCA) Permits

If disturbance limits are greater than one acre, the construction of the proposed project will require a National Pollutant Discharge Elimination System/State Disposal System Construction Stormwater (CSW) General Permit issued by the MPCA. The CSW permit will require the preparation of a SWPPP that explains how stormwater will be controlled within the project area during construction.

Based on the findings of the desktop review of the MPCA's "What's In My Neighborhood?" database, it is not anticipated that environmental impacts such as contaminated soil and debris will be encountered during stream restoration activities; therefore, it is not anticipated that the project will require additional permits for disposing of contaminated soil. In the unlikely event that environmental impacts are encountered during the creek restoration earthwork, contaminated materials will need to be handled and managed appropriately. The response to discovery of contamination typically includes entering the MPCA's voluntary program. A construction contingency plan could be prepared for the project in accordance with MPCA guidance. This would include specifying initial procedures for handling potentially impacted materials, collecting analytical samples, and working with the MPCA to determine a method for managing impacted materials.

### 7.2.3 Public Waters Work Permit

The MDNR regulates projects constructed below the ordinary high water level of public waters, watercourses, or wetlands, which alter the course, current, or cross section of the water body. Public waters regulated by the MDNR are identified on published public waters inventory maps. Neither the Mount Olivet Stream Stabilization nor Parkers Lake Drainage Improvements projects are located within public waters. It is not anticipated that a public waters permit will be necessary for either project.

### 7.2.4 Minnesota Environmental Assessment Worksheet

The Minnesota administrative rules (MN Rules 4410.4300) require the preparation of an Environmental Assessment Worksheet (EAW) for any project that will "change or diminish the course, current, or cross-section of one acre or more of any public water or public waters wetland." Since the proposed projects are not located within the footprint of a public water and if the impacts are anticipated to be below 1 acre, preparation of an EAW should not be necessary.

### 7.2.5 Minnesota Wetland Conservation Act

The Minnesota Wetland Conservation Act (WCA) regulates the filling and draining of wetlands and excavation within Type 3, 4, and 5 wetlands—and may regulate any other wetland type if fill is proposed. The WCA is administered by local government units (LGUs), which include cities, counties, watershed management organizations, soil and water conservation districts, and townships. The City of Plymouth is the LGU for the entire project area. BWSR oversees administration of the WCA statewide.

As described in Minnesota rules 8420, the WCA is applicable to the types of wetland impacts that will be a part of this project and a permit related to wetland impacts may be required; however, the LGU will have the final determination.

### 7.2.6 Local Permits

The City of Plymouth also has a permitting process and the requirements should be reviewed within the context of the specific work to be performed at each site.

## 7.3 Temporary Closure

A portion of Clifton E. French Regional Park (for access to the Mount Olivet Stream Stabilization) and Parkers Lake Community Playfields will need to be closed to the public during the construction. Additionally, depending on construction access and staging, there may be temporary impacts to the Mount Olivet Lutheran Church parking lot and roadways within the Parkside Apartments complex.

## 7.4 Other Project Impacts

### 7.4.1 Tree Loss

The proposed projects include the removal of trees; the final number will depend on the alternatives selected. Estimates are that the Mount Olivet Stream Stabilization project would remove 39 trees and the Parkers Lake Stream project would remove 20 trees. The two potential wet retention pond projects along the Parkers Lake stream alignments, Alternative 5a and Alternative 5b, will require removal of an estimated six trees and 35 trees, respectively. All of the trees are located in areas where bank grading or site access will be necessary. Many of the trees removed for the project are proposed for reuse on site as part of stream stabilization measures. Refer to each of the alternatives'' descriptions in Section 6 for specific details on tree species, diameter, and count.

A detailed tree inventory was completed for this feasibility study and should be used during final design to specify tree replacement, if necessary, and to verify specific trees to be saved. Required tree removals should target dying or diseased and undercut trees first, followed by less desirable or disease-susceptible species such as box elder, cottonwood, and ash. Close coordination with the City of Plymouth forestry department will be important. Public stakeholder input on tree loss will also be sought.

### 7.4.2 Impacts to Bats

Preservation of bat species in Minnesota has recently become an important issue. White Nose Syndrome (WNS) has been attributed to the deaths of millions of bats in recent years across the United States, and all four species that hibernate in Minnesota are susceptible to the disease (Reference (11)). Bats typically hibernate in sheltered areas such as caves, but some bats nest in trees during summer months. Extensive tree removals are to be avoided when bats are not hibernating to avoid inadvertently destroying nests. During final design, there should be additional consultation with the US Fish and Wildlife Service or MDNR regarding the timing of tree removals and the potential impacts to bats.

### 7.4.3 Sanitary Sewer

A sanitary sewer line for the City of Plymouth runs along the stream corridor at the Parkers Lake Stream Stabilization project site. The pipe is buried below the ground surface; however, several manholes are located at the surface throughout the reach. The final project design should avoid disturbance of these manholes, if possible, and should maintain unobstructed access to the manholes for maintenance purposes. Prior to final design for this project, the City of Plymouth should determine whether any sewer maintenance near the stream is necessary so that impacts to the project area can be minimized, if possible.

### 7.4.4 Impacts to Parkers Lake Community Playfields and Clifton E. French Regional Park

The project alternatives include construction within both Parkers Lake Community Playfields and Clifton E. French Regional Park (access only). Several of the water quality alternatives may require temporary closure of roads within the Parkers Lake Community Playfields for storm sewer improvements or temporary impacts to the ballfields. Close coordination with City of Plymouth Parks staff will be necessary to ensure limited impacts to park users and special events. Similarly, construction access may occur through Clifton E. French Regional Park at the Mount Olivet Stream Stabilization site. Construction timing and impacts to park roads will be coordinated closely with TRPD staff.

# 8.0 Project Modeling Results and Anticipated Pollutant Removals

This section discusses the results of the hydrologic, hydraulic, and water quality modeling and provides information on potential project impacts of each concept, including permitting requirements.

## 8.1 Hydrologic, Hydraulic, and Water Quality Modeling

### 8.1.1 Hydrologic and Hydraulic Modeling

Hydrologic and hydraulic information is available for both sites. For this analysis, we utilized the BCWMC 2019 FEMA XP-SWMM model, which is the updated version of the 2017 BCWMC Phase 2 XP-SWMM model. The model is the preliminary FEMA model for improved floodplain mapping and modeling within the Bassett Creek watershed and is currently under review by the MDNR. We used the model to evaluate the Atlas 14, 2- and 100-year, 24-hour design storm events to estimate flood elevations, flows, and velocities.

In addition to the flood elevations, flows, and velocities, we used these results to calculate shear stresses, which were used to inform the stream stabilization concept designs. A summary of the 100-year, 24-hour model results are provided for the two stream locations in Table 8-1.

**Table 8-1 Hydraulic Model Results by Project Site for the 100-Year, 24-Hour Event**

| Site | Contributing Drainage Area, Acres | 100-Year Discharge, cfs | 100-Year Peak Velocity, fps | 100-Year Peak Shear Stress, psf |
|---|---|---|---|---|
| Mount Olivet | 211 | 15 | 0.8 | 1.0 |
| Parkers Lake | 175 | 114 | 3.2 | 0.2 |

Table 8-2 provides a summary of stability threshold values for various stream bank and stream bed materials. The model results for the 100-year event in Table 8-1 indicate that the sandy loam soils present at both project sites are expected to be mobile during this event. Further review of smaller, more frequent events during final design is suggested to verify the frequency that threshold values are surpassed and to aid in the specification of materials for proposed conditions.

**Table 8-2 Published Threshold Values for Selected Stream Bank and Stream Bed Materials**

| Stabilization Technique | Allowable Velocity (fps) | Allowable Shear Stress ($lbs/ft^2$) |
|---|---|---|
| Sandy loam soil[a] | 1.75–2.25 | 0.045–0.05 |
| Stiff clay[a] | 3–4 | 0.26 |
| Riprap (12-in $D_{50}$)[a,b] including rock riffles | 10–13 | 5.1 |
| Riprap (24-in $D_{50}$)[a,c] including rock vanes | 14–18 | 10.1 |
| Rootwads[d] | N/A | N/A |
| VRSS and toewood[d] | N/A | N/A |

a – from Reference (12)
b – for use in constructed riffles and grade control
c – for use in rock vanes
d – design and installation guidelines in References (13) and (14)

For the proposed stormwater management practices at the Parkers Lake Community Playfields, the model was updated to incorporate the storage curves, storm sewer routing, and outlet modifications to evaluate the impact of the various stormwater management alternatives on flood elevations and flows to demonstrate that proposed conditions should have no negative impact on any existing-conditions flood conditions.

Final design efforts should include additional refinements to the XP-SWMM modeling and review of the final design water surface profile to ensure the projects do not impact adjacent property. Similarly, the stability thresholds for the proposed features should be reviewed to ensure the final design will be stable. The constructed improvements should be incorporated into the BCWMC XP-SWMM model after project completion.

### 8.1.2 Water Quality Modeling

The BCWMC developed the P8 model in 2012 for Bassett Creek and its contributing watersheds and updates the model annually. This model was refined to incorporate more detail in the existing subwatersheds and routing in the Parkers Lake Community Playfields area. The refined model was used to evaluate the existing conditions and the impact of the stormwater management concepts on average annual sediment and TP load reductions.

Final design efforts should include additional refinements to the P8 modeling. The constructed improvements should be incorporated into the BCWMC P8 model after project completion, if appropriate.

The P8 model cannot be used to evaluate the impact of stream stabilization measures (e.g., bed and bank stabilization). An approach developed by Rosgen et. al. (Reference (7)) that quantifies the erosion rates and quantities based on field observations was used to determine pollutant load reductions for the stream stabilization project. See additional discussion in Section 8.2.1.

## 8.2 Anticipated Pollutant Removals

The pollutant (total phosphorus (TP) and total suspended solids (TSS)) removals for the stream projects at Mount Olivet Stream Stabilization project area and Parkers Lake Drainage Improvements project area were quantified using approaches developed by Rosgen, et al. (Reference (15) and BWSR (Reference (16)). The proposed stormwater water quality improvements at the Parkers Lake site were developed using the BCWMC's P8 model.

### 8.2.1 Pollutant Removals—Stream Alternatives

The proposed stabilization measures will result in reduced stream bank erosion and, therefore, reduced sediment and phosphorus loading to the streams at Mount Olivet Stream Stabilization project area and Parkers Lake Drainage Improvements project area and all downstream water bodies, including Medicine Lake, Bassett Creek, the Mississippi River, and Lake Pepin. The existing stream bank erosion rate (in units of feet per year) for each stabilization site was estimated based on a field assessment method known as the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model (Reference (15)).

The BANCS model uses two erosion-estimation tools to develop risk ratings for the Bank Erosion Hazard Index (BEHI) and Near-Bank Stress (NBS). The BEHI rating evaluates the susceptibility of a segment of stream bank to erosion as a result of multiple processes: surface erosion, fluvial entrainment, and mass erosion (wasting). The NBS rating characterizes the energy distribution against a segment of stream bank; disproportionate energy distribution in the near-bank region can accelerate bank erosion. The BEHI and NBS estimation tools are applied in a field assessment for each segment of stream bank potentially contributing sediment to the stream channel. The Commission Engineer performed BEHI and NBS assessments for multiple segments of the streams at the Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvement project sites during site visits in November and December 2019.

The field-determined BEHI and NBS ratings for the Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvements sites are shown in Table 8-3 and Table 8-4.

For the Mount Olivet Stream Stabilization project area, sites in Reaches 1 and 2, as well as the upstream portions of Reach 3 from stream stationing 0+00 to 7+50, are generally rated "high" for BEHI; NBS ratings for these sites were rated as "very low," which limits bank erosion. Sites in the downstream area of Reach 3 and for Reach 4, from stream stationing 7+50 to 10+25, are rated "very low" to "moderate" for BEHI and "very low" for NBS. For NBS, sites in all reaches are rated very low.

For the Parkers Lake Drainage Improvements project area, sites in Reach 1, from stream stationing 0+00 to 5+00, are generally rated "high" for BEHI; NBS ratings for these sites were rated as "very low," which limits bank erosion. There is no stream channel (only pipe) from stationing 5+00 to 8+00. Most sites in Reach 2, from stream stationing 8+00 to 10+25, are rated "high" for BEHI and "low" to "moderate" for NBS.

To convert BEHI and NBS ratings into a stream bank erosion rate estimate, the BANCS model relies on measured bank erosion data to develop relationships applicable to various hydrologic and geologic conditions. No such relationship is currently available for Minnesota; this feasibility study uses relationships developed from data collected in sedimentary and metamorphic geologic regions in North Carolina (Figure 5-34 of Reference (15)). The estimated bank erosion rate for each stabilization site is shown in Table 8-3 and Table 8-4; estimated erosion rates range from 0.001 to 0.07 feet per year for the Mount Olivet Stream Stabilization project area and 0.08 to 0.28 feet per year for the Parkers Lake Drainage Improvements project area.

The estimated total sediment load from bank erosion is calculated using the approximate dimensions of the eroding stream banks at each site. The effects of stabilization alternatives on water quality are estimated based on the assumption that each stabilization alternative successfully addresses erosion at the site and brings erosion to a low rate, representative of a stable stream in this geologic setting. For this analysis, a stable low erosion rate is assigned a nominal value of 0.02 feet per year (moderate BEHI and low NBS). The resulting estimated sediment load reduction for stabilization at each site is shown in Table 8-3and Table 8-4. The corresponding reduction of TSS and TP load are calculated using an estimation tool developed by BWSR (Reference (16)). The BWSR tool assumes that all eroded sediment becomes TSS, which is conservative because eroded sand and gravel are typically not suspended but transported as bedload. The BWSR tool also assumes that TP load is equivalent to 1.0 pound TP per ton of eroded sediment.

The total reduction in pollutant loading as a result of stabilizing the Mount Olivet Stream Stabilization and Parkers Lake Drainage Improvement sites within the project area is estimated as 10,560 lb/yr TSS (5.3 lb/yr TP) and 40,140 lb/yr TSS (20.1 lb/yr TP), respectively. The load reduction achieved by the Mount Olivet Stream Stabilization project may assist in meeting the load reduction goals for TP described in the Medicine Lake Excess Nutrients TMDL Implementation Plan (Reference (4)).

**Table 8-3** **Estimated existing bank erosion and pollutant loading at Mt. Olivet site**

| Reach | Alternative | Site Description | Alternative Description | Site Length | Length of Eroding Bank (ft) | Est. Avg. Bank Height (ft) | BEHI rating | NBS rating | Est. Erosion Rate* (ft/yr) | Est. Erosion Rate (CF/yr) | Est. Sed. Load (ton/yr) | "Stable" Sed. Load (ton/yr) | Est. Sed. Load Reduction (ton/yr) | TSS Reduction (lb/yr) | TP Reduction (lb/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 0+00 To 1+50 | 1 | Upstream reach with straight channel with access to flood plane with minimal vegetation | Stabilize channel with rock cross vein | 150 | 30 | 3 | High | Very low | 0.07 | 6.3 | 0.3 | 0.1 | 0.2 | 430 | 0.22 |
| | 2 | | Stabilize channel with rock cross vein | | 30 | | | | | 6.3 | | | 0.2 | 430 | 0.22 |
| Station 1+50 To 2+00 | 1 | Upstream reach of ravine with access to floodplain with storm sewer outfall in heavily wooded area | No stream restoration along this reach | 100 | 50 | 3 | High | Very low | 0.008 | 1.2 | 0.1 | 0.1 | 0.0 | 0 | 0.00 |
| | 2 | | No stream restoration along this reach | | 50 | | | | | 1.2 | | | 0.0 | 0 | 0.00 |
| Station 2+00 To 5+00 | 1 | Upstream reach of ravine with significant to severe channel degradation and little floodplain connection with storm sewer outfalls in heavily wooded area | Stabilize channel with rock cross veins; stabilize scarp surface with grading and vegetation; remove debris to unhinder stream path and decrease scarping | 250 | 155 | 5 | High | Very low | 0.07 | 54.3 | 2.6 | 0.7 | 1.9 | 3,730 | 1.87 |
| | 2 | | Stabilize channel with rock cross veins; stabilize scarp surface with grading and vegetation; remove debris to unhinder stream path and decrease scarping | | 155 | | | | | 54.3 | | | 1.9 | 3,730 | 1.87 |
| Station 5+00 To 6+75 | 1 | Upstream reach of ravine with significant to severe channel degradation and little floodplain connection with storm sewer outfalls in heavily wooded area | Stabilize channel with rock cross veins; stabilize scarp surface with grading, vegetation, and rootwads; rip rap revetment will be installed along with a new drop pstructure and piping at the SW corner of the parking lot to decrease the severe bank erosion | 175 | 195 | 6 | High | Very low | 0.07 | 81.9 | 3.9 | 1.1 | 2.8 | 5,630 | 2.82 |
| | 2 | | Stabilize channel with rock cross veins; stabilize scarp surface with grading, vegetation, and rootwads; rip rap revetment will be installed along with a new drop pstructure and piping at the SW corner of the parking lot to decrease the severe bank erosion | | 195 | | | | | 81.9 | | | 2.8 | 5,630 | 2.82 |
| Station 6+75 To 7+50 | 1 | Ravine with significant channel degradation and moderate access to floodplain in heavily | Stabilize scarp surface with grading and vegetation | 75 | 40 | 4 | High | Very low | 0.07 | 11.2 | 0.5 | 0.2 | 0.4 | 770 | 0.39 |
| | 2 | | Stabilize scarp surface with grading and vegetation | | 40 | | | | | 11.2 | | | 0.4 | 770 | 0.39 |
| Station 7+50 To 8+00 | 1 | Downstream reach of channel with significant channel degradation and access to floodplain in | Stabilize channel with rock cross vein | 50 | 0 | 2 | Moderate | Very low | 0.008 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.00 |
| | 2 | | Stabilize channel with rock cross vein | | 0 | | | | | 0.0 | | | 0.0 | 0 | 0.00 |
| Station 8+00 To 9+50 | 1 | Downstream reach of channel with opening to wetland floodplain in an open area with mainly grasses as vegetation | Stabilize channel with rock cross vein and grading; restore wetland area | 150 | 250 | 1 | Very low | Very low | 0.001 | 0.3 | 0.0 | 0.2 | 0.0 | 0 | 0.00 |
| | 2 | | Stabilize channel with rock cross vein, re-meandering stream channel, and grading | | 250 | | | | | 0.3 | | | 0.0 | 0 | 0.00 |
| Station 9+50 To 10+25 | 1 | Downstream reach of stream without channel degredation with access to floodplain in a | No stream restoration along this reach | 75 | 0 | 1 | Low | Very low | 0.003 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.00 |
| | 2 | | No stream restoration along this reach | | 0 | | | | | 0.0 | | | 0.0 | 0 | 0.00 |
| **Alternative 1 - Totals** | | | | | **720.0** | | | | | | **7.5** | **2.5** | **5.3** | **10,560.0** | **5.3** |
| **Alternative 2 - Totals** | | | | | **720.0** | | | | | | **7.5** | **2.5** | **5.3** | **10,560.0** | **5.3** |

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Table ___ Erosion

**Table 8-4** **Estimated existing bank erosion and pollutant loading at Parkers Lake site**

| Reach | Alternative | Site Description | Alternative Description | Site Length | Length of Eroding Bank (ft) | Est. Avg. Bank Height (ft) | BEHI rating | NBS rating | Est. Erosion Rate* (ft/yr) | Est. Erosion Rate (CF/yr) | Est. Sed. Load (ton/yr) | "Stable" Sed. Load (ton/yr) | Est. Sed. Load Reduction (ton/yr) | TSS Reduction (lb/yr) | TP Reduction (lb/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 0+00 To 1+00 | 1 | Upstream reach with straight channel with stormwater inflow with minimal access to flood plane with vegetation | Stabilize stream with underground stormwater pipe | 100 | 30 | 6 | High | Very High | 0.28 | 50.4 | 2.4 | 0.2 | 2.3 | 4,510 | 2.25 |
| | 2 | | Stabilize stream bank with rock toe stabilization and rock cross vanes | | 30 | | | | | 50.4 | | | 2.3 | 4,510 | 2.25 |
| | 3 | | Stabilize stream bank with rock cross vanes, stream bank grading, vegetation, and root wads | | 30 | | | | | 50.4 | | | 2.3 | 4,510 | 2.25 |
| Station 1+00 To 2+50 | 1 | Upstream reach with straight channel with minimal access to flood plane with vegetation | Stabilize stream with underground stormwater pipe | 150 | 209 | 8 | High | Very Low | 0.08 | 133.8 | 6.4 | 1.6 | 4.8 | 9,660 | 4.83 |
| | 2 | | Stabilize stream bank with rock toe stabilization and rock cross vanes | | 209 | | | | | 133.8 | | | 4.8 | 9,660 | 4.83 |
| | 3 | | Stabilize stream bank with rock cross vanes, stream bank grading, vegetation, and root wads | | 209 | | | | | 133.8 | | | 4.8 | 9,660 | 4.83 |
| Station 2+50 To 4+00 | 1 | Upstream reach with straight channel with moderate access to flood plane with vegetation and significant erosion for recreational courts and apartment buildings | Stabilize stream with underground stormwater pipe | 150 | 116 | 6 | High | Very Low | 0.08 | 55.7 | 2.7 | 0.7 | 0.0 | 0 | 0.00 |
| | 2 | | Stabilize stream bank with rock toe stabilization and rock cross vanes as well as riprap revetment for additional erosion from recreational courts and apartment buildings | | 116 | | | | | 55.7 | | | 0.0 | 0 | 0.00 |
| | 3 | | Stabilize stream bank with rock cross vanes, stream bank grading, vegetation, and root wads | | 116 | | | | | 55.7 | | | 0.0 | 0 | 0.00 |
| Station 4+00 To 5+00 | 1 | Upstream reach with straight channel with moderate access to flood plane with vegetation and significant erosion for recreational courts and apartment buildings | Stabilize stream with underground stormwater pipe | 100 | 25 | 6 | High | Very Low | 0.08 | 12.0 | 0.6 | 0.1 | 0.0 | 0 | 0.00 |
| | 2 | | Stabilize stream bank with rock toe stabilization as well as riprap revetment for additional erosion from recreational courts and apartment buildings | | 25 | | | | | 12.0 | | | 0.0 | 0 | 0.00 |
| | 3 | | Stabilize stream bank with rock stream bank grading and riprap revetment | | 25 | | | | | 12.0 | | | 0.0 | 0 | 0.00 |
| Station 5+00 To 8+00 | 1 | No stream reach | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | | | |
| Station 8+00 To 8+75 | 1 | Downstream reach with stormwater inflow with access to flood plane with vegetation | Stabilize stream with underground stormwater pipe | 75 | 152 | 6 | High | Low | 0.1 | 91.2 | 4.4 | 0.9 | 3.5 | 7,030 | 3.51 |
| | 2 | | Stabilize stream bank with rock toe stabilization, rock cross vanes, stream channel grading, and riprap revetment | | 152 | | | | | 91.2 | | | 3.5 | 7,030 | 3.51 |
| | 3 | | Stabilize stream bank with rock cross vanes, stream bank grading, vegetation, and root wads | | 152 | | | | | 91.2 | | | 3.5 | 7,030 | 3.51 |
| Station 8+75 To 11+25 | 1 | Downstream reach with stormwater inflow with access to flood plane with vegetation | Stabilize stream with underground stormwater pipe | 250 | 298 | 6 | High | Moderate | 0.13 | 232.4 | 11.2 | 1.7 | 9.5 | 18,940 | 9.47 |
| | 2 | | Stabilize stream bank with rock toe stabilization, rock cross vanes, and riprap riffles | | 298 | | | | | 232.4 | | | 9.5 | 18,940 | 9.47 |
| | 3 | | Stabilize stream bank with rock cross vanes, stream bank grading, vegetation, root wads, and rip rap riffles | | 298 | | | | | 232.4 | | | 9.5 | 18,940 | 9.47 |
| | | | | **Alternative 1 - Totals** | **830.0** | | | | | | **27.7** | **5.2** | **20.1** | **40,140.0** | **20.1** |
| | | | | **Alternative 2 - Totals** | **830.0** | | | | | | **27.7** | **5.2** | **20.1** | **40,140.0** | **20.1** |
| | | | | **Alternative 3 - Totals** | **830.0** | | | | | | **27.7** | **5.2** | **20.1** | **40,140.0** | **20.1** |

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Table ___ Erosion

### 8.2.2 Pollutant Removals—Stormwater Alternatives

We used the P8 pollutant loading models to evaluate the existing conditions and the proposed stormwater management alternatives to quantify the estimated pollutant removals for TSS and TP. To estimate the annual removals, we ran these models for a 10-year period, utilizing long-term climatic data from the Minneapolis-St. Paul International Airport. Table 8-5 summarizes the average annual pollutant removals for each alternative.

**Table 8-5 Estimated Pollutant Removal by Stormwater Management Alternatives at Parkers Lake Community Playfields**

| Alternative | TSS Removal (lbs/yr) | TP Removal (lbs/yr) |
|---|---|---|
| **Alternative 4:** Enhanced filtration | 273 | 1.2 |
| **Alternative 5a:** Wet retention—North | 878 | 2.6 |
| **Alternative 5b:** Wet retention—South | 1,074 | 3.5 |
| **Alternative 6:** Chloride management | Chloride reduction strategies may have limited impact on TP and TSS load reductions; however, data compiled from the MPCA suggests that implementation of smart salting recommendations can result in 30–70% reductions in chloride use. Although chloride usage can vary significantly from year to year based on the climatic conditions, based on the monitoring data from TRPD, this could reduce chloride loading to Parkers Lake on average by 163 – 380 lbs chloride per acre of watershed per year. | |

# 9.0 Project Cost Considerations

This section presents a screening-level cost estimate of the evaluated alternatives, discusses potential funding sources, and provides an approximate project schedule.

## 9.1 Cost Estimates

The cost estimate is a Class 4 feasibility-level cost estimate as defined by the American Association of Cost Engineers International (AACE International) and uses the assumptions listed below and detailed in the following sections.

- The cost estimate assumes a 20% construction contingency.
- Costs associated with design, permitting, and construction observation (collectively "engineering") are assumed to be 30% of the estimated construction costs (excluding contingency).
- Construction easements may be necessary to construct the project; however, the cost is expected to be negligible due to current project ownership.
- Additional work may be required to determine if cultural and/or historical resources are present at any project site.

The Class 4 level cost estimates have an acceptable range of between -20% to -30% on the low range and +20% to +50% on the high range. Based on the development of concepts and initial vetting of the concepts by the City of Plymouth, BCWMC, and MDNR, it is not necessary to utilize the full range of the acceptable range for the cost estimate. We assume the final costs of construction may be between -20% and +30% of the estimated construction budget. The assumed contingency for the project (20%) incorporates the potential high end of the cost estimate range.

Table 9-1 summarizes the feasibility-level total construction cost estimates, the 30-year annualized total construction cost estimates, and the annualized costs per pound of TSS and TP removed for the Mount Olivet Stream Stabilization Project. Table 9-2 summarizes the feasibility-level total construction cost estimates, the 30-year annualized total construction cost estimates, and the annualized costs per pound of TSS and TP removed for the Parkers Lake Stream Stabilization and Water Quality Improvement Project. Appendix E provides the detailed cost-estimate tables for all alternatives.

**Table 9-1 Mount Olivet Stream Stabilization Project Alternatives Cost Summary**

| Alternative Description | Project Cost Estimate(1) | Annualized Cost(2) | TP Loading | | TSS Loading | |
|---|---|---|---|---|---|---|
| | | | Load Reduction (lb/yr) | Cost/lb/yr Reduced(3) | Load Reduction (lb/yr) | Cost/lb/yr Reduced(3) |
| **Alternative 1**. Bio-engineering, wetland restoration and manhole structure | $134,000 ($107,00–$174,000) | $10,000 | 5.3 | $1,892 | 10,560 | $0.95 |
| **Alternative 2**. Bio-engineering, and stream re-meander | $111,000 ($89,000–$144,000) | $8,000 | 5.3 | $1,509 | 10,560 | $0.76 |

(1) A Class 4 screening-level opinion of probable cost, as defined by the American Association of Cost Engineers International (AACE International), has been prepared for these alternatives. The opinion of probable construction cost provided in this table is based on the Commission Engineer's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. The cost opinion is based on project-related information available to the Commission Engineer at this time and includes a conceptual-level design of the project. It includes 20% project contingency and 30% for planning, engineering, design, and construction administration. The lower bound is assumed at -20% and the upper bound is assumed at +30%.

(2) Assumed to be 15% of the total project cost for annual maintenance, plus replacement cost associated with major repairs and the initial project cost distributed evenly over a 30-year project lifespan.

(3) Annualized cost divided by estimated annual pollution load reduction.

**Table 9-2 Parkers Lake Stream Stabilization and Water Quality Improvement Project Alternatives Cost Summary**

| Alternative Description | Project Cost Estimate(1) | Annualized Cost(2) | TP Loading | | TSS Loading | |
|---|---|---|---|---|---|---|
| | | | Load Reduction (lb/yr) | Cost/lb/yr Reduced(3) | Load Reduction (lb/yr) | Cost/lb/yr Reduced(3) |
| **Alternative 1**. Replace stream with storm sewer | $208,000 ($166,000–$270,000) | $15,000 | 20.1 | $748 | 40,140 | $0.37 |
| **Alternative 2**. Hard armoring | $204,000 ($163,000–$265,000) | $14,000 | 20.1 | $698 | 40,140 | $0.35 |
| **Alternative 3**. Bio-engineering | $113,000 ($90,000–$147,000) | $8,000 | 20.1 | $399 | 40,140 | $0.20 |
| **Alternative 4**. Enhanced Filtration | $214,000 ($171,000–$278,000) | $14,214 | 1.2 | $11,835 | 273 | $52.07 |
| **Alternative 5a**. Wet Retention—North | $145,000 ($116,000–$189,000) | $9,625 | 2.6 | $3,702 | 878 | $10.96 |
| **Alternative 5b**. Wet Retention—South | $192,000 ($154,000–$250,000) | $12,752 | 3.4 | $3,751 | 1,074 | $11.87 |
| **Alternative 6**. Chloride Management | $300,000 | Chloride reduction strategies may have limited impact on TP and TSS load reductions; however, data compiled from the MPCA suggests that implementation of smart salting recommendations can result in 30–70% reductions in chloride use. Although chloride usage can vary significantly from year to year based on the climatic conditions, the monitoring data from TRPD suggests that this could reduce chloride loading to Parkers Lake on average by 163 – 380 lbs chloride per acre of watershed per year. | | | | |

(1) A Class 4 screening-level opinion of probable cost, as defined by the American Association of Cost Engineers International (AACE International), has been prepared for these alternatives. The opinion of probable construction cost provided in this table is based on the Commission Engineer's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. The cost opinion is based on project-related information available to the Commission Engineer at this time and includes a conceptual-level design of the project. It includes 20% project contingency and 30% for planning, engineering, design, and construction administration. The lower bound is assumed at -20% and the upper bound is assumed at +30%.

(2) Assumed to be 15% of the total project cost for annual maintenance, plus replacement cost associated with major repairs and the initial project cost distributed evenly over a 30-year project lifespan.

(3) Annualized cost divided by estimated annual pollution load reduction.

### 9.1.1 Chloride Reduction Costs

The northern watershed to Parkers Lake is 652 acres. Based on 2011 University of Minnesota impervious coverage data for the Twin Cities, the watershed has approximately 374 acres of impervious area. Removing the estimated roof area (126 acres per 2018 Microsoft Building footprint data) and right-of-way impervious area ((36 acres) managed by the City of Plymouth), there are approximately 212 acres of private drives, sidewalks, and parking lots where chloride management can be targeted.

Because the details of the demonstration project have not been defined, some project example costs (and planning level unit costs (if applicable) for implementation of these types of chloride reduction approaches were compiled and are summarized in the Table 9-3.

**Table 9-3 Planning Level Unit Costs for Implementation of Chloride Reduction Projects**

| Chloride Reduction Practice | Example Project Costs[1] | Planning Level Unit Costs[2] |
|---|---|---|
| Upgrades to Segmented Plow Blades | $50,000 | $10,000 / blade (+ replacement blade) |
| Upgrade Trucks with Brining Equipment | $10,000-$90,000 | N/A |
| Upgrades to Brine Making Equipment | $60,000-$90,000 | N/A |
| Automated pavement anti-icing systems | $90,000 | $7–20/SF |
| Pavement snowmelt systems | N/A | $10-25/SF |
| Permeable Pavements | N/A | $16-40/SF |

1 – Chloride reduction example project costs based on information related to chloride reduction projects from the City of Plymouth or as submitted to the Nine Mile Creek Watershed District (NMCWD) cost-share program from 2010-2018. All costs were adjusted to 2020 dollars.

2 – Planning level unit costs (if applicable) based on information from the NMCWD, recent bid tabs, information from the United States Department of Transportation Intelligent Transportation Systems Joint Program Office. All costs were adjusted to 2020 dollars.

### 9.1.2 Temporary Easements

Most of the project is located on property owned by the City of Plymouth, areas where the City has access easements, or on TRPD property. The costs associated with temporary construction easements, if required, are typically negligible; no costs for temporary construction easements are included in this estimate.

### 9.1.3 Off-Site Sediment Disposal

Based on the results of the desktop review of the MPCA's "What's In My Neighborhood?" database, it is assumed that a Phase I assessment of bank material will not be necessary and that sediment disposed off-site will not require additional testing or special disposal as hazardous or dredged material. As such, these costs are not included in this estimate.

### 9.1.4 Wetland Mitigation

Stream banks are considered to be wetlands and disturbing the banks as part of a restoration project is a temporary wetland impact. Additionally, several small wetlands were identified at both project sites. However, because the purpose of restoration is to create a channel and permanent wetland that can support a riparian ecosystem, the impacts are considered to be self-mitigating. Therefore, stream bank restoration projects do not typically require additional costs for wetland mitigation.

### 9.1.5 Tree Replacement and Revegetation

It is assumed that the City of Plymouth will determine where tree replacements will be desired (based on estimated tree removals and long-term plans for the park land) during final design. For the cost estimate, tree replacements are assumed for each tree removed. Discussions with the City have indicated that tree removals associated with the project may open the canopy in such a way that provides benefits for reestablishing vegetation and it may not be desirable to replace trees along the project extents. Because many of the stabilization sites have significant shade cover, the costs of shade-tolerant species (shrubs and grasses), appropriate site preparation, seeding, and maintenance to establish the vegetation are included in the cost estimate.

### 9.1.6 30-Year Cost

The 30-year cost for each alternative is based on anticipated maintenance and replacement costs. For alternatives with an estimated life span less than 30 years, significant maintenance is assumed to occur at the end of the estimated life span (i.e., 20 years for bio-engineering, 30 years for hard armoring or storm sewer infrastructure). For bioengineering alternatives, the maintenance is assumed to equal 25% of the original construction cost. Annual maintenance estimates are based on maintenance costs associated with the initial "establishment" period; 15% is assumed for bio-engineering alternatives and 2% for other alternatives incorporating hard armoring or storm sewer infrastructure.

For stormwater management practices, the estimated life was assumed to be 30 years. Annual maintenance estimates are assumed to be 2% for the stormwater management practices.

The 30-year cost for each alternative is calculated as the future worth of the initial capital cost (including contingency and engineering costs) plus the future worth of annual maintenance and significant maintenance at the end of the alternative life span. A 3% rate of inflation is assumed. The annualized cost for each alternative is calculated as the value of 30 equal, annual payments of the same future worth as the 30-year cost.

### 9.1.7 Annualized Pollutant Reduction Cost

Estimated annual loading reductions for TSS and TP are included for each alternative in Table 9-1 and Table 9-2. The loading reductions are based on the assumption that each alternative is successful in reducing bank erosion at each site. The annualized pollutant-reduction cost for each alternative is the annual load reduction divided by the annualized 30-year cost.

For the recommended stabilization alternatives presented in Table 9-1 and Table 9-2, the estimated total annualized pollutant reduction costs range from $400 to $1,900 per pound TP and $0.20 to $0.95 per pound TSS. For reference, the Medicine Lake TMDL Implementation Plan (Reference (4)) assumed a pollutant reduction cost ranging from $500 to $5,000 per pound TP.

### 9.1.8 Miscellaneous Costs

Most site costs include miscellaneous items needed during construction (e.g., a rock construction entrance, a filter dike to control in-stream sediment disturbance, and restoration of access paths). Based on previous project experience, the estimate for each alternative includes some costs that could be applied to these miscellaneous items.

## 9.2 Funding Sources

The BCWMC will utilize the BCWMC CIP funds to implement these projects. The source of these funds is an ad valorem tax levied by Hennepin County over the entire Bassett Creek watershed on behalf of the BCWMC.

## 9.3 Project Schedule

The design of these projects is scheduled to begin in fall 2020. The construction work will likely be completed during the fall and winter of 2021/2022. This would require the BCWMC to hold a public hearing and order the project in September 2020 in time to submit its ad valorem tax levy request to Hennepin County. If project construction is scheduled for fall or winter, spring or summer 2021 bidding is recommended. This will allow contractors to acquire necessary quantities of plants and seeds at a reasonable price. In the intervening time, the City will gather public input, prepare the final design, and obtain permits.

# 10.0 Alternatives Assessment and Recommendations

## 10.1 Overview

The final project will consist of a combination of the alternatives discussed in Section 5.0. The costs of the alternatives recommended for the final design are summarized in Section 9.0. Alternatives that could be implemented in combination were chosen if they presented cost-effective TP and TSS loading reductions without producing significant impacts to surrounding land uses. In cases where only one alternative could be implemented, priority was given to options that were innovative, cost-effective, and used natural materials. The ability of alternatives to improve stream habitat and vegetative surroundings (identified as priorities in stakeholder meetings) was also taken into consideration in choosing the final stream stabilization alternatives.

## 10.2 Mount Olivet Stream Stabilization

Stabilization and restoration of stream banks within the Mount Olivet Stream Stabilization project area will provide water quality improvement by 1) repairing actively eroding sites and 2) preventing erosion at other sites by installing preemptive measures to protect existing stream banks. Alternative 1 is recommended for this stabilization because it will achieve the water quality goals listed above and result in the creation of new wetland. The wetland will provide additional pollutant removals and habitat while also creating an interpretive feature for the surrounding park land. In addition to the wetland restoration, this alternative includes a focus on bio-engineering practices for most of the eroded bank stabilization, installation of rock cross vanes to minimize future erosion of the channel bed, and stabilization of the Mount Olivet Church parking lot outfall with a concrete manhole and outfall.

The final design process should include continuing to work closely with the City of Plymouth, Mount Olivet Lutheran Church, Three Rivers Park District, and Parkside Apartments to develop a plan to successfully establish riparian vegetation on and near the banks within the project area.

The design and construction costs for the recommended alternative will total approximately $134,000. The total estimated project capital cost includes an estimated $86,000 in construction costs, $17,000 in construction contingency, and $31,000 for design, permitting, and construction observation (all costs rounded to the nearest $1,000). We recommend that the BCWMC use these costs to develop a levy request for this project and that it proceed to design and construction.

## 10.3 Parkers Lake Drainage Improvements

The Parkers Lake stream stabilization includes the same goals as identified above for the Mount Olivet Stream Stabilization. Alternative 3 is recommended for the stabilization at Parkers Lake because it uses bio-engineering practices, which are strongly encouraged by both the BCWMC and the U.S. Army Corps of Engineers. This alternative is the least expensive option and will provide the greatest riparian habitat improvements.

The final design process should include continuing to work closely with the City of Plymouth and Lakeview Commons Apartments to develop a plan to successfully establish riparian vegetation on and near the banks within the project area.

The design and construction costs for the recommended restoration alternative will total approximately $113,000. The total estimated project capital cost includes an estimated $72,000 in construction costs, $14,000 in construction contingency, and $27,000 for design, permitting, and construction observation (all costs rounded to the nearest $1,000). We recommend that the BCWMC use these costs to develop a levy request for this project and that it proceed to design and construction.

**Table 10-1 Recommended Stream Stabilization and Water Quality Improvement Project Alternatives Cost Summary**

| Alternative Description | Project Cost Estimate(1) | Annualized Cost(2) | TP Loading | | TSS Loading | |
|---|---|---|---|---|---|---|
| | | | Load Reduction (lb/yr) | Cost/lb/yr Reduced(3) | Load Reduction (lb/yr) | Cost/lb/yr Reduced(3) |
| **Mount Olivet Alternative 1**. Bio-engineering, wetland restoration and manhole structure | $134,000 ($107,000–$174,000) | $10,000 | 5.3 | $1,892 | 10,560 | $0.95 |
| **Parkers Lake Alternative 3**. Bio-engineering | $113,000 ($90,000–$147,000) | $8,000 | 20.1 | $399 | 40,140 | $0.20 |
| **Parkers Lake Alternative 6**. Chloride management | $300,000 | Chloride reduction strategies may have limited impact on TP and TSS load reductions; however, data compiled from the MPCA suggests that implementation of smart salting recommendations can result in 30–70% reductions in chloride use. Although chloride usage can vary significantly from year to year based on the climatic conditions, the monitoring data from TRPD suggests that this could reduce chloride loading to Parkers Lake on average by 163 – 380 lbs chloride per acre of watershed per year. | | | | |

(1) A Class 4 screening-level opinion of probable cost, as defined by the American Association of Cost Engineers International (AACE International), has been prepared for these alternatives. The opinion of probable construction cost provided in this table is based on the Commission Engineer's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. The cost opinion is based on project-related information available to the Commission Engineer at this time and includes a conceptual-level design of the project. It includes 20% for project contingency and 30% for planning, engineering, design, and construction administration. The lower bound is assumed at -20% and the upper bound is assumed at +30%.

(2) Assumed to be 15% of the total project cost for annual maintenance plus replacement cost associated with major repairs and the initial project cost distributed evenly over a 30-year project lifespan.

(3) Annualized cost divided by estimated annual pollution load reduction.

# 11.0 References

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19. **Minnesota Pollution Control Agency.** *MPCA Stream Habitat Assessment (MSHA) Protocol for Stream Monitoring Sites.* 2014.

# Appendices

# Appendix A

## 2019 Stream Erosion Site Photos

# Appendix B

## Tree Survey Results

# Appendix C

## Wetland Delineation and Notice of Decision

# Appendix D

## Archeological Reconnaissance Survey

# Appendix E

## Detailed Cost Estimate