Feasibility Report for the Bassett Creek Main Stem Erosion Repair Project

Minneapolis, Minnesota

Prepared for
Bassett Creek Watershed Management Commission

May 2016

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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.

Jeff Weiss

Jeff Weiss
PE #: 48031

May 6, 2016
Date

Acronyms and Abbreviations

Acronym	Description
BCV	Bassett Creek Valley
BCWMC	Bassett Creek Watershed Management Commission
BMNA	Bryn Mawr Neighborhood Association
CIP	Capital Improvement Plan
cfs	cubic feet per second (stream flow rate)
ESA	Environmental Site Assessment
fps	foot per second (stream flow velocity)
HNA	Harrison Neighborhood Association
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MPRB	Minneapolis Park and Recreation Board
RMP	2009 BCWMC Resource Management Plan
SHPO	State Historic Preservation Office
USACE	United States Army Corps of Engineers

1.0 Executive summary

1.1 Background

The Bassett Creek Watershed Management Commission's (BCWMC) 2015 Watershed Management Plan (Plan) addresses the need to repair and stabilize stream reaches damaged by erosion or affected by sedimentation. 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 stream bank restoration and stabilization.

This study examines the feasibility of completing erosion repair and creek bank stabilization at sites along the Main Stem of Bassett Creek from Cedar Lake Road to Dupont Avenue North (the entrance to the New Bassett Creek tunnel) and Second Avenue North (the entrance to the Old Bassett Creek tunnel), plus the Fruen Mill site between Glenwood Avenue North and the Soo Line Railroad Bridge. These reaches of the creek are collectively referred to as the project area (see Figure 2-1). The Plan's 10-year Capital Improvement Program (CIP) includes this project area, which will be completed in 2017 and 2018 through an ad valorem tax levied by Hennepin County on behalf of the BCWMC.

1.2 Site characteristics

The project area along Bassett Creek extends approximately 4,000 feet, including approximately 800 feet at the Fruen Mill site and 3,200 feet between Cedar Lake Road and the Bassett Creek Tunnel entrances. Three reaches have been identified for inclusion in this feasibility study based on bridges and the Bassett Creek tunnel that clearly delineate the ends of each reach (see Figure 2-1). Reach 1 includes the historic Fruen Mill on the east bank and a wooded portion of Bassett Creek Park on the west bank. Reaches 2 and 3 are within an area of historically heavy industrial use downstream of Cedar Lake Road that includes the City of Minneapolis impound lot on the south bank.

Within the project area, Bassett Creek is a low-gradient, channelized stream that flows through an unconfined alluvial valley. Since construction of the Fruen Mill Dam circa 1900, the creek has been armored in approximately its current alignment through Reach 1. In Reaches 2 and 3, the stream was channelized into its current alignment between Cedar Lake Road and the entrance to the Old Bassett Creek Tunnel in the 1930s, with an additional channel connecting with the New Bassett Creek Tunnel constructed in 1992. The channel bed and banks throughout the project area vary in composition. Some banks and portions of the bed have been heavily armored with riprap while other banks appear to consist of fill materials used during historic channelization of the reaches. Unarmored sections of the bed are mostly varying mixtures of silt, sand, and gravel. Additional description of the stream geomorphic characteristics, channel alignment, and watershed land use is provided in Section 3.0.

A Phase I Environmental Site Assessment was completed for the project area in December 2015 (Appendix D), which identified several recognized environmental conditions requiring additional investigation of potential soil contamination. A Phase II Environmental Investigation was performed in February 2016 (Appendix E), and included soil sampling at multiple sites where stream bank stabilization is recommended. The Phase II investigation results show that most of the soil in the areas targeted for stabilization does not meet Minnesota Pollution Control Agency (MPCA) guidelines for unregulated fill, indicating the soil is not suitable for reuse at another site and if removed, will require disposal at a landfill.

Portions of Bassett Creek and fringe wetlands were delineated in November 2015 (Appendix G). Wetlands delineated in the project area totaled approximately 0.5 acres and were made up of seasonally flooded basin, shallow marsh/shrub–carr, and excavated wet meadow/shallow marsh communities.

1.3 Recommended stabilization project description

This feasibility study evaluates a variety of alternatives for stabilizing up to 15 sites along Bassett Creek within the project area. The measures considered for potential implementation include the following:

- Restoring the vegetative buffer and improving stream bank vegetation
- Installing a variety of stream stabilization measures, including riprap, live fascines, vegetated reinforced soil stabilization (VRSS), rock or log vanes, and stone toe protection
- Removing non-native channel bed material (brick and concrete block)

The recommended stabilization measures include a combination of bioengineering and hard armoring techniques and are discussed in Section 5.2 and shown in Figure 5-2, Figure 5-3, and Figure 5-4. Additional details for all stabilization alternatives considered for this study are provided in Appendix I.

1.4 Project impacts and estimated costs

Potential impacts from the stabilization project are discussed in Section 6.0; these include temporary impacts to walking trail usage, tree loss, and bat habitat. The most significant consideration for the project is the need to manage excavated soils because of the high likelihood of soil contamination, as indicated by the results of the Phase I Environmental Site Assessment (ESA) and the subsequent Phase II environmental investigation. Completion of the proposed project will reduce risks associated with the residual soil contamination in the project area by establishing an improved cover on the stream bank. Historical environmental concerns on adjoining properties located beyond the creek bank will not be addressed as part of this project.

The proposed project will result in reduced stream bank erosion and, therefore, reduced sediment and phosphorus loading to Bassett Creek. Estimates of existing erosion rates and pollutant loading are presented in Section 6.3. The total reduction in pollutant loading as a result of the project is estimated as 48,300 pounds per year total suspended sediment and 27.8 pounds per year total phosphorus. The majority of this load reduction will be achieved by stabilizing three sites of eroding bank: in the vicinity of the Fruen Mill dam (Site 5), downstream of Cedar Lake Road (Site 6), and downstream of Irving Avenue (Site 12).

The feasibility-level opinion of cost for implementing all of the identified measures for the 2017 Bassett Creek Main Stem Erosion Repair Project is $932,000, as shown in Table 8.1. This total includes $530,000 for construction, $159,100 each for construction contingency and engineering (design, permitting, and construction observation), and $83,000 for environmental oversight (field oversight, planning, and reporting). The costs result in a 30-year annualized cost of approximately $2,360 per pound of phosphorus reduction and approximately $1.36 per pound of TSS reduction. The methodology and assumptions used for the cost estimates are discussed in Section 7.0, and detailed cost estimates for all stabilization alternatives considered are provided in Appendix J. When adding in the cost for the feasibility study ($104,600), the total project cost is $1,036,600.

The cost estimate above summarizes the costs for final design and construction. Table 1-1 summarizes the total project cost estimate, including feasibility study costs.

Table 1.1 Project Cost Summary

Project Component	Estimated Project Cost
Construction Cost Estimate	$530,000
Construction Contingency	$159,100
Engineering (Design, Permitting, and Reporting)	$159,100
Environmental Oversight (field oversight, planning, and reporting)	$83,000
Subtotal	**$932,000**
Feasibility Study (this report)	$104,600
Project Total	**$1,036,600**

1.5 Recommendations

Erosion repair and creek bank stabilization within the 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 stream banks. We recommend that the opinion of cost identified in this study be used to develop a levy request for this project and that the erosion repair and creek bank stabilization proceed to the design and construction phase.

2.0 Background and objectives

The BCWMC 2015 Watershed Management Plan (Plan, Reference (1)) addresses the need to repair and stabilize stream reaches damaged by erosion or affected by sedimentation. Section 3.4 of the Plan describes the issue and the benefits of stream erosion repair and creek bank stabilization, and Section 4.2.5 describes the Commission's policies related to stream bank restoration and stabilization. The Plan's 10-year CIP includes stream bank restoration and stabilization projects.

Per discussion with the U.S. Army Corps of Engineers (USACE), this feasibility study follows the protocols developed by the USACE and the BCWMC for projects included in the 2009 BCWMC Resource Management Plan (RMP, Reference (2)). Although the project is not included in the RMP, it is in close proximity and similar to other RMP projects.

Erosion repair and creek bank stabilization of sites along the Bassett Creek Main Stem between Cedar Lake Road and Irving Avenue N is included in the BCWMC current CIP (2017CR-M). The City of Minneapolis requested evaluation of additional sites downstream of Irving Avenue (to the entrances to the Old and New Bassett Creek tunnels) as well as at the Fruen Mill site between Glenwood Avenue North and the Soo Line Railroad Bridge crossing (which was not able to be completed in the previous project, 2012CR-M) (see Figure 2-1). These additional sites have many of the same erosion and instability issues as the portion of the creek included in the CIP. This study examines the feasibility of the stabilization work on the collective project area, including the CIP reach and additional sites. This study was developed with input from the City of Minneapolis and the Minneapolis Park and Recreation Board (MPRB).

Sites within the project area would be stabilized as a group, with design and construction costs included in the BCWMC 2017 CIP.

2.1 Goals and objectives

The objectives of this study are to:

- Evaluate the feasibility of implementing stream bank stabilization measures and re-establishing desirable vegetation within the project area along Bassett Creek.
- Develop conceptual designs.
- Provide an opinion of costs for measures that could potentially be used at each erosion site.

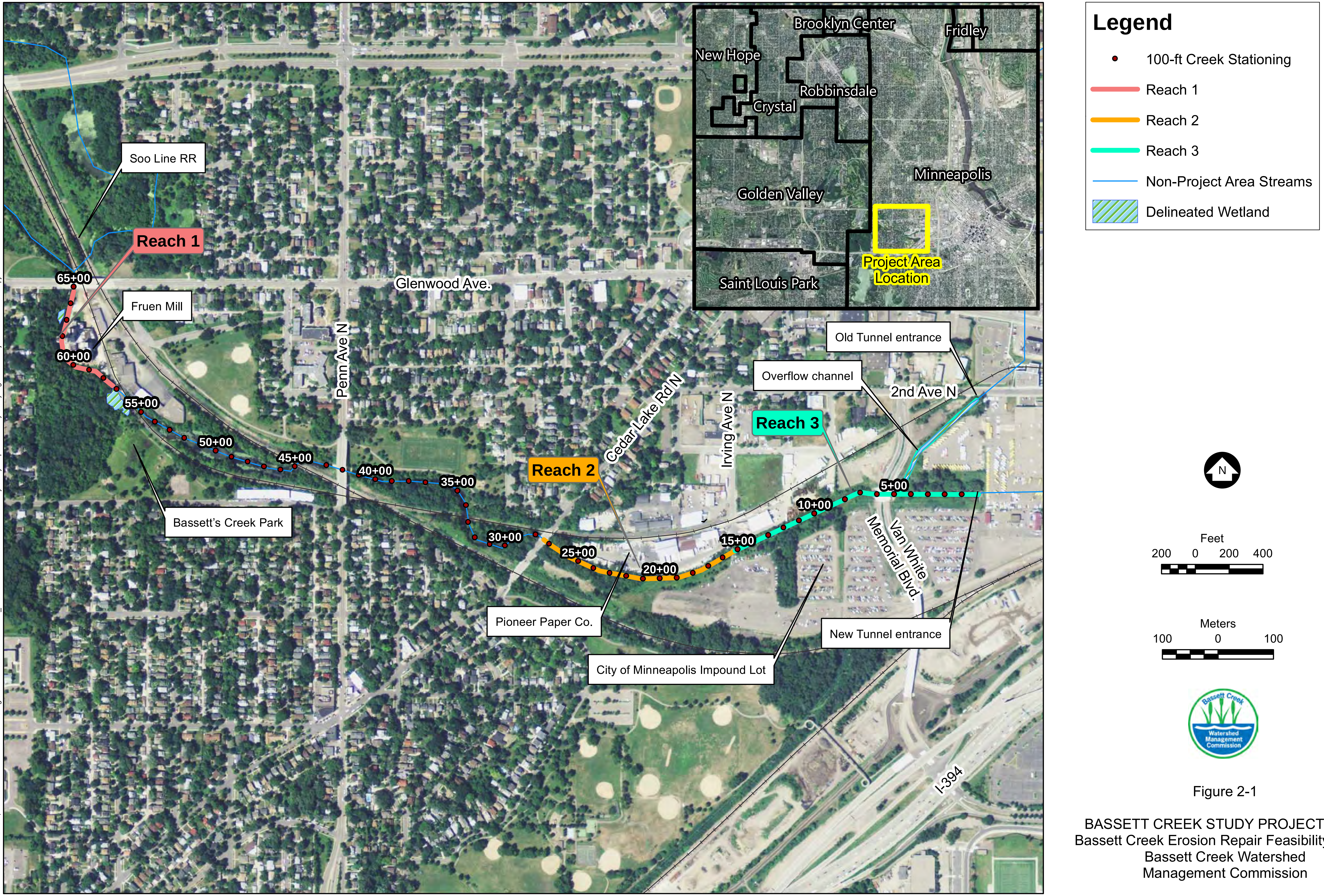


Figure 2-1

BASSETT CREEK STUDY PROJECT AREA
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed
Management Commission

Barr Footer: ArcGIS 10.3, 2016-03-10 10:16 File: \\barr.com\gis\Client\BassettCreek\Work_Orders\2015\Bassett Creek Feasibility Study\Maps\Feasibility Study\Figure 2-1 Project Area.mxd User: pjh2

2.1.1 Stream stabilization goals

The goals of the stream stabilization project include:

- Reducing sediment loading and associated nutrient and contaminant loading to Bassett Creek and improving downstream water quality by stabilizing eroding banks.
- Preserving natural features along Bassett Creek and contributing to natural habitat quality and species diversification by planting native vegetation in eroded areas.
- Preventing future channel erosion along the creek and subsequent degradation of water quality downstream by establishing a stable channel dimension and profile.
- Provide public education about the creek and its water quality and habitat.

2.1.2 Considerations

Key considerations for stabilization approaches included:

- Accommodating historically significant features, as well as consideration of future development in the Fruen Mill area.
- Maintaining existing floodplain storage by ensuring that project features do not increase flood elevations.
- Minimizing tree loss, where possible.
- Minimizing grading and excavation in areas with potentially contaminated soils.
- Supporting sustainable use of public trails.

These considerations were key factors in determining final recommendations and will be accounted for through final design.

2.2 Background

2.2.1 Project area description

The Bassett Creek project area is divided into three reaches, as shown on Figure 2-1, and discussed in Section 3.2.

- Reach 1 extends 800 feet from Glenwood Avenue on the upstream end to the Soo Line Railroad Bridge crossing on the downstream end.
- Reach 2 extends 1,150 feet from Cedar Lake Road on the upstream end to Irving Avenue on the downstream end.
- Reach 3 extends 1,550 feet from Irving Avenue on the upstream end to the entrance to the New Bassett Creek Tunnel at Dupont Avenue on the downstream end. Reach 3 also includes the 500-

foot-long overflow channel to the entrance to the Old Bassett Creek Tunnel at Second Street North.

The 3,000 feet of Bassett Creek between Reach 1 and Reach 2 is not included in the project area because it was evaluated in a previous study (see Section 2.2.2.4).

Land use adjacent to all three reaches is a mixture of industrial, and recreational (parkland). Active and abandoned industrial facilities abut portions of all three reaches. Other portions of all three reaches include wooded hill slopes; in Reach 1 these wooded slopes are part of the Bassett's Creek Park and include a walking path adjacent to the creek.

The Commission Engineer conducted multiple site visits in the autumn of 2015 to 1) identify sites in need of stabilization; 2) meet with stakeholders on site; 3) review conceptual stabilization alternatives; and 4) observe the creek during different flow conditions. Photos of identified bank erosion locations are included in Appendix A; the sites presented in this report are considered the most important locations for erosion repair and creek bank stabilization to meet the BCWMC goals and objectives.

Stream bank erosion is a natural process that occurs at some rate on all alluvial 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 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 7,000 feet of stream bank in the project area, approximately 3,760 feet (more than half) 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, destroys aquatic habitat, and reduces the discharge capacity of the channel.

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 best management practices (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 increase erosion rates. In addition, the heavy industrial use of the riparian area throughout the project area has decreased groundcover on the stream banks and adjacent wooded areas, increasing the potential for erosion.

2.2.2 Past documents and activities addressing the project area

2.2.2.1 Bassett Creek Flood Control Project

A series of studies were conducted in the 1970s and 80s with the goal of reducing flooding throughout the Bassett Creek watershed, but especially along the aging and undersized Bassett Creek Tunnel (now referred to as the "Old Bassett Creek Tunnel"). The Bassett Creek Flood Control Project was constructed between 1979 and 1996 and was a $40 million cooperative effort of the USACE, the BCWMC, state agencies, and member cities (see Section 2.8.1 of Reference (1) for further details).

The principal feature of the Bassett Creek Flood Control Project was the 1.7-mile tunnel through downtown Minneapolis (now referred to as the "New Bassett Creek Tunnel"), constructed in three phases between 1979 and 1992. The New Bassett Creek Tunnel carries the entire flow of Bassett Creek from the tunnel entrance at Dupont Avenue North into the Mississippi River just downstream of St. Anthony Falls. The Old Bassett Creek Tunnel now carries local flow tributary to it from areas downstream of its entrance, and these areas were removed from the jurisdiction of the BCWMC and transferred to the Mississippi Water Management Organization in a joint agreement finalized in 2000 (see Appendix I of Reference (1)). The two tunnel entrances are also connected by an overflow channel, which is designed to carry 50 cfs from Bassett Creek to the Old Bassett Creek Tunnel in the 100-year flood.

As part of the flood control project, a portion of Bassett Creek was moved and lowered approximately two feet between Irving Avenue N and the entrance to the New Bassett Creek Tunnel. The channel was also moved slightly upstream of Irving Avenue N. The realignment ended approximately 600 feet upstream of Irving Avenue; however the bed was not lowered upstream of Irving Avenue due to a sanitary sewer crossing under the Irving Avenue Bridge (Reference (3)).

Other major features of the project included the following:

- Control structures at Highway 100, Wisconsin Avenue, Highway 55, and the Golden Valley Country Club, all in Golden Valley
- Markwood/Edgewood area modifications in Crystal and New Hope (Edgewood control structure, Edgewood Avenue basin, and Markwood channel improvements)
- Medicine Lake outlet structure in Medicine Lake
- Bassett Creek Park Pond in Crystal
- Replacement of 10 street crossings in New Hope, Crystal, and Golden Valley
- Flood-proofing of five homes in Crystal

The combined outcome of the measures implemented for the Bassett Creek Flood Control Project reduced flood elevations along the Bassett Creek corridor by 2 feet in Golden Valley, 1.5 feet in Crystal, and up to 4.5 feet in Minneapolis.

2.2.2.2 MPRB erosion site inventory (2005)

In 2005, the MPRB conducted an erosion inventory and assessment of the Bassett Creek Main Stem as it flows through MPRB land and adjacent private properties from Golden Valley Road to approximately Irving Avenue N (see the inventory map included as Appendix B). MPRB staff completed the inventory by walking the length of Bassett Creek and identifying, locating, and documenting sites of significant bank erosion and sediment deposition, as well as the presence of obstructions, storm sewer outlet structures, and other utilities within the stream channel. Documentation of each site included its location on aerial photographs, notes with site-specific details, and a digital photograph. A total of 28 unique erosion locations were identified—seven within the current project area. The locations outside of the current project area were addressed by a previous stabilization project, see Section 2.2.2.4.

The extent of erosion at each site was estimated based on the percentage of erosion over the entire bank and classified as *minor* (less than 25%), *moderate* (25–50%), or *severe* (more than 50%). The causes of erosion were typically related to the following:

- Heavy foot traffic resulting in surface runoff across exposed slopes, steep slopes, or shaded slopes
- Storm sewer outfalls discharging above the normal water level of the creek without adequate energy dissipation
- Incising of the stream channel and cut bank formation due to elevated flow rates.

2.2.2.3 Bassett Creek Valley Master Plan (2006) and Bassett Creek Valley Stream and Habitat Restoration Implementation Plan (2007)

Completed in 2000, updated in 2006, and adopted by the City of Minneapolis, the Bassett Creek Valley (BCV) Master Plan (References (4) and (5)) outlined a land use vision and tests alternatives for redevelopment in the historic Bassett Creek Valley within Minneapolis. The BCV Master Plan also envisioned enhancements for the reach of Bassett Creek between Cedar Lake Road on the west and the entrance to the Bassett Creek Tunnel systems on the east, including realigning the creek into a meandering channel and surrounding the creek with open space, parkland, and trails. The BCV Master Plan acknowledged the history of widespread and variable environmental contamination along the creek, and assumed that site remediation would be required in order to redevelop the area for use as open space with public access.

After the BCV Master Plan was completed, a study called the Bassett Creek Stream and Habitat Restoration Implementation Plan (Implementation Plan, Reference (6)) was carried out to further explore the challenges, alternatives, and steps that would be needed to achieve BCV Master Plan's vision regarding the creek. The "preferred design" detailed in the Implementation Plan (see drawing in Appendix C) included stream bank improvements, a meandering channel section located away from areas with the highest concentrations of known soil contamination, extensive areas of restored prairie and tree canopy south of the creek, and a network of trails and bridge crossings.

The 2017 streambank stabilization project is not a step toward implementing the BCV Master Plan vision. It is not known at this time when, or whether, implementation of the BCV Master Plan vision will take place. The 2017 streambank stabilization project is needed to remedy current problems and prevent further degradation.

2.2.2.4 Bassett Creek Main Stem Restoration Project (2012-2015)

In 2012 the BCWMC completed a feasibility study for restoration and stabilization of the sites discussed in Section 2.2.2.2 (BWCMC CIP 2012CR, Reference (7)). Although most of the sites evaluated in the 2012 feasibility study were upstream of the current project area, the study did include recommendations for bank stabilization at Fruen Mill. The recommended stabilization measures at the Fruen Mill site included bank grading and floodplain excavation, riprap toe protection, relocation of the existing foot path, removal of concrete pavement and stone walls, tree removals, and vegetation.

In 2014-2015 the MPRB implemented the 2012CR-M restoration project within the 2012 feasibility study area. Although the plans for the project (Reference (8)) included erosion repair and creek bank stabilization measures within the Fruen Mill site, no work was performed downstream of Glenwood Avenue North due to potential flood elevation impacts associated with proposed trail improvements and lack of right of entry from property owners.

Although no work was performed in 2014-2015 within the Fruen Mill site, the project sought and received approval for construction from the USACE and the State Historic Preservation Office (SHPO). The proposed work included walking path repair, fieldstone boulder toe stabilization, removal of a collapsed retaining wall from within the creek, and instructions to not disturb the existing historic walls on the uphill side of the walking path (see Sheet 20 of Reference (8)). The permit granted for the project by the USACE under Section 404 of the Clean Water Act (Reference (9)) included the following conditions recommended by the SHPO:

- Stream bank stabilization in Bassett's Creek Park (opposite Fruen Mill) would be conducted utilizing field stone to the minimal extent possible, ranging in size from 18-inch to 24-inch, and would be backfilled and vegetation restored if possible.
- Adjacent retaining walls in Bassett's Creek Park would be repaired or selectively replaced in-kind.
- An existing non-historic wooden retaining wall in Bassett's Creek Park would be replaced with a dry laid limestone retaining wall.

2.2.2.5 BCWMC Watershed Management Plan (2015)

The Plan (Reference (1)) addresses the need to repair and stabilize stream reaches damaged by erosion or affected by sedimentation. Prior to 2007, the costs for channel stabilization projects were covered by a channel maintenance fund established by the BCWMC. However, as authorized, this fund was not sufficient to cover the costs of all the restoration and stabilization projects identified. In January 2007, the BCWMC's Technical Advisory Committee recommended that the Commission add stream channel restoration and stabilization projects to the Commission's 10-year CIP. The BCWMC then identified and prioritized potential channel restoration and stabilization projects by stream reach and prepared cost estimates. Larger projects were added to the CIP in May 2007. These included the Main Stem of Bassett Creek, the North Branch of Bassett Creek, the Sweeney Lake Branch of Bassett Creek, and Plymouth Creek—reaches with documented increases in stream bank erosion, streambed aggradation, or scour. The portion of the project area between Cedar Lake Road and Irving Avenue is included in the current BCWMC 10-year CIP (2017CR-M) for construction in 2017–2018.

Table 2.1 presents completed and future restoration projects included in the BCWMC CIP, along with their estimated start dates and costs.

Table 2.1 BCWMC channel restoration and stabilization projects

Creek Project	Target Project Start	Estimated Project Cost	Final Project Cost (nearest $1,000)
Sweeney Lake Branch	2008 (complete)	$500,000(1)	$386,000(4)
Plymouth Creek, Reach 1	2010 (complete)	$965,000(1)	$939,000(5)
Bassett Creek Main Stem, Reach 2 (Crystal border to Regent Ave.)	2010 (complete)	$636,000(1)	$604,000(4)
Bassett Creek Main Stem, Reach 1 (Duluth St. to Crystal Border)	2011 (complete)	$580,200(1)	$580,000(5)
North Branch	2011 (complete)	$834,900(1)	$713,000(4)
Bassett Creek Main Stem 2012 (Golden Valley Road to Irving Ave.)	2012 (complete)	$856,000(2)	$858,000(5)
Bassett Creek Main Stem 2015, 10th Ave. to St. Croix Ave. (2015-CR)	2015 (underway)	$1,503,000(3)	final cost not available
Plymouth Creek, from Annapolis Lane to 2,500 feet upstream (west) of Annapolis Lane (2017CR-P))	2017 (feasibility study underway)	$600,000(3)	–
Bassett Creek Main Stem 2017, Cedar Lake Rd to Irving Ave. (2017CR-M)	2017 (underway, this study)	$800,000(3)	–
Main Stem Channel Restoration, Bassett Creek Drive to Golden Valley Road (in Golden Valley) to reduce phosphorus and sediment loading (2021CR-M)	2021	$500,000(3)	–

(1) Costs as estimated in revised 2011 CIP
(2) Costs as estimated in 2011 BCWMC Watershed Management Plan amendment
(3) Costs as estimated in 2015–2025 CIP (Table 5-3 in the Plan)
(4) Costs as provided on the BCWMC website
(5) Costs as provided in the BCWMC construction projects spreadsheet

2.2.2.6 BCWMC Biotic Index and Habitat Monitoring

During 2015, the BCWMC monitored Bassett Creek to evaluate the macroinvertebrate community, water quality, and habitat (Reference (10)). Macroinvertebrates are organisms without backbones which are visible to the eye without the aid of a microscope. The BCWMC began periodic monitoring of the macroinvertebrate communities in creeks throughout the watershed in 1980 and has monitored every three years since 2000. One of the monitoring locations on the Bassett Creek Main Stem is within the current project area, extending 590 feet downstream from Irving Avenue (approximately Station 9+40 to Station 15+30 on Figure 2-1).

The 2015 monitoring downstream of Irving Avenue found that water quality and dissolved oxygen concentrations met MPCA standards and have been relatively stable over time. Stream bank erosion and embeddedness (the degree by which large particles such as cobbles are covered by small particles such as sand and silt) were prevalent and habitat diversity was limited; these factors may contribute to biological impairment at this location. The Macroinvertebrate Index of Biological Integrity score at this location was

19—well beneath the MPCA standard of 37. Bassett Creek has not yet been assessed by the MPCA for macroinvertebrates and, hence, the stream is not designated as impaired for macroinvertebrates.

3.0 Site characteristics

3.1 Bassett Creek watershed

The watershed area tributary to the project area along Bassett Creek (upstream of the New Bassett Creek Tunnel inlet) is approximately 25,000 acres and drains portions of the cities of Plymouth, Medicine Lake, Minnetonka, New Hope, Crystal, Robbinsdale, St. Louis Park, Golden Valley, and Minneapolis (Figure 3-1). The watershed to the project area is nearly fully urbanized, but includes a number of lakes and wetlands; about 75% of the watershed first drains to a lake or wetland before discharging to Bassett Creek (Reference (11)). Existing land use includes single- and multi-family residential, commercial/industrial/institutional, highway/railway, parks, undeveloped land, and water surface areas.

3.2 Stream characteristics

The project area along Bassett Creek (Figure 2-1) is divided into three reaches, totaling approximately 4,000 feet.

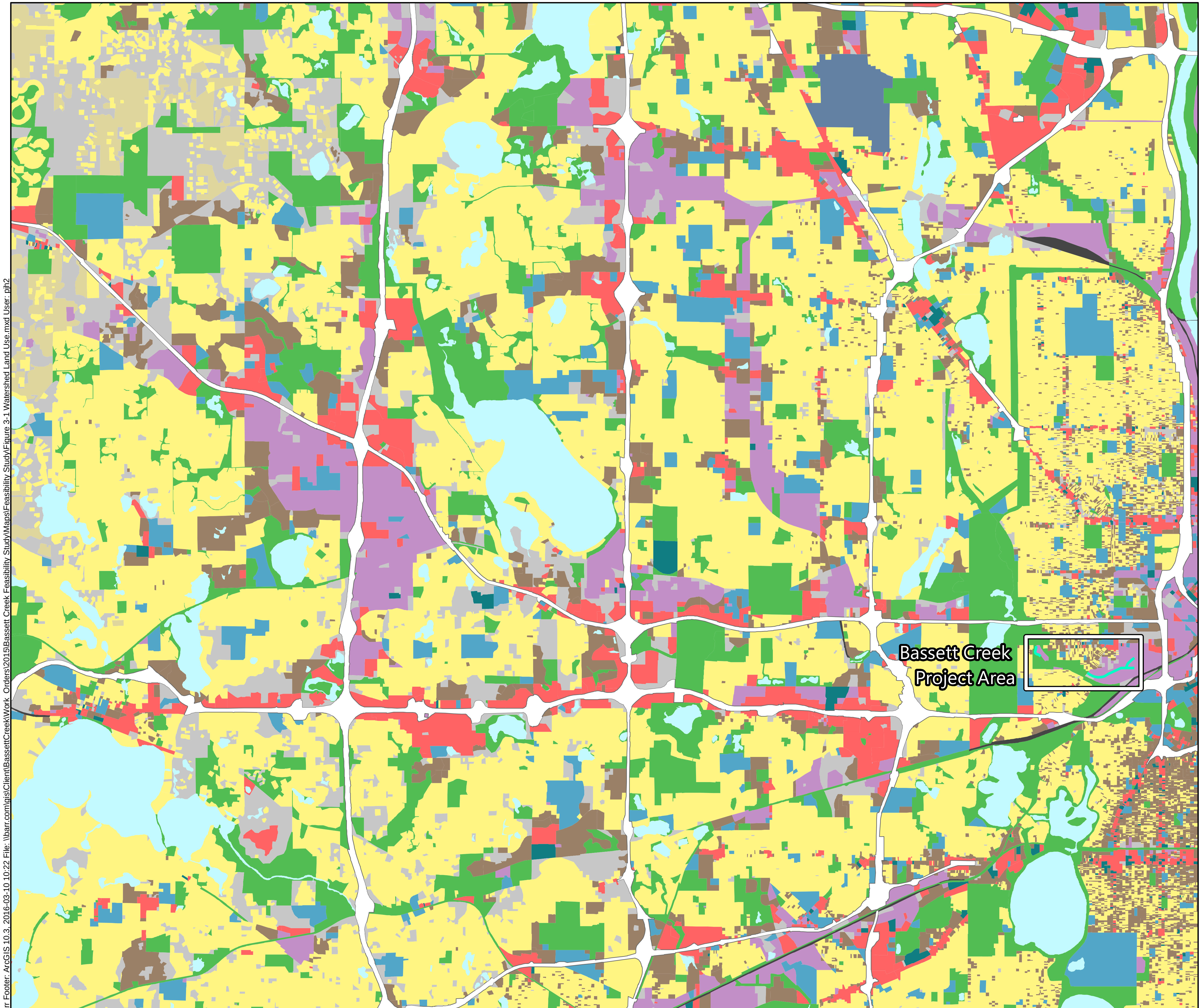
- Reach 1 extends 800 feet from Glenwood Avenue on the upstream end to the Soo Line Railroad Bridge crossing on the downstream end.
- Reach 2 extends 1,150 feet from Cedar Lake Road on the upstream end to Irving Avenue on the downstream end.
- Reach 3 extends 1,550 feet from Irving Avenue on the upstream end to the New Bassett Creek Tunnel entrance at Dupont Avenue on the downstream end.

An additional overflow channel in Reach 3 extends 500 feet from Van White Memorial Boulevard to the Old Bassett Creek Tunnel entrance at Second Avenue North (see Section 2.2.2.1 for discussion of flood flows).

The Commission Engineer reviewed previously documented erosion sites and walked the entire project area to investigate the scale and severity of erosion problems, identify additional sites, and perform an initial qualitative geomorphic assessment.

3.2.1 Surrounding land use

Reach 1 includes the historic Fruen Mill (portions originally constructed in 1872) and Fruen Mill Dam (now a sheet pile and riprap structure) and the historic Glenwood/Inglewood complex on the east bank. These facilities are presently undergoing phased redevelopment and mixed-use development is expected. The west bank of Reach 1 is a wooded portion of Bassett Creek Park, which contains walking trails that connect the playground and park along Chestnut Avenue West to the larger Theodore Wirth Regional Park north of Glenwood Avenue. Historic limestone and brick retaining walls, in various states of repair, are on both sides of Bassett Creek through Reach 1 (see Section 2.2.2.4 for further discussion of previous plans to address the retaining walls).



Legend

Study Reaches

Watershed Management Boundary

Metropolitan Council 2010 Generalized Landuse

- Agricultural
- Single Family Residential
- Multifamily Residential
- Commercial
- Industrial
- Institutional
- Mixed Use
- Park, Recreational or Preserve
- Rights-of-Way (i.e., Roads)
- Airport
- Railway (inc. LRT)
- Vacant or Unknown
- Water

N

Miles

1 0 1

Figure 3-1

BASSETT CREEK WATERSHED
LAND USE/LAND COVER
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed
Management Commission

Reaches 2 and 3 are within an area of historically heavy industrial use that extensively modified the pre-settlement landscape. Several industrial facilities exist on the north bank of the creek, while today the south bank is primarily occupied by the City of Minneapolis impound lot. The impound lot is located on the site of the former Irving Avenue Dump, where dump material and contaminated soils are still present. The areas immediately adjacent to the creek include wooded hill slopes in Reach 2 that transition to open channel banks with grass and shrub cover for the remainder of Reaches 2 and 3.

See Section 3.4 for more detail related to the environmental impacts of past land use on the project area.

3.2.2 Stream geomorphic assessment

Within the project area, Bassett Creek is a low-gradient, channelized stream that flows through an unconfined alluvial valley historically occupied by wetlands.

The Commission Engineer performed an initial qualitative geomorphic assessment of the project area during a field visit; a detailed geomorphic assessment, aided by a channel survey, should be completed prior to detailed design. Stream flow nearly equal to the bankfull flow was observed during a site visit on November 18, 2015. Based on provisional data from the Metropolitan Council Watershed Outlet Monitoring Program (WOMP) stream gage at the Irving Avenue Bridge, the average flow for that date was approximately 130 cfs.

Within the project area, Bassett Creek has an approximate average bankfull depth of 2.5 to 3 feet, and an approximate bankfull width of 25 to 30 feet. The stream is channelized throughout the project area and does not include any significant meandering. It is confined to a channel with lower banks between 2.5 and 6.5 feet high with little or no floodplain. In the upstream half of Reach 1 the water level is controlled by the sheet pile and riprap structure at the historic Fruen Mill Dam location; the bank height upstream of the structure is approximately 2 feet and the stream is able to access the narrow floodplain at the base of the Fruen Mill structures. The stream profile in the remainder of the project area is steepest in the upstream part of Reach 2 (Station 20+00 to 26+00; Figure 5-3), as well as at the Irving Avenue Bridge separating Reaches 2 and 3.

The channel bed and banks throughout the project area vary and include both native and imported materials. Riprap (field stone, angular rock, bricks, and concrete) is present in portions of all three reaches, especially throughout Reach 1, in the steep portion of Reach 2, and at the Irving Avenue and Van White Memorial Boulevard Bridges in Reach 3. Downstream of the Van White Memorial Boulevard Bridge in Reach 3 the stream bed is primarily sand and silt and the banks are clay.

3.2.3 Historic channel alignment

As noted in Section 3.2.1, Bassett Creek and the surrounding landscape in the project area has been significantly altered in the last 160 years, especially in the vicinity of Reaches 2 and 3. A public land survey map from 1854 (included in Appendix C) shows Bassett Creek meandering through the project area, flowing into a large wetland, and exiting the wetland to the north-northeast near the approximate location of Humboldt Avenue North. Extensive filling of the wetland occurred over many years, especially to the south and east of the creek in an area known as the Irving Avenue Dump. The stream was channelized into its current alignment between Cedar Lake Road and the entrance to the Old Bassett Creek Tunnel at Second Avenue North between the early 1900s and the 1930s, and the Old Tunnel was built in sections during the same period (compare the 1934 and 1937 aerial photos included in Appendix C). Aerial photos from the 1930s onward show no changes to the horizontal stream alignment through most of the project area. The channel alignment was adjusted in the early 1990s to cut off most flow to the Old Tunnel and direct the downstream half of Reach 3 to the New Bassett Creek Tunnel entrance at Dupont Avenue North (see 2004 aerial photo included in Appendix C).

As part of the flood control project, a portion of Bassett Creek was moved and lowered between Irving Avenue and the entrance to the New Bassett Creek Tunnel. The bed of the channel was lowered approximately two feet between Irving Avenue and the entrance to the New Tunnel. The channel was also moved slightly upstream of Irving Avenue. The realignment ended approximately 600 feet upstream of Irving Avenue; however the bed was not lowered upstream of Irving Avenue due to a sanitary sewer crossing under the Irving Avenue Bridge (Reference (3)).

It is unclear where the historic Bassett Creek channel in Reach 1 existed prior to construction of the Fruen Mill. Aerial photos from the 1930s onward show no changes to the stream alignment in the vicinity of the mill; the mill dam and the downstream railroad crossing are shown in approximately their present locations. The channel alignment upstream of Glenwood Avenue (upstream of Reach 1) was changed in the 1940s to create a direct outflow from Wirth Lake and abandon a portion of the channel to the east of the railroad. Additional historical maps are included in the Phase I Environmental Site Assessment (ESA) Report (Appendix D).

Bassett Creek is confined within a man-made channel throughout the project area and would not be expected to migrate significantly over time. The channelization of Reaches 2 and 3 in the 1930s appears to have included brick linings placed in portions of the stream channel and lower banks to prevent erosion. Brick lining along the lower banks is visible in an historical photo from 1936 (included in Appendix C); the brick layer can still be seen at low flow in some places in Reach 2. The bricks and other introduced riprap material have likely helped to reduce erosion, especially in the upstream half of Reach 2 where the stream slope is the greatest. In addition, the historical walls and mill dam in Reach 1 have served to armor the stream banks and prevent significant bank movement.

3.2.4 Available hydrologic and hydraulic models

Hydrologic and hydraulic information is available for Bassett Creek in the form of an XP-SWMM hydrologic and hydraulic model and an earlier HEC-1 hydrologic model and HEC-2 hydraulic model. The XP-SWMM model was produced by the Commission Engineer in 2012 for Bassett Creek and its contributing watersheds as authorized by the BCWMC. It incorporates data from the earlier HEC-1 and HEC-2 models and updated survey information. Based on the XP-SWMM model, velocities within the stream channel are expected to range from 2 fps to 2.5 fps in most of the project area for the 2-year event, with higher velocities from 7 fps to 9 fps in Reach 1 both upstream and downstream of the Fruen Mill dam. Velocities within the stream channel are expected to range from 5 fps to 6 fps in most of the project area for the 100-year event, with higher velocities from 9 fps to 10 fps in Reach 1. These results are similar to those in HEC-RAS models developed for the 2015 stabilization project (see Section 2.2.2.4). An updated hydrologic and hydraulic model of the project area is currently under development for the City of Minneapolis and the BWCMC (BCWMC Phase II XP-SWMM model). If possible, the updated model should be used during detailed design to confirm the range of anticipated velocities and aid in choosing final stabilization measures.

3.3 Site access

The proposed work sites are located both on public property (City of Minneapolis and MPRB) and private property (the majority of the north/east stream bank). Temporary construction easements will be required for construction of the stream stabilization project. Coordination with private property owners will be essential to complete final design and achieve site access for construction and maintenance. Relatively few obstacles or infrastructure are blocking access to the proposed work areas. Potential site access locations are presented in Figure 5-2 through Figure 5-4.

3.4 Phase I Environmental Site Assessment (ESA)

In conformance with ASTM International Practice E 1527-13A, a Phase I ESA was completed for the project area in December 2015. A copy of the Phase I ESA is included in Appendix D. The Phase I study area included the three reaches of Bassett Creek that are in the project area plus all properties within 50 feet of the creek centerline to focus on the properties with the greatest potential to affect soil within the project area. For the purposes of the Phase I ESA, this group of properties is referred to as "the Property".

The Phase I ESA identified the following Recognized Environmental Conditions (REC; i.e., the presence or release of hazardous substances or petroleum products in, on, or at the Property):

- **Identified releases on the Property and adjoining properties.** The area surrounding the Property has historically been used for industrial activities associated with petroleum and hazardous chemical releases to the environment; several regulated release sites have been documented on parcels within 50 feet of the creek centerline. Groundwater and soil contamination, including hazardous levels of lead in the soil, has been documented on the Property.

- **Undocumented dumping and filling.** Dumping and filling has historically occurred along most of the Property, most significantly on the south side of Reaches 2 and 3 at the City of Minneapolis impound lot (the former Irving Avenue Dump site). The regulatory database report performed for the Phase I ESA (see Appendix D) also confirms the presence of an unpermitted dump near Reach 2. Some fill mounds and debris were also observed during the site visit.

- **Visible sheen on water.** Iridescent sheens were observed in water along the shores of the creek as well as near some culverts during the site visit.

3.5 Phase II Environmental Investigation

Following the Phase I ESA, the Property was enrolled in the MPCA voluntary remediation program in December 2015 and assigned site #VP33640. Based on the results of the Phase I ESA, a Phase II investigation work plan (Work Plan) was developed to further characterize the soils in the areas targeted for repair or stabilization and to evaluate options for managing soils where planting, grading, or excavation may be needed (Reference (12)). A review and summary of previously documented soil impacts in the project area were included in the Work Plan and used to identify data gaps and develop the scope of work for the investigation. The Work Plan was approved by the MPCA on January 26, 2016 (Reference (13)).

The results of the investigation are documented in the Phase II Investigation Report, which is included in Appendix E. The Phase II investigation results show that most of the soil in the areas targeted for stabilization does not meet MPCA guidelines for unregulated fill (Reference (14)), indicating the soil is not suitable for reuse at another site and requires landfill disposal. Soil samples collected in each reach of the project area either contained debris or chemical concentrations above MPCA guidelines for unregulated fill, except for soil samples collected on the west bank of Reach 1.

Contaminants identified in the soil with concentrations above MPCA criteria for unregulated fill include arsenic, mercury, lead, benzo(a)pyrene equivalents and diesel range organics. Lead concentrations above MPCA unregulated fill criteria were identified in soil samples collected at the City of Minneapolis impound lot. Subsequent analysis using the toxicity characteristic leaching procedure indicated the soils are not characteristically hazardous and do not require additional stabilization prior to disposal at a non-hazardous waste landfill. However, due to the heterogeneity of the fill soil, the presence of debris, and historical documentation of hazardous levels of lead in the soils at the impound lot, there remains a potential for hazardous concentrations of lead to be present in the soils along the creek.

3.6 Cultural and historical resources

The initial cultural resource literature review (Phase Ia review) for the project area included a records search of files at the Minnesota SHPO. The literature review resulted in the identification of four bridges and portions of structures associated with the Fruen Mill within the area of potential effect. Three of the bridges may be more than 50 years old. If these structures will be affected by the proposed project additional evaluation may be required under federal regulations governing protection of historic properties (36 CFR 800.4). The full report of the archeological literature review is included as Appendix F.

A cultural resources assessment of Bassett's Creek Park and the historic walls on the west bank of Bassett Creek opposite Fruen Mill was completed in 2014 as part of the stabilization project completed in 2015. It was recommended that it be considered potentially eligible for the National Register of Historic Places (NRHP) and that the retaining walls be considered contributing elements of this property (Reference (15)). See Section 2.2.2.4 for further discussion of previous plans to address the retaining walls.

The same cultural resources assessment also included the Fruen Mill Complex and Glenwood-Inglewood Water Company (Blondo 2014). The assessment found that these properties did not retain the integrity needed to be eligible for listing on the NRHP.

Although no project work was performed in 2015 in the Fruen Mill area, the work was permitted and the recommendations and requirements from the SHPO with regards to the retaining walls (see Section 2.2.2.4) are expected to apply to the current project.

3.7 Wetlands

Portions of Bassett Creek and adjacent wetlands within the project area were delineated on November 25, 2015. The wetland delineation was established according to the routine on-site determination method specified in the USACE Wetlands Delineation Manual (Reference (16)) and the USACE Midwest Regional Supplement (Reference (17)). The delineation and assessment are necessary to meet the requirements of a USACE Section 404 Permit and the Wetland Conservation Act. Regulatory approval is required for wetland delineations performed as a part of this feasibility study where impacts may occur. A site review should be completed as part of final design during the 2016 growing season. The site review would be conducted by a Technical Evaluation Panel consisting of representatives from the Minnesota Board of Water and Soil Resources, Hennepin County, City of Minneapolis, the MDNR, and USACE.

Two areas of Bassett Creek (west and east) and three wetlands directly adjacent to the creek were delineated within the project area. Both sections of the creek were delineated as riverine systems, totaling approximately 3,500 feet and composed of both linear and meandering stream channel. Wetlands delineated adjacent to the creek totaled approximately 0.52 acres and were made up of seasonally flooded basin (Type 1, PEMA), shallow marsh/shrub–carr complex (Type 3/6, PEM/SS1C), and excavated wet meadow/shallow marsh complex (Type 2/3, PEMB/Fx) communities. These wetlands are shown in Figures 7 and 8 in Appendix G.

A full summary of the wetland delineation, including figures and field data sheets, is in Appendix G.

4.0 Stakeholder input

The BCWMC approved a public stakeholder engagement plan in fall 2015 that identified stakeholder groups, messages, and avenues for stakeholder engagement. The following represents the implementation of the engagement plan and the input gathered from stakeholders.

4.1 Public stakeholder meetings

The BCWMC Administrator, Commissioners, and City of Minneapolis staff attended multiple neighborhood meetings and events to provide information, gather input and answer questions from area residents. In November 2015, a postcard was mailed to every address in the Bryn Mawr and Harrison neighborhoods inviting residents and businesses to learn more about the project and offer input at various venues including:

- Harrison Neighborhood Art Festival, November 21, 2015: Provided information through a display, site photos, and renderings of stabilization techniques
- Bryn Mawr Neighborhood Association (BMNA) Board Meeting, December 9, 2015: Gave presentation with general BCWMC information, project information, site photos, and renderings of stabilization techniques
- Harrison Neighborhood Association (HNA) Board Meeting, December 14, 2015: Gave presentation with general BCWMC information, project information, site photos, and renderings of stabilization techniques
- Bassett Creek Valley Redevelopment Oversight Committee Meeting, February 16, 2016: Gave presentation with general BCWMC information, project information, site photos, and renderings of stabilization techniques

In addition to these events, articles about the project were printed in the November/December 2015 issues of the HNA and BMNA newsletters and a special webpage on the project was promoted through materials and on the BCWMC homepage.

Generally, residents were supportive of the project, although some residents are hoping for bigger changes in the area through the implementation of the BCV Master Plan. The following comments were gathered from residents through the outreach efforts:

- Concern about impacts in the Fruen Mill area including impacts to natural springs in the area downstream and across from Fruen Mill, a desire to maintain a walking path across from Fruen Mill, a desire to keep the boulders and rock at the Fruen Mill Dam in place, and a desire to coordinate restoration efforts with the redevelopment of the Fruen Mill site.
- Concern about the effects of dewatering, if needed, and impacts on springs.
- A desire to improve or not degrade navigability along this stretch for canoes and kayaks.

- A desire for more buffer (including vegetative buffer), particularly along the Pioneer Paper property in Reach 2.
- Concerns about beavers destroying willow stakes that might be planted.
- A desire for cofferdams, if needed, to keep construction areas from impacting water quality.
- Recognition that changes at the Minneapolis Impound Lot might be a good opportunity to dovetail projects and/or improve the impact of this project.

4.2 Technical stakeholder meeting

A technical stakeholder meeting was held on-site in the morning of December 7, 2015. Attendees included representatives from the City of Minneapolis, BCWMC, USACE, MDNR, and the Commission Engineer. The attendees reviewed the design concepts for each of the three reaches and provided technical feedback. Items discussed included:

- The project schedule and meeting objectives
- The erosion sites and other creek deficiencies
- Design concepts
- Permit requirements for potential wetland impacts and stream meanders
- Potential habitat improvements

The meeting provided an opportunity to review the project site and discuss options, giving consideration to ideal restoration scenarios and practical realities of site constraints and the industrial history of the project area that may contain pockets of contamination despite past efforts to remediate the soil. USACE and MDNR representatives expressed their preference for bioengineering techniques whenever possible.

The Commission Engineer also met with a representative of redevelopment interests in the Fruen Mill area. The representative was supportive of the project and did not express any concerns aside from a request for additional stream bank stabilization downstream of the railroad bridge by the Fruen Mill, which is outside of the current project area. The representative also assured his willingness to cooperate with access for additional investigations and construction.

Similarly, representatives from the City of Minneapolis, BCWMC, and the Commission Engineer met with the representatives from the Pioneer Paper Company on February 11, 2016. The primary objective of the meeting was to gain access to the property to conduct additional soil investigations; however it was also an opportunity to discuss the project in general. Pioneer Paper representatives were supportive of the project and expressed a willingness to cooperate. A key component of the cooperation will be coordinating construction to minimize impact on their day-to-day operations.

As part of the BCWMC public stakeholder process, a notice of the project was sent to all property owners along the creek. Adjacent property owners will also be re-notified prior to work commencing on the creek.

5.0 Potential improvements

This section provides a summary of the alternatives for stabilization of Bassett Creek. Section 5.1 includes a general description of the stabilization alternatives and techniques evaluated (see Appendix H for more detail). Section 5.2 provides a description of all of the sites and the recommended improvements for each site, shown in Figure 5-2 through Figure 5-4 and summarized in Table 5.1. A complete discussion of all stabilization alternatives considered for each site, including the advantages and disadvantages of each alternative, is provided in Appendix I.

Rather than presenting several stabilization alternatives for the entire project area or for each reach, the discussion in Section 5.2 focuses on the recommended stabilization measures at each site. Stabilization sites with similar characteristics and stabilization alternatives (Sites 10 and 11) are discussed together.

Although the sites for stabilization are discussed individually, final project design will likely result in a nearly continuous implementation of stabilization techniques through all three stream reaches. The stabilization sites identified in Figure 5-1 generally abut and overlap one another; however, not all stream banks within each reach need stabilization and recommended techniques may differ between adjacent sites.

5.1 Description of stabilization alternatives

The BCWMC and the City of Minneapolis may select different stabilization approaches at each site (even sites with similar characteristics) to best meet the overall project goals. As such, there are a large number of possible alternative combinations that would benefit the entire project area. 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. Areas with significant shade cover present challenges for some bioengineering techniques, but with properly-selected shade-tolerant species (shrubs and grasses), appropriate site preparation, seeding, and maintenance, bioengineering techniques can be used successfully in most locations. If sites are properly designed and if vegetation is well-established, bioengineering techniques can also be low maintenance over the long term. Due to biodegradation of construction materials and variable success with establishing vegetation, 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 Bassett Creek feasibility study, including the USACE and MDNR, expressed a preference for bioengineering over hard armoring for stream stabilization, where possible. In addition, the current BCWMC Plan states: "recognizing their benefits to biodiversity and more natural appearance, the BCWMC will strive to implement stream and stream bank restoration and stabilization projects that use soft armoring techniques (e.g., plants, logs, vegetative mats) as much as possible and wherever feasible" (see Section 4.2.5 of Reference (1)).

5.1.2 Stream stabilization techniques evaluated

The following stream stabilization techniques were evaluated for stabilizing Bassett Creek within the project area. Example figures and additional descriptions for selected techniques are included in Appendix H.

Hard armoring techniques

- **Riprap-lined channel**—riprap throughout an entire channel cross section to control stream bed elevations and prevent fluvial erosion
- **Riprap toe protection—**riprap along the toe of the stream bank, usually not higher than the 1 – 2 year water surface elevation, to protect the toe of the bank from erosion
- **Riprap slope stabilization—**riprap along a steep slope to protect from fluvial erosion and prevent undercutting and slumping
- **Boulder wall stabilization—**boulders along a steep slope to protect from fluvial erosion and prevent undercutting and slumping

Bioengineering techniques

- **Boulder or log vane—**boulders or large logs 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, control stream bed elevations, and create scour pool habitat features

- **Constructed riffle—**gravel or cobble material installed in the stream bed to create natural flow patterns, create varied habitat features, and frequently to control stream bed elevations

- **Vegetated buffer—**vegetation established along a stream bank or overbank area to stabilize bare soils and increase resistance to fluvial erosion

- **Vegetated reinforced slope stabilization (VRSS)—**soil lifts created with long-lasting but biodegradable fabric and vegetated to stabilize steep slopes and encourage establishment of root systems for further stabilization

- **Root wads or toe wood—**tree trunks with the root ball attached, installed either singly (root wads) or in conjunction with additional large woody debris and VRSS (toe wood) to achieve one or more of the following goals: increase bank roughness and resistance to erosion, create undercut/overhanging bank habitat features, re-direct flows away from banks, and provide a bench for establishment of riparian vegetation

- **Live fascines and stakes—**live cuttings of re-sprouting woody species such as willow and dogwood, installed in bundles (fascines) or inserted into stream banks (stakes) to stabilize bare soils and increase resistance to fluvial erosion

- **Composite rock/wood bank protection—**stone toe protection topped with a fabric-wrapped soil lift (VRSS), with logs embedded in the stone toe protruding into the flow to achieve one or more of the following goals: increase bank roughness and resistance to erosion, create undercut/overhanging bank habitat features, re-direct flows away from banks, and provide a bench for establishment of riparian vegetation

5.1.3 Non-site-specific techniques and considerations

Educational signage: Due to the setting of Reach 1 (in a public park and with traffic from a popular walking trail), there are techniques and considerations that are not specific to individual erosion sites. The public setting of portions of the project area provides an opportunity to educate park users about riparian ecology and the efforts of the BCWMC and City of Minneapolis to improve water quality by stabilizing erosion sites. It will also provide a means to encourage trail users to stay on the trail and out of revegetated areas.

Management of contaminated soils: Soil that is removed during construction will generally require landfill disposal rather than being reused offsite. Soil management will involve field screening for evidence of environmental impacts and may also require additional soil sampling and laboratory analysis to characterize the soil for landfill disposal or to identify whether hazardous concentrations of contaminants, particularly lead, are present in the soils. If hazardous levels of lead are identified, chemical stabilization of those soils would be required prior to disposal at a local non-hazardous waste landfill.

Soil excavated for the project will be managed in accordance with a response action plan (RAP) for the project, which will be developed in conjunction with the final project design and will be submitted to the MPCA for review and approval. The RAP will document proposed soil handling, sampling and disposal methods, and will include a contingency plan that outlines additional steps if unexpected environmental impacts such as evidence of historical lead battery recycling or disposal activities are observed during the creek erosion repair project. Work involving oversight and handling of contaminated soil for the project will be completed by OSHA Hazardous Waste Operations trained personnel. The evaluation of stabilization alternatives summarized in Section 5.2 includes consideration of the requirements and costs associated with contaminated soil management.

Management of historical features: Brick and stone walls are present in the Fruen Mill areas of Reach 1. Some of these features may no longer have cultural or historical value, but any disturbance of the walls will require permitting and approval from the Minnesota SHPO. See Section 2.2.2.4 for previous SHPO guidance regarding stream bank stabilization in the vicinity of these retaining walls. Similar to previous plans for stabilizing this reach, the evaluation of stabilization alternatives summarized in Section 5.2 assumes that disturbance of the walls should be avoided, if possible, but that limited removal and replacement of nonfunctioning or collapsed sections of wall will be permitted.

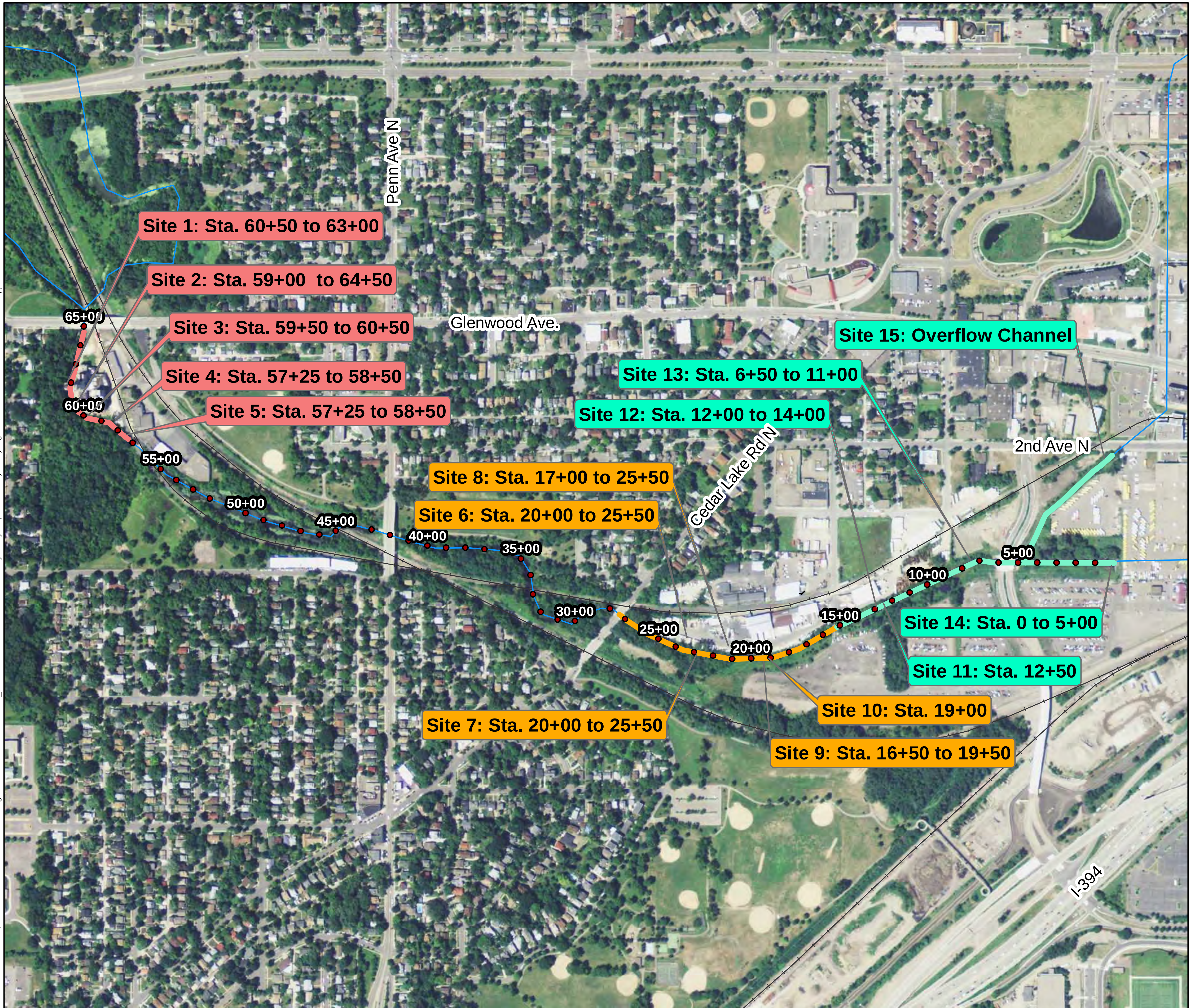
Management of debris: Many of the stabilization sites contain debris along the stream channel and banks, including non-native channel materials such as concrete and brick as well as construction and other debris. General (non-contaminated) debris removal is included in the alternatives as appropriate.

5.2 Recommended alternatives for stabilization

The following discussion is organized by “stabilization sites” within each reach. Stabilization sites for the entire project area are shown in Figure 5-1. Sites with similar characteristics and stabilization alternatives (Sites 10 and 11) are discussed together. Recommended stabilization alternatives for each reach are shown in Figure 5-2 (Reach1), Figure 5-3 (Reach 2), and Figure 5-4 (Reach 3). A complete discussion of all stabilization alternatives considered for each site is provided in Appendix I.

The final project will consist of a combination of the alternatives discussed in Appendix I. The alternatives recommended for final design are summarized in the following sections. The advantages and disadvantages of the recommended stabilization alternatives are summarized in Table 5.1. Alternatives that could be implemented in combination were chosen if they presented cost-effective pollutant loading reductions (see Sections 6.0 and 7.0) without producing significant impacts to surrounding land uses, including not increasing the existing flood elevations. 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 alternatives.

As discussed in Section 2.2.2.4, the 2015 stabilization project on Bassett Creek included plans for stabilizing the banks in the Fruen Mill area. The plans were approved by SHPO; however the work adjacent to the Fruen Mill was not completed. For work in areas that will impact historic structures in the Fruen Mill area, a final design that is consistent with the plans previously approved by SHPO should minimize the permitting effort for this project.



Legend

- Reach 1
- Reach 2
- Reach 3
- Non-Project Area Streams
- River Stationing Points

N

Feet
200 0 200 400

Meters
100 0 100

Figure 5-1

BASSETT CREEK POTENTIAL STABILIZATION SITES
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed Management Commission

Barr Footer: ArcGIS 10.3, 2016-03-10 10:25 File: \\barr.com\gis\Client\BassettCreek\Work_Orders\2015\Bassett Creek Feasibility Study\Maps\Feasibility Study\Figure 5-1 Potential Stab. Sites.mxd User: pjh2

5.2.1 Site 1

Site 1 includes a segment of the MPRB walking trail that runs along the west bank of Bassett Creek opposite the Fruen Mill complex, extending from Station 60+50 to 63+00 on Figure 5-2. The trail runs adjacent to the stream throughout this site and is inundated at bankfull and flood flows; portions of the trail occasionally experience minor erosion.

Recommended alternative summary (Alternative 1B, Appendix I): Retain the trail in its current position adjacent to the low-flow stream channel, but design its surface and edges to be stable when submerged. Stabilize the in-stream trail edge with riprap and the walking surface with plastic geocells filled with coarse gravel, which can be designed to withstand the expected maximum velocity over the walking trail of approximately 7 fps. Adjustments to the trail width will likely be contingent on grading on the opposite channel bank (Site 2) to maintain the existing channel cross section. Remove unnatural materials from the channel adjacent to this site. This recommendation is consistent with plans previously permitted by SHPO.

5.2.2 Site 2

The entire eastern bank of Bassett Creek through the Fruen Mill complex is identified as Site 2 (Station 59+00 to 64+50 on Figure 5-2). The eastern stream bank through this site is fully armored with a combination of historical limestone blocks and concrete; some of the armoring materials are failing or have collapsed into the stream. This site was not included in the previous plans permitted by SHPO. Furthermore, due to the location on a site that has the potential to be redeveloped, the implementation of the recommendations may be most efficient if it is coordinated with redevelopment on the Fruen Mill site.

Recommended alternative summary (Alternative 2A, Appendix I): Remove the failing concrete slabs (and the limestone blocks, if possible) and grade the stream bank to a stable slope (3 feet horizontal to 1 foot vertical or flatter). Establish vegetation along the stream bank to provide long-term stability. If possible, coordinate stabilization activities with grading or landscaping performed during redevelopment of the Fruen Mill site. Remove unnatural materials from the channel adjacent to this site.

5.2.3 Site 3

Site 3 is a short section of the western stream bank opposite the Fruen Mill complex (Station 59+50 to 60+50 on Figure 5-2). Rock riprap has been placed along the bank upstream of the Fruen Mill Dam to protect the walking trail, which is near the creek's bankfull elevation. Bank erosion is present in several locations between the upstream end of the riprap and an historical limestone block wall (submerged during high flows).

Recommended alternative summary (Alternative 3A, Appendix I): Install riprap toe protection from the upstream end of the existing riprap to tie into the historical stone wall. Remove unnatural materials from the channel adjacent to this site. This recommendation is consistent with plans previously permitted by SHPO.

5.2.4 Site 4

Downstream of the Fruen Mill Dam, a concrete swale on the Fruen Mill property directs surface runoff from the paved areas east of Bassett Creek into the stream (Station 58+50 on Figure 5-2). Because the swale is on the outside of the meander bend, high flows are gradually eroding the bank under the swale. This site also includes the east bank of the creek from the swale to the Soo Line Railroad Bridge (Station 57+00 to 58+50 on Figure 5-2). This site was not included in the previous plans permitted by SHPO. Furthermore, due to the location on a site that has the potential to be redeveloped, the implementation of the recommendations may be most efficient if it is coordinated with redevelopment on the Fruen Mill site.

Recommended alternative summary (Alternative 4C, Appendix I): Install riprap toe protection along the eastern stream bank from the upstream side of the existing swale, extending downstream to the railroad bridge. If possible, coordinate stabilization activities with grading or landscaping performed during redevelopment of the Fruen Mill site. Grade the stream bank to a stable slope to provide additional flow capacity to offset construction of stabilization measures for Site 5.

5.2.5 Site 5

Site 5 is located downstream of the Fruen Mill Dam and upstream of the Soo Line Railroad Bridge, along the west bank of Bassett Creek (Station 57+00 to 58+50 on Figure 5-2). The majority of the stream flow is along the opposite (east) bank, but the downstream railroad bridge causes a flow constriction and backwater along the west bank. Highly turbulent flows have eroded the toe of the west bank and created a 7-foot-high cut bank. This site was not included in the previous plans permitted by SHPO; however it is unlikely to impact any historic structures.

Recommended alternative summary (Alternative 5C, Appendix I): Install riprap toe protection and VRSS to increase roughness of the lower banks and establish a vegetated bench at the toe of the high, eroding banks. Establishment of a vegetated bench will likely be contingent on grading on the opposite channel bank (Site 4) to maintain the existing channel cross section.

5.2.6 Site 6

Site 6 is located along the northern bank of Bassett Creek, downstream of Cedar Lake Road in Reach 2 (Station 20+00 to 25+50 on Figure 5-3). The stream bank throughout this site is approximately 6 feet tall and steep, with areas of undercutting visible on the bottom 2 feet of bank. In many areas the undercutting appears to follow a layer of bricks into the stream bank; these bricks are thought to be from the channelization of Bassett Creek in the 1930s (see Section 3.2.3). Although the stream bank is vegetated with trees of varying sizes, many are undercut and in danger of falling into the stream.

Recommended alternative summary (Alternative 6B, Appendix I): Install bioengineering in the form of VRSS to stabilize the stream bank and encourage vegetative growth. Install riprap toe protection to prevent erosion and undercutting along the lower stream bank.

5.2.7 Site 7

Site 7 is located along the same portion of Bassett Creek as Site 6 (Station 20+00 to 25+50 on Figure 5-3), but comprises the stream bed rather than the banks. The bed consists of a mixture of native and imported materials, including rock riprap, concrete blocks, and bricks. The stream slope through this site is steeper than the surrounding areas of Bassett Creek. A 66-inch storm sewer outfalls to Bassett Creek from the south at approximately Station 23+00.

Recommended alternative summary (Alternative 7B, Appendix I): Remove imported bed materials and create a step-pool bed structure using constructed boulder or log vanes. Anchor the vanes into the stream banks, as needed, but do not adjust the banks otherwise. Position the vanes to protect the storm sewer outlet and facilitate storm sewer discharge. This approach will create a stable stream bed, improve in-stream habitat, and retain or improve navigability of the creek for recreational uses.

5.2.8 Site 8

Site 8 is located along the same portion of Bassett Creek as Sites 6 and 7 (Station 17+00 to 25+50 on Figure 5-3), but includes the overbank areas on the north side of the stream rather than the stream bed or banks. This area, which extends nearly to the top of the existing stream bank, is on private property used for trailer storage and a parking lot. Debris from the industrial operation at the site can be blown down the stream banks and runoff from the parking lot enters the stream either as sheet flow or through one of several storm sewer outlets.

Recommended alternative summary (Alternative 8A, Appendix I): Remove debris from the top of the stream bank and stabilize the immediate top of the bank with a row of trees approximately 3 feet wide. The establishment of this narrow vegetated buffer is contingent upon the approval of the landowner and operator of the Pioneer Paper facility.

5.2.9 Site 9

Site 9 is located along an undercut southern bank of Bassett Creek, downstream of the heavily wooded section of Reach 2 (Station 17+00 to 20+50 on Figure 5-3). Although the upper bank is well-vegetated with grasses, the lower banks do not have extensive root mass or surface protection.

Recommended alternative summary (Alternative 9D, Appendix I): Use willow cuttings harvested from adjacent locations on Bassett Creek to create live stakes and fascines. Install fascines along the stream bank toe and live stakes along the top of the bank. This approach will result in a stand of thick-growing willows along the southern bank to aid in screening the City of Minneapolis Impound Lot from view from neighborhoods to the north.

5.2.10 Sites 10 and 11

Sites 10 and 11 consist of stormwater outfalls protruding from the stream banks and elevated above the channel bottom at Station 19+00 (Figure 5-3) and Station 12+50 (Figure 5-4). Flow obstruction, created by the outfalls during periods of high flow, has created erosion at both outlet locations.

Recommended alternative summary (Alternatives 10B and 11B, Appendix I): Shorten the outfall at Site 10 so it does not protrude from the stream bank, and add riprap below both outfalls to prevent erosion during high-flow conditions.

5.2.11 Site 12

Site 12, in Reach 3, includes both stream banks from Station 12+00 to 14+00 (see Figure 5-4). The bed and banks of Bassett Creek downstream of the Irving Avenue Bridge are lined with rock riprap for approximately 150 feet. The toe of both banks is eroding immediately downstream of the riprap due to high-velocity flow exiting the riprap-lined section. This site is entirely within the BCWMC water quality, habitat, and macroinvertebrate monitoring location discussed in Section 2.2.2.6.

Recommended alternative summary (Alternatives 12C and 12D, Appendix I): Install riprap toe protection along the outer banks to reduce the sediment loading and loss of bank. Install a boulder cross vane at the downstream end of the existing riprap toe to direct flow to the center of the stream and away from the stormwater outfall, while also improving in-stream habitat by creating a scour pool in the center of the channel.

5.2.12 Site 13

Site 13 is located along the northern bank of Bassett Creek, upstream of Van White Memorial Boulevard in Reach 3 (Station 6+50 to 10+00 on Figure 5-4). The northern stream bank throughout this site is undercut and the lower banks do not have extensive root mass or surface protection, although the bank is not high. Construction access to the site is challenging in several locations due to fencing and trees near the top of the stream bank. The upstream portion of this site is within the BCWMC water quality, habitat, and macroinvertebrate monitoring location discussed in Section 2.2.2.6.

Recommended alternative summary (Alternative 13D, Appendix I): Use willow cuttings harvested from adjacent locations on Bassett Creek to create live stakes and fascines. Install fascines along the stream bank toe and live stakes along the top of the bank. This approach would improve in-stream cover and help to stabilize undercut banks, which will improve the in-stream habitat quality, while minimizing disturbance of potentially-contaminated soils. Willow live stakes will also result in a stand of thick-growing willows along the northern bank to aid in screening the City of Minneapolis Impound Lot from view from neighborhoods to the north.

5.2.13 Site 14

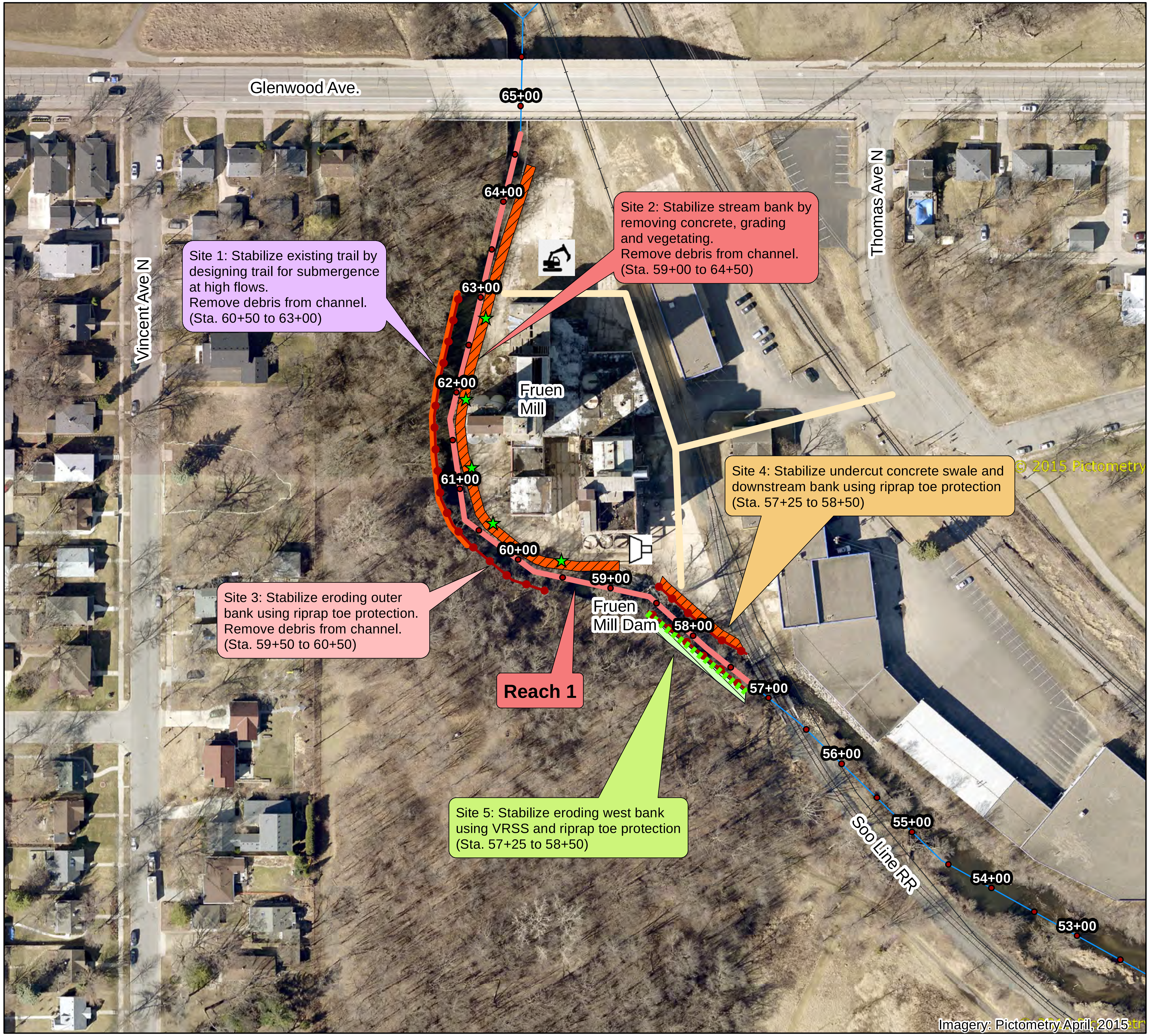
Site 14 represents the final 500 feet of Bassett Creek (Station 0+00 to 5+00 on Figure 5-4), downstream of the Van White Memorial Bridge, before the creek enters the Bassett Creek Tunnel. The lower stream banks through this site are largely bare, but have significant clay content and do not appear to be actively eroding. The water levels at this site frequently appear to be controlled by the Bassett Creek Tunnel inlet structure.

Recommended alternative summary (Alternative 14A, Appendix I): Improve stream bank vegetation by adding groundcover and willow cuttings harvested from adjacent locations on Bassett Creek.

5.2.14 Site 15

Site 15 is located along the high-flow channel that connects Bassett Creek to the Old Bassett Creek Tunnel. This channel conveys water from the Bassett Creek Main Stem only during high-flow events (see Section 2.2.2.1). There are several small trees growing on the lower banks of the channel and woody debris within the channel which may prevent the high-flow channel from operating as designed, but there are no signs of erosion along the channel.

Recommended alternative summary (Alternative 15A, Appendix I): Remove existing small trees and woody debris from the abandoned channel. This alternative represents maintenance of the high-flow channel rather than erosion repair or stabilization, and as such this recommendation is not included in the overall project cost estimate.



Legend

- Debris Removal
- VRSS
- Riprap
- Trail
- Construction Access
- Grading
- Vegetated Buffer
- 100-ft Creek Stationing
- Pedestrian Bridge
- Outfall
- Construction Staging Location

Note: Soil removals from Sites 2 & 4 are assumed to require landfill disposal and may require stabilization prior to disposal.

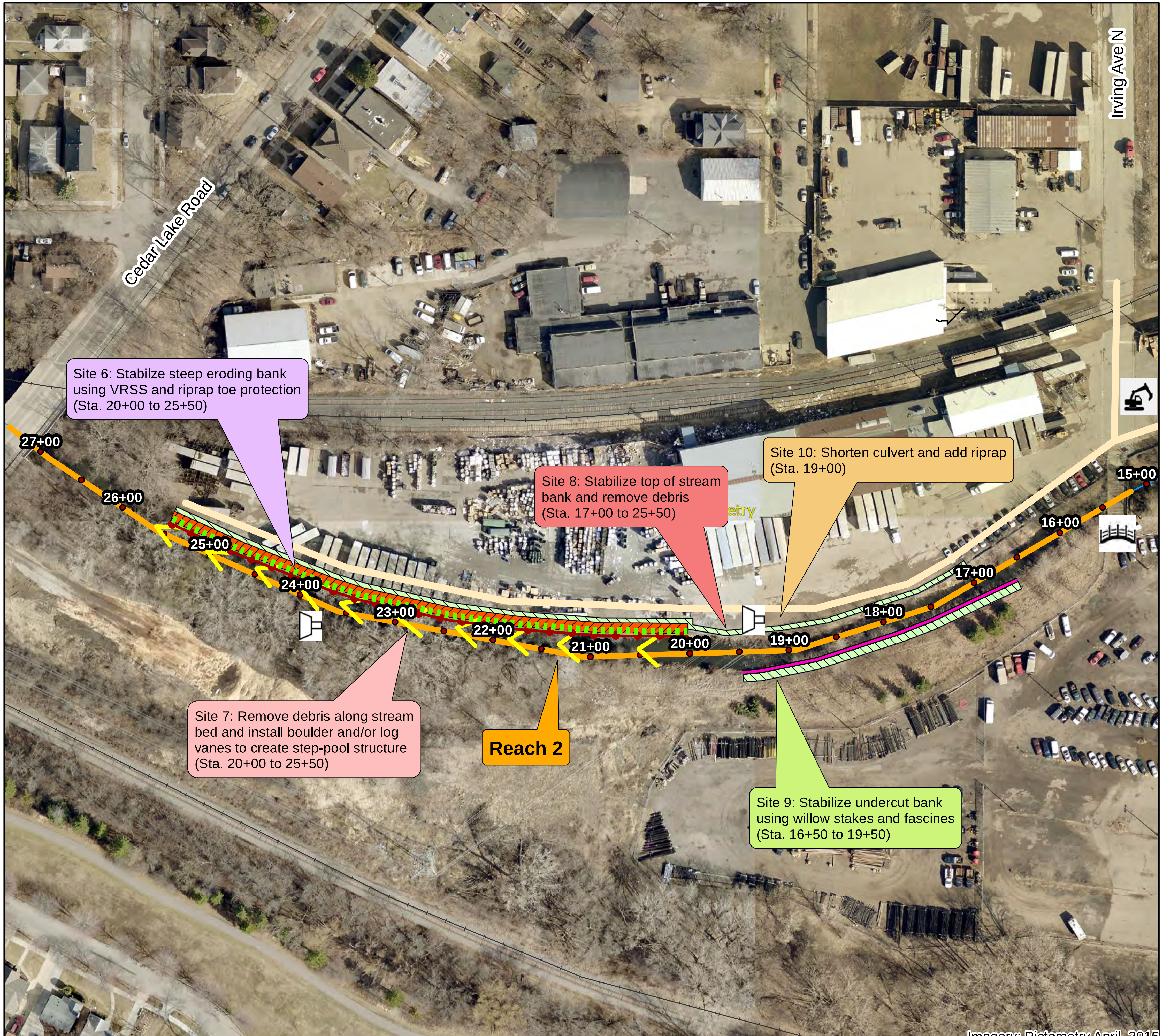
N

Feet
200 0

Meters
50 0

FIGURE 5-2
BASSETT CREEK REACH 1
RECOMMENDED ALTERNATIVES
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed
Management Commission

Barr Footer: ArcGIS 10.3, 2016-03-10 10:40 File: \\barr.com\gis\Client\BassettCreek\Work_Orders\2015\Bassett Creek Feasibility Study\Maps\Feasibility Study\Figure 5-2 Reach 1 Recommended Alts.mxd User: pjh2



Legend

- Debris Removal
- Live Fascines
- VRSS
- Riprap
- Cross Vanes
- Construction Access
- Grading
- Vegetated Buffer
- 100-ft Creek Stationing
- Pedestrian Bridge
- Outfall
- Construction Staging Location

Note: Soil removals from Sites 6 & 7 are assumed to require landfill disposal and may require stabilization prior to disposal.

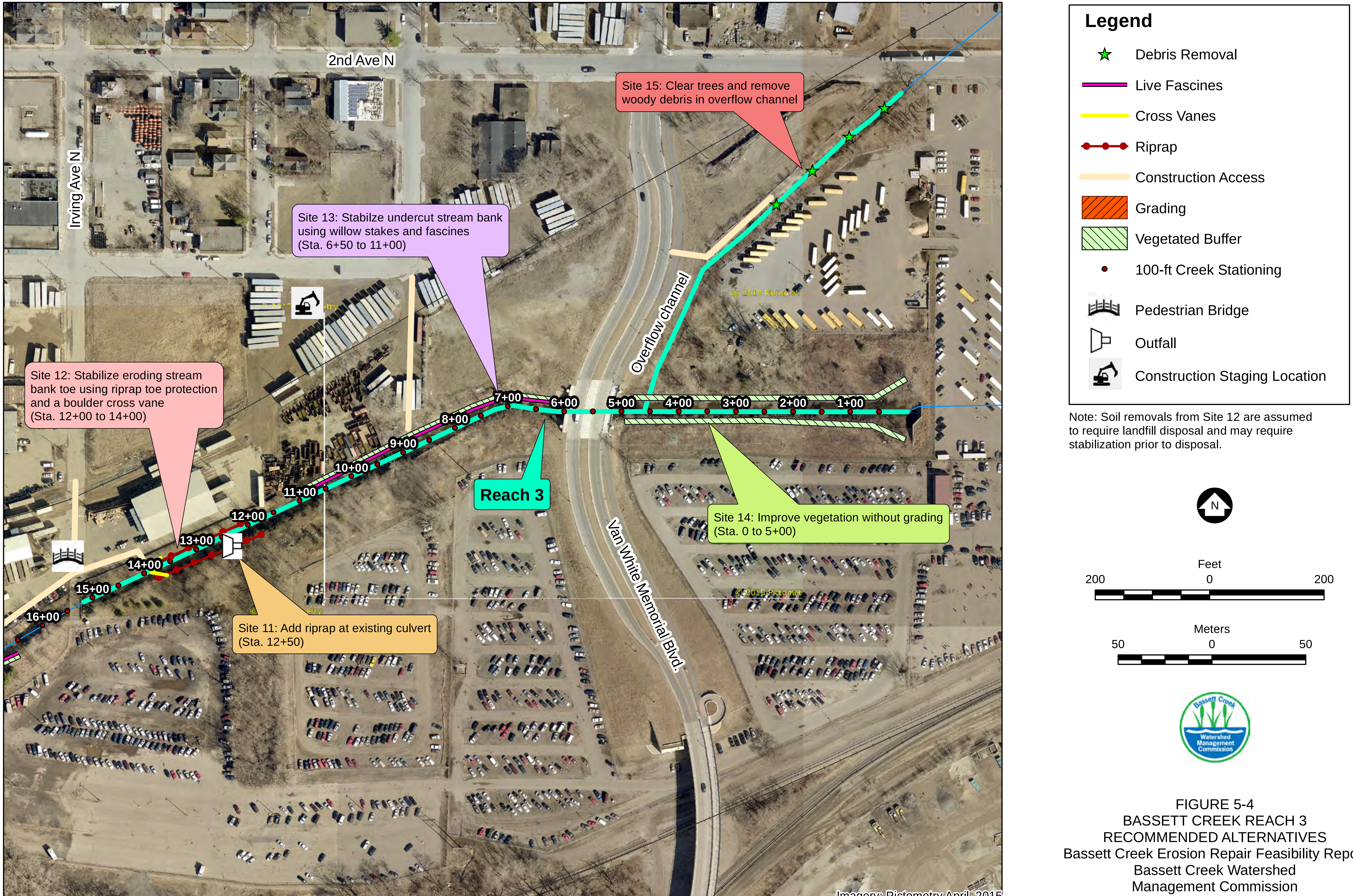
N

Feet
200 0

Meters
50 0

FIGURE 5-3
BASSETT CREEK REACH 2
RECOMMENDED ALTERNATIVES
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed
Management Commission

Barr Footer: ArcGIS 10.3, 2016-03-10 10:53 File: \\barr.com\gis\Client\BassettCreek\Work_Orders\2015\Bassett Creek Feasibility Study\Maps\Feasibility Study\Figure 5-3 Reach 2 Recommended Alts.mxd User: pjh2



Note: Soil removals from Site 12 are assumed to require landfill disposal and may require stabilization prior to disposal.

FIGURE 5-4
BASSETT CREEK REACH 3
RECOMMENDED ALTERNATIVES
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed
Management Commission

Barr Footer: ArcGIS 10.3, 2016-03-10 11:20 File: \\barr.com\gis\Client\BassettCreek\Work_Orders\2015\Bassett Creek Feasibility Study\Maps\Feasibility Study\Figure 5-4 Reach 3 Recommended Alts.mxd User: pjh2

Table 5-1 Bassett Creek feasibility study recommended alternatives summary

Reach	Site	Alternative	Alternative Description	Advantages	Disadvantages
Reach 1	Site 1	Alternative B	Design trail for submergence at high flows	Trail will still be an access to the lower portion of the right bank.	Trail impassable at high flow; regular maintenance required.
Reach 1	Site 2	Alternative A	Grade stream bank and vegetate	Naturalizes the bank and improves access to the stream.	Requires coordination w/ redevelopment; may be difficult to permit. May require soil correction.
Reach 1	Site 3	Alternative A	Extend riprap to tie into historic wall	Stabilizes the bank using existing erosion control structure and preserves historic wall.	Does not reduce shear stress.
Reach 1	Site 4	Alternative C	Install riprap toe protection	Stabilizes the bank, extends stabilization downstream.	Does not encourage vegetation establishment.
Reach 1	Site 5	Alternative C	Install VRSS and riprap toe protection	Stabilizes the bank and improves aesthetics.	Shorter life span than hard armoring and more expensive to install.
Reach 2	Site 6	Alternative B	Install VRSS and riprap toe protection	Improves water quality and aesthetics. Requires less soil correction.	Shorter life span than hard armoring and more expensive to install.
Reach 2	Site 7	Alternative B	Install boulder and/or log vanes to create step-pool structure	Contributes to habitat and reduces shear stress. Requires less bed disturbance and testing.	Aggradation could be developed downstream of the step -pool structure.
Reach 2	Site 8	Alternative A	Remove debris and stabilize top of bank	Reduces erosion from overland flow and debris entering stream.	Limited ability to filter overland flow.
Reach 2	Site 9	Alternative D	Install willow stakes and live fascines	Improves bank erosion resistance and aesthetics, uses on-site materials.	Does not create in-stream pools.
Reach 2	Site 10	Alternative B	Shorten culvert and add riprap	Prevents local bed erosion, requires minimal excavation.	Culvert remains elevated at low creek flows.
Reach 2	Site 11	Alternative B	Add riprap at existing culvert	Prevents local bed erosion, requires minimal excavation.	Culvert remains elevated at low creek flows.
Reach 3	Site 12	Alternative C	Install riprap toe protection	Effective at reducing bank erosion, resilient to large flood events.	Does not encourage vegetation establishment.
Reach 3	Site 12	Alternative D	Install boulder cross vane	Contributes to habitat and reduces shear stress.	Sedimentation can occur and stream conveyance could be reduced.
Reach 3	Site 13	Alternative D	Install willow stakes and live fascines	Improves bank erosion resistance and aesthetics, uses on-site materials.	Does not create in-stream pools.
Reach 3	Site 14	Alternative A	Improve vegetation without grading	Improves bank erosion resistance and aesthetics, uses on-site materials.	Does not create natural profile or cross-section.
Reach 3	Site 15	Alternative A	Clear trees and remove woody debris	Improves conveyance and reduces flooding potential.	Can increase velocities.

6.0 Project requirements and impacts

This section discusses the land ownership and permitting requirements of the stabilization project. The impacts of the project, including the estimated pollution reduction associated with each alternative are also discussed.

6.1 Easement acquisition

The proposed work sites are located on both public property (owned by the City of Minneapolis and MPRB) and private property (the majority of the north/east stream bank). Temporary construction easements are not included in the opinion of cost and are not expected to have significant effect on total project costs. However, coordination with private property owners will be essential to complete final design and facilitate site access for construction and maintenance. Most of the private property owners within the project area have been contacted as part of the Phase I ESA and the Phase II investigation; all of those contacted expressed support for the project and are assumed to be willing to work with the City of Minneapolis on a construction easement agreement.

6.2 Permits required for the project

Development of this feasibility study and assessment of potential alternatives has incorporated feedback from anticipated permitting agencies, including the USACE, MDNR, City of Minneapolis and the MPRB (see Section 4.2).

The proposed project will require 1) a Clean Water Act Section 404 Permit from the USCAE, or Letter of Permission under a General Permit, and Section 401 certification from the MPCA, 2) compliance with the Minnesota Wetland Conservation Act, 3) a Construction Stormwater General Permit from the MPCA, compliance with the MPCA's guidance for managing dredged materials and MPCA approval of a RAP for handling contaminated soils, 4) a Public Waters Work Permit from the MDNR, 5) compliance with Minnesota environmental review rules, 6) an Erosion and Sediment Control Plan approved by the City of Minneapolis, and 7) a Construction Permit for work on MPRB land.

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.

As discussed in Section 2.0, 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, which is intended to streamline USACE permitting.

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 F, and previous approvals associated with the Fruen Mill area are discussed in Section 2.2.2.4. If more detailed information is requested by the Minnesota SHPO, a Phase I Archaeological Survey may be required. This 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.

MPCA Permits and Approvals

Construction of the proposed project will likely disturb more than one acre of soil (primarily for grading outside of the Bassett Creek bed) and will therefore likely 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 stormwater pollution prevention plan that explains how stormwater will be controlled within the project area during construction.

Based on the Phase I ESA findings (Appendix D) and Phase II Investigation results (Appendix E), environmental impacts such as contaminated soil and debris are present in the soils in the erosion repair project area. The project area has been enrolled in the MPCA voluntary remediation program (#VP33640) and contaminated soils will be managed in accordance with a RAP, which will be submitted to the MPCA for review and approval. The RAP will include a construction contingency plan outlining additional sampling or soil management procedures to undertake if environmental impacts inconsistent with the known conditions are identified during the project. MPCA review of a RAP is expected to take approximately 30 business days.

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. Bassett Creek is a public watercourse, so the proposed work will require a MDNR Public Waters Work Permit.

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.” The proposed work is not expected to disturb more than one acre of public water or public waters wetland (Bassett Creek and adjacent wetlands). Note that this measurement is specific to the area of public water disturbed, not the total area of soil disturbed for the project. Therefore the proposed work is not expected to require preparation of an EAW to be submitted to the Minnesota Environmental Quality Board (MEQB).

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 (LGU), which include cities, counties, watershed management organizations, soil and water conservation districts, and townships. The City of Minneapolis is the LGU for the entire project area. The Minnesota Board of Water and Soil Resources (BWSR) oversees administration of the WCA statewide.

As described in Minnesota rules 8420, WCA does not apply to the types of wetland impacts resulting from this project and a WCA approval should not be required; however, the LGU will have the final determination.

The MDNR may determine that the project area qualifies as a public waters wetland and that permitting is required. The proposed project will involve grading existing stream banks and excavating in a floodplain to provide better floodplain connection. This type of work can generally be considered as self-mitigating and/or enhancing existing wetlands; therefore, wetland mitigation is not expected to be required.

Local Permits

The City's requirements for an Erosion and Sediment Control plan will need to be reviewed within the context of the specific work to be performed at each site. For sites in Reaches 1 and 2 that include construction or access through MPRB land, an MPRB Construction Permit will be required.

Table 6.1 shows the list of expected permitting agencies for each reach. This list is only an estimate; each reach should be scoped for permits as site construction details are developed.

Table 6.1 Potential permit requirements by work site

Reach Number	Agencies That May Require Permits
1	City of Minneapolis, MPRB, MDNR, MPCA, USACE
2	City of Minneapolis, MDNR, MPCA, USACE
3	City of Minneapolis, MDNR, MPCA, USACE

6.3 Water quality impacts

The proposed erosion repair and creek bank stabilization measures will result in reduced stream bank erosion and a subsequent reduction in sediment and phosphorus loading to Bassett Creek and downstream water bodies. The existing stream bank erosion rate (in units of feet per year) for each stabilization site has been estimated based on a field assessment method known as the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model (Reference (18)).

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 from 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 Bassett Creek during site visits in September 2015.

The field-determined BEHI and NBS ratings for each site along Bassett Creek are shown in Table 6.2. Sites with existing stream bank armoring in Reaches 1 and 2 are generally rated *low* or *low/moderate* for BEHI due to the effects of the armoring measures at limiting bank erosion. Most sites in Reach 3 are rated *moderate* for BEHI, except for the downstream-most Site 14 due to its high clay content. For NBS, sites in all reaches are rated *low,* except for *moderate* ratings at sites with localized stresses due to the effects of channelization (constricted and high-stress flood flows) or flow obstructions (culverts or existing hard armoring).

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 Colorado (Figure 5-34 of Reference (18)). The estimated existing bank erosion rate for each stabilization site is shown in Table 6.2; these rates range from 0.01 feet per year to 0.25 feet per year.

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 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 0.01 feet per year at Site 14 (due to clay soils) and 0.04 feet per year at the remaining sites. The resulting estimated sediment load reduction at each site is shown in Table 6.2. The corresponding reduction of total suspended sediment (TSS) and total phosphorus (TP) load are calculated using a tool developed by BWSR (Reference (19)) and shown in Table 6.2. The BWSR tool assumes that all eroded sediment becomes TSS. This is a conservative assumption because eroded sand and gravel is not typically suspended, but transported as bedload. The BWSR tool also assumes that TP load is equivalent to 1.15 pound TP per pound of eroded sediment.

The total reduction in pollutant loading as a result of stabilizing the sites within the project area is estimated as 48,300 pounds per year TSS and 27.8 pounds per year TP. The majority of this load reduction will be achieved by stabilizing three segments of eroding bank in the vicinity of the Fruen Mill dam (Site 5), downstream of Cedar Lake Road (Site 6), and downstream of Irving Avenue (Site 12).

Table 6-2 **Estimated existing bank erosion and pollutant loading by site**

Reach	Site	Site Description	Site Length (1)(2)	Est. Avg. Bank Height (ft)	BEHI rating	NBS rating	Est. Erosion Rate(3) (ft/yr)	Est. Sed. Load(4) (ton/yr)	"Stable" Sed. Load(5) (ton/yr)	Est. Sed. Load Reduction (ton/yr)	TSS Reduction(6) (lb/yr)	TP Reduction(6) (lb/yr)
Reach 1	Site 1	Eroding pedestrian trail	250	1.5	Low	Moderate	0.08	1.4	0.7	0.7	1440	0.8
Reach 1	Site 2	Bank armored with concrete and stone	525	2.5	Very low	Very low	0.01	0.6	0.6	0	0	0
Reach 1	Site 3	Bank erosion adjacent to riprap	80	2	Low	Moderate	0.08	0.6	0.3	0.3	620	0.4
Reach 1	Site 4	Undercut concrete swale and downstream banks	110	3	Low	Moderate	0.08	1.3	0.6	0.6	1,270	0.7
Reach 1	Site 5	High eroding bank	100	5	High	Low	0.25	6.0	1.0	5.1	10,110	5.8
Reach 2	Site 6	Steep undercut and eroding bank	550	5	Low/Mod	Moderate	0.08	10.6	5.3	5.3	10,590	6.1
Reach 2	Site 7	Stream bed with imported materials	550	0	n/a	n/a	0	0	0	0	0	0
Reach 2	Site 8	Paved top of stream bank	850	0	n/a	n/a	0	0	0	0	0	0
Reach 2	Site 9	Undercut outer stream bank	285	3	Low/Mod	Moderate	0.08	3.3	1.6	1.6	3,290	1.9
Reach 2	Site 10	Culvert perched at low flows	10	4	Moderate	Moderate	0.25	0.5	0.1	0.4	810	0.5
Reach 3	Site 11	Culvert perched at low flows	10	4	Moderate	Moderate	0.25	0.5	0.1	0.4	810	0.5
Reach 3	Site 12	Eroding stream bank toe	*180*	3	Moderate	Low	0.15	7.8	2.1	5.7	11,440	6.6
Reach 3	Site 13	Undercut outer stream bank	480	3	Low/Mod	Low	0.08	5.5	2.8	2.8	5,550	3.2
Reach 3	Site 14	Bare lower stream banks	*500*	2.5	Very low	Low	0.02	2.4	1.2	1.2	2,410	1.4
Reach 3	Site 15	Overflow channel with woody debris	500	0	n/a	n/a	0	0	0	0	0	0
							Totals	40.6	16.4	24.2	48,300	27.8

(1) For site lengths in *italics* , bank erosion is estimated to occur along both banks (total length of eroding bank is double the site length).

(2) Sites 7, 8, and 15 are not eroding banks and do not contribute appreciable sediment load to the stream.

(3) Erosion rates derived from Colorado BEHI/NBS data for sedimentary/metamorphic geology, Figure 5-34 of Reference (13).

(4) Calculated as length (ft) x height (ft) x erosion rate (ft) / 27 (ft3/cy) x 1.3 (ton/cy).

(5) Estimated from a representative very low BEHI, very low NBS erosion rate of 0.01 ft/yr for Sites 2, 14 & 15. Estimated from a representative low BEHI, low NBS erosion rate of 0.04 ft/yr for all other sites.

(6) Calculated from equations in Reference (14), TSS reduction of 1.0 lb/lb sediment, TP reduction of 1.15 lb/ton sediment.

6.4 Other project impacts

Tree Loss

The proposed project includes the removal of approximately 115 trees; the final number will depend on the alternatives selected. All of the trees are located in areas where bank grading or site access will be necessary, especially within Sites 6 through 8, and many are less-desirable species such as box elder. A detailed tree inventory should be completed during the final design process with the goal of identifying specific trees to remove and save. Close coordination with the MPRB forestry department will be important for tree removals, protection of those trees to be saved, and replacing trees during site restoration at the end of the project.

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 (20)). 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 inadvertent destruction of nests. Additional consultation with the US Fish and Wildlife Service or MDNR regarding the timing of tree removals and the potential impacts to bats should take place during final design.

Sanitary Sewer

A 52-inch sanitary sewer trunk line for the City of Minneapolis crosses Bassett Creek beneath the Irving Avenue Bridge. The pipe is buried approximately 5 feet below the stream bottom, and the entire stream channel below the bridge is lined with riprap. No stabilization work is anticipated in the vicinity of this sewer line, and it will not be disturbed.

In addition, a 27-inch sanitary sewer for the City of Minneapolis runs along the north bank of Bassett Creek between Cedar Lake Road and Irving Avenue. The majority of this sewer line is abandoned; four manholes on the abandoned line are located at the surface in the vicinity of Reach 2. Two additional manholes and an active portion of the sewer are located between approximately Station 18+00 and Irving Avenue. The final project design should avoid disturbance of the active manholes and sewer and should coordinate with the City of Minneapolis if construction activities are expected to approach the abandoned manholes and sewer.

Impacts to Bassett Creek Park

Due to the proximity of the walking trail to some of the stabilization sites in Reach 1, temporary trail closures will likely be necessary during construction to ensure the safety of park users. Trail closures are expected to last up to several weeks during construction, but would not be long-term.

Storm Sewer

The final project design should include an assessment of all storm sewer outfalls in the vicinity of the project area. The City of Minneapolis may elect to perform any required maintenance of the outfalls concurrently with this project.

7.0 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.

7.1 Cost estimate

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

- The cost estimate assumes a 30% 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 related cost is expected to be negligible.
- Costs associated with environmental oversight are included for alternatives that will potentially require removal of contaminated soils.
- Additional work may be required to determine if cultural and/or historical resources are present at any project site.

The total construction and 30-year cost estimates for each recommended erosion repair and creek bank stabilization alternative are summarized in Table 7.1. Detailed cost-estimate tables for all alternatives considered are provided in Appendix J.

Class 4 cost estimates have an acceptable range of between -15% to -30% (low range) and +20% to +50% (high range). Based on the development of concepts and initial vetting by the City of Minneapolis and MDNR, we do not consider it necessary to use the full 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 (30%) incorporates the potential high end of the cost-estimate range.

For the recommended erosion repair and creek bank stabilization alternatives presented in Table 7.1, the total estimated construction cost is $530,000. The Class 4 cost-estimate range for construction costs is $424,000 to $689,000. The total capital cost is estimated to be $932,000, which includes estimated construction costs of $530,000, plus $159,100 each for construction contingency and engineering (design, permitting, and construction observation), and $83,000 for environmental oversight (field oversight, planning, and reporting). As shown in Table 1-1, the total project cost is $1,036,600 when accounting for the cost of the feasibility study.

7.1.1 Temporary easements

The project area is located on both private and public property (owned by the City of Minneapolis and the MPRB). For areas where a temporary construction easement may be necessary, the costs are typically negligible; no costs for temporary easements are included in this estimate. However, coordination with private property owners will be essential to achieve site access for construction and maintenance.

7.1.2 Contaminated soil management

Based on the results of the Phase II investigation (Appendix E), the cost estimate assumes that all excavated soil and sediment is potentially contaminated and will need to be disposed of off-site at a landfill. Construction costs for contaminated soil disposal and stabilization are included in the cost estimate for each alternative.

Additional engineering costs associated with managing and disposing of contaminated soil include costs for developing a RAP, environmental field oversight of excavation, screening and sampling soils by environmental staff during construction, completing a RAP implementation report documenting the soil management activities, and MPCA charges for regulatory review and assistance. Estimates for these additional engineering costs are included in Table J-39 of Appendix J.

7.1.3 Wetland mitigation

Stream banks are considered wetlands, and disturbing the banks as part of a stabilization project is a temporary wetland impact. However, because the purpose of stream bank repair and stabilization is to create a stable bank that can support a riparian ecosystem, the impacts are considered to be self-mitigating. Therefore, stream bank stabilization projects do not typically require additional costs for wetland mitigation.

7.1.4 Tree replacement and revegetation

Coordination with the City of Minneapolis and MPRB will be required for final determination of tree and shrub species and quantities. 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.

7.1.5 Thirty-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 at the end of the estimated life span shown in Table 7.1 (equal to 50% of the original construction cost for hard armoring alternatives and 25% for bioengineering alternatives). Annual maintenance estimates are a fraction of the costs associated with the initial "establishment" period maintenance; 50% is assumed for vegetation-only alternatives (Alternatives 8A and 8B) and 25% for all other alternatives. For the recommended stabilization alternatives presented in Table 7.1, the estimated cost of annual maintenance is $6,500 (2016 dollars).

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 and significant maintenance. 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. For the recommended stabilization alternatives presented in Table 7.1, the total estimated 30-year cost is $3,130,000; the equivalent annualized cost is $65,700.

7.1.6 Annualized pollutant-reduction cost

Estimated annual loading reductions for TSS and TP are included for each recommended alternative in Table 7.1. The loading reductions are based on the assumption that each alternative is successful in reducing bank erosion at each site to a nominal rate of 0.01 or 0.04 feet per year—representative of a well-vegetated, stable bank with very low to low near-bank erosive stress (see Section 6.3). The annualized pollutant-reduction cost for each alternative is the annual load reduction divided by the annual cost. Annualized pollutant-reduction costs for all alternatives are provided in Appendix J.

Annualized costs for TP removal range from $500 per pound TP to $4,580 per pound TP. Many alternatives with high TP removal costs have minimal impact on the pollutant loading from the project area (e.g., shortening culverts at Sites 10 and 11). Alternatives that are estimated to have the most cost-effective pollutant reductions include installing VRSS and riprap toe protection at Site 5 and installing live fascines and willow stakes at Sites 9 and 13.

For the recommended stabilization alternatives presented in Table 7.1, the estimated total annualized pollutant reduction costs are $2,360 per pound TP and $1.36 per pound TSS. This estimate includes the construction and engineering costs associated with contaminated soil removal management.

7.1.7 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, restoration of access paths). Based on previous project experience, the estimate for each alternative includes some costs for these miscellaneous items (6% for erosion and sediment control measures).

7.2 Funding sources

The City of Minneapolis proposes to use BCWMC CIP funds to pay for the project. The source of these funds is an ad valorem tax levied by Hennepin County over the entire Bassett Creek watershed.

7.3 Project schedule

The design of this project is scheduled to begin in late 2016. The construction work will likely be completed during the fall and winter of 2017-2018. The BCWMC will hold a public hearing and order the project in September 2016 in time to certify its 2017 ad valorem tax levy to Hennepin County. If project construction is scheduled for fall or winter, bidding is recommended in the spring or summer of 2017. 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.

Table 7-1 Bassett Creek recommended alternatives cost estimates

Reach	Site	Alternative	Alternative Description	Construction Cost Estimate (1)	Construction Contingency (2)	Engineering (3)	Environ. Oversight (4)	Capital Cost Estimate (5)	Annualized Cost (6)	TP Loading: Load Reduction (lb/yr)	TP Loading: Cost/lb Reduced(7)	TSS Loading: Load Reduction (lb/yr)	TSS Loading: Cost/lb Reduced(7)
Reach 1	Site 1	Alternative B	Design trail for submergence at high flows	$ 23,800	$ 7,140	$ 7,140	$ -	$ 38,100	$ 2,900	0.83	$ 3,490	1,440	$ 2.01
Reach 1	Site 2	Alternative A	Grade stream bank and vegetate	$ 43,680	$ 13,100	$ 13,100	$ 7,500	$ 77,400	$ 5,200	0	--	0	--
Reach 1	Site 3	Alternative A	Extend riprap to tie into historic wall	$ 9,170	$ 2,750	$ 2,750	$ -	$ 14,700	$ 1,100	0.35	$ 3,100	620	$ 1.77
Reach 1	Site 4	Alternative C	Install riprap toe protection	$ 19,030	$ 5,710	$ 5,710	$ 4,500	$ 35,000	$ 2,700	0.73	$ 3,690	1,270	$ 2.13
Reach 1	Site 5	Alternative C	Install VRSS and riprap toe protection	$ 27,400	$ 8,220	$ 8,220	$ -	$ 43,800	$ 3,000	5.81	$ 520	10,110	$ 0.30
Reach 2	Site 6	Alternative B	Install VRSS and riprap toe protection	$ 203,180	$ 60,950	$ 60,950	$ 12,000	$ 337,100	$ 22,800	6.09	$ 3,740	10,590	$ 2.15
Reach 2	Site 7	Alternative B	Install boulder and/or log vanes to create step-pool structure	$ 70,630	$ 21,190	$ 21,190	$ 7,500	$ 120,500	$ 9,300	0	--	0	--
Reach 2	Site 8	Alternative A	Remove debris and stabilize top of bank	$ 24,040	$ 7,210	$ 7,210	$ -	$ 38,500	$ 2,600	0	--	0	--
Reach 2	Site 9	Alternative D	Install willow stakes and live fascines	$ 13,760	$ 4,130	$ 4,130	$ -	$ 22,000	$ 1,500	1.89	$ 790	3,290	$ 0.46
Reach 2	Site 10	Alternative B	Shorten culvert and add riprap	$ 2,980	$ 890	$ 890	$ -	$ 4,800	$ 400	0.47	$ 860	810	$ 0.49
Reach 2	Site 11	Alternative B	Add riprap at existing culvert	$ 3,170	$ 950	$ 950	$ -	$ 5,100	$ 400	0.47	$ 860	810	$ 0.49
Reach 3	Site 12	Alternative C	Install riprap toe protection	$ 41,980	$ 12,590	$ 12,590	$ 4,500	$ 71,700	$ 5,500	6.6	$ 840	11,440	$ 0.48
Reach 3	Site 12	Alternative D	Install boulder cross vane	$ 8,010	$ 2,400	$ 2,400	$ -	$ 12,800	$ 1,000				
Reach 3	Site 13	Alternative D	Install willow stakes and live fascines	$ 20,450	$ 6,140	$ 6,140	$ 3,000	$ 35,700	$ 2,400	3.2	$ 750	5,550	$ 0.43
Reach 3	Site 14	Alternative A	Improve vegetation without grading	$ 16,500	$ 4,950	$ 4,950	$ -	$ 26,400	$ 2,500	1.4	$ 1,810	2,410	$ 1.04
Reach 3	Site 15	Alternative A	Clear trees and remove woody debris (8)	$ -	$ -	$ -	$ -	$ -	$ -	0	--	0	--
Project-wide			Educational signage	$ 2,500	$ 750	$ 750	$ -	$ 4,000	$ 200	–	–	–	–
			Environmental Planning and Reporting (9)	$ -	$ -	$ -	$ 44,000	$ 44,000	$ 2,200	–	–	–	–
			Project Totals*:	**$ 530,000**	**$ 159,100**	**$ 159,100**	**$ 83,000**	**$ 932,000**	**$ 65,700**	**27.8**	**$ 2,360**	**48,340**	**$ 1.36**

* Costs may not sum due to rounding.

(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 Barr'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 Barr at this time and includes a conceptual-level design of the project.

(2) Assumed 30% contingency on construction costs.

(3) Assumed 30% of construction costs for design, permitting, and adminstration.

(4) See Table J-39 for assumptions. A portion of these costs may be eligible for reimbursement through an environmental grant program if a grant is pursued and successfully awarded.

(5) Includes estimated initial construction cost (with 30% contingency) and design, permitting, and adminstration costs (30% of construction cost).

(6) Future value of capital cost, annual maintenance cost, and major maintenance cost at end of expected life span, annualized to 30-year value assuming 3% inflation rate.

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

(8) Site 15 is considered a maintenance item rather than a stabilization measure and will be addressed separately by the City of Minneapolis. The total estimated cost is $18,000.

(9) Costs to prepare contaminated soil management specifications, RAP and RAP implemenation report; soil import or disposal characterization sampling, MPCA coordination and grant application assistance. See Table J-39 for assumptions. A portion of these costs may be eligible for reimbursement through an environmental grant program if a grant is pursued and successfully awarded.

8.0 Alternatives assessment and recommendations

The final project will consist of a combination of the alternatives discussed in Section 5.0 and detailed in Appendix I. The costs of the alternatives recommended for the final design are summarized for each reach in Table 8.1. Alternatives that could be implemented in combination were chosen if they presented cost-effective TP and TSS loading reductions, without significant impacts to surrounding land uses. In cases where only one alternative could be implemented, priority was given to options that were 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.

Stabilization and restoration of stream banks within the project area will provide water quality improvement by 1) repairing actively eroding sites and 2) using preemptive measures to prevent erosion at other sites.

Using the recommended alternatives, design and construction costs for erosion repair and stabilization of this section of Bassett Creek total approximately $932,000, or about $333 per foot of stabilized stream (approximately 2,800 feet of stabilized stream out of the total project area stream length of 3,500 feet). This is in the lower third of the range of costs associated with the feasible alternative combinations evaluated in Appendix J (from $799,000 to $1,330,000) and represents cost-effective stream stabilization with an emphasis on bioengineering techniques, where possible. Costs for stream stabilization projects of similar scale often range between $250 and $400 per foot; costs at the high end of this range are often used for rapid planning-level cost estimates. Therefore, the anticipated cost for stabilizing this reach of Bassett Creek is slightly above the middle of the typical price range for the recommended work, reflecting the complexity of the sites to be stabilized and the additional costs associated with contaminated soil management.

The total estimated project capital cost of $932,000 includes an estimated $530,000 for construction, $159,100 each for construction contingency and engineering (design, permitting, and construction observation), and $83,000 for environmental oversight (field oversight, planning, and reporting). As shown in Table 1-1, the total project cost is $1,036,600 when accounting for the cost of the feasibility study. We recommend that these costs be used to develop a levy request for this project and that it proceed to the design and construction phase.

Table 8-1 Bassett Creek recommended alternatives cost summary

Reach	Construction Cost Estimate (1)	Construction Contingency (2)	Engineering (3)	Environ. Oversight (4)	Capital Cost Estimate (5)	Annualized Cost (6)	TP Loading		TSS Loading	
							Load Reduction (lb/yr)	Cost/lb Reduced(7)	Load Reduction (lb/yr)	Cost/lb Reduced(7)
Reach 1	$ 123,100	$ 36,900	$ 36,900	$ 12,000	$ 209,000	$ 14,900	7.73	$ 1,930	13,440	$ 1.11
Reach 2	$ 317,800	$ 95,300	$ 95,300	$ 19,500	$ 528,000	$ 37,000	8.91	$ 4,150	15,500	$ 2.39
Reach 3	$ 86,900	$ 26,100	$ 26,100	$ 7,500	$ 146,600	$ 11,400	11	$ 1,020	19,400	$ 0.59
Educational signage	$ 2,500	$ 750	$ 750	$ -	$ 4,000	$ 200	–	–	–	–
Environmental Planning and Reporting (8)	$ -	$ -	$ -	$ 44,000	$ 44,000	$ 2,200	–	–	–	–
Project Totals*:	**$ 530,000**	**$ 159,100**	**$ 159,100**	**$ 83,000**	**$ 932,000**	**$ 65,700**	**27.8**	**$ 2,360**	**48,340**	**$ 1.36**

* Costs may not sum due to rounding.

(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 Barr'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 Barr at this time and includes a conceptual-level design of the project.

(2) Assumed 30% contingency on construction costs.

(3) Assumed 30% of construction costs for design, permitting, and adminstration.

(4) See Table J-38 for assumptions. A portion of these costs may be eligible for reimbursement through an environmental grant program if a grant is pursued and successfully awarded.

(5) Includes estimated initial construction cost (with 30% contingency) and design, permitting, and adminstration costs (30% of construction cost).

(6) Future value of capital cost, annual maintenance cost, and major maintenance cost at end of expected life span, annualized to 30-year value assuming 3% inflation rate.

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

(8) Costs to prepare contaminated soil management specifications, RAP and RAP implemenation report; soil import or disposal characterization sampling, MPCA coordination and grant application assistance. See Table J-38 for assumptions. A portion of these costs may be eligible for reimbursement through an environmental grant program if a grant is pursued and successfully awarded.

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