# Feasibility Report for
# North Branch Bassett Creek Restoration Project

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Bassett Creek Watershed Management Commission

**September 2010**

# *Feasibility Report for North Branch Bassett Creek Restoration Project*

## *Crystal, Minnesota*

## *Prepared for Bassett Creek Watershed Management Commission*

## *September 2010*

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

______________________________________________

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## September 2010

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# 1.0 Executive Summary

## 1.1 Background

In January 2007 the Bassett Creek Watershed Management Commission's Technical Advisory Committee recommended that the Commission add stream channel restoration projects to the Commission's 10-year Capital Improvements Program (CIP). The restoration projects included the Main Stem of Bassett Creek, the North Branch of Bassett Creek, the Sweeney Lake Branch of Bassett Creek, and Plymouth Creek. The Commission completed a draft Resource Management Plan (RMP) in April 2009 (updated July 2009) that included several stream restoration projects. North Branch Bassett Creek was one of the stream projects included in the RMP; the project includes the restoration of a reach from 32nd Avenue North to approximately 200 feet upstream of Douglas Drive North (**Figure 1**, Location Map). This reach is included in the Commission's CIP for design and construction in 2011 (the scheduled construction date has changed since completion of the RMP).

In 2008, the City of Golden Valley completed the Commission's first channel restoration project – the Sweeney Lake Branch, King Hill Area project. This project involved restoration of approximately 600 feet of the upstream end of the Sweeney Lake Branch of Bassett Creek. The Plymouth Creek, Reach 1 and Bassett Creek Main Stem, Reach 2 projects are currently underway.

## 1.2 General Project Description and Estimated Cost

The potential stabilization measures identified for implementation in this reach consist of the following:

- removal of trees and vegetation,
- grading reaches of stream bank,
- stabilizing storm sewer outfalls that discharge into the channel,
- establishing new vegetation on areas disturbed by construction,
- installing a variety of stream stabilization measures to address erosion problems, including riprap, biologs, cross vanes, j-vanes, live stakes, live fascines, and vegetated reinforced soil slope (VRSS)

The North Branch construction costs are estimated to be $834,900. A detailed cost estimate is included in **Section 4.3**. Temporary construction easements are not included in the cost estimate at this time, but they are not expected to significantly increase the total cost. The proposed restoration work within the City of Crystal is mostly on private property and will require temporary construction easement acquisitions to complete construction.

## 1.3 Recommendations

The Commission's CIP includes restoration of North Branch Bassett Creek, with project design and construction work slated to begin in 2011. The stabilization of this reach will provide water quality improvement by 1) repairing actively eroding sites; and 2) preventing erosion at other sites by installing preemptive measures to protect existing stream banks. This project will also be cost efficient because no permanent easements will be required.

It is recommended that the restoration of North Branch Bassett Creek proceed into the design and construction phase of the project. It is also recommended that the Bassett Creek CIP be revised to reflect the revised cost estimate.

# 2.0 Background and Objective

## 2.1 Goals and Objective

The North Branch Bassett Creek project reach has erosion problems in at least 20 locations. The objective of this study is to review the feasibility of implementing measures to stabilize the stream banks and storm sewer outfalls on the North Branch Bassett Creek and to provide conceptual designs and cost estimates of measures that could potentially be used at each of the 20 erosion sites.

### Stream Stabilization

The City of Crystal has recognized the importance of addressing stream erosion and sedimentation issues; however, funding limitations have prevented repair of these sites to date. With the availability of funding from the BCWMC, repair of these sites can now proceed.

The City of Crystal has completed periodic erosion inventories along this reach, beginning in 2003. The city's latest inventory identified 16 erosion sites, all with moderate erosion. Barr staff added four sites (Sites 1, 9, 13, and 18) with minor to moderate erosion or the potential for erosion problems in the near future. One of the sites previously identified as moderate erosion by the city was reclassified as severe erosion.

The goals of the stream stabilization project are to:

- Stabilize eroding banks to improve water quality.
- Preserve natural beauty along North Branch Bassett Creek and contribute to the natural habitat and species diversification in place by planting eroded areas with native vegetation.
- Prevent future channel erosion along the creek and the resultant negative water quality impact of such erosion on downstream water bodies.

**Considerations**

- Restoration must minimize floodplain impacts. Several businesses and residences are located near the creek, so it is critical to ensure the proposed project does not increase flood elevations that impact these properties.
- Maintain existing floodplain storage and cross sectional areas.

## 2.2 Background

### 2.2.1 Reach Description

The North Branch Bassett Creek (**Figure 1**) project reach extends for approximately 3,000 feet, from 32nd Avenue North to approximately 200 feet upstream of Douglas Drive, in the City of Crystal. Land use immediately adjacent to this reach is a mix of high density residential (apartments and condominiums) and single family residential.

Barr Engineering (Barr) staff walked the reach in June 2010 and identified a total of 20 sites on this reach that need some form of stabilization to address bank erosion, scour, and/or bank failure. Of the 20 sites, four have minor to moderate erosion, 15 have moderate erosion, and one has severe erosion. The total length of bank erosion is approximately 1,500 feet. Photos of each of the erosion sites are found in Appendix A. The bank failures along this reach appear to be caused by a combination of natural stream erosion processes, problems associated with changing watershed hydrology, and excessive shading that, in some places, has shaded out the understory. Even when cities incorporate best management practices (BMPs) to minimize the impacts of increased runoff, development still fundamentally changes the hydrology of the watershed. The BMPs commonly used reduce the impacts of urban development on streams receiving stormwater runoff, but physical changes and increased rates of erosion occur.

Implementation of the project will require coordination between the BCWMC and the City of Crystal to ensure long term project success. Most importantly, the City of Crystal will need to assist in the maintenance of the designed measures, particularly the vegetation maintenance component since poor vegetation management practices are a common cause of bank failures. A major aspect of the vegetation component will be the City working with the private landowners to ensure that the plantings and maintenance meet the objectives of stream bank stabilization while considering the landowners' needs.

### 2.2.2 Past Documents and Activities Addressing this Reach

#### City Erosion Inventory

The City of Crystal has completed erosion inventories and assessments on the North Branch Bassett Creek as it flows through the City. The City has updated its inventory every one to two years.

City staff completed the inventories by walking the length of the North Branch, 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 includes mapping the location of the site on aerial photographs, notes on the details of each site, and a digital photograph of each site.

The City of Crystal's erosion inventory identified 16 erosion sites within the study reach. When Barr staff completed a field review of the reach in 2010, four additional sites were identified as having minor to moderate erosion problems or the potential for erosion problems in the near future. Combining the 16 sites identified by the City and the four sites added by Barr staff brings to 20 the number of erosion sites along the reach.

**BCWMC**

As part of the *Bassett Creek Main Stem Watershed Management Plan* (2000), the BCWMC estimated the sediment and phosphorus loading to Bassett Creek from channel erosion. Three erosion scenarios were evaluated for increased loadings resulting from three levels of channel erosion - minor, moderate, and severe. The most likely scenario for Bassett Creek was between the moderate and severe scenarios with approximately ten percent of the stream channel suffering from erosion. Similar scenarios were used to estimate the additional loading of phosphorus to Bassett Creek.

The 2000 study results indicated that moderate channel erosion could contribute an additional 1,000,000 pounds of suspended sediments annually (increase from approximately 500,000 pounds to 1,500,000 pounds) and 50 pounds of phosphorus annually (increase from approximately 2,650 pounds to 2,700 pounds) to the Main Stem of Bassett Creek. The study results also showed that stabilizing the Main Stem of Bassett Creek could reduce total phosphorus (TP) loads by an estimated 96 pounds per year and total suspended solids (TSS) loads by an estimated 200,000 pounds per year.

More recent computations completed for this feasibility study show that restoring this reach of the North Branch Bassett Creek could reduce TP loads by an estimated 68 pounds per year and TSS loads by an estimated 119,000 pounds per year.

The BCWMC Watershed Management Plan recognized the need to restore stream reaches damaged by erosion or affected by sedimentation. The BCWMC established a fund to cover the costs of channel stabilization projects. However, the fund as authorized was insufficient to cover the costs of all of the identified projects. In January 2007 the BCWMC's Technical Advisory Committee recommended that the Commission add stream channel restoration projects to the Commission's ten-year CIP. The BCWMC then went through a process to identify potential channel restoration projects by stream reach, prepared cost estimates for the restoration of the reach, prioritized the restoration projects, and added the larger projects to the CIP. These restoration projects included the Main Stem of Bassett Creek, the North Branch of Bassett Creek, the Sweeney Lake Branch of Bassett Creek, and Plymouth Creek. These reaches of the creek have experienced increased stream bank erosion, streambed aggradation, or scour. These erosion and aggradation processes are a combination of natural processes, and increased runoff volumes and higher peak discharges in these reaches of the creek that occur with urban development in the watershed. 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. The Commission added several of these channel restoration projects to their long range CIP in May of 2007, including North Branch Bassett Creek.

The BCWMC completed a draft Resource Management Plan (RMP) in April 2009 (updated July 2009) for water quality improvement projects within the Bassett Creek watershed scheduled for design and construction between 2010 and 2016. The goal of the RMP was to streamline the permitting process with the U.S. Army Corps of Engineers (USACE) for all of the projects. The RMP provided concept designs for stabilizing the stream banks along this reach of Bassett Creek as well as background information about impacts to wetlands, threatened and endangered species, and cultural and historical resources. The North Branch Bassett Creek was included in the RMP. Relevant information from the RMP is included in this feasibility study.

Table 1 presents the restoration projects included in the RMP, along with their estimated start dates and costs. This reach of North Branch Bassett Creek is included in the Commission's CIP for design and construction in 2011 (the scheduled construction date has changed since completion of the RMP).

**Table 1 Channel Restoration Projects added to CIP and included in the RMP**

| Creek Project | Target Project Start | Estimated Project Cost[1] |
|---|---|---|
| Plymouth Creek, Reach 1 (PC-1) | 2010 | $965,200 |
| Bassett Creek Main Stem, Reach 2 | 2010 | $780,000 |
| Bassett Creek Main Stem, Reach 1 | 2011 | $715,000 |
| North Branch | 2013 | $660,000 |
| Plymouth Creek, Reach 2 (PC-2) | 2015 | $559,000 |

[1] Costs as estimated in revised 2009 CIP

In 2008, the City of Golden Valley completed the Commission's first channel restoration project – the Sweeney Lake Branch, King Hill Area project. This project involved restoration of approximately 600 feet of the upstream end of the Sweeney Lake Branch of Bassett Creek. The Plymouth Creek, Reach 1 and Bassett Creek Main Stem, Reach 2 projects are currently underway.

# 3.0 Site Characteristics

## 3.1 Bassett Creek Watershed

The watershed area for the North Branch Bassett Creek is approximately four square miles and drains portions of Plymouth, New Hope, and Crystal. Existing land use includes approximately 28 percent commercial/industrial; 40 percent single-family residential; four percent multi-family residential; seven percent highway; seven percent parks and undeveloped land; and water surface area over the remaining land area.

## 3.2 Stream Characteristics

The North Branch Bassett Creek project reach (**Figure 2**) extends for approximately 3,000 feet, from 32nd Avenue North to approximately 200 feet west of Douglas Drive, in the City of Crystal. The stream is relatively shallow in most places except for occasional deep pools. The riparian vegetation is a mixture of native and non-native trees and shrubs.

For this feasibility study, Barr staff walked the reach to further investigate the scale and severity of the erosion problems. Barr staff observed the previously documented erosion sites and identified additional erosion sites. The sites added by Barr staff are for the most part minor erosion sites. These sites were added to the feasibility study as it is more cost effective to fix minor repairs before they become severe, particularly if a contractor is under contract and on-site to complete repairs to adjacent sites.

## 3.3 Site Access

Access for many of the sites on the North Branch Bassett Creek will be more difficult because most of the sites are located on private property. Access to each site will require crossing private property and restoring the property at the end of the project.

## 3.4 Wetlands

The wetlands associated with the North Branch Bassett Creek project reach were delineated in accordance to the COE Wetland Delineation Manual and Midwest Regional Supplement. The delineation and assessment was necessary to meet the requirements of a Section 404 Permit and the Wetland Conservation Act. The assessment also included the use of the Minnesota Routine Assessment Method (MnRAM 3.0), which is a comprehensive ranking system designed to help qualitatively assess functions and values associated with Minnesota wetlands for the purpose of managing local wetland resources. Four wetlands totaling approximately 4.6 acres within the study reach were identified and field delineated. These are primarily floodplain forest riparian wetlands which border the North Branch Bassett Creek for the extent of the study area, and are separated by roads. MNRAM functional wetland assessments were also performed; the wetlands generally scored low in many environmental criteria. Final design should avoid or minimize wetland impacts.

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

## 3.5 Cultural and Historical Resources

A reconnaissance survey of the North Branch Bassett Creek project reach was completed in June 2010 to determine if any sites may require further investigation for cultural or historical importance. The survey was completed by reviewing historical aerial photographs, interviewing local residents, and walking the relevant reaches to observe conditions on the ground.

The survey found no sites with archeological potential that justify additional investigation. The full report of the survey, including figures, is included in Appendix C.

# 4.0 Potential Improvements

## 4.1 Description of Potential Improvements

As described in Section 1.2, the project along North Branch Bassett Creek consists of a variety of stream stabilization measures to address erosion problems. **Figure 2** shows the 20 stabilization sites and **Table 2** lists the potential stabilization measures for each site. The following paragraphs describe the potential stream stabilization practices proposed for this reach. There are dozens of stream restoration techniques that can be used, although not all of them would be practicable or applicable to the stream erosion problems on Bassett Creek. The techniques discussed below and included in the conceptual design are among commonly used techniques. Those included in the concept design were selected for their functionality and the expectation that most contractors have had experience with installation of the technique. The final design will determine the most appropriate measures to use at each individual site to meet the objectives of all parties involved. The final design could include techniques not included in these concept designs.

### Riprap

Riprap (also called stone toe protection) is used to protect the toe of the stream bank. In-stream riprap typically consists of cobble-sized rock (six inches to 12 inches in diameter). The riprap is keyed in to the streambed and extends up the bank to approximately the bankfull level elevation. The bankfull level is the elevation of the water in the channel during a 1.5-year return frequency runoff event. In some cases, this level may be below the top of the stream bank. Riprap is typically used in conjunction with planting of the upper banks to provide full bank protection. Riprap is especially effective in heavily shaded areas, where it is difficult to establish vegetation. **Figure 3** illustrates this practice.

### Cross Vanes

Cross vanes (or constructed riffles) are drop structures, which are typically constructed of boulders and rocks to flatten the slope of the channel and reduce the velocity of the flow in the channel. Cross vanes extend across the creek bottom, and are embedded in each bank. Cross vanes direct the main flow to the center of the stream to reduce bank erosion. **Figure 4** illustrates this practice.

### J-Vanes

J-vanes (also called rock vanes) are constructed of boulders embedded into the creek bottom. The vanes are embedded in the stream bank and are oriented upstream to direct the flow away from that bank. J-vanes typically occupy no more than one-third of the channel width. **Figure 5** illustrates this practice.

### Vegetated Reinforced Slope Stabilization (VRSS)

VRSS is a bioengineering method that combines rock, geosynthetics, soil, and plants to stabilize steep, eroding banks. VRSS typically involves protecting layers of soil with a blanket or geotextile material creating "soil lifts" (also called "soil pillows") and planting or seeding native vegetation on the slope. The vegetation's root systems provide the long-term slope stabilization. **Figure 6** illustrates this practice.

### Pipe Outlet Stabilization

Pipe outlet stabilization measures vary according to specific site circumstances and problems. At most sites, additional rock riprap is needed at the pipe outlet. In other cases, pipe realignment and/or lowering of the pipe may be needed to correct existing problems, prevent future erosion, and prevent pipe failure. **Figure 7** illustrates this practice.

### Biologs

Biologs are natural fiber rolls made from coir fiber that are laid along the toe of the stream bank slope to stabilize the toe of the stream bank. Biologs 10 – 22 inches in diameter are typically used. Because they are made of natural fiber, vegetation can grow on the biologs. When needed, grading of the stream bank slope above the biolog is used to create a more stable slope (2:1 to 3:1). **Figure 8** illustrates this practice.

### Live Stakes

Live stakes are dormant stem cuttings, typically willow and dogwood species. They are collected and installed during the dormant season (late fall to early spring) and grow new roots and leaves, quickly and cheaply establishing woody vegetation on a stream bank. The willows and dogwoods grow into stands that provide long lasting bank protection. **Figure 9** illustrates this practice.

### Live Fascines

Live fascines also use dormant willow and dogwood cuttings collected and installed during the dormant season. In this case, the cuttings are bundled together and planted in a row parallel to the stream flow. They can be effective in reducing sheet erosion along a slope because a portion of the fascine extends above the ground surface. The willows and dogwoods grow into linear stands of shrubs that provide long lasting bank protection. **Figure 10** illustrates this practice.

### Site Grading

In many places, the eroding bank will be graded to a 2:1 or 3:1 slope. This provides a stable slope that will not naturally slough and it provides a surface that is flat enough on which vegetation can be planted or seeded.

**Table 2 Potential stabilization measures at each site.**

| Site # | Station | Potential Stream Stabilization Practices[1] | Photos[2] |
|---|---|---|---|
| 1[3] | 0+00 | Grade banks to 2:1 slope.<br>Install two cross vanes.<br>Install 200 feet biolog.<br>Remove 12 trees. | 1 |
| 2 | 2+50 | Grade banks to 2:1 slope.<br>Install riprap for toe protection.<br>Remove 12 trees. | 2, 3 |
| 3 | 3+50 | Grade banks to a 3:1 slope<br>Install three j-vanes.<br>Install 75 feet biolog. | 4 |
| 4 | 4+25 | Grade left bank to a 2:1 slope.<br>Place removed material below undercut trees.<br>Install riprap on placed material.<br>Install biolog and live stakes on graded bank.<br>Remove six trees. | 5 |
| 5 | 6+00 | Grade bank to a 3:1 slope.<br>Install one cross vane.<br>Install 150 feet biolog.<br>Remove ten trees. | 6 |
| 6 | 7+50 | Remove and dispose of failing wall.<br>Grade both banks to 2:1 slope.<br>Install one cross vane.<br>Install 300 feet biolog.<br>Remove 12 trees. | 7, 8 |
| 7 | 9+40 | Remove 15 trees.<br>Install riprap in front of sanitary manhole.<br>Regrade steep banks to 2:1 slope. | 9 |
| 8 | 11+00 | Regrade banks to 2:1 slope.<br>Install riprap to protect sanitary manhole.<br>Install two j-vanes.<br>Remove four trees. | 10 |
| 9[3] | 12+00 | Clear debris jam. | 11 |
| 10 | 13+00 | Install riprap to protect sanitary manhole.<br>Install one j-vane.<br>Remove two trees | 12 |
| 11 | 15+00 | Install fill and riprap to protect sanitary manhole<br>Install two j-vanes.<br>Remove one tree. | 13 |
| 12 | 16+60 | Install 400 feet biolog.<br>Install shade-tolerant shrubs.<br>Remove three trees. | 14 |
| 13[3] | 18+00 | Grade steep bank to 2:1<br>Install 4 j-vanes.<br>Remove three trees. | 15 |

| Site # | Station | Potential Stream Stabilization Practices[1] | Photos[2] |
|---|---|---|---|
| 14 | 19+00 | Protect sanitary manhole by pushing stream away from manhole.<br>Install riprap for additional manhole protection.<br>Install four j-vanes.<br>Remove five trees. | 16 |
| 15 | 19+50 | Remove two trees.<br>Install 60 feet biolog.<br>Install live stakes. | 17 |
| 16 | 20+50 | Remove eight trees.<br>Install 450 square feet of VRSS.<br>Install two j-vanes | 18 |
| 17 | 21+50 | Remove disposed grass clippings.<br>Install 100 feet biolog.<br>Install 50 feet live fascines.<br>Plant shrubs and trees to vegetate bank.<br>Remove two trees | 19 |
| 18[3] | 23+50 | Remove four trees.<br>Regrade banks to 2:1 slope.<br>Install 2 j-vanes. | 20 |
| 19 | 24+00 | Remove two trees.<br>Install 200 feet of biolog. | 21 |
| 20 | 29+00 | Remove 16 trees<br>Install 1,000 square feet of VRSS. | 22 |

[1] All sites will be revegetated with native grasses, shrubs, and trees. The final design phase will determine which practices will be used at each site and may or may not use the practices specified in this table.
[2] Photos are located in Appendix A
[3] Sites added by Barr Engineering

## 4.2 Project Impacts

### 4.2.1 Easement Acquisition

Temporary construction easements will be required to complete the stabilization work for this project because most of the identified erosion sites are located on private property. For this study, it was assumed that temporary construction easements will cost approximately $1,000 for each site, for a total of $20,000.

### 4.2.2 Permits Required for Project

The proposed project will require 1) a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers (COE) and Section 401 certification from the Minnesota Pollution Control Agency (MPCA), 2) compliance with the Minnesota Wetland Conservation Act, and 3) a Public Waters Work Permit from the Minnesota Department of Natural Resources (MNDNR). The proposed project should also follow the MPCA's guidance document for managing dredged materials.

### Section 404 Permit

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

The Bassett Creek project was included in the *Resource Management Plan for Bassett Creek Watershed Management Commission Water Quality Improvement Projects 2010 – 2016* submitted to the COE in April 2009 (revised in July 2009). The goal of the *Resource Management Plan* (RMP) is to complete on a conceptual level the COE permitting process for all of the projects proposed.

The COE 404 permit requires a Section 106 review for historic and cultural resources. The results of the archeological reconnaissance study are included as Appendix C. If more detailed information is requested by the State Historic Preservation Office (SHPO), then a Phase I Archaeological Survey may need to be completed. A Phase I Archaeological Survey can be completed in 45 days or less during the frost-free period. The COE staff anticipates that the 404 permit review and approval process could require 120 days to complete.

### Minnesota Wetland Conservation Act

The Wetland Conservation Act (WCA) regulates the filling and draining of wetlands and excavation within Type 3, 4, and 5 wetlands. In addition, the WCA may regulate all types of wetland alteration if any wetland 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. Crystal is the LGU for the proposed project site. The Minnesota Board of Water and Soil Resources (BWSR) oversees administration of the WCA statewide.

The proposed project will only involve grading existing stream banks and other stream bank work. This type of work can generally be considered self mitigating and will not require wetland mitigation, but all work requires review by the LGU.

### Public Waters Work Permit

The MNDNR regulates projects constructed below the ordinary high water level of public waters or public waters wetlands, which alter the course, current, or cross section of the water body. Public waters regulated by the MNDNR are identified on published public waters inventory (PWI) maps.

Bassett Creek is a public water/water course, so the proposed work will require a MNDNR public waters work permit.

The first few hundred feet of the North Branch Bassett Creek project reach upstream of 32nd Avenue North is a designated County Ditch (CD 18).

### 4.2.3 Other Project Impacts

#### Tree Loss

The proposed project includes the removal of approximately 119 trees. All of the trees are located in areas where bank grading or site access will be necessary. A detailed tree inventory should be completed during the final design process. Tree replacement is discussed in Section 4.3.

#### Water Quality Impacts

The proposed stabilization measures will result in a reduction of the sediment and phosphorus loading to Bassett Creek and all downstream water bodies, including the Mississippi River and Lake Pepin. As discussed in Section 2.1.2, the BCWMC estimated sediment and phosphorus loading to Bassett Creek from channel erosion as part of the *Bassett Creek Main Stem Watershed Management Plan* (2000). The study results also showed that stabilizing the Main Stem of Bassett Creek could reduce total phosphorus (TP) loads by an estimated 96 pounds per year and total suspended solids (TSS) loads by an estimated 200,000 pounds per year.

Also as noted in Section 2.1.2, more recent computations show that restoring this reach of the North Branch Bassett Creek could reduce TP loads by an estimated 68 pounds per year and TSS loads by an estimated 119,000 pounds per year.

## 4.3 Cost Estimate

The estimated project design and construction cost for the North Branch Bassett Creek restoration project is $834,900. A feasibility-level cost estimate for the project construction is included in **Table 3. Figure 2** shows the corresponding site numbers and stationing referenced in **Table 3**. The following sections explain some of the assumptions that are a part of the cost estimate.

### 4.3.1 Temporary easements

The costs of obtaining temporary construction easements within the City of Crystal are often negligible; however for the purposes of this cost estimate, it was assumed that construction easements for each private property would be $1,000. With 20 sites in need of repair, the total cost estimate for temporary construction easements is $20,000 (**Table 3**).

### 4.3.2 Off-site sediment disposal

The cost estimate includes the costs of testing stream bank material for hazardous compounds that would require them to be treated as dredged materials per MPCA regulations. It is assumed that approximately one half of the excavated material will require special disposal at an estimated costs of $29,100 (**Table 3**).

### 4.3.3 Wetland mitigation

As discussed in Section 4.2.2, stream bank restoration and repair is considered to be a self-mitigating wetland impact. Stream banks are considered to be wetlands and disturbing the banks as part of a restoration project is a temporary wetland impact. However, because the nature of stream bank repair and restoration is to create a stable bank that can support a riparian ecosystem, the impacts are considered to be self-mitigating. Therefore, stream bank restoration projects do not require an additional cost for wetland mitigation.

### 4.3.4 Tree replacement

The cost estimate (Section 4.3) assumes that trees will be replaced on a two-to-one (2:1) basis. It also assumes that the replacements will be made at the site where the original trees were removed. Therefore, if five trees are removed at a given site, then ten trees will be planted during site restoration. The two-to-one replacement ratio assumes that over time, there will be some tree loss due to natural causes (storm/wind damage, disease, etc) and natural competition.

### 4.3.5 Percentages of estimated construction costs

The cost estimate also assumes that 10% of the construction costs will be for mobilization and demobilization. This cost is included in the site subtotal for each site.

### 4.3.6 Miscellaneous

Most sites include various miscellaneous items that are needed during construction. Such items include a rock construction entrance, a filter dike to control in-stream sediment disturbance, and restoration of access paths. Together, these items total approximately $6,000. Because some sites are close together, a single filter dike can be used to control in-stream sediment from multiple sites. Likewise, a single construction entrance and access path restoration can be used for multiple sites. Therefore, these items were not included in the cost estimate for each site.

The opinion of probable construction costs provided in this report is made on the basis of 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.

## 4.4 Funding Sources

The City of Crystal proposes to use BCWMC capital improvement program (CIP) funds to pay for this project. BCWMC channel restoration projects are funded through the BCWMC's CIP and are paid for via an ad valorem tax levied by Hennepin County over the entire Bassett Creek watershed.

## 4.5 Project Schedule

The project design and construction work is slated to begin in 2011. The construction work will likely be completed during the winter of 2011—2012. For project design and construction work to occur in 2011, the Commission must hold a public hearing and order the project in time for the Commission's submittal of its 2011 ad valorem tax levy request to Hennepin County by October 1, 2010. If project construction is to occur in fall or winter, it is recommended that the project bidding take place in the summer. This will allow contractors to acquire plants and seeds at a reasonable price for the required quantities. In the intervening time, the City will gather public input, conduct the environmental review, prepare the final design, and obtain permits.

**Table 3. Site Locations, Potential Stream Stabilization Practices, and Overall Cost Estimate for Bassett Creek Reach 2**

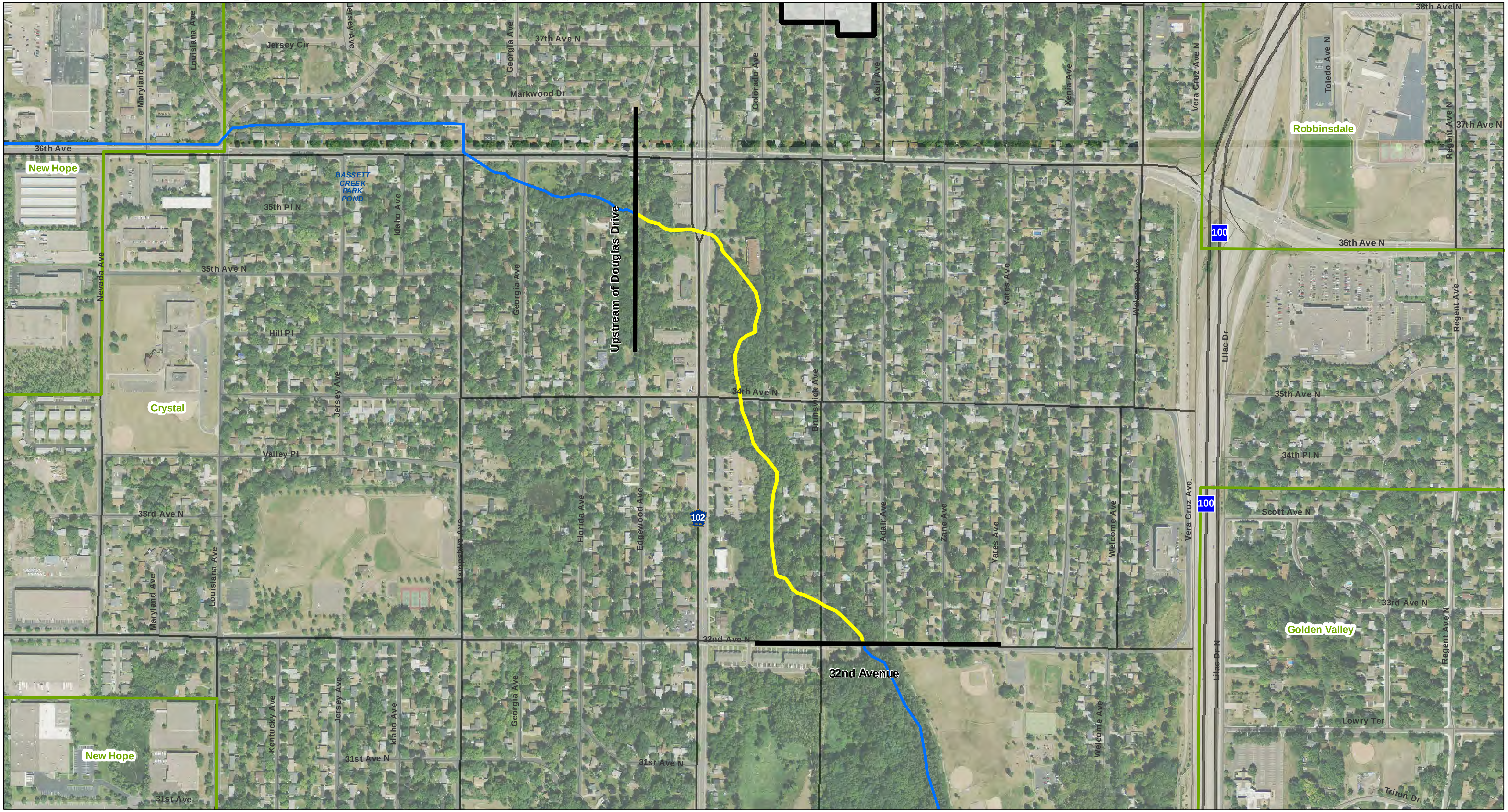
| Site # | Downstream station (1) | Site length (feet) | Proposed stream restoration practices | Site Subtotal (2) |
|---|---|---|---|---|
| 1(3) | 0+00 | 200 | 200' of biolog; remove 12 trees; 2 cross vanes; grade banks to 2:1 slope | $ 52,300 |
| 2 | 2+50 | 50 | Grade banks to 2:1 slope; install riprap; remove 12 trees | $ 24,600 |
| 3 | 3+50 | 75 | Grade banks to 3:1; install riprap; 75' of biolog; seed with native grasses. | $ 17,700 |
| 4 | 4+25 | 40 | Grade bank to 2:1 slope; install riprap; 40' biolog; install live stakes; remove 6 trees | $ 18,700 |
| 5 | 6+00 | 75 | Grade bank to 3:1 slope; 1 cross vane; 150' biolog; remove 10 trees | $ 22,800 |
| 6 | 7+50 | 150 | Grade banks to 2:1 slope; remove failing retaining wall; 1 cross vane; 300' biolog; remove 12 trees | $ 55,200 |
| 7 | 9+40 | 40 | Grade banks to 2:1; remove 15 trees; install riprap in front of sanitary manhole; | $ 25,900 |
| 8 | 11+00 | 25 | Grade banks to 2:1; install riprap to protect sanitary manhole; 2 j-vanes; remove 4 trees. | $ 14,500 |
| 9(3) | 12+00 | 20 | Clear debris jam | $ 2,400 |
| 10 | 13+00 | 20 | Install riprap to protect sanitary manhole; 1 j-vane; remove 2 trees. | $ 14,700 |
| 11 | 15+00 | 20 | Install riprap to protect sanitary manhole; 2 j-vanes; remove 1 tree. | $ 16,700 |
| 12 | 16+60 | 200 | 400' biolog; remove 3 trees; shade-tolerant shrubs | $ 18,400 |
| 13(3) | 18+00 | 40 | Grade bank to 2:1 slope; 4 j-vanes; remove 3 trees | $ 20,900 |
| 14 | 19+00 | 30 | Slightly re-route stream to protect sanitary manhole; install riprap for manhole protection; 4 j-vanes; remove 5 trees. | $ 28,800 |
| 15 | 19+50 | 30 | 60' biolog; live stakes; remove 2 trees | $ 6,900 |
| 16 | 20+50 | 50 | 450 square feet of VRSS; 2 j-vanes; remove 8 trees | $ 45,100 |
| 17 | 21+50 | 50 | 100' biolog; 50' live fascines; remove grass clippings; revegetate bank; remove 2 trees. | $ 14,500 |
| 18(3) | 23+50 | 35 | Grade banks to 2:1 slope; 2 j-vanes; remove 4 trees | $ 16,300 |

| Site # | Downstream station [1] | Site length (feet) | Proposed stream restoration practices | Site Subtotal [2] |
|---|---|---|---|---|
| **19** | 24+00 | 200 | 200' biolog; remove 2 trees | $ 9,300 |
| **20** | 29+00 | 150 | 1000 square feet of VRSS; remove 16 trees | $ 81,800 |
| | | | Testing for hazardous materials and off-site disposal | $ 29,100 |
| | | | Temporary construction easements | $ 20,000 |
| | | | *Subtotal* | *$ 556,600* |
| | | | | |
| | | | Design, Permitting, and Administration (25%) | $ 139,150 |
| | | | *Subtotal* | *$ 695,750* |
| | | | | |
| | | | Construction Contingency (20%) | $ 139,150 |
| | | | **Summation** | **$ 834,900** |

(1) Stream stationing: 0+00 at 32nd Ave
(2) All sites include restoration seeding and erosion control blanket for disturbed areas, and a 2:1 tree replacement as needed.
(3) Sites added by Barr Engineering

## *Figures*

Barr Footer: Date: 9/15/2010 9:14:01 PM File: I:\Client\BassettCreek\Work_Orders\Bassett Creek Feasibility Study (2010)\Maps\Figure_1_Location_Map_N_Branch.mxd User: jdw




Bassett Creek Watershed Management Commission
www.bassettcreekwmo.org

500 250 0 500
Feet

N
W E
S

**Legend**

- North Branch Study Area
- North Branch Bassett Creek
- Municipal Boundaries

NORTH BRANCH BASSETT CREEK

Figure 1
North Branch Bassett Creek Restoration Project
Bassett Creek Watershed Management Commission
September 2010

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Bassett Creek Watershed Management Commission
www.bassettcreekwmo.org

300 150 0 300 Feet

**Legend**

- Study Sites
- Sanitary Sewers
- North Branch Bassett Creek

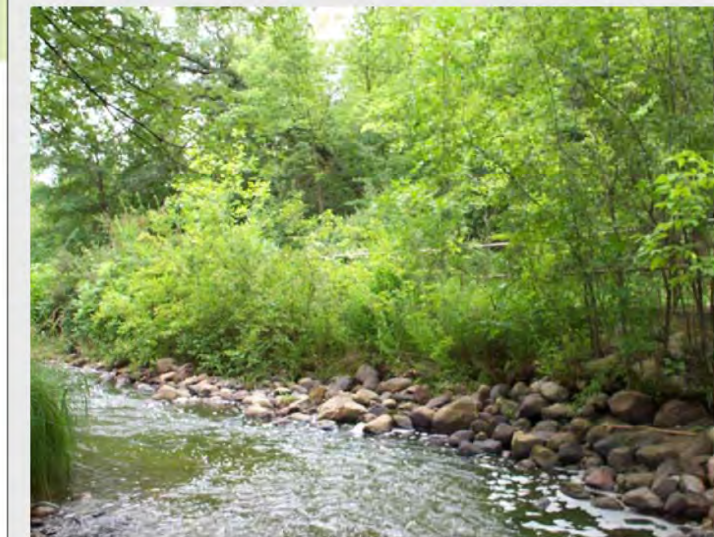
EROSION SITES AND STATIONING

Figure 2
North Branch Bassett Creek Restoration Project
Bassett Creek Watershed Management Commission
September 2010

# Stream Stabilization Plan

Stone Toe Protection is constructed from cobble-sized rock on the creek edges. It extends to approximately the bankfull level, which will protect the channel banks for flow events that occur every 1 to 2 years or less. The material will extend into the ground to resist scour. Coarse gravel is used to separate the larger rock material from underlying soil. Stone toe protection is typically used in conjunction with revegetation of the upper banks.

## SIMILAR PROJECTS

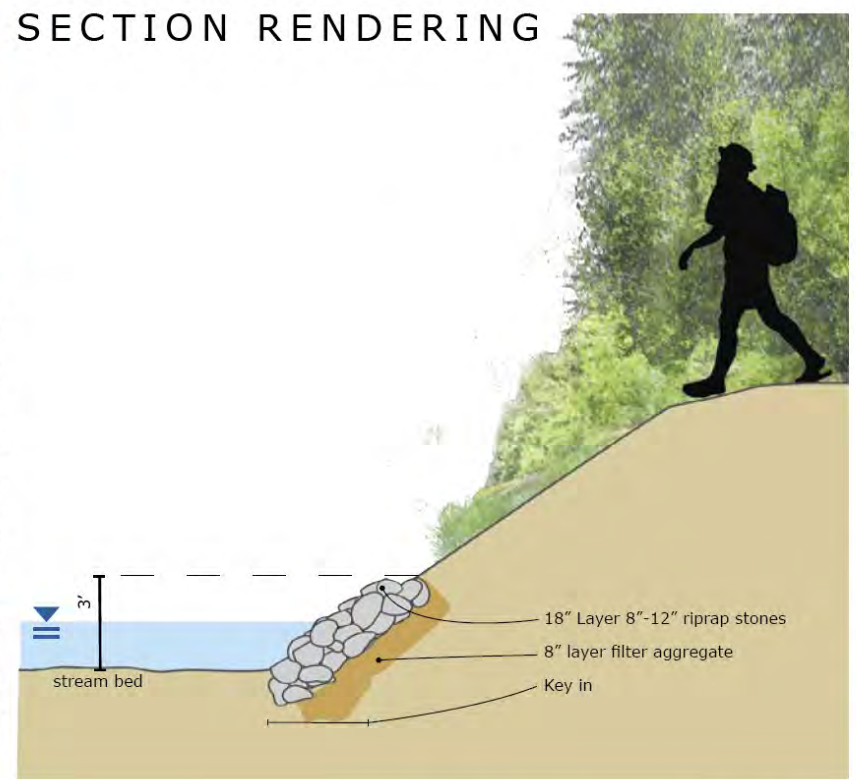


Stone toe protection has been used extensively in Nine Mile Creek's Lower Valley, in conjunction with deflector dikes, grade control measures and stabilization of large bank failures. Following the 1987 "super storm," the proposed design allowed the stream to continue its course while taking measures to protect areas where water flow was eroding valley walls. The resulting measures have stabilized the stream channel and valley walls while blending seamlessly with the natural environment.

## EXISTING CONDITIONS

Fluvial bank erosion is caused by water in the stream moving past the streambanks. The shear stress caused by the flow entrains soil particles into the flow, causing the stream bank to erode away. This is the most common type of erosion that occurs in streams. Virtually all streams experience this type of erosion as their flow path evolves over time. However, the rate of fluvial bank erosion can increase when the stream is out of equilibrium with its watershed. Increased flow from a watershed will increase the rate of fluvial bank erosion. In many cases, it appears to be a part of the natural process of stream evolution. In places where the channel is confined by the valley walls, however, fluvial bank erosion can lead to failure of the high banks. It can also undermine storm sewer inlets.

## SECTION RENDERING




## MATERIALS

Materials will consist of cobble-sized material with coarse gravel filter layer to provide separation from the underlying soil. Natural fieldstone material will be used.

# Stone Toe Protection

Bank Protection

BARR

**Figure 3**

# Stream Stabilization Plan

Grade control measures are used where channel downcutting has occurred. Various types of weirs are commonly used to provide grade control on streams, particularly in steeper systems. Weirs can be constructed of sheetpile, concrete, or natural materials such as rock. In most cases, natural rock is used to emulate natural riffles. Large boulders would comprise the core of the structure, with smaller rock material placed on the upstream and downstream sides of the boulders to provide a gradual transition to the channel.

The riffles will serve to raise the surface of the water profile, and will reconnect the stream to its floodplain areas. Following the installation of the riffles, pools will be created upstream of the riffles. However, these pools will fill with sediment over time, which will in effect raise the channel bottom to the desired elevation.

## MATERIALS

Materials will consist of various gradations of rock, ranging from large, 3-foot boulders to coarse gravel.

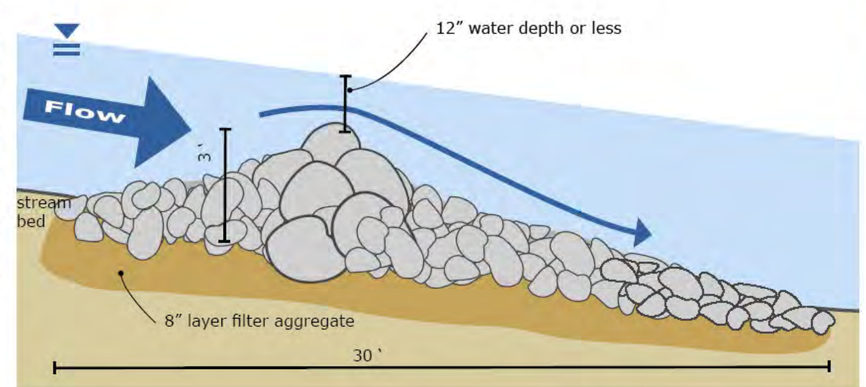
## SIMILAR PROJECTS

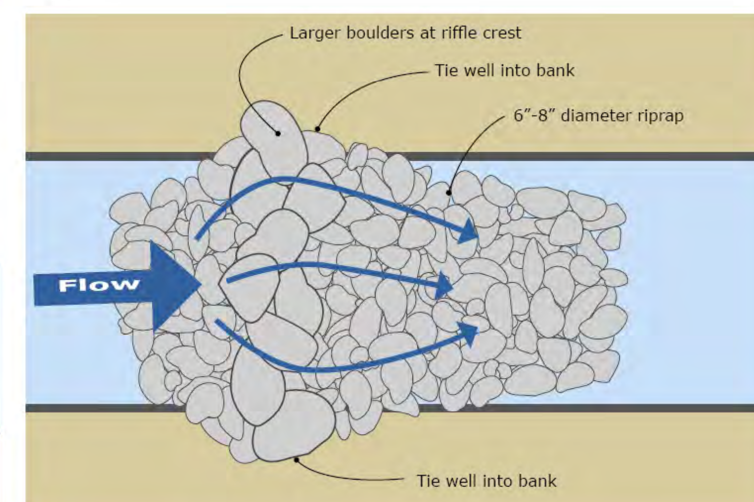
Following the 1987 "super storm," a rapids was constructed on Nine Mile Creek downstream of the 106th Street Bridge. The rapids was one of several grade-control structures that were installed on a three-mile stretch of creek in the lower valley. The proposal allowed the stream to continue its course while taking measures to protect areas where water flow was eroding valley walls. Protection measures included applying porous deflector dikes, burying sheetpile walls parallel to the creek to prevent undercutting of slopes, installing weirs (rock or capped sheetpile) to limit stream-bed degradation, and improving storm-sewer outlets.

## EXISTING CONDITIONS

Channel incision occurs when there is an imbalance between the sediment supply and the sediment carrying capacity of the stream. Erosion will occur when the sediment carrying capacity of a stream exceeds the sediment supply. In streams with cohesive banks and steep channel slope, the erosion will first occur primarily on the channel bottom because that is where the erosive forces are the strongest. As the channel deepens, the stream will gradually become wider as the banks eventually fail. The stream will gradually return to equilibrium; however, the process can take many years and significant amounts of erosion will occur during the process.

## SECTION/PLAN RENDERING




# Constructed Riffle

Grade Control

BARR

**Figure 4**

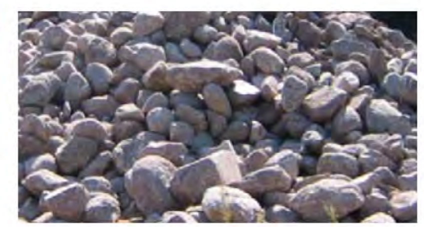
# Stream Stabilization Plan

Rock vanes are constructed from boulders on the creek bottom. They function by diverting channel flow toward the center and away from the bank. They are typically oriented in the upstream direction and occupy no more than one third of the channel width. Vanes are largely submerged and inconspicuous. The rocks are chosen such that they will be large enough to resist movement during flood flows or by vandalism, with additional smaller rock material to add stability. Rock vanes function in much the same way as root wads in that they push the stream thalweg (zone of highest velocity) away from the outside bend. They also promote sedimentation behind the vane, which adds to the toe protection.

Vanes can also be constructed from both banks, forming an upstream-pointing "V." In this configuration, the vane protects both banks and also provides grade control.

## MATERIALS

Materials will consist of various gradations of rock, ranging from large, 3-foot boulders to coarse gravel.



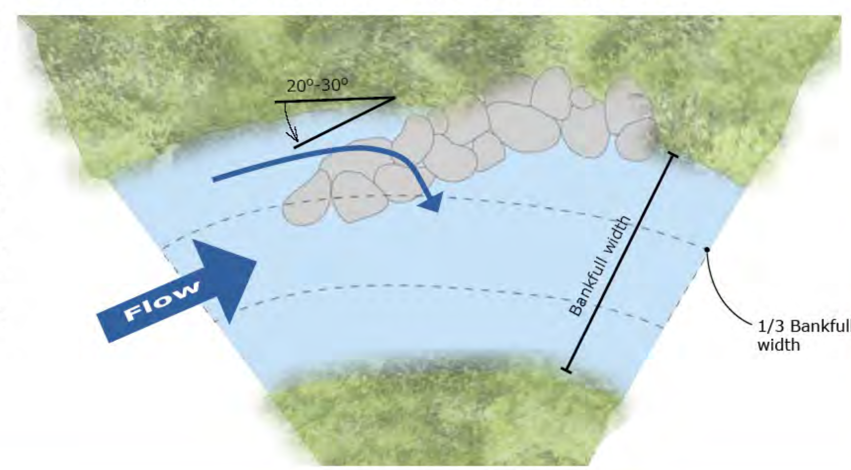
## SIMILAR PROJECTS

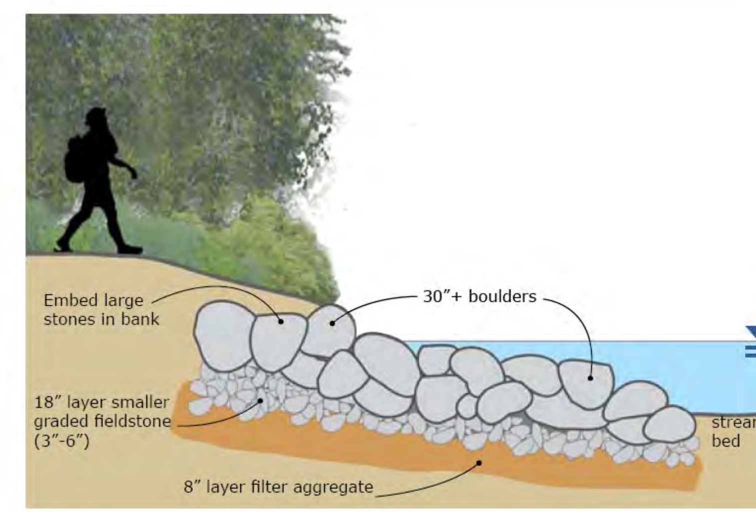
Here is an example of a stabilization project designed for a 1,000-foot long, 20-foot high streambank that was severely eroded. The channel was directed away from the bank toe by installing six rock vanes. The bank was planted with native vegetation and protected with erosion control blanket, while the terrace above the bank was graded to redirect surface runoff to a less vulnerable area. The restored streambank withstood significant flooding during 2001, and has become nicely vegetated (see picture above).

## EXISTING CONDITIONS

Fluvial bank erosion is caused by water in the stream moving past the streambanks. The shear stress caused by the flow entrains soil particles into the flow, causing the stream bank to erode away. This is the most common type of erosion that occurs in streams. Virtually all streams experience this type of erosion as their flow path evolves over time. However, the rate of fluvial bank erosion can increase when the stream is out of equilibrium with its watershed. Increased flow from a watershed will increase the rate of fluvial bank erosion. In places where the channel is confined by the valley walls, however, fluvial bank erosion can lead to failure of the high banks. It can also undermine storm sewer inlets.

## PLAN/SECTION RENDERING




# Rock Vanes

Bank Protection

BARR

**Figure 5**

# Stream Stabilization Plan

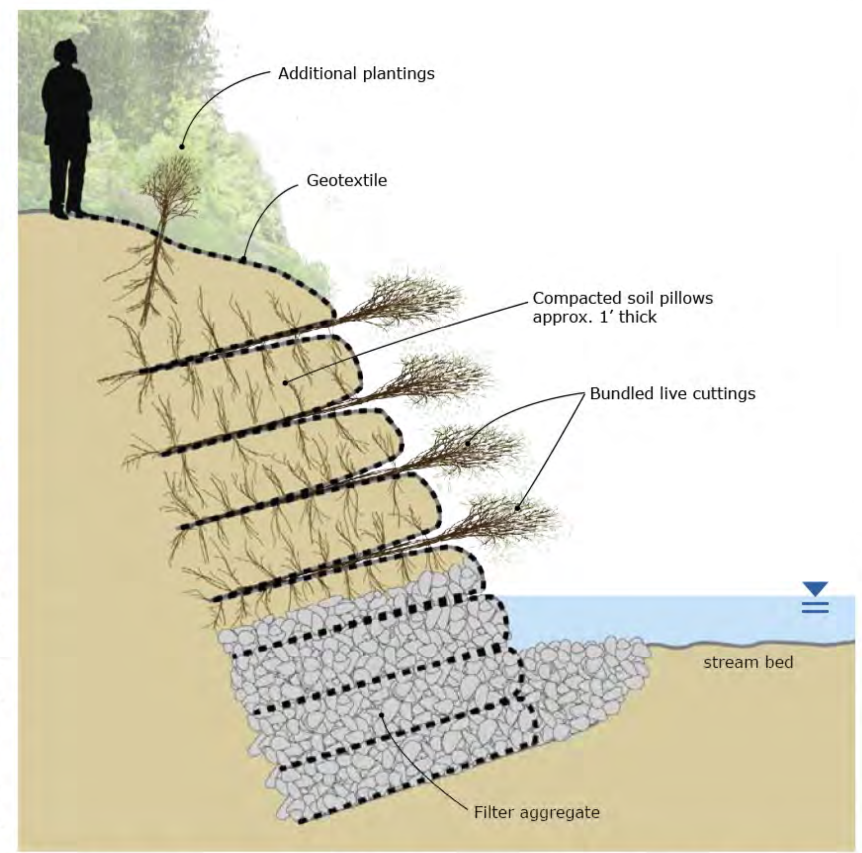
## EXISTING CONDITIONS

Fluvial bank erosion is caused by water in the stream moving past the streambanks. The shear stress caused by the flow entrains soil particles into the flow, causing the stream bank to erode away. This is the most common type of erosion that occurs in streams.

Virtually all streams experience this type of erosion as their flow path evolves over time. However, the rate of fluvial bank erosion can increase when the stream is out of equilibrium with its watershed. Increased flow from a watershed will increase the rate of fluvial bank erosion.

Soil Pillows are utilized in a bioengineering method known as Vegetated Reinforced Slope Stabilization (VRSS). The method combines rock, geosynthetics, soil and plants to stabilize steep, eroding slopes in a structurally sound manner. VRSS typically involves protecting layers of soils with a blanket or geotextile material (e.g. erosion control blanket) and vegetating the slope by either planting selected species (often willow or dogwood species) between the soil layers or by seeding the soil with desired species before it is covered by the protective material. In either case, with adequate light and moisture, the vegetation grows quickly and provides significant root structure to strengthen the bank. This method tends to be labor intensive and, therefore, relatively expensive.

## SECTION RENDERING




In places where the channel is confined by the steep valley walls, however, fluvial bank erosion can lead to failure of the high banks. It can also undermine storm sewer inlets.

For sites where groundwater seepage is a problem and where it is desirable to maintain steep banks, soil pillows are a feasible solution.

## SIMILAR PROJECTS

The Mill Creek Restoration Project utilized soil bioengineering design to stabilize 175 linear feet of severely eroding streambanks within the Caldwell Recreation Park in southeastern Ohio. The work included two 25-foot vegetated reinforced soil slope (VRSS) sections, two 50-foot fill bank sections protected with woven coir and direct woody plantings, and a 12.5-foot tie-in on the upstream and downstream end of streambank work area.

## MATERIALS

Materials consist of graded rock for the lower layers of the structure and for internal drainage, if necessary. Geotextile fabric is used to wrap the soil. Plants, such as willow or dogwood, or seed mixture is used for planting in and between the soil pillows.

# Soil Pillows

Bank Protection

**Figure 6**

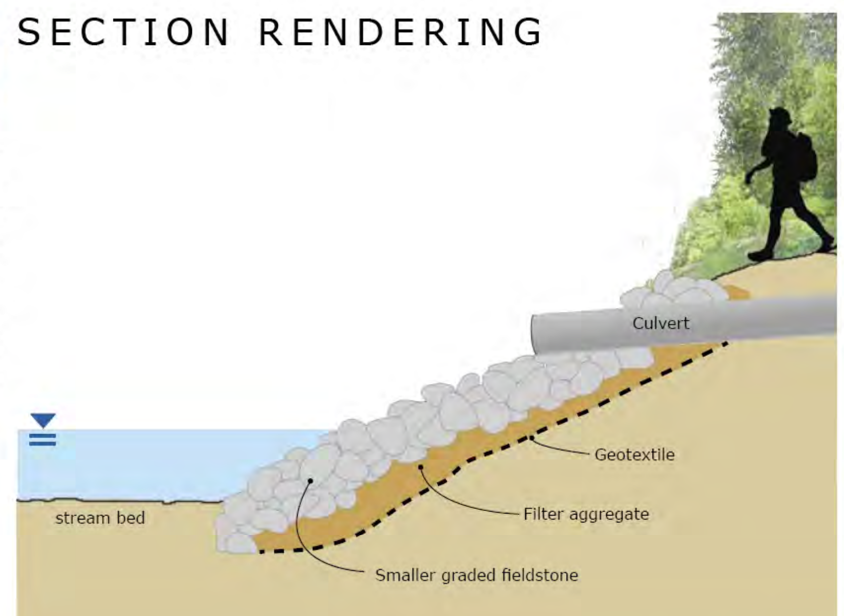
# Stream Stabilization Plan

Culvert Stabilization is somewhat unique to each situation, depending on the site circumstances. Most sites require additional rock placement with a granular filter layer (rather than filter fabric). Some cases may require re-alignment and/or lowering of the outlet to better align with the stream channel. Typically, outlets should be aligned in the downstream channel direction so that flow doesn't impinge on the opposite bank. It is usually desireable for the culvert to enter the stream at or just above the normal water level in order to minimze the potential for undercutting.

## EXISTING CONDITIONS

Erosion is frequently observed at culvert outlets for a variety of reasons, including insufficient erosion protection at the culvert outlet, streambank erosion, and channel downcutting, which leaves the culvert perched above the channel. Filter fabric is often used at culvert outlets to separate riprap protection from underlying soils, however the fabric provides a slippery surface for the riprap, which commonly slides into the channel.

## SECTION RENDERING




## SIMILAR PROJECTS

There are many culvert stabilization designs used on various streams and rivers. Because they are often small projects, the work is often performed by local municipalities or completed as part of a larger project.

## MATERIALS

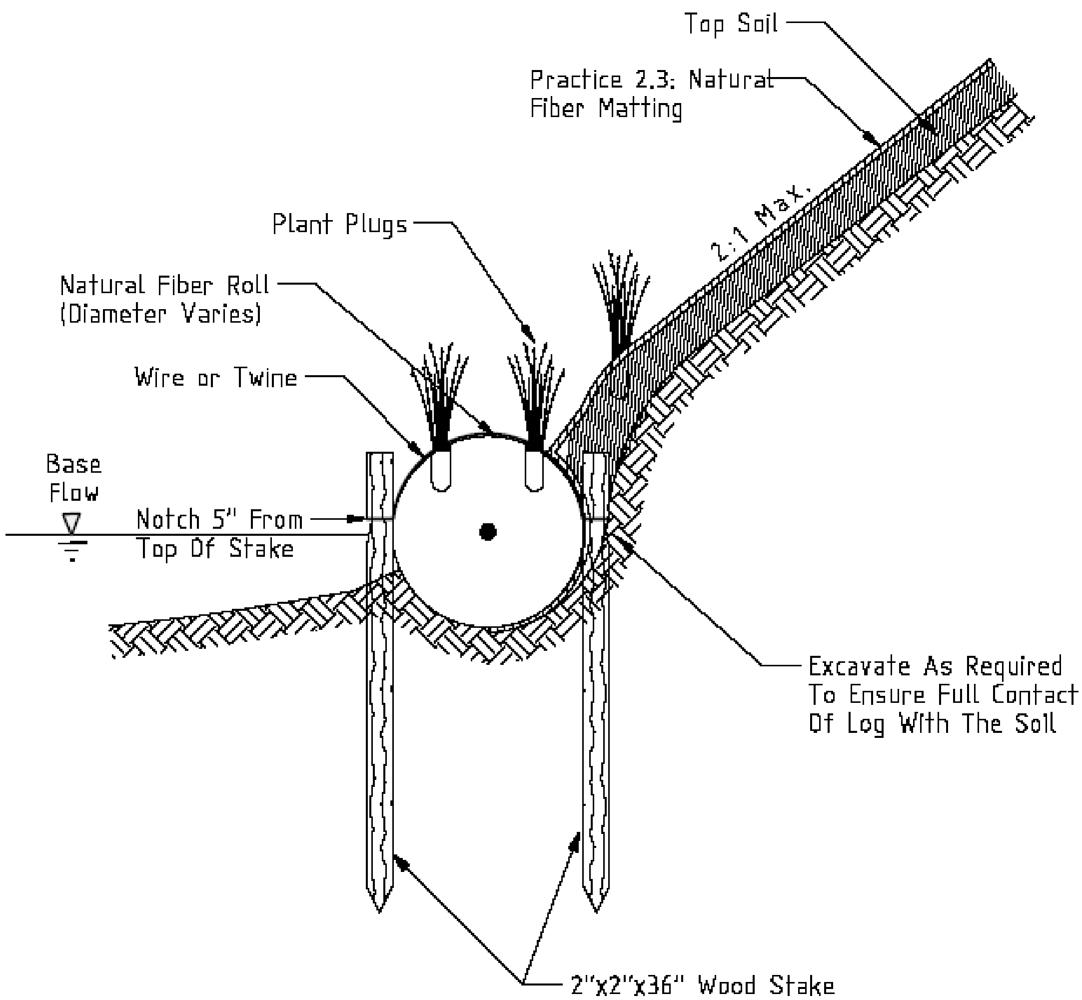
Materials consist of rock materials ranging from graded riprap (either fieldstone, or, for steep slopes, angular) and granular filter material (typically coarse gravel). If necessary, additional pipe, manholes and end sections may be necessary.

# Culvert Stabilization

Bank Protection

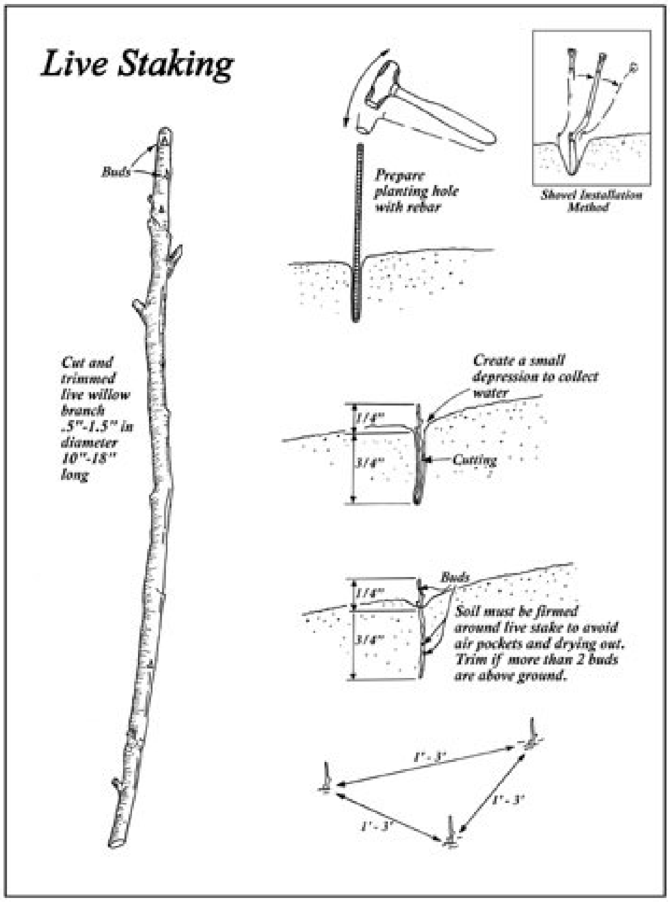
BARR

**Figure 7**



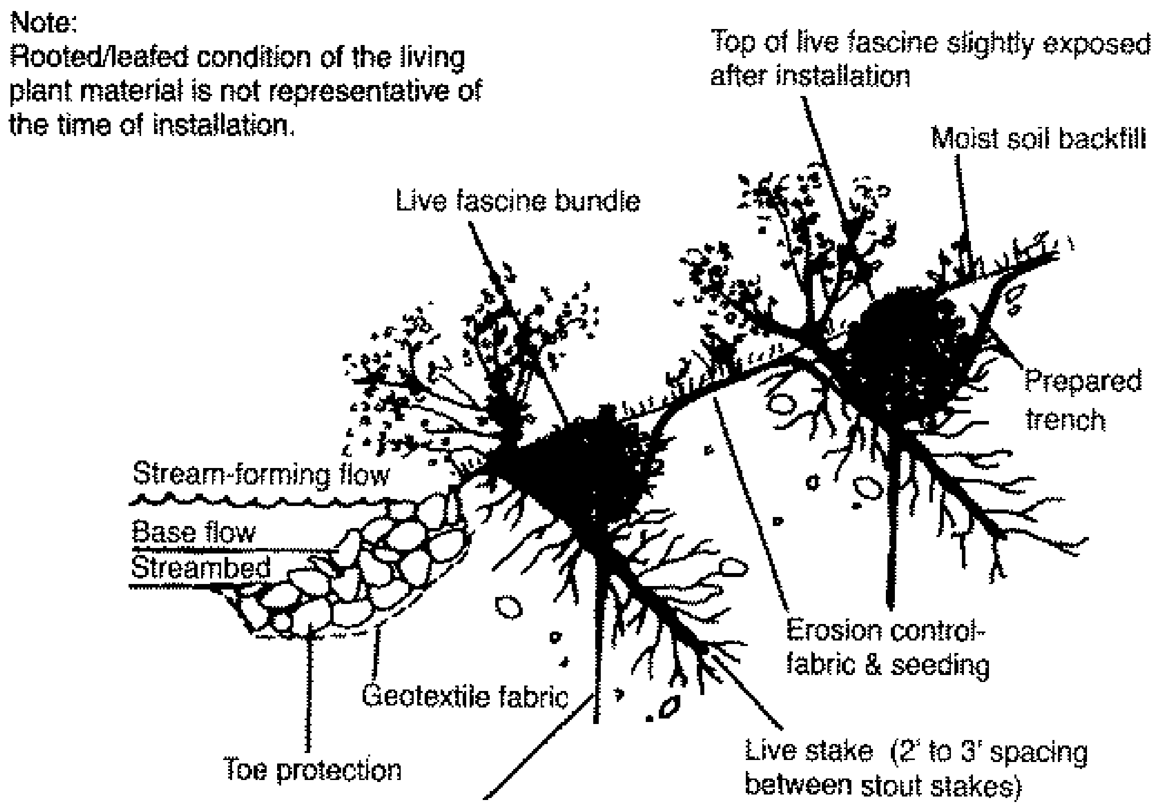

Source:
The Virginia Stream Restoration & Stabilization Best Management Practices Guide

**Figure 8**
**Biologs Bank Protection**
**North Branch Bassett Creek Restoration Project**
**Bassett Creek Watershed Management Commission**




Source: http://www.sf.adfg.state.ak.us/SARR/restoration/techniques/livestake.cfm

**Figure 9**
**Live Stakes for Bank Protection**
**North Branch Bassett Creek Restoration Project**
**Bassett Creek Watershed Management Commission**




Source: http://www.dnr.state.oh.us/water/pubs/fs_st/stfs14/tabid/4169/Default.aspx

**Figure 10**
**Live Fascines for Bank Protection**
**North Branch Bassett Creek Restoration Project**
**Bassett Creek Watershed Management Commission**

# *Appendices*

# *Appendix A*

## *2010 Site Photos*

**Photo 1**. *Site 1*. Looking upstream at both banks.

**Photo 2**. *Site 2*. Moderate erosion.

**Photo 3**. *Site 2*. Severely eroding bank.

**Photo 4**. *Site 3*. Moderately eroding bank

**Photo 5**. *Site 4*. Erosion being curtailed by tree roots.

**Photo 6**. *Site 5*. Moderate to severe erosion.

**Photo 7**.  *Site 6*.  Banks being held by failing wall.

**Photo 8**.  *Site 6*.  Opposite bank without wall.

**Photo 9**. *Site 7.* Moderate erosion.

**Photo 10**. *Site 8*. Moderate erosion

**Photo 11**. *Site 9*. Debris jam.

**Photo 12**. *Site 10*. Manhole in need of additional support and protection.

**Photo 13**. *Site 11*. Exposed manhole.

**Photo 14**. *Site 12*. Moderate erosion.

**Photo 15**. *Site 13*. Scarp formation with severe erosion

**Photo 16**. *Site 14.* Exposed manhole at outside of stream bend.

**Photo 17**. *Site 15.* Minor bank erosion with undercut trees.

**Photo 18**. *Site 16* Fallen tree with large scarp in background.

**Photo 19**. *Site 17.* Steep bank with some litter and soil present.

**Photo 20**. *Site 18.* Moderate erosion with undercut trees.

**Photo 21**. *Site 19.* Steep bank with erosion present.

**Photo 22**. *Site 20.* Minor bank erosion with undercut trees.

# *Appendix B*

## *Wetland Delineation*

# North Branch Bassett Creek Wetland Delineation Report for the Bassett Creek Feasibility Study

## Bassett Creek Stream Restoration Project
## City of Crystal, MN

**Prepared for**
**Bassett Creek Watershed Management Commission**

**August 2010**

BARR

4700 West 77th Street
Minneapolis, MN 55435-4803
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Fax: (952) 832-2601

# North Branch Bassett Creek
# Wetland Delineation Report
# Bassett Creek Feasibility Study
# Bassett Creek Watershed Management Commission
# City of Crystal, MN
# August, 2010

## Table of Contents

## List of Figures



## List of Appendices

# 1.0 Introduction

Barr Engineering Company (Barr) has completed the delineation and mapping of wetlands within the North Branch of Bassett Creek (North Branch) study area in accordance with the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (1987 Edition) and the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region* (2008). The study area is located within Sections 20 and 21, Township 118N, Range 21W, in the City of Crystal, in Hennepin County, Minnesota. A location map is provided in Figure B-1. The extent of delineation and mapping includes a one-mile reach of North Branch which flows in a generally southeasterly direction and is bounded to the north by 36$^{th}$ Avenue and to the south by Bassett Creek Pond. Figure B-2 provides aerial photography that covers the entire area where wetlands were delineated. Barr Engineering identified and delineated nine hydrologically-connected wetlands within the bounds described above.

The extent of the restoration area is smaller than the area included in the delineation. The restoration area includes North Branch Bassett Cree between 32$^{nd}$ Avenue North and approximately 200 feet upstream of Douglas Drive. The delineation results for the restoration area are included in the discussion and summation of wetlands in this report. Barr Engineering identified and delineated five hydrologically-connected wetlands within the restoration area. Details of the delineation methodology and wetland descriptions are reflected in later sections of this report.

### Section 404 Permit

The proposed Bassett Creek Stream Restoration Project will require a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers (COE). Under Section 404 of the Clean Water Act (CWA), the COE regulates the placement of fill into wetlands, if the wetlands are hydrologically linked to a water of the United States. North Branch of Bassett Creek is directly connected to the Mississippi River, a water of the United States. Additionally, the MPCA will likely be involved in any wetland mitigation requirements as part of the CWA Section 401 water quality certification process for the 404 Permit.

### Minnesota Wetland Conservation Act

The Wetland Conservation Act (WCA) regulates the filling and draining of wetlands and excavation within Type 3, 4, and 5 wetlands. In addition, the WCA may regulate all types of wetland alteration if any wetland 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 Crystal is the LGU for the proposed project site. The Minnesota Board of Water and Soil Resources (BWSR) oversees administration of the WCA statewide.

# 2.0 General Environmental Setting

The following sections describes mapped and documented data on the North Branch study area, including hydrology, available land cover data, and mapped soil units, and mapped wetland community information.

## 2.1 Hydrology

The North Branch is one of several branches of Bassett Creek which make up the ±25,000 acre Bassett Creek Watershed. The North Branch is a small, winding, shallow stream located in a suburban-urban setting and drains portions of the cities of Plymouth, New Hope, Crystal, and Golden Valley. It begins in the City of Plymouth at the Bassett Creek Watershed boundary and flows in a southeasterly direction before flowing through Bassett Creek Pond and connecting with the north-flowing Main Stem of Bassett Creek just upstream of Highway 100. From there, Bassett Creek flows southeast towards the City of Minneapolis where it discharges into the Mississippi River.

The topography at 36$^{th}$ Avenue is 880 feet above mean sea level (AMSL). The elevation gradually decreases to 846 feet (AMSL) where it discharges into Bassett Creek Pond. A 2-foot contour topographic map and USGS Quadrangle map are included as Figures B-3a, B-3b, and B-4, respectively.

## 2.2 Land Use/Land Cover

The one-mile extent of North Branch of Bassett Creek occurs in medium and high-density single-family residential areas of Crystal. Other land uses surrounding North Branch include multi-family residential, retail commercial, and community park. The stream crosses numerous residential streets and county highways and is typically abutted by the backyards of residential housing. Generally, a forested vegetation buffer is in place, but occasionally, cleared landscaped yards directly abut the stream edge. Available land cover data is presented in Figure B-5. Representative photographs of the land cover around North Branch are attached in Appendix B-1.

## 2.3 Soils

According to the United States Department of Agriculture Natural Resources Conservation Service Soil Data Mart for Hennepin County, there are two major soil classifications that occur within the study area, which are depicted in Figure B-6 and are described below.

U1A - URBAN LAND-UDORTHENTS, WET SUBSTRATUM, COMPLEX, 0 TO 2 PERCENT SLOPES

*Component: Urban land (80%)*

The Urban land component is mainly commercial, industrial or residental areas with 65 to 100 percent of the map unit covered by impervious surfaces. The majority of the area was originally occupied by wet depressional soils, mineral or organic.

*Component: Udorthents, wet substratum (20%)*

The Udorthents, wet substratum component is comprised of fill material placed in wet depressional areas to match the adjoining upland landscape. Because of the variability of the components in this map unit, interpretations for specific uses are not available and onsite investigation is needed.

U2A - UDORTHENTS, WET SUBSTRATUM, 0 TO 2 PERCENT SLOPES

The Udorthents, wet substratum component is comprised of fill material placed in wet depressional areas to match the adjoining upland landscape. Because of the variability of the components in this map unit, interpretations for specific uses are not available and onsite investigation is needed.

## 2.4 National Wetlands Inventory

United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) database was consulted for the presence of wetlands within the study area. According to NWI data, which was mapped in the 1980s in the State of Minnesota, several wetlands occur within the study area, including forested, emergent, and open water wetlands. The mapped NWI wetlands align somewhat with actual site conditions, but often over or under-estimate actual wetland extent. Below are the descriptions for the Cowardin (1979) classification codes, as shown in Figure B-7.

PFO1/EMCd - Palustrine forested, broad-leaved deciduous/Emergent, seasonally flooded, partially drained or ditched

PFO1C - Palustrine forested, broad-leaved deciduous, seasonally flooded

PEMCd - Palustrine emergent, seasonally flooded, partially drained or ditched

PUBGx - Palustrine, unconsolidated bottom, intermittently exposed, excavated

PUBGd - Palustrine, unconsolidated bottom, intermittently exposed, partially drained or ditched

PUBF - Palustrine, unconsolidated bottom, semi-permanently flooded

## 2.5 Public Waters Inventory

The DNR Public Waters Inventory (PWI; a.k.a. Protected Waters Inventory) database was consulted for the presence of wetlands or other surface waters in or near the study area receiving statutory protection. The North Branch of Bassett Creek is a PWI Watercourse. West of Brunswick Ave. (Figure B-1), North Branch is designated as a PWI Natural Watercourse. East of Brunswick Avenue, it is designated as a PWI Altered Natural Watercourse. In addition, a Public Water, Unnamed (27-646 P) occurs at the south end of North Branch, to include Bassett Creek Pond. A portion of the southern extent of the study area and delineated wetland occurs within the limits of this Public Water (Figure B-7).

# 3.0 Wetland Delineation

## 3.1 Wetland Delineation and Classification Methods

This assessment was designed to evaluate the ecological conditions and characteristics of the study area to identify wetlands and other surface waters that may be claimed as jurisdictional by federal and/or state agencies. The study area included all areas 75 feet from both sides of the stream centerline. All wetlands and surface waters wholly or partially within this study area were delineated. Wetlands that entirely occur outside of the study area were not delineated.

Before field investigations, desk-top preliminary data was collected and reviewed. National Wetlands Inventory mapping is a useful off-site tool in identifying the possible presence of wetlands. Other data available included aerial photography, topographical data, and soils data. Field investigations were conducted on June 9 and July 8, 2010 by Barr to identify and delineate jurisdictional wetland boundaries on the property.

The delineation was conducted according to the Routine On-Site Determination Method specified in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (1987 Edition) and the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region* (2008). North Branch, from 36$^{th}$ Avenue to Bassett Creek Pond was traversed on foot and field delineated.

In determining the jurisdictional wetland boundaries, the three jurisdictional wetland qualifiers, wetland hydrology, hydrophytic vegetation, and hydric soils were examined as evidence of wetland presence or absence. Wetlands and adjacent upland data on hydrology, vegetation, and soils were recorded in *Wetland Determination Data Form – Midwest Region* data sheets, which are included in Appendix B-1. Because the wetlands are relatively homogeneous, data points were completed for only a few representative wetlands. The wetland boundaries were recorded using a Trimble Global Positioning System with sub-meter accuracy. The wetland boundaries were then mapped using ArcMap 9.0 Geographic Information System software. Photo documentation of typical wetlands encountered along North Branch is provided in Appendix B-2.

Soil profiles were excavated with the use of a Dutch auger, typically up to a depth of 24 inches below the ground surface or when definitive hydric soil indicators were encountered. The soil sample points reported in Appendix B-2 were located close to the water-ward extent of the wetland line, for the wetland data point, and close to the land-ward extent of the wetland line for the upland data point. The soil profiles from each boring were examined for hydric soil indicators according to the *Pocket Guide to Hydric Soil Field Indicators* (Wetland Training Institute 2004). Soil colors were determined with the aid of a Munsell® soil color chart. Soil textures were determined by feel. The hydrologic conditions within the immediate vicinity of each soil boring were documented.

Vegetative plots were established for herbaceous layers, and when possible, in a nested fashion with shrub and tree layers, within each wetland and adjacent upland data point. The plant species at each sample location were identified and their wetland indicator status (for Region 3) was noted (Reed 1988; USDA 2010). Efforts were made to meet the Army Corps Delineation Manual plot size requirements for each stratum, but due to wetland shape and size and steep site topography, rectangular plots were often created, but still covered a suitable percentage of wetland area. Dominant species were determined by use of the 50/20 rule.

The delineated wetlands habitat types were classified using the U.S. Fish and Wildlife Service Circular 39 System (U.S. Fish and Wildlife 1956) and the U.S. Fish and Wildlife Service Cowardin System (Cowardin *et al*. 1979).

## 3.2 Delineation Results

With few exceptions, the entire one-mile stretch of the North Branch study area is abutted by riparian wetlands. The wetlands contiguous to, and which include, the North Branch stream channel are in most cases are floodplain forested wetlands, best described as Type 1 “Seasonally flooded basins or flats” under the Circular 39 System or PFO1A “palustrine forested, broad-leaved deciduous, temporarily flooded” under the Cowardin System. The individual wetland polygons are an artificial product of one contiguous wetland system becoming separated by roadways. These wetlands remain hydrologically connected by large under-road culverts. The four wetlands encountered and delineated in the North Branch restoration area total ±4.6 acres. Although all wetlands in the study area occur in conjunction with North Branch, hydrologic indicators were not always encountered, even close to the stream channel. However, in most cases, secondary hydrologic indicators were present, such as floodplain geomorphic setting and the FAC-neutral test. The wetland delineation results are presented in Figures 8 and 9.

Except where noted, the vegetation is similar in all wetland areas. Box elder is the most common species in the canopy. Large cottonwood trees are also common and scattered throughout. Other typical canopy species include American elm, silver maple, and green ash. In the shrub layer, buckthorn can be problematic, often occurring in high densities. Other shrubby vegetation largely consists of young forest canopy species listed above, along with occasional red-osier dogwood, black willow, sumac, mulberry, and elderberry. The ground cover under dense forest canopy is often dominated by jewelweed, stinging nettle, American horehound, and Virginia creeper. In more open areas, the ground cover consists of reed canary grass, garlic mustard, bird's foot trefoil, giant goldenrod, and Canada goldenrod.

As described above, a total of nine wetlands were delineated in the study area, but only five wetlands are present within the restoration area. The following sections describe all nine wetlands in the study area in additional detail. Only wetlands D, E, F, G, and H are located within the restoration area

### 3.2.1 Wetland A (±0.11 acres)

Wetland A is located at the northernmost extent of the North Branch study area. It is a depressional system, surrounded by fill placed for housing and 36$^{th}$ Ave. construction. Vegetation is a largely herbaceous wet meadow (Type 2), with reed canary grass dominating, surrounded by a fringe of black willow.

### 3.2.2 Wetland B (±0.05 acres)

Wetland B is a small depressional wetland created incidentally from the drainage caused by surrounding fill placed for housing and road construction. Unlike other wetlands delineated along North Branch, Wetland B is not directly connected to Bassett Creek, except during high rainfall events.

Wetland and upland data points were recorded in Wetland B (SB1 and SB2 in Appendix B-2), as shown on Figure B-8. Wetland B is a herbaceous wet meadow (Type 2; PEMB), dominated by reed canary grass. Speckled alder surrounds the wetland edge. Soils are 10YR 2/1 in color to a depth of 8 inches, with 25-50% redoximorphic features from 8-24 inches; sandy clay loam in texture; and meets the Redox Dark Surface hydric soil criteria. Wetland B met the secondary hydrologic indicators of observed drainage patterns, geomorphic position, and passing the FAC-neutral test.

### 3.2.3 Wetland C (±0.33 acres)

Wetland C is a narrow floodplain forest, surrounded by residential housing to the north and high topographic relief to the south.

### 3.2.4 Wetland D (±0.16 acres)

Wetland D is as explained above for Wetland C.

### 3.2.5 Wetland E (±0.03 acres)

Wetland E is a small turn in the creek surrounded by roads, driveway, and parking lot. It receives additional stormwater drainage from a field to the northeast. It is mainly dominated by common buckthorn and box elder.

### 3.2.6 Wetland F (±0.73 acres)

Wetland F is a long and winding, unbroken stretch of riparian floodplain forest. It is surrounded by single-family and multi-family residential housing occurring at often abrupt higher topography than the wetland and stream channel.

### 3.2.7 Wetland G (±3.23 acres)

Most of Wetland G can be described similarly as Wetland F. At the southern end of Wetland G, the topography flattens out, allowing for broader wetland expanse. However, in some areas, common buckthorn is dense, to the exclusion of a ground cover layer. Where openings exist, typical wetland grasses and forbs occur. Elsewhere, typical forest canopy of box elder is noted.

A wetland only data point was recorded here (SB4 in Appendix B-2), as shown on Figure B-9. Wetland G is a floodplain forest (Type 1; PFO1), dominated by box elder and common buckthorn. Soils are 10YR 2/1 in color to a depth of 14 inches, with 1% redoximorphic features; the texture is loam; and meets the Thick Dark Surface hydric soil criteria. Wetland G secondary hydrologic indicators met include geomorphic position and the FAC-neutral test.

### 3.2.8 Wetland H (±0.43 acres)

Wetland H is turn in the stream channel surrounded by roadways and residential housing.

A wetland only data point was recorded here (SB3 in Appendix B-2), as shown on Figure B-9. Wetland H is a floodplain forest (Type 1; PFO1), dominated by box elder and green ash, with a ground cover of dense garlic mustard. Soils are 10YR 2/2 in color to a depth of 24 inches, with 10-20% redoximorphic features; the texture is sandy clay loam; and meets the Redox Dark Surface hydric soil criteria. Wetland H exhibited geomorphic position and passed the FAC-neutral test as secondary hydrologic indicators.

### 3.2.9 Wetland I (±4.52 acres)

Wetland I is a higher-quality wetland system within Bassett Creek Park. Like the other wetlands, it is bounded by higher topography to the west and east. Additional stormwater drainage is received offsite at the northern extent of wetland. Wetland I marks the southerly extent of North Branch, where it discharges into Bassett Creek pond. The southerly end of Wetland I is herbaceous and shrubby marsh land, dominated by cattail and black willow.

Wetland and upland data points were recorded here (SB5 and SB6 in Appendix B-2), as shown on Figure B-9. Wetland I is a floodplain forest (Type 1; PFO1A), dominated by box elder, with a ground cover of garlic mustard. Soils are 10YR 2/1 in color to a depth of 13 inches, with 10% redoximorphic features; the texture is loam and sandy clay; and meets the Thick Dark Surface hydric soil criteria. Wetland H exhibited drift deposits as a primary indicator of hydrology.

# 4.0 MNRAM Assessment

The Minnesota Routine Assessment Method (MnRAM 3.0) is a comprehensive ranking system designed to help qualitatively assess functions and values associated with Minnesota wetlands for the purpose of managing local wetland resources. Full methodology guidance is available online (BWSR 2009). Some of the criteria evaluated and numerically ranked include vegetative diversity, water quality, fish and wildlife habitat, recreational value, and restoration potential. Functions are ranked from .001 to 1.0, signifying low to high values. When a wetland function has exceptional quality, it is given a score of 2.0.

While performing MNRAM assessments, wetlands in North Branch were grouped and assessed together according to proximity and similarity in habitat and community type. In MNRAM, each assessment is given a unique “wetland name” created from the section, township, and range the assessment occurred in, followed by the sequential number of the assessment. Below are the wetland names noted in the MNRAM assessment summary sheets and the wetlands that were grouped together for each assessment.

27-118-21-20-001: Wetland B

27-118-21-20-002: Wetlands A, C, and D

27-118-21-21-001: Wetlands E, F, G, and H

27-118-21-21-002: Wetland I

The MNRAM summary sheets are presented in Appendix B-3. In general, the wetlands scored relatively low. This is mainly due to the urbanized setting, limited upland buffer, nuisance and exotic species, and problems inherent to the stream itself such as stream bank erosion and degraded water quality from stormwater drainage.

# 5.0 Summary

The wetlands associated with the North Branch of Bassett Creek were delineated in accordance to the COE Wetland Delineation Manual and Midwest Regional Supplement. Nine wetlands totaling approximately 9.6 acres were identified and field delineated. Of these, five wetland totaling approximately 4.6 acres are located within the restoration area. These are primarily floodplain forest riparian wetlands which border North Branch for the extent of the one-mile study area, and are separated by roads. In addition, MNRAM functional wetland assessments were also performed. The wetlands generally scored low in many environmental criteria.

# 6.0 References


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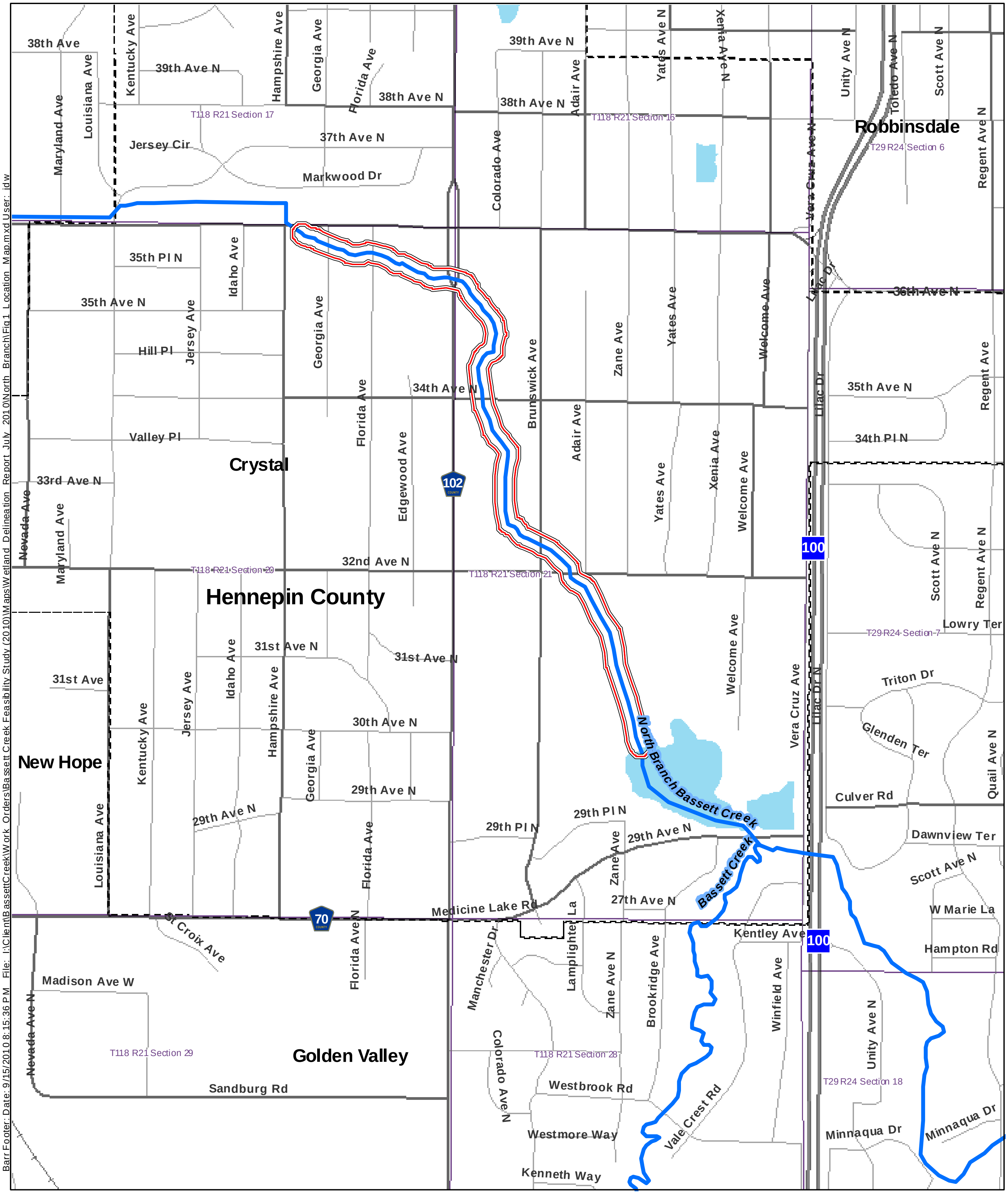
## *Figures*




North Branch Study Area

Creek Channels

Cities and Townships

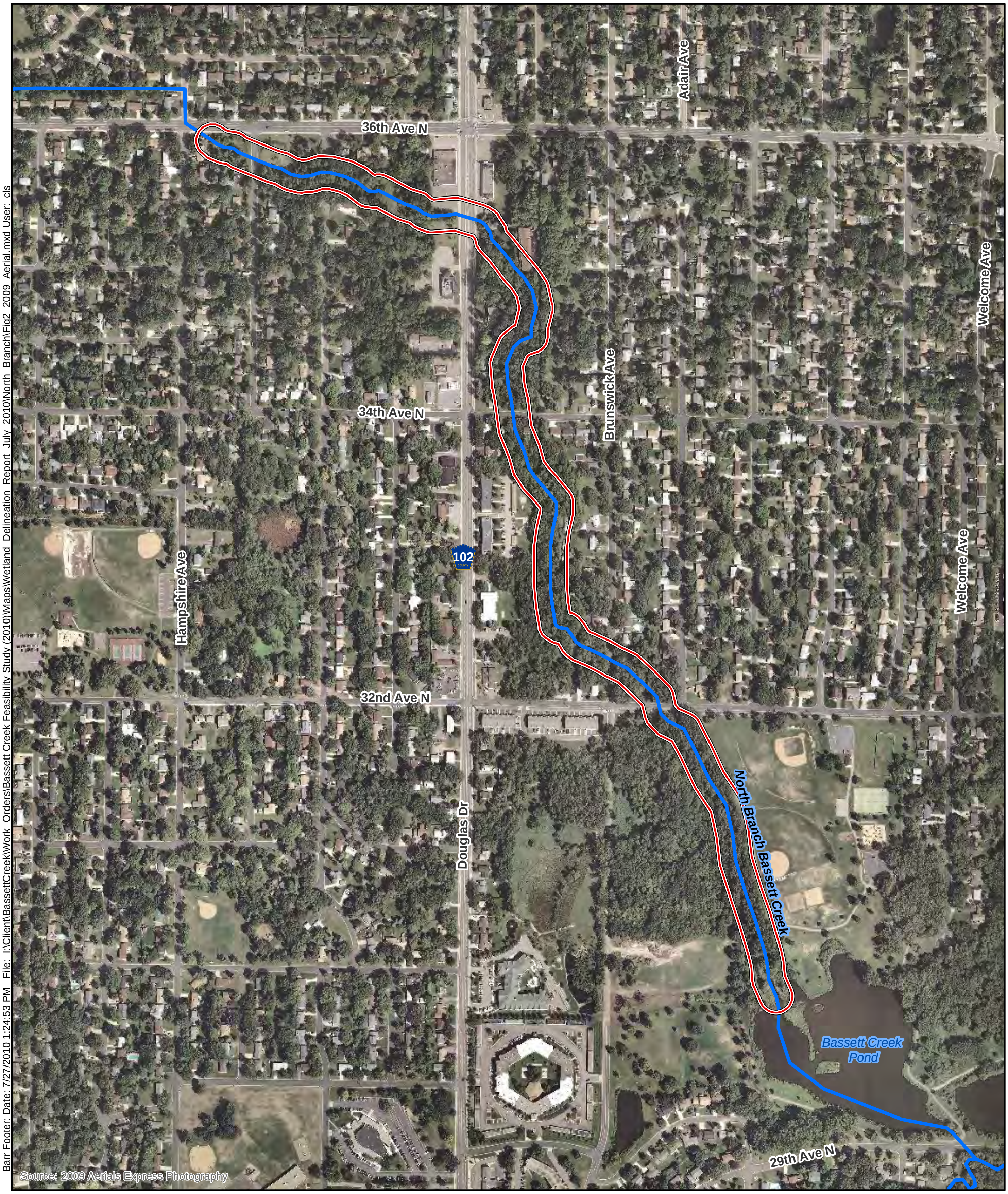
N W E S

1,000 500 0 1,000 Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-1
LOCATION MAP
Bassett Creek Watershed
Management Commission
August 2010

BARR




North Branch Study Area

Creek Channels

N
W E
S

600 300 0 600
Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-2
2009 AERIAL PHOTO
Bassett Creek Watershed
Management Commission
August 2010

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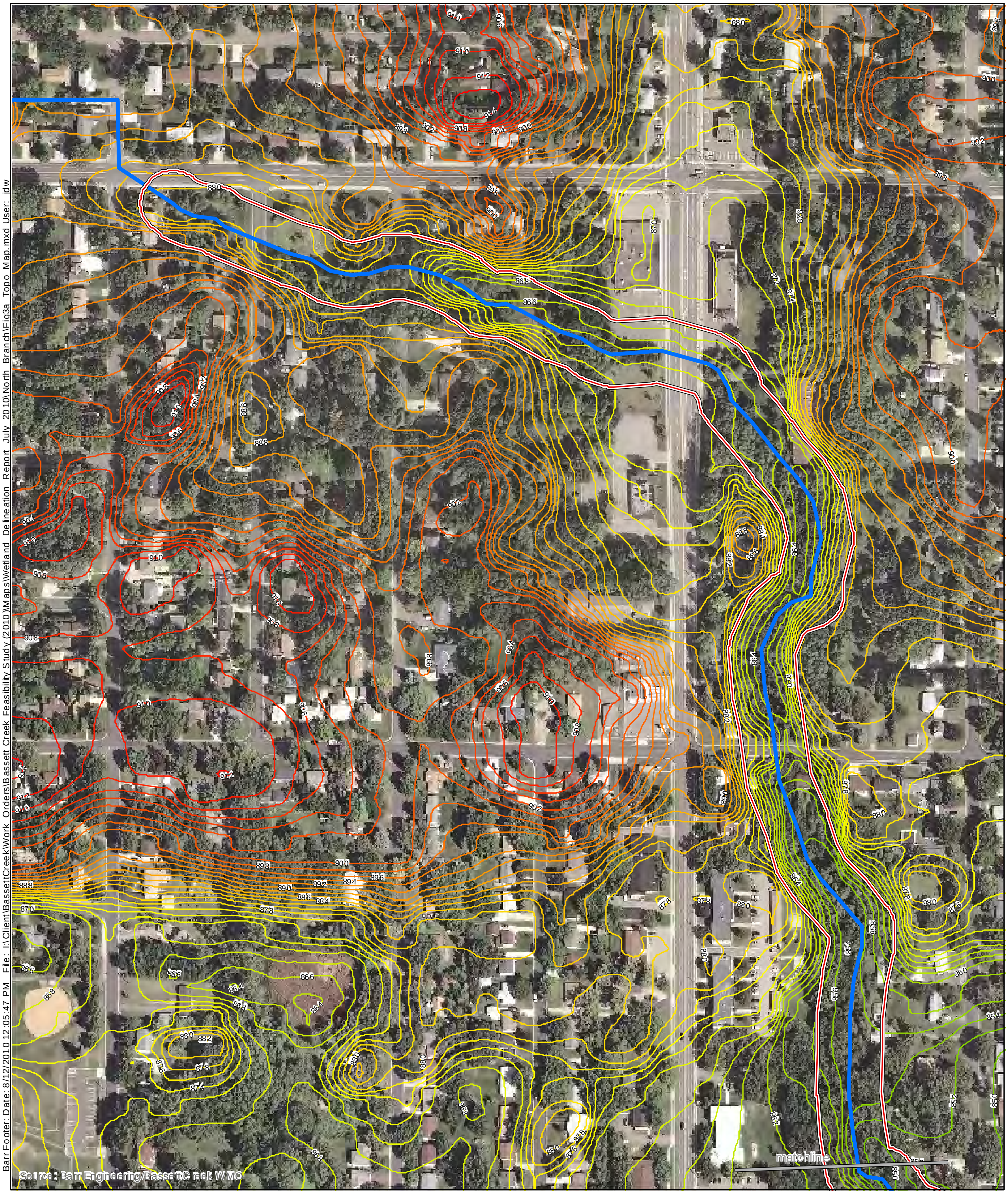


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North Branch Study Area

Creek Channels

N
W E
S

300 150 0 300
Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-3a
TOPOGRAPHIC MAP
Bassett Creek Watershed
Management Commission
August 2010

BARR




North Branch Study Area

Creek Channels

N
W E
S

300 150 0 300
Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-3b
TOPOGRAPHIC MAP
Bassett Creek Watershed
Management Commission
August 2010

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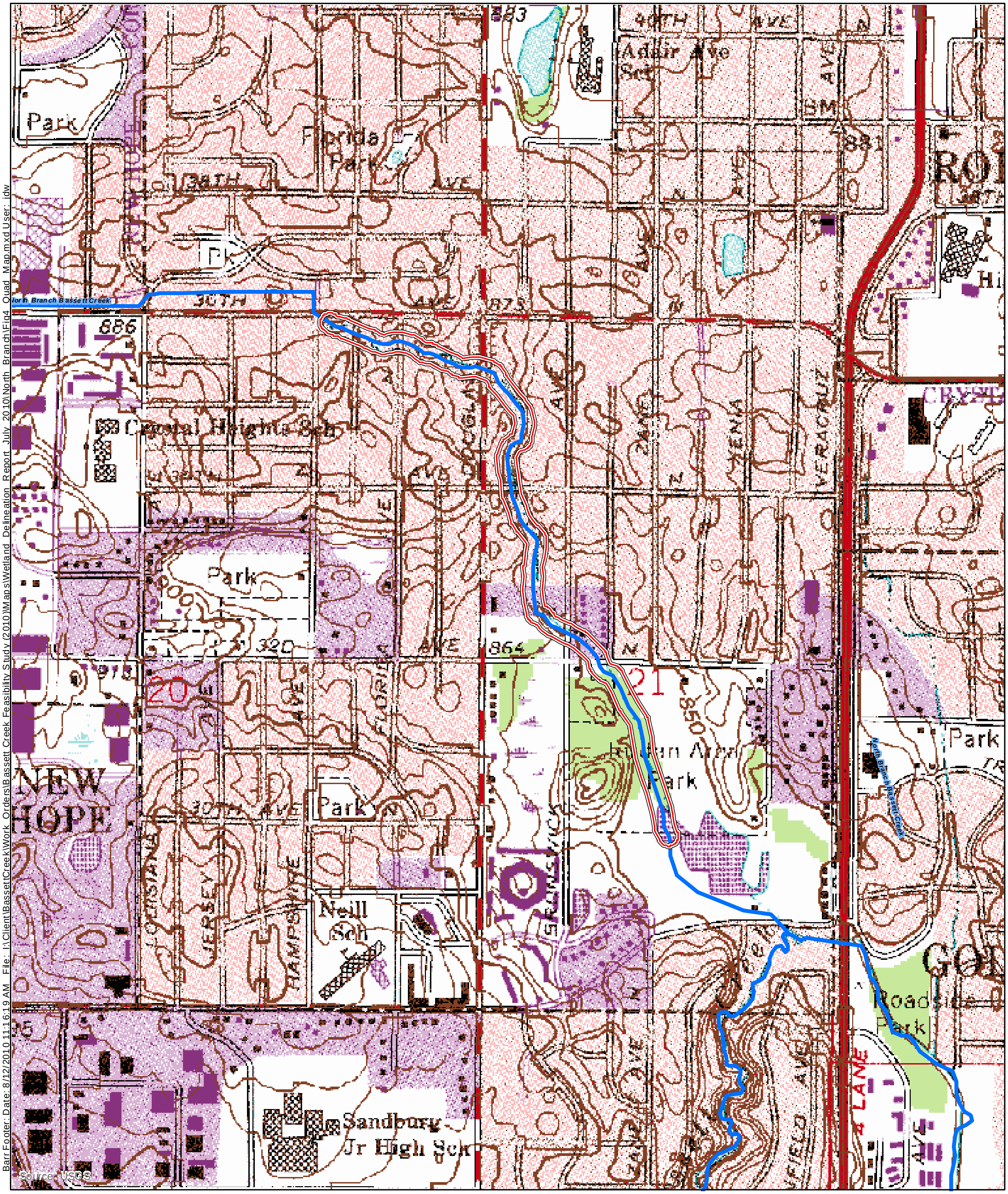



North Branch Study Area

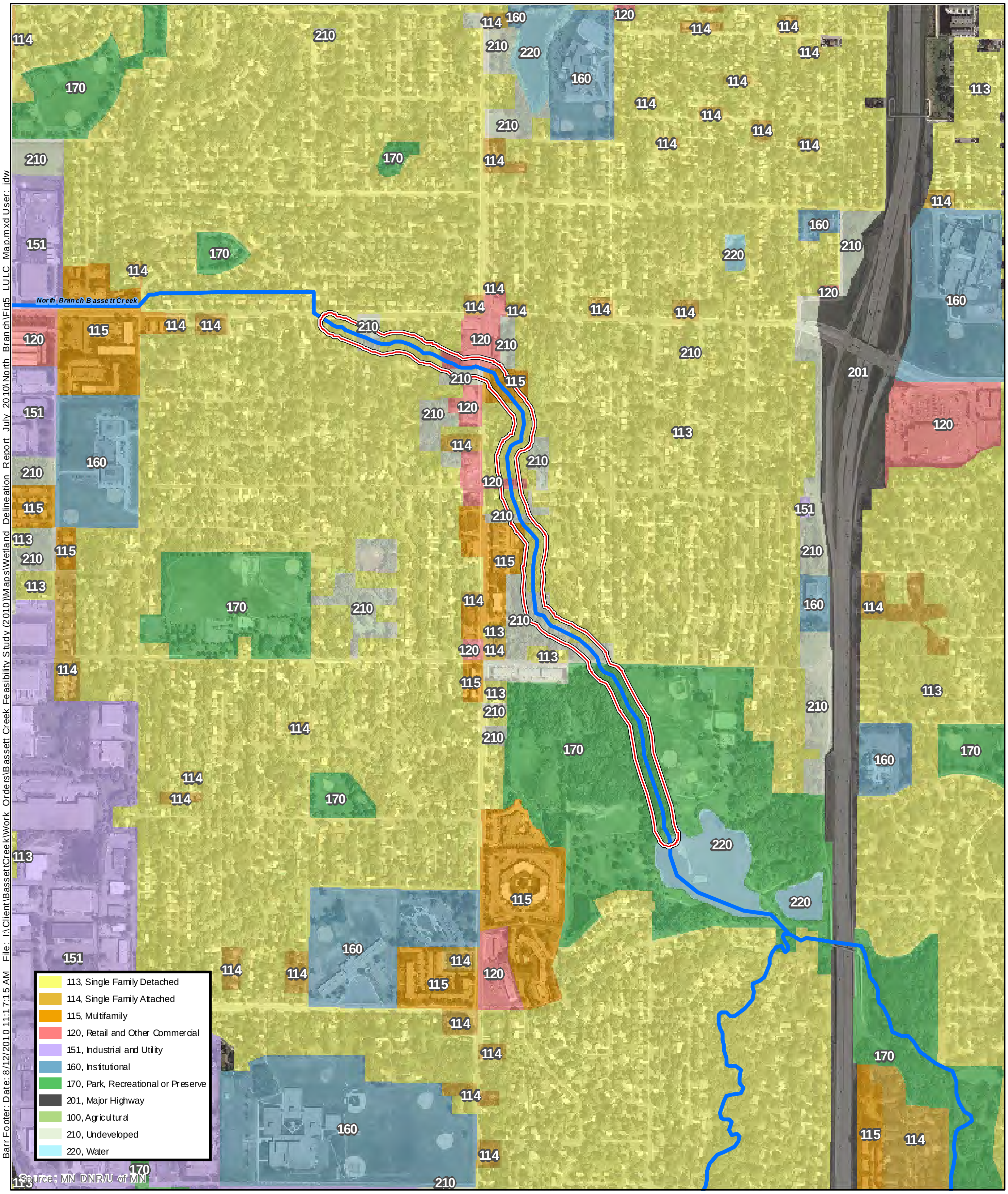
Creek Channels

N
W E
S

1,000 500 0 1,000
Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-4
QUAD MAP
Bassett Creek Watershed
Management Commission
August 2010




North Branch Study Area

Creek Channels

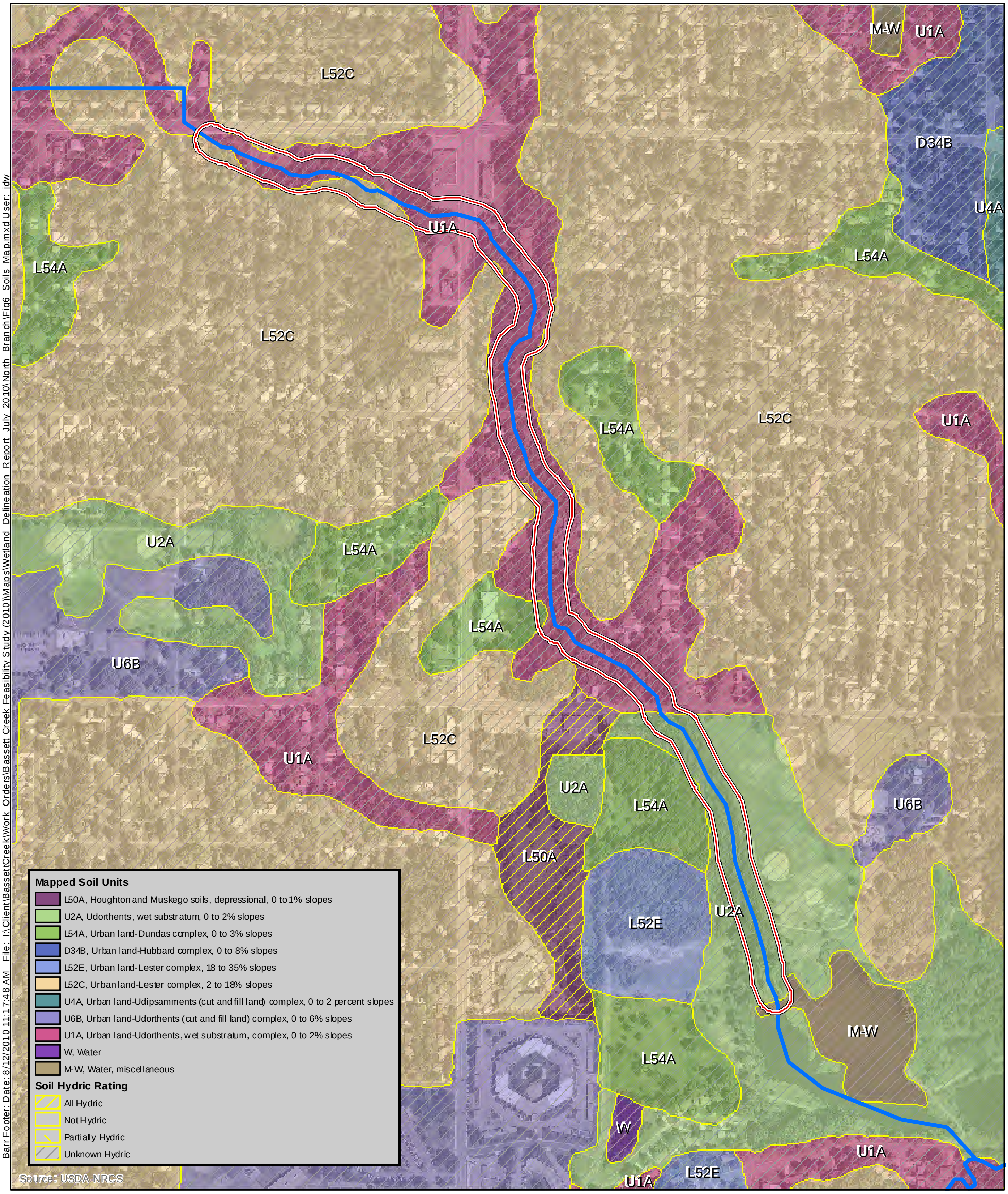
N
W E
S

1,000 500 0 1,000
Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

BARR

Figure B-5
2005 LAND COVER MAP
Bassett Creek Watershed
Management Commission
August 2010




North Branch Study Area

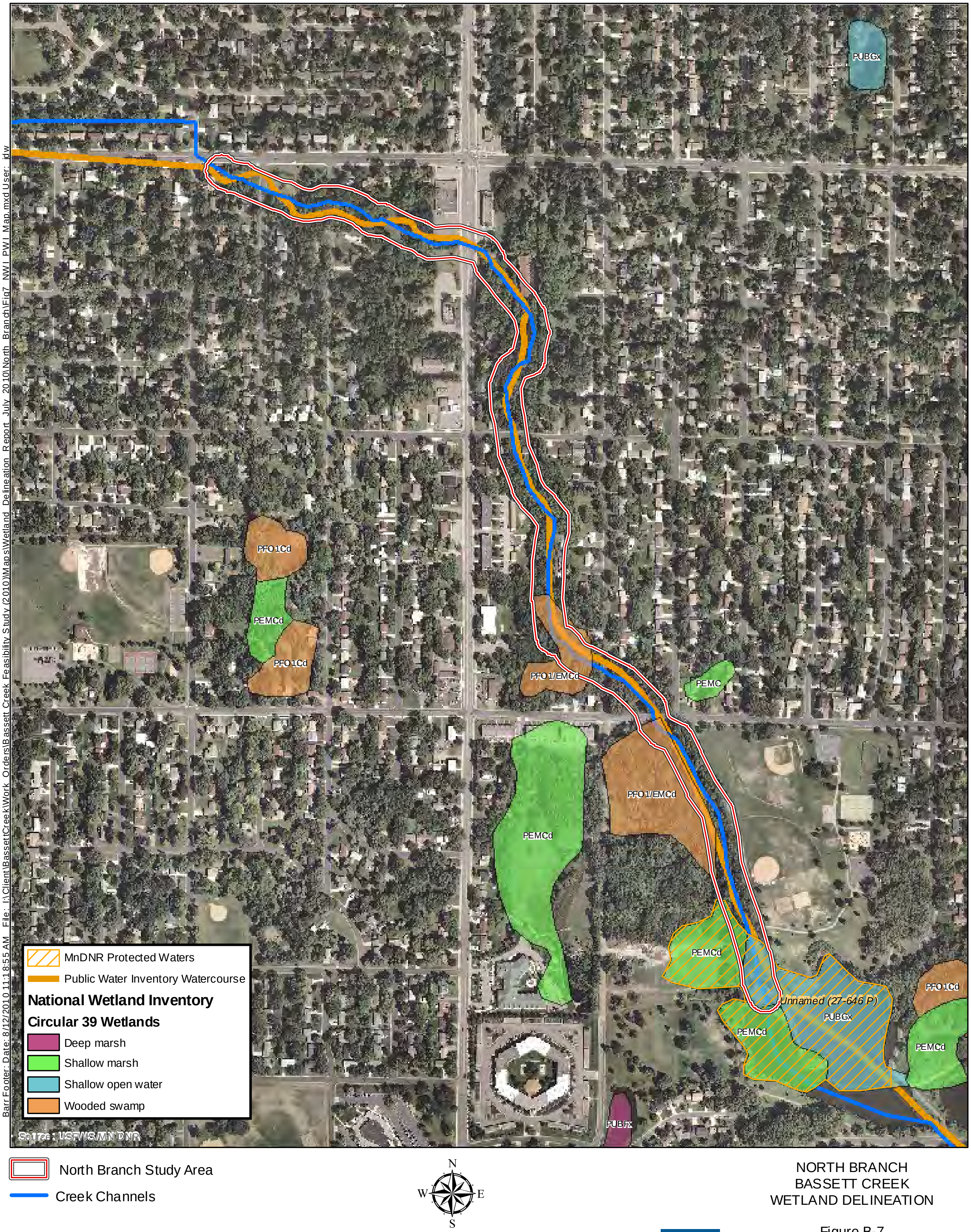
Creek Channels

N W E S

600 300 0 600 Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

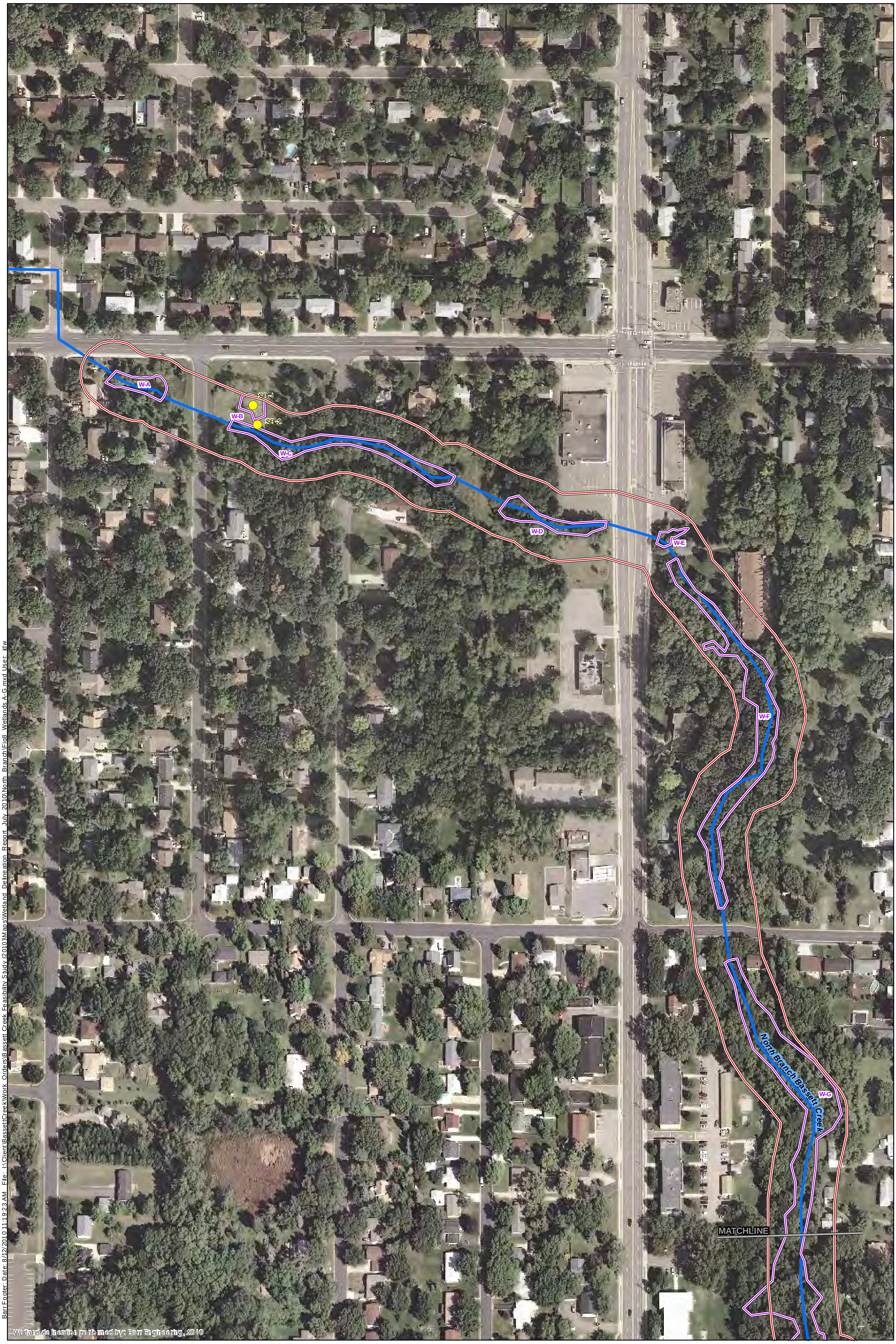
Figure B-6
SOILS MAP
Bassett Creek Watershed
Management Commission
August 2010




NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

BARR

Figure B-7
NATIONAL WETLAND INVENTORY/
PUBLIC WATERS INVENTORY MAP
Bassett Creek Watershed
Management Commission
August 2010




North Branch Study Area

Creek Channels

Wetland Delineation

Data Point

N
W E
S

200 100 0 200 Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-8
WETLANDS A THROUGH G
Bassett Creek Watershed
Management Commission
August 2010

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North Branch Study Area

Creek Channels

Wetland Delineation

Data Point

N
W E
S

200 100 0 200 Feet

NORTH BRANCH
BASSETT CREEK
WETLAND DELINEATION

Figure B-9
WETLANDS G THROUGH I
Bassett Creek Watershed
Management Commission
August 2010

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# *Appendix C*

## *Cultural and Historical Resources*

REPORT ON PRELIMINARY RECONNAISSANCE SURVEY
CONDUCTED BY ARCHAEOLOGICAL RESEARCH SERVICES (ARS)
ALONG NORTH BRANCH OF BASSETT CREEK

CITIES OF CRYSTAL AND GOLDEN VALLEY, HENNEPIN COUNTY, MINNESOTA

During the week of June 14th, 2010, ARS conducted a pedestrian survey of two segments of Bassett Creek, i.e., the main stem between Wisconsin Avenue and Highway 100 and the north branch between 36th Avenue and Bassett Creek Pond.

A records and literature search that was completed in 2009 for the Basset Creek Watershed Management Commission (BCWMC) Resource Management Plan did not identify any known archaeological or historic resources along these two segments of the creek[1]. Nor, however, did it indicate that any systematic efforts had been made to survey these areas for cultural evidence. Consequently, as cultural resources are legally protected from adverse impact caused by publicly funded and/or licensed projects,[2] such survey efforts will presumably be required in order to determine how future management plans for Bassett Creek can ensure that archaeological evidence -- and possibly also above-ground historic features -- are adequately protected either through avoidance or mitigative data recovery.

In order to determine what areas along these two segments have archaeological and historic potential, ARS staff, under the direction of Christina Harrison:

1. compared current aerial photographs to earlier ones from the 1940s-1990s in order to determine changes in land use, vegetation patterns and, in some cases, topography;

2. interviewed property owners and other local residents likely to have knowledge about any past findings of archaeological/historic nature;

3. Walked the entire length of the two segments inspecting both creek banks as well as any portions of the valley floor that may be impacted by future erosion control efforts.

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1 Harrison, Christina, 2009. Cultural Resource Phase 1A Review Conducted for the Bassett Creek Watershed Management Commission Resource Management Plan, Hennepin County, Minnesota.

2 At the federal level, by Section 106 of the National Historic Preservation Act, within the state and its subdivisions, by the Minnesota Field Archaeology and the Minnesota Private Cemeteries Acts, as described in Harrison 2009.

Large scale aerial photographs of the survey areas were provided by Barr Engineering. Observations and recommendations were noted and referenced by subareas as indicated on the applicable aerial photographs, included in Appendix C Figures C01 to C04. Initial efforts to identify subareas by GPS readings proved too imprecise to be useful, due primarily to the usually quite dense foliage and frequently narrow, steep-sided topography of the valley.

In the following discussions and recommendations, standard Phase I testing refers to shovel testing at controlled intervals which may vary according to topographic and vegetation factors but should not exceed 10 meters/30 feet. Testing, recording and laboratory procedures should be in compliance with SHPO guidelines. As needed, recommendations should be provided for more intensive evaluative testing.

NORTH BRANCH FIGURES C01, C02 AND C03 (N 1/2)

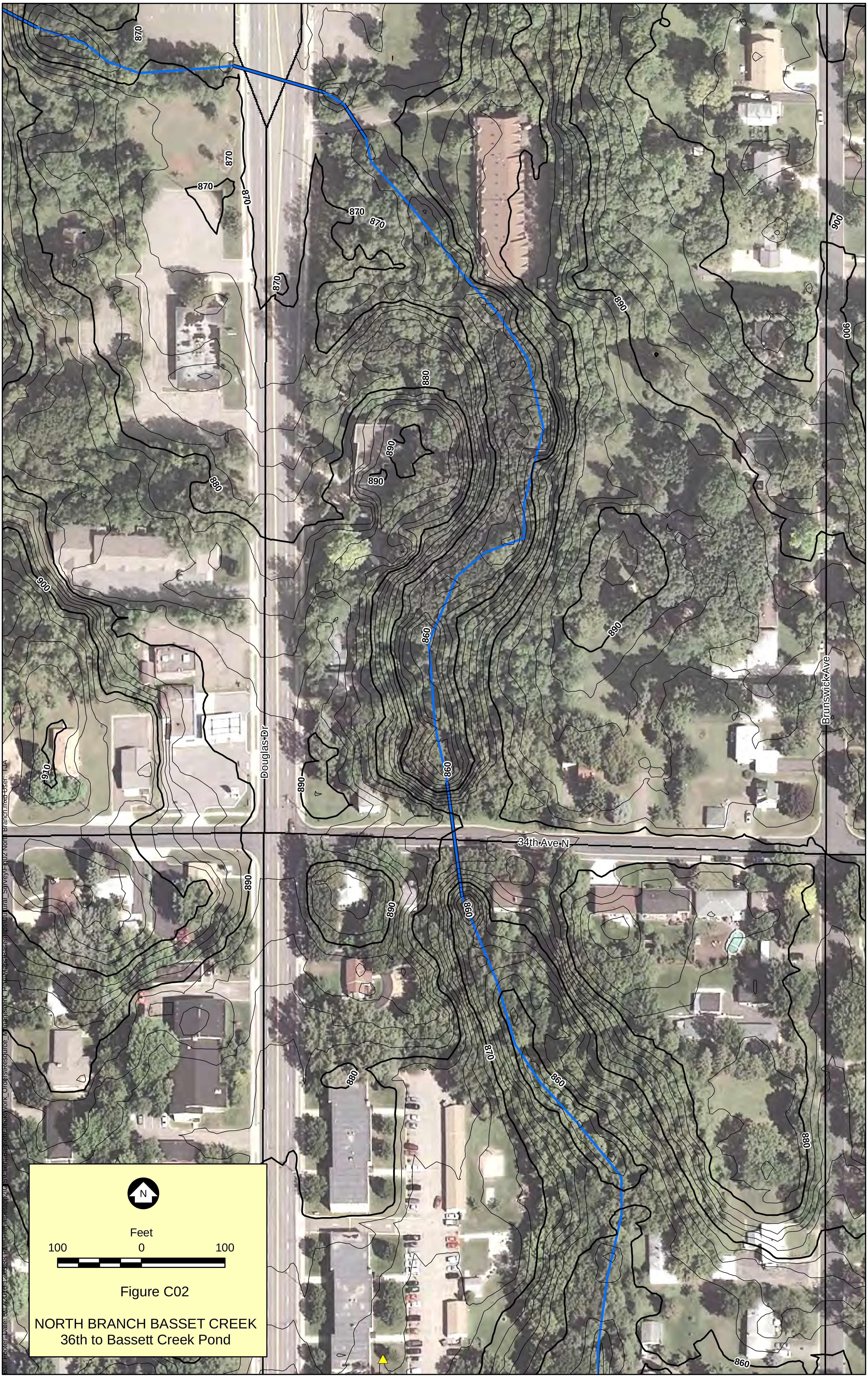
Within these segments, the creek flows either (a) through culverts buried beneath embankments that accommodate Douglas Drive, Georgia Avenue, 34th Avenue and 32nd Avenue as well as a driveway, a parking lot and a pedestrian trail, or (b) through very low marshy areas flanked by steeply rising higher ground that lacks archaeological potential.

NORTH BRANCH FIGURE C03 (S 1/2) AND C04

South of 32nd Avenue, the frequently straightened course of the creek follows a narrow, wooded valley that is flanked on the west by a high wooded ridge and pronounced east-facing slope, on the east by open parkland which, judging by comparison with historic aerial photographs, has been much modified by landscaping and extensive filling of a large wetland. Visual inspection along the frequently eroded banks as well as the areas adjacent to the creek indicated that all lack archaeological potential.

Figure C01

NORTH BRANCH BASSET CREEK
36th to Bassett Creek Pond



Douglas Dr
34th Ave N
Brunswick Ave
N
Feet
100 0 100
Figure C02
NORTH BRANCH BASSET CREEK
36th to Bassett Creek Pond

Figure C03

NORTH BRANCH BASSET CREEK
36th to Bassett Creek Pond


Figure C04

NORTH BRANCH BASSET CREEK
36th to Bassett Creek Pond