Minnehaha Creek Watershed District *REQUEST FOR BOARD ACTION*

MEETING DATE: 9/11/14

TITLE: Ordering of the 54th St. Bypass Channel Project

RESOLUTION NUMBER: 14-XXX

PREPARED BY: Becky Houdek

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REVIEWED BY: ☐Administrator ☐ Counsel ☐ Program Mgr. (Name):_____
☐ Board Committee ☐ Engineer ☐ Other

WORKSHOP ACTION:

☒ Advance to Board mtg. Consent Agenda.	☐ Advance to Board meeting for discussion prior to action.
☐ Refer to a future workshop (date):_____	☐ Refer to taskforce or committee (date):_____
☐ Return to staff for additional work.	☐ No further action requested.
☐ Other (specify): _____	

PURPOSE or ACTION REQUESTED:
Ordering of the 54th St. Bypass Channel Project in the amount of $118,750

PROJECT/PROGRAM LOCATION:
Minnehaha Creek at West 54th St. in Edina

PROJECT TIMELINE:

Oct 2013	Board authorized investigation of alternatives for 54th St. grade control structure
March 2014	Board authorization to refine bypass channel concept for integration into 54th St. road reconstruction
May 2014	Public information meeting and public hearing
June 2014	City postponed road reconstruction until 2015
Sept 2014	*Project ordering*
Fall-Spring 2015	Develop cooperative agreement with City of Edina and continue collaboration on Arden Park area improvements
June-Nov 2015	City construction incorporates fish passage culvert; District pays/reimburses for culvert installation
2015-2016	District final design and construction of connecting channel and possible upstream improvements

PROJECT/PROGRAM COST:

Fund name and number:	54th St Fish Bypass, 3147
Current budget:	$0 (new fund); $49,000 budgeted for 2015
Expenditures to date:	$40,059 from fund 2401 for feasibility and culvert design
Requested amount of funding:	$0

PAST BOARD ACTIONS:

October 10, 2013	Res. 13-101: Authorization to investigate feasibility of removing the 54th St. grade control structure in Minnehaha Creek, while maintaining recreational functionality
March 13, 2014	Res. 14-020: Authorization to work with the City of Edina to incorporate fish passage into the 54th St. road reconstruction project
May 22, 2014	Public hearing (No action required)

SUMMARY:

Background

In October 2013, the Board authorized staff to contract with Inter-Fluve, Inc. to investigate alternatives for the West 54th St. grade control structure in Edina. The structure was recommended for removal in the District's 2003 Stream Assessment because it is a barrier to fish passage and creates an impoundment causing accumulation of sediment, degrading upstream aquatic habitat.

Minnehaha Creek is impaired for both fish and macroinvertebrate index of biotic integrity (IBI). Based on a 2003 DNR survey, fish species using the creek include northern pike, largemouth bass, smallmouth bass, bluegill, green sunfish, minnows, shiners, and suckers. While there are a number of stressors affecting fish IBI in Minnehaha Creek, habitat and connectivity are critical components.

Staff presented the City's proposed 2014 reconstruction of West 54th St. as an opportunity to evaluate options for improving fish passage, possibly through removal of the grade control structure. Given the recreational value of the standing wave created by the structure for kayakers, the Board's authorization to investigate alternatives included direction that the current recreational functionality should be maintained.

At the March 13, 2014 Board Workshop, staff presented the findings of Inter-Fluve's analysis and the options for providing fish passage (see attached memo dated 1-22-14). The recommendation approved by the Board at that meeting was to advance the low flow bypass channel option for further analysis and incorporation as a bid-alternate into the City's bid package for the reconstruction of West 54th Street. The bypass channel would allow fish passage for an average of 225-240 days per year, connecting the 8 miles of stream channel downstream of West 54th Street to the 1.15 miles upstream.

A public information meeting and formal public hearing were held in May to obtain input on the proposed fish bypass channel. There were twenty-nine residents who signed a letter in support of the proposed project while a few expressed concerns about the value of the bypass channel given other factors limiting the viability of a healthy fish population in this area (e.g. lack of sustained flow, habitat, dissolved oxygen).

In June, following a low response to its bid advertisement, the City decided to postpone construction of West 54th St. until summer 2015. Staff used this delay as an opportunity to further analyze habitat improvements that could be completed in the stream section that would be made accessible to fish by the bypass channel (Reaches 15 and 16). Recommendations from Inter-Fluve (see attached memo dated 8-1-14) focused primarily on improvements to riparian vegetation. Other potential improvements included the addition of deeper pools and woody debris.

Long Term Vision

As the Board considers this project for ordering, it is important to reinforce that full removal of the structure would be the preferred option from an ecological standpoint as it is the most effective at achieving the goals of improving stream processes, habitat, and fish passage. Staff's recommendation to pursue the bypass channel option is based on the Board's direction to preserve the current recreational functionality.

Minnehaha Creek is a complex system, and as with any urban stream, there are a number of competing interests and goals that need to be taken into account when making management decisions. As part of the development of the next generation Comprehensive Plan, staff recommends that a subwatershed implementation plan be developed for Minnehaha Creek that lays out a long-term vision that includes baseflow, habitat, connectivity, recreation, water quality, flood control, and other components affecting the system.

Establishing a long-term vision will help the District when considering difficult management decisions such as the removal or alteration of the 54th St. structure. For instance, if the District's long-term vision is to remove all barriers and impoundments on the creek to restore natural stream function and address its impairments, then that should be taken into consideration when determining the District's level of investment in improving these reaches in their current condition.

Recommendation

Given the need to establish a long-term vision for the creek, the ongoing coordination with the City of Edina on its plans for Arden Park area improvements, and the Board's direction to limit the District's 2015 levy to a five percent increase, staff recommends that the Board order the 54th St. Bypass Channel project in the amount of $118,000, but only levy for and implement the culvert portion in 2015 for approximately $40,000.

Installation of the culvert is a relatively low cost way to preserve the District's ability to construct the bypass channel in the future while a broader plan and long-term vision for the area is developed. The City has expressed its willingness to incorporate the bulk-headed culvert into its bid documents and construct it as part of the road reconstruction project, with payment from the District (see attached letter of understanding). If the project is ordered, staff will work with the City to develop a cooperative agreement for the partnership.

In addition, consistent with Inter-Fluve's recommendation to focus upstream habitat improvement efforts on riparian vegetation, staff plans to target Reaches 15 and 16 as priority areas for streambank restoration through its cost share program. The current condition of these reaches is very similar to what existed along Reach 14 prior to the District's 2013 restoration project (riprap, retaining walls, turf grass). Following repair from this year's record flooding, staff will use the Reach 14 project as a demonstration site and model for expanding this work upstream.

Attachments:
1-22-14 Technical Memorandum – Barrier removal alternatives
5-18-14 Technical Memorandum - Culvert design
8-1-14 Draft Memorandum - Reach 15-16 habitat recommendations
Letter of understanding from City

RESOLUTION

RESOLUTION NUMBER: 14-XXX

TITLE: Ordering of 54th St. Bypass Channel Project

WHEREAS, the Minnehaha Creek Watershed District (MCWD) has adopted a watershed management plan (WMP) in accordance with Minnesota Statutes §103B.231;

WHEREAS, the WMP capital improvement program includes a Minnehaha Creek Stream Restoration Project which encompasses stream restoration work that would enhance riparian corridor vegetation; stabilize streambanks through bioengineering; add fish and macroinvertebrate habitat; create pool-riffle complexes; incorporate woody debris; remove select grade controls; and enhance educational and recreational opportunities;

WHEREAS, there is a grade control structure in Minnehaha Creek at the 54th St. bridge in Edina that was recommended for removal in the 2003 Stream Assessment because it is a barrier to fish passage and creates an impoundment causing accumulation of sediment and degradation of aquatic habitat upstream;

WHEREAS, Minnehaha Creek is on the State's Impaired Waters List for both fish and macroinvertebrate index of biotic integrity;

WHEREAS, the City of Edina is scheduled to reconstruct a section of 54th Street, including the bridge over Minnehaha Creek, in 2015 which presents an opportunity for removal or modification of the grade control structure;

WHEREAS, Inter-Fluve Inc. completed an alternatives analysis that identified a bypass channel option that would provide fish passage for an average of approximately 224 days of the year allowing access to an additional 1.15 miles of creek, including an area identified in the 2003 Stream Assessment as good spawning habitat;

WHEREAS, this analysis has been reviewed and fully considered by the MCWD Board of Managers;

WHEREAS, the City of Edina has agreed to incorporate the culvert portion of the bypass channel into their road reconstruction project with payment by the MCWD;

WHEREAS, the total cost of the bypass channel project (Project) is estimated at $118,750 with the culvert portion accounting for approximately $40,000 of the total cost;

WHEREAS, in accordance with Minnesota Statutes § 103B.251, subdivision 3, the MCWD held a duly noticed public hearing on ordering of the Project on May 22, 2014, at which time all interested parties had the opportunity to speak for and against the Project; and

WHEREAS, the Board of Managers finds that the Project will be conducive to public health and promote the general welfare, and is in compliance with Minnesota Statutes §§103B.205 to 103B.255 and the MCWD's WMP adopted pursuant to §103B.231;

NOW, THEREFORE, BE IT RESOLVED, that pursuant to Minnesota Statutes § 103B.251 and the WMP, the MCWD Board of Managers orders the Project, with a total estimated cost of $118,750.

Resolution Number 14-XXX was moved by Manager _____, seconded by Manager _____.
Motion to adopt the resolution ___ ayes, ___ nays, ___abstentions. Date: _____.

_____ Date:_____
Secretary

DRAFT Technical Memorandum

Minnehaha Creek 54th Street Barrier Removal

Date: January 22, 2014

To: Becky Houdek

Organization: Minnehaha Creek Watershed District

From: Inter-Fluve Design Team

Introduction

Inter-Fluve Inc. is under contract to help Minnehaha Creek Watershed District (District) identify and evaluate mitigation or removal alternatives for the grade control structure located on Minnehaha Creek at 54th Street in Edina, Minnesota. The Inter-Fluve team has been requested to evaluate fish passage alternatives as well as in-stream improvements within the reach immediately upstream of the existing grade control structure. The alternatives have been evaluated within the context of the overall stream system and the recent restoration work implemented by the District. The evaluation of the grade control alternatives includes technical assessment of fish passage and quantification of the benefits of ecological continuity of the stream corridor.

Purpose and Need

To understand the purpose and need for any treatment of the 54th Street control structure, it is important to first understand the impacts of the structure. The Minnehaha Creek Watershed District Watershed Plan has several goals for improving the overall health of the watershed and integrating public use of watershed features. Included in this list is improvement of water quality in Minnehaha Creek and "restoring ecological integrity in the creek through streambank restoration, habitat improvement, improved quality and more stable flows". Although not specifically stated, the District has demonstrated the importance of establishing geomorphic function through repeated geomorphic assessments and channel restoration projects throughout the corridor. Inter-Fluve completed geomorphic and biologic assessments of the creek for the District in 2003/2004 and 2012 (MCWD 2003 and 2012). The 2012 assessment documented changes

in geomorphic and biological function since the 2003/2004 assessment. Both assessments have helped the District understand the relationship between geomorphic function, stream connectivity and the quality of life in the stream and riparian corridor. The 54th Street control structure and the apron immediately downstream of the control structure interrupt that function and connectivity. The impacts of the control structure can be summarized as follows:

1. Fish passage barrier – The control structure is a barrier to upstream fish migration. Fish species using the creek are primarily lentic outmigrants from Lake Minnetonka and Lake Nokomis, including northern pike, largemouth bass, smallmouth bass, bluegill, green sunfish, cyprinids (minnows, shiners) and catastomids (suckers).
2. Impoundment sedimentation – The control structure is a small dam, and as such impounds incoming sediment, causing accumulation of fines in the channel and the creation of a small pond in Arden Park. Impoundments increase stream water temperatures, degrade stream habitat, cover important spawning habitat, interrupt the flow of sediment and nutrients and convert stream ecosystems to more of a lake ecosystem.

The purposes for removing or modifying the control structure is then to restore fish passage, improve sediment transport through the reach, improve fish and wildlife habitat and improve geomorphic function consistent with other projects within the Minnehaha Creek corridor.

Is there a need for improved fish passage? Yes, during certain years and times of year. During wetter years, when Minnehaha Creek maintains even minimal baseflow (e.g. <5 cfs), providing fish passage helps to maintain a functioning aquatic ecosystem by providing a forage and predatory fish community and also giving fish an opportunity to improve year class strength by spawning in alternative locations to Lake Minnetonka and Lake Nokomis. The main factor limiting ecosystem health in Minnehaha Creek is the complete drying of the stream during hot summers and winters where water release from Gray's Bay Dam is eliminated. In drier years, the benefit to providing fish passage may only be realized during the spring runoff.

Is there a need for improved geomorphic function in this reach? Yes, if this is a District goal for the entire length of Minnehaha Creek. In the past channel restoration projects on Minnehaha Creek, the goal has been to increase channel length and thus available habitat area through sinuosity, restore native riparian vegetation and provide in-stream complexity through wood placement and riffle and pool construction. Removal of the 54th Street control structure would accomplish these goals if accompanied by restoration of the channel upstream. Lowering of the structure and construction of a steep riffle or bypass would not restore full geomorphic function, as the crest of the steep riffle would still act like a dam, impounding water and sediment upstream.

Complicating the geomorphic and ecosystem function equation is perception of the control structure as a facsimile for natural barriers. It can be argued that in the past beavers created temporary dams that blocked flow and created marginal wetlands, much like the 54th St. control structure is doing now. Beaver dams are certainly a natural feature of stream systems, but they

are temporary and are regularly destroyed by flood events, after which the stream returns to a free-flowing state. They are rarely long-term impassable fish barriers. This cycle repeats itself over time. The pond upstream of the structure does provide long-term residual pool habitat for fish, and during dry months can provide refugia until flows improve. In the case of the 54th Street control structure, the barrier is permanent and consequently the potential pool refuge in the impoundment has silted in and sediment is not able to be mobilized through natural processes – eliminating any low flow ecological benefit the structure may have provided.

Considerations for Design

There are three primary considerations and limitations which impact the design process and decision relative to the future of the existing grade control structure:

1. MNDNR survey data shows largemouth bass and bluegill as being the dominant gamefish in Minnehaha Creek. Data on forage fish is limited, but during the past two fluvial geomorphic assessments conducted by Inter-Fluve (2003 and 2012), large numbers of white suckers were also observed. These species, with the exception of suckers, are all evolved to lake conditions and are not strong coasting swimmers. They have the capacity for bursting at higher speeds through short distances. Fish swimming data is either non-existent or limited for these species. Available sources (Peake 2008, Bell 1991) suggest that northern pike and white sucker have no difficulty passing short distances at velocities less than 4 feet per second. For rock ramp or fish bypass channel design, MNDNR typically uses slopes less than 2% with no drops exceeding 0.5 feet (L. Aadland, pers. comm.). Our design approach simulates natural channel bed conditions, providing roughness and interstitial space for passage of a variety of fish species. Target velocities during bankfull or lower flows are less than 4 feet per second.
2. The existing control structure hydraulics generate a "standing wave" which is a result of the flow changing from a high velocity state (supercritical) to a low velocity state (subcritical). The standing wave is utilized by kayakers, but is an impediment to canoes and to fish migration. The existing condition results in a required portage of canoes over 54th Street, which does not currently include a sidewalk or striped crosswalk. Removal of the grade control structure would provide safe passage for all boaters through the stream reach, but would eliminate the standing wave recreational feature.
3. There are some concerns expressed over loss of impoundment and the potential for a dry creek bed through Arden Park. The loss of impoundment is a concern voiced by members of every community with a dam or grade control structure on a stream or river reach. Fundamentally, many of these impoundments are more than a generation old and consequently part of the perceived "natural" landscape for residents. The reality is that the structures and associated impoundments are engineered systems with a defined design life. The concerns relative to a dry creek

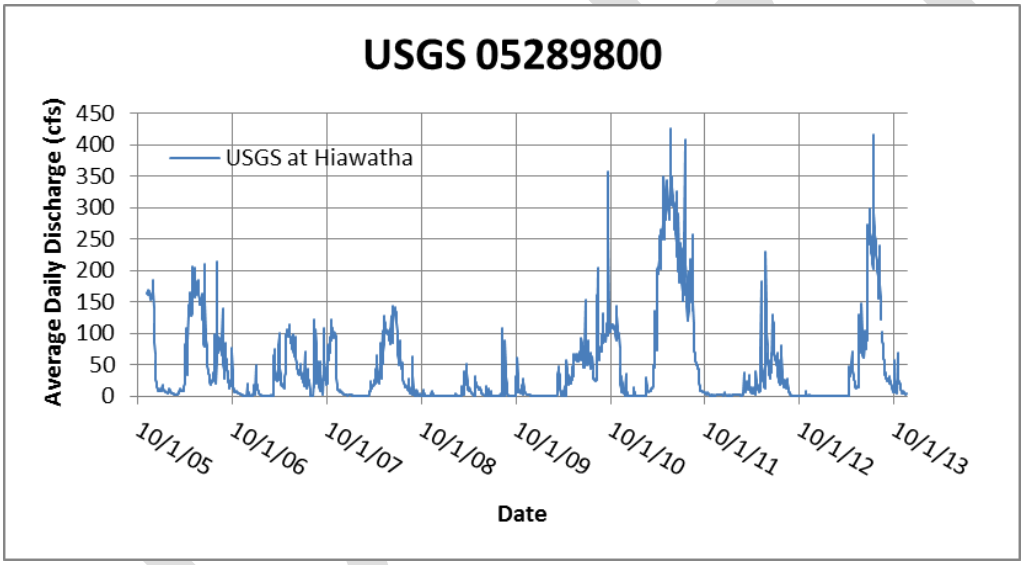
bed are valid and are anticipated to continue based on the current management of Grays Bay dam. The District currently operates the dam based on a plan developed in coordination with local municipalities and the State's Department of Natural Resources. The dry creek conditions experienced are detrimental to stable ecology of the stream and to stream aesthetics, but any modification of flows to allow freshets would require redrafting of the dam management plan.

Conceptual Analysis and Design

Hydrology

Minnehaha Creek is heavily influenced by managed flow releases from Grays Bay Dam. Stream flows closest to the 54th Street site are recorded at USGS gage 05289800 "MINNEHAHA CREEK AT HIAWATHA AVE. IN MINNEAPOLIS, MN" approximately 7.2-miles downstream. The gage has flow records of average daily discharge for the period of record November 5, 2005 through the present (November 2013). Flows range from 0 cfs to a maximum flow of 426 cfs.

Figure 1: Historical Gage Flow Record



A detailed XPSWMM model of Minnehaha Creek was prepared by Wenck Associates, Inc. for the District. Projected discharges from the XPSWMM model were provided to Inter-Fluve at the Excelsior Boulevard location, which is located upstream of the project area. XPSWMM model predicted flows for the 1.5-year through 100-year events include the following:

Event	XPSMM Peak Flow (cfs)
1.5-Year	133
10-Year	460
50-Year	490
100-Year	500

Although a 100-year discharge of 1,100-cfs is included in the 2004 Flood Insurance Study (FIS), it is not being used for this study.

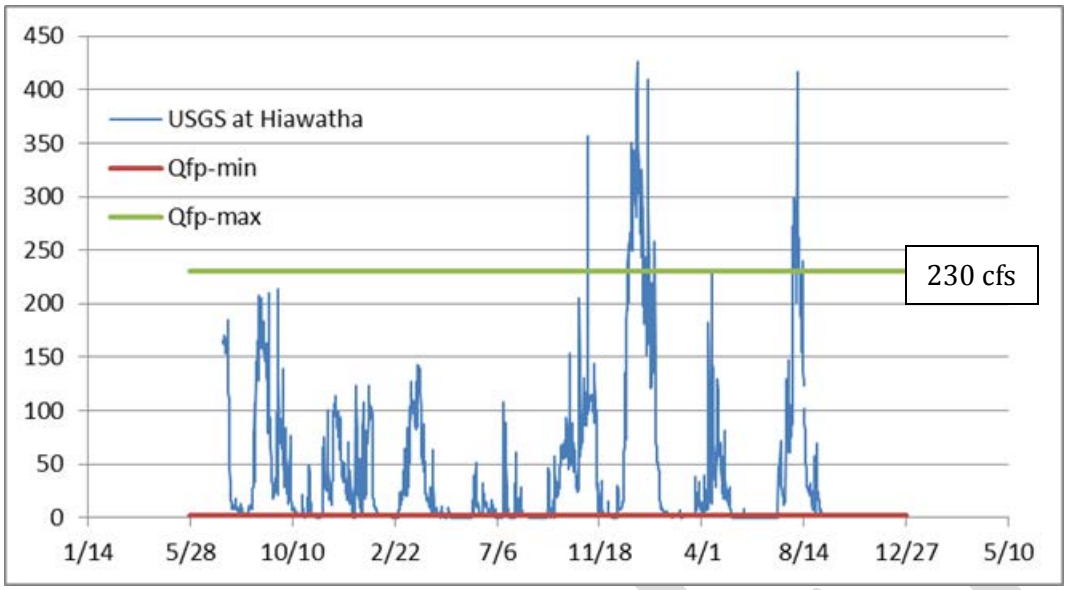
Ideal creek flows for canoeing on Minnehaha Creek are between 75 to 150 cfs (MCWD website). Anecdotal information indicates that kayakers surf and play on the standing wave formed below the grade control weir during flows ranging from 100 to 400 cfs (B. Houdek, personal communication).

Hydrology was also considered with respect to fish passage benefit if the barrier at 54th Street is mitigated by implementation of one of the alternatives presented in this report. Daily flow data from the Hiawatha Ave gauge from 2006 to present was evaluated to determine the number of days per year that flow in Minnehaha Creek exceeds 2.5 cfs (approximate minimum fish passable flow) and the number of days per year that flows are between 2.5 and 230 cfs (approximate maximum fish passable flow) (see table below). On average, fish passage will increase from zero days per year under current conditions to approximately 224 to 238 days per year (or 61% to 65% of the year) if one of the fish passage alternatives is chosen.

Calendar	Number of Days	
Year	>2.5 cfs	from 2.5 to 230cfs
2006	311	311
2007	292	292
2008	204	204
2009	160	160
2010	263	261
2011	267	185
2012	192	192
2013	216	186

Flows in Minnehaha Creek exceed the 230 cfs threshold for fish passage only 5% of the time. Therefore, in terms of flow duration, fish passage in Minnehaha Creek is increased by 95% over existing conditions if the barrier at 54th Street is mitigated (Figure 2).

Figure 2: Gage Flow with Fish Passage Criteria



Hydraulics

Hydraulics of Minnehaha Creek at the 54th Street crossing were modeled using the U.S. Army Corps of Engineers' HEC-RAS one-dimensional hydraulic model. The model includes stream geometry from the cross sectional survey data collected by Wenck Associates in November 2013. The model includes coverage from about 400 feet downstream of the bridge to 380 feet upstream of the bridge. An additional 3,400 feet of Minnehaha Creek upstream of the bridge is represented with cross sections from the XPSWMM model. The model coverage includes the reach impounded by the grade control.

Values of Manning's n roughness coefficients were estimated at 0.038 for channel and 0.08 for vegetated floodplain. These values are based on professional opinion and are approximate. Later design phases should include cross referencing with FEMA hydraulic and XPSWMM modeling and calibration to high flows if data are available. For this conceptual level analysis the model provides reasonable comparisons between existing and proposed alternatives.

The model was run in mixed mode to capture both subcritical (deep, slow flow) and supercritical (shallow, fast flow) conditions. Model flows include a number of flows ranging from 50-cfs to 500-cfs to capture low through XPSWMM 100-year discharge values. The mixed mode modeling approach requires boundary conditions at the downstream and upstream ends of the modeled reach. At this preliminary level a downstream flow-water surface elevation rating curve was not obtained. The downstream boundary condition was set at critical depth. In order to arrive at a normal depth condition by the second cross section, the model includes eight interpolated sections between the two most downstream surveyed cross sections. The upstream boundary condition was also set at critical depth. Given that the model extends 1,650 feet upstream of the reach backwatered by the grade control it was not necessary to include additional interpolated cross sections.

Results of the conceptual level HEC-RAS model provide a number of parameters including water surface elevations, flow velocities, tractive force (also referred to as shear - a measure of the erosive

force exerted on the channel boundary) and Froude number. Froude number represents subcritical and supercritical conditions, with a value of 1.0 being critical conditions. For this project it provides an estimate of the likelihood that the standing wave will persist. For existing conditions the Froude number exceeds 2.5 as it passes over the crest of the grade control and drops to about 0.5 downstream of the grade control. This confirms model prediction of an established standing wave that is used by kayakers to play and surf. For proposed alternatives changes to the Froude number are evaluated to determine impact to the standing wave.

The existing conditions model was copied and modified to represent each of the proposed construction alternatives: 1) grade control removal, 2) roughened channel and 3) bypass channel. Specific details and model predictions are discussed in each of the following sections.

Alternative 0 – Do Nothing Alternative

The design team modeled the existing conditions as a base-line for evaluation of proposed construction alternatives. The summary and recommendations section of this technical memorandum include the existing "Do Nothing" results of the hydraulic modeling and the current impact the 54th Street control structure has on fish passage.

Alternative 1 – Removal and channel restoration

Removal of the 54th Street grade control structure and restoration of the channel through Arden Park at a pre-settlement grade is the only available option for achieving all of the stated goals above. This alternative would include demolition of the existing control structure and thus would drop the channel grade through the park, converting the pond back to a free flowing stream. The grade drop at the control structure would be dissipated through 4 or 5 riffle and pool sequences over a channel spanning roughly 2,000 feet upstream of the road crossing. Removal would encompass the following aspects:

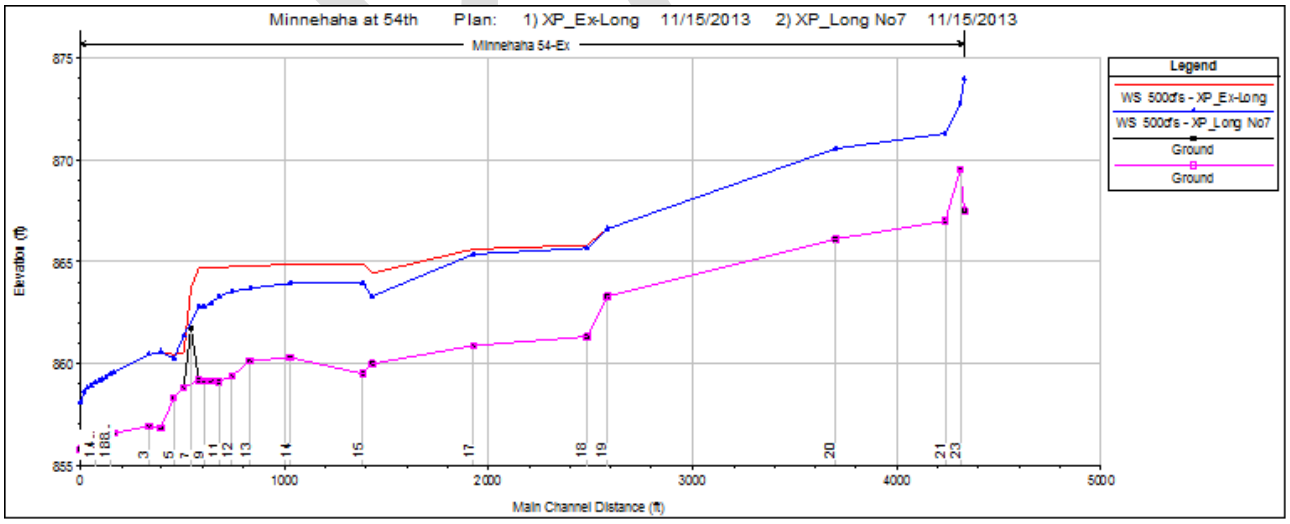
- Grade control removal – The control structure would be demolished and the materials removed off site. The former site would be restored as part of the channel restoration, and would tie into the crossing at 54th Street.
- Channel and floodplain grading – A stable channel bed would be constructed, including constructed gravel and cobble riffles and pools for fish habitat.
- Streambank stabilization – Streambanks would be stabilized using bioengineering techniques. Native vegetation would be used with landscaping plants to transition from the native riparian zone to the manicured lawn of the park setting.

Pros/cons for Alternative 1 – Removal and restoration:

- Fish passage – Fish and in-stream wildlife passage would be restored upstream to Browndale dam providing access to an additional 1.15 miles of creek, creating a continuous 9.21 miles of creek habitat passable to fish.
- Geomorphic/ecological function restoration – The restored channel would transport incoming sediment downstream, process nutrients and provide riverine habitat complexity for over 2,000 feet of Minnehaha Creek.

- Water quality – Dam removals can reduce stream temperatures locally by reducing the area of solar exposure. Removal increases stream velocity and thus decreases the residence time of water through the reach. Lower water temperatures help to reduce algal blooms and maintain habitat for more sensitive riverine species of invertebrates and fish.
- Recreational boating – Any hazard posed to canoes by the 54th Street control structure would be eliminated with its removal. Canoes would not have to take out and portage across 54th Street and could pass through the entire reach and under the existing crossing. A con of this alternative is the elimination of the standing wave which kayakers currently utilize.
- Park aesthetics - Existing park aesthetics would not be significantly impacted and could be enhanced depending on the design. At the widest point, the pond width has been reduced approximately 80% due to sediment infilling and aquatic vegetation and has gone from 250 feet down to 50 feet. Because the pond has been so narrowed, restoration of the stream channel through the park would result in only a 20-foot reduction of current stream width, from 50 feet down to 30 feet.
- Flood reduction – Flooding, particularly at floods near bankfull, could be reduced in the park as these flows would be contained within the new channel at a lower elevation (See Figure 3). The grade control removal scenario has been evaluated within a HEC-RAS model and flood elevation decreases up to about 2080 feet upstream of the existing grade control.
- Maintenance - Minimal to no maintenance would be required.
- Mosquito control – Stagnant water ponds like the one upstream of the control structure produce more mosquitoes than do riverine systems. Removal of the control structure would significantly reduce mosquito larvae habitat in Arden Park.

Figure 3: HEC – RAS Profile of 100-year flood elevations



Note: Red = Existing 100-yr water level, Blue = Proposed 100-yr water level, Purple = Ground

Cost Estimate:

A conceptual level cost estimate was prepared for planning purposes. Stream dewatering, erosion control, barrier removal, channel reconstruction, site cleanup, and revegetation is estimated to cost approximately $160,000.

Alternative 2 – Roughened Channel

The Alternative 2 - Roughened Channel includes removal of the grade control structure and construction of a stone riffle (Appendix, Sheet 2). The roughened channel geometry generally mimics stream riffles with a varying cross section that blends into existing riparian vegetation. With a varying cross section, fish are able to choose the depth and velocity conditions they prefer. Fish passage is provided over a broad range of flows.

The roughened channel is designed using engineering methods for riprap to provide a desired level of stability. The HEC-RAS model includes a run representing roughened channel conditions. Model generated values for shear stress were used to design stone size. Riprap methods were then used to design a gradation of stone sizes that would be stable for flows up to the XSPSWMM 100-year flood flow event of 500-cfs. Cobble and finer materials are amended to the larger stone and are placed in the voids to reduce permeability of this stone placement in order to keep low flows from passing subsurface and to create a natural riffle aesthetic. The design gradation for the 24 inch and smaller stone is shown on the conceptual plans. An example photo of a similar type constructed roughened channel at a slope of 1.3-percent is shown in Figure 4.

Figure 4: 1.3% Slope Roughened Channel Example

Inter-Fluve evaluated the possibility of a standing wave under the roughened channel alternative. HEC-RAS model results indicate that maximum Froude numbers during the 100 to 400 cfs kayaker

play flows are only about 1.0. This is a strong indication that a standing wave will not form for the roughened channel alternative. The kayaker play wave will be eliminated with this option.

HEC-RAS model results for the canoe passage flows of 75 to 150 cfs indicate that Froude numbers will drop from 2.5 for existing conditions to 1.0 for the roughened channel conditions.

Pros/cons for Alternative 2 – Roughened channel:

- Fish passage – Fish and in-stream wildlife passage would be restored upstream to Browndale Dam providing access to an additional 1.15 miles of creek, creating a continuous 9.21 miles of creek habitat passable to fish.
- Geomorphic/ecological function restoration – This alternative maintains the current pond and associated geomorphic and sedimentation impacts.
- Water quality – This alternative maintains current solar exposure and temperature impacts as described above.
- Recreational boating – Any hazard posed to canoes by the 54th Street control structure would be eliminated with its removal. Canoes would not have to take out and portage across 54th Street and could pass through the entire reach and under the existing crossing. A riffle condition would provide a recreational benefit. A con of this alternative is the elimination of the standing wave which kayakers currently utilize.
- Park aesthetics - The roughened channel would provide a riffle-like feature that would provide a visual and audible aesthetic.
- Flood reduction – No change.
- Maintenance - Minimal to no maintenance would be required.
- Mosquito control – This alternative maintains current pond and thus mosquito breeding conditions.

Cost Estimate:

A conceptual level cost estimate was prepared for planning purposes. Stream diversion/dewatering and erosion control, removal of grade control from the stream bed, placing roughened channel stone and site cleanup and revegetation is estimated to cost approximately $150,000.

Alternative 3 – Bypass Channel

A low flow bypass channel is proposed as a fish passage alternative that would allow the existing mainstem fish passage barrier to remain in place for whitewater recreation. Two potential bypass channel alignments were evaluated under this alternative; one south of 54th Street (Alignment A) and one north of 54th Street (Alignment B) (Appendix, Sheet 1). Based on discussions with the City of Edina and District staff, the southern location (Alignment A) was preferred.

Alignment A

Alignment A proposes to place a bypass culvert upstream of the existing fish passage barrier on Minnehaha Creek for routing mainstem low flows into the culvert and into a low flow channel on the river right bank below 54th Street bridge. The channel reconnects with the mainstem approximately 100 feet downstream of the bridge. The culvert inlet invert elevation is set 0.3' below the crest

elevation of the existing mainstem fish passage barrier approximately 150 feet downstream. Setting the invert at this elevation ensures that low flows are diverted to the culvert.

Preliminary hydraulic analysis of the culvert suggests that a 49"(span)x33"(rise) pipe arch culvert will accommodate low flow bypass for flows from 2.5 cfs (minimum flow that provides at least 6" of depth in the culvert) up to approximately 30 cfs (when the pipe begins to flow full). Based on the fish passage criteria discussed above, a hydraulic analysis was conducted using Fish Xing software to determine the maximum flow that fish will successfully pass through the culvert. It was determined that the maximum flow allowing fish passage is 16 cfs which occurs when flow in the mainstem is approximately 230 cfs. Preliminary sizing of the low flow channel accommodates up to 30 cfs. Further hydraulic analysis and design will refine the design if this alternative is chosen.

Pros/cons for Alternative 3, Alignment A – Bypass channel:

- Fish passage - The low flow bypass provides fish passage for an average of approximately 224 days of the year (or 61% of the time) allowing access to an additional 1.15 miles of creek, creating a continuous 9.21 miles of creek habitat passable to fish. Fish passage is limited when flows are too low to meet depth criteria or too high to meet velocity criteria in the culvert and bypass channel.
- Geomorphic/ecological function restoration – This option maintains the current pond and associated geomorphic and sedimentation impacts.
- Water quality – This option maintains current solar exposure and temperature impacts as described above.
- Recreational boating - This alternative allows for continued kayaker use of the standing wave created by the grade control structure. Canoes would need to continue to portage across 54th Street.
- Park aesthetics - Existing park aesthetics would not be significantly impacted and could be enhanced depending on the design.
- Flood reduction – No change.
- Maintenance – Maintenance would be required to remove debris from the culvert inlet.
- Mosquito control – This option maintains current pond and thus mosquito breeding conditions.
- Other - The bypass channel bisects a walking path that connects the parking lot on the west approach of 54th Street bridge with the canoe launch located below the bridge and immediately downstream of the bypass channel outlet. A pedestrian bridge may be required on the river right bank to maintain access. Installation of the culvert will impact traffic flow during construction. Traffic will need to be accommodated with one lane.

Cost Estimate:

A conceptual level cost estimate was prepared for planning purposes. Stream dewatering and erosion control, installation of a fish passable culvert with low flow channel construction, site cleanup, and revegetation is estimated to cost approximately $118,750. This estimate also includes a pedestrian stream crossing that would likely be required to maintain fishing and boater access to the existing wooden canoe launch located in that same area.

Alignment B

Alignment B proposes to construct a low flow bypass channel approximately 200 feet upstream of the existing fish passage barrier on the river left bank of Minnehaha Creek. The proposed alignment reconnects with the mainstem just downstream of the existing fish passage barrier and immediately upstream of the 54th Street Bridge. Further analysis of this alignment alternative was not conducted after discussions with project stakeholders. The narrow corridor available for this alignment between Minnehaha Boulevard and the mainstem makes this alternative relatively infeasible as compared with the other alternatives presented in this report.

Cost Estimate:

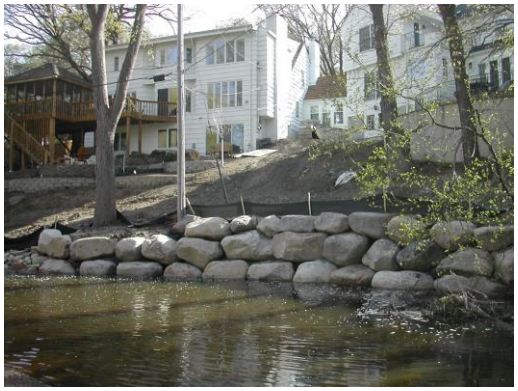
A conceptual level cost estimate was not completed for this alternative per the direction of District staff, as this alternative was not the technical preferred alternative.

In-Channel Habitat Improvement Options

In-stream habitat and geomorphic function enhancement options for Minnehaha Creek in the vicinity of the 54th Street barrier may be considered in addition to or in the absence of the alternatives discussed above. The fluvial geomorphic and biological assessments of Minnehaha Creek conducted in 2003 and 2012 characterize the 54th Street reach (Reach 15 - 54th Street West to Wooddale Avenue) as having marginal riparian habitat quality and poor in-stream habitat quality (MCWD, 2003 and 2012). Channel mobility is limited by the dam, rip rap, a stone wall, and other structures built to stabilize the stream. Where stabilizing structures do not exist, much of the streambanks are turf grass managed to the stream edge by residential landowners with some reed canary grass and cattail buffer. An extensive, 200-ft wide floodplain forest does exist on the river right bank upstream from the 54th Street barrier interrupted only by a small park/hockey rink.

Based on the Stream Visual Assessment Protocol (SVAP) conducted in 2003 and 2012, pools in 2012 were shallower than in 2003 (evidence that the stream is aggrading) with fewer types of in-stream fish cover and insect/invertebrate habitat. Large woody debris (LWD) was not observed and recruitment is negligible. The 54th Street barrier impounds sediment and limits habitat complexity. Overall, the SVAP decreased from 5.8 in 2003 to 4.4 in 2012. An SVAP score of 6.0 or lower is considered poor habitat quality.

Figure 5: Example of current bank conditions at site



In-stream habitat and geomorphic function along the reach could be enhanced by creation of native riparian buffers along the streambanks in place of turf grass and/or rip rap. Streambanks could be stabilized with bioengineering techniques until native vegetation is established. Buffer creation and enhancement could assist in recruiting large woody habitat within 30-40 years. Natural streambanks will also enhance habitat cover and insect/invertebrate populations, and increase the potential for natural deep pool and riffle formation. The backwatered portion of the channel upstream of the 54th Street barrier could be enhanced by adding large woody habitat providing cover for residual pool habitat and refugia during dry months until flows in Minnehaha Creek improve. Finally, channel width could be narrowed based on initial hydraulic evaluations, which would allow construction of naturalized banks without significant impacts to adjacent property. An estimate of potential construction costs for the potential range of in-channel improvements was not completed at this juncture. Further discussion with District staff to refine goals and success metrics is recommended before proceeding with this option. In the case of the structure removal, riffle and pool construction and bank stabilization would need to be included as part of the design, as the drop in grade would expose erodible impoundment soils prone to transport. The project would require that sediment be actively managed and a new channel alignment and channel bed constructed.

Summary and Recommendation

A number of alternatives were considered to improve stream processes and fish passage past the 54th Street grade control including:

- Alternative 0 - Do nothing,
- Alternative 1 - removal of the structure,
- Alternative 2 - removal of the structure and construction of a roughened channel riffle and
- Alternative 3 - construction of a bypass structure around the grade control.

Based on ecological criteria, the Alternative 1 - Removal of the Structure is most effective and least cost option available to achieve the goals of improving stream process and fish passage. If Alternative 1 is not desired, the design team would recommend Alternatives 2 – Removal of the Structure and Construction of the Roughened Channel Riffle. Alternative 2 has the advantage of improving fish passage and canoe passage while maintaining the pond water surface elevations. Alternative 3 – the bypass channel alternative, will improve fish passage while maintaining the existing standing wave that forms below the grade control that is used recreationally by kayakers, but has long term maintenance requirements that likely offset the slightly lower capital costs. Alternatives 1 and 2 are both considered low maintenance, whereas Alternative 3 will require maintenance to remove debris from the culvert inlet. The following table provides a summary of the design alternatives.

Minnehaha Creek, 54th Street - alternatives summary table.

Alternative	Description	Pros/Cons	Increased upstream fish habitat (river miles)	Average fish passable days (1)	Required maintenance	Canoe passable	Standing wave (Kayak Ammenity)	Conceptual cost estimate
0 - Do nothing	No change to existing grade control structure.	**Pro:** - No disturbance or cost **Con:** - No fish passage	0	0	low	No	Yes	$0
1 - Remove grade contro	Remove grade control structure.	**Pro:** - Provides fish passage - Restores stream process - Improves canoe passability **Con:** - Construction disturbance	1.15	238	low	Yes	No	$160,000
2 - Roughened channel	Remove grade control structure. Construct a roughened channel (riffle).	**Pro:** - Provides fish passage - Maintains pond water surface elevation - Improves canoe passability - Provides riffle aesthetics **Con:** - Construction disturbance	1.15	238	low	Yes	No	$150,000
3 - Bypass channel	No change to existing grade control structure. Install a fish pass culvert through 54th Street and construct a bypass channel south of 54th Street.	**Pro:** - Provides fish passage - Maintains pond water surface elevation - Maintains recreational conditions **Con:** - Impacts to south flood plain area - Susceptible to debris - Limitations of fish passage during high flow	1.15	224	mod-high	No	Yes	$118,750
Notes:	1 - based on average daily flows for years 2006 through 2013 recorded at USGS gage at Hiwawatha Ave							

MCWD VISION STATEMENT

The Minnehaha Creek Watershed District is committed to a leadership role in protecting, improving and managing the surface waters and affiliated groundwater resources within the district, including their relationships to the ecosystems of which they are an integral part. We achieve our mission through regulation, capital projects, education, cooperative endeavors, and other programs based on sound science, innovative thinking, an informed and engaged constituency, and cost effective use of public funds.

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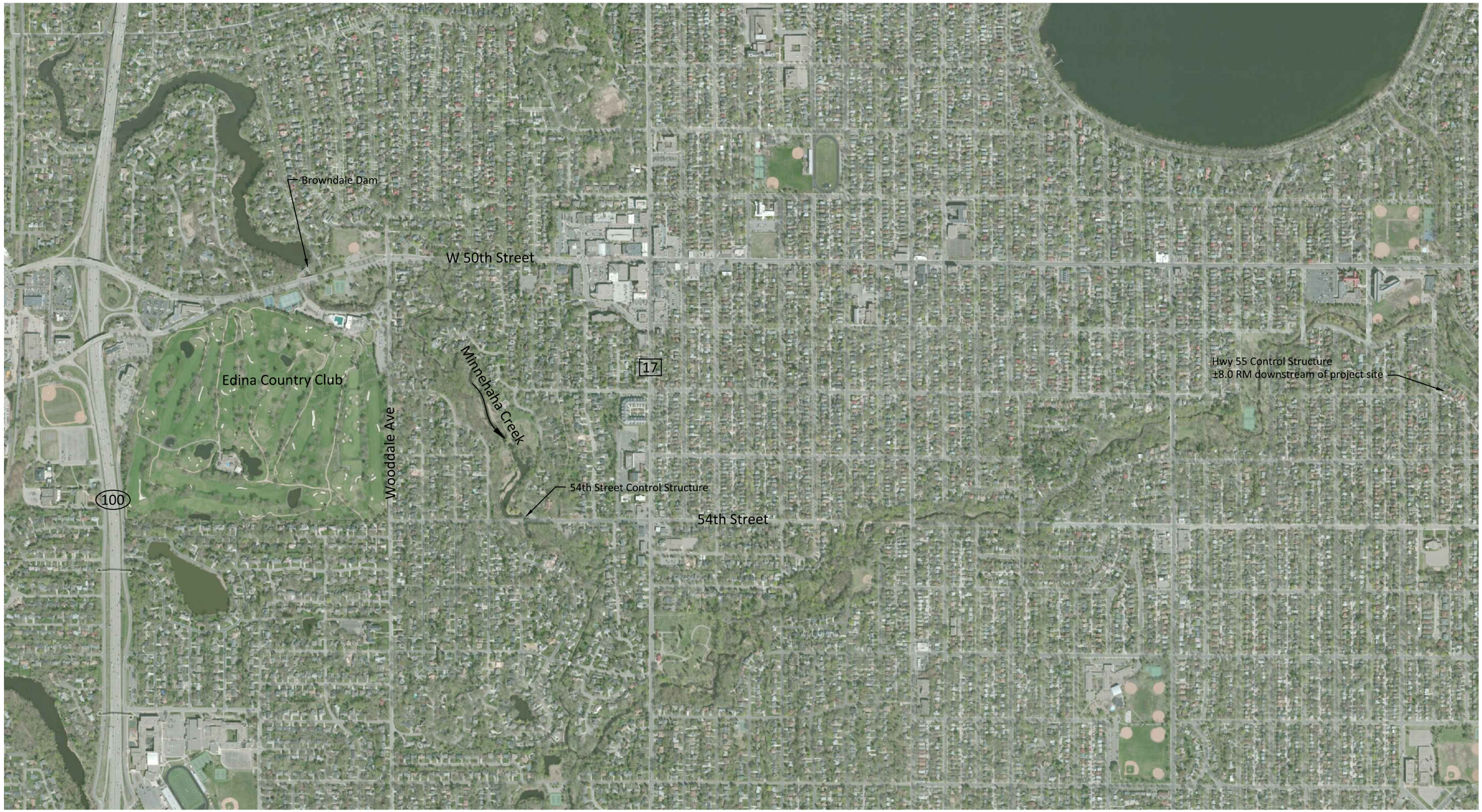
L. Aadland, pers. Comm

Appendix

Graphics

Cost estimates



AERIAL PHOTO VIEW

0 1000 2000

SCALE IN FEET

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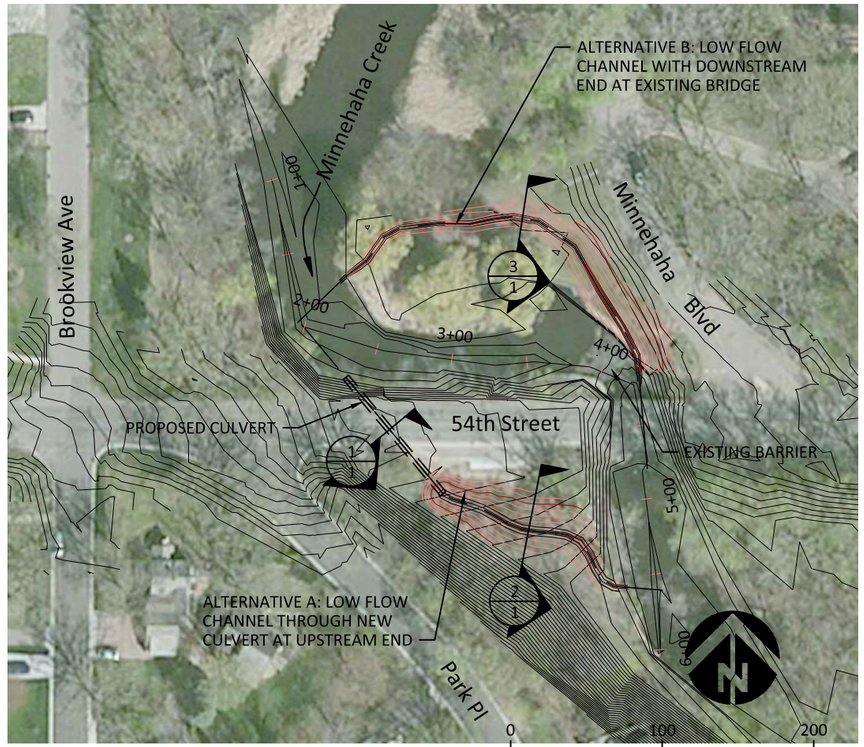
MINNEHAHA CREEK 54th STREET BARRIER REMOVAL
AERIAL MAP SHOWING LOCATIONS OF UPSTREAM AND DOWNSTREAM CREEK BARRIERS

G:\M-P\Minnehaha Ck 54th St Barrier_130245\8 Drawings\IFI_Minnehaha_Concept



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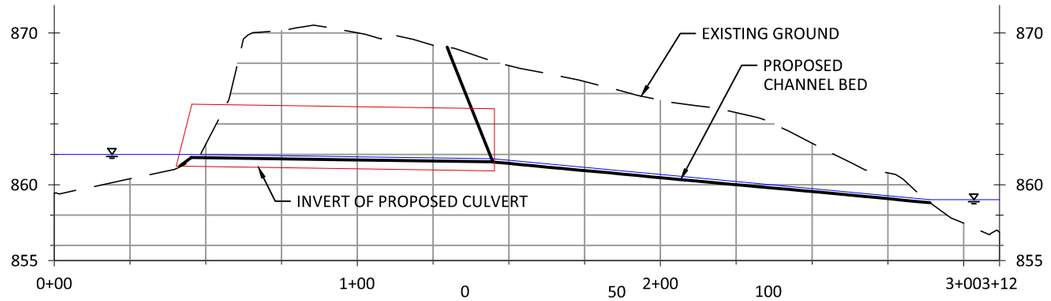
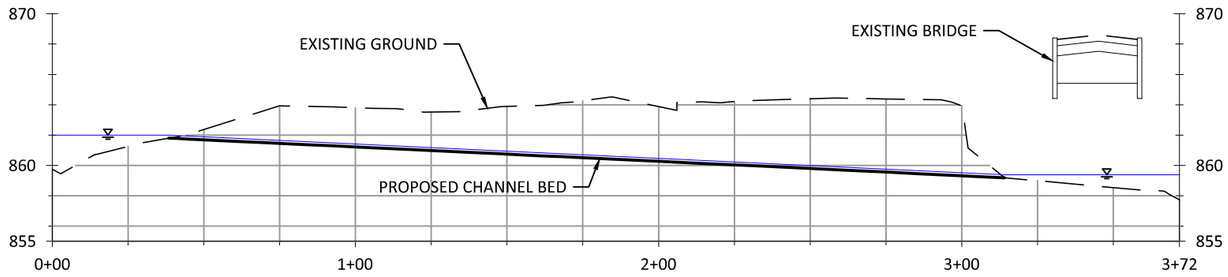


PROFILE - ALTERNATIVE A

SCALE IN FEET

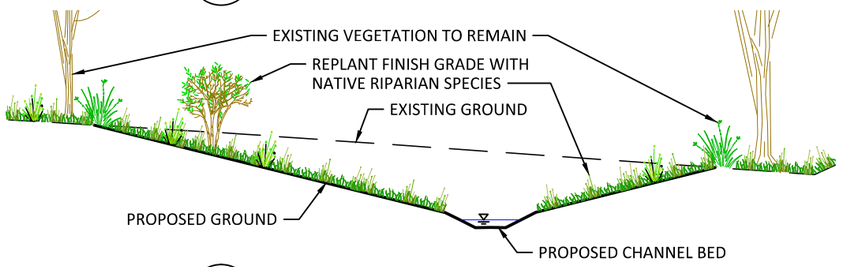


PROFILE - ALTERNATIVE B

SCALE IN FEET

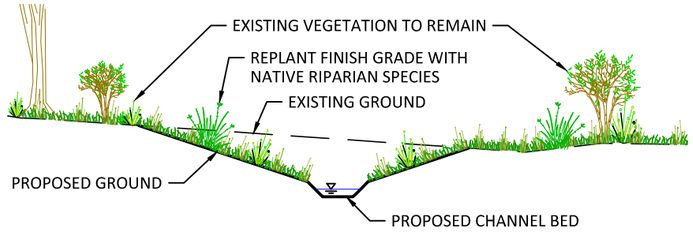
1/1 SECTION - PROPOSED CULVERT

NOT TO SCALE



2/1 SECTION - PROPOSED CHANNEL

NOT TO SCALE



3/1 SECTION - PROPOSED CHANNEL

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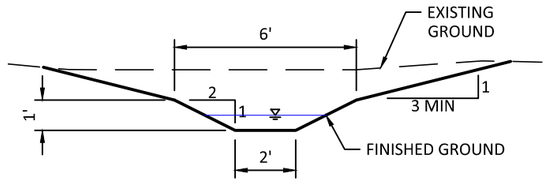

4/1 TYPICAL CHANNEL SECTION

NOT TO SCALE

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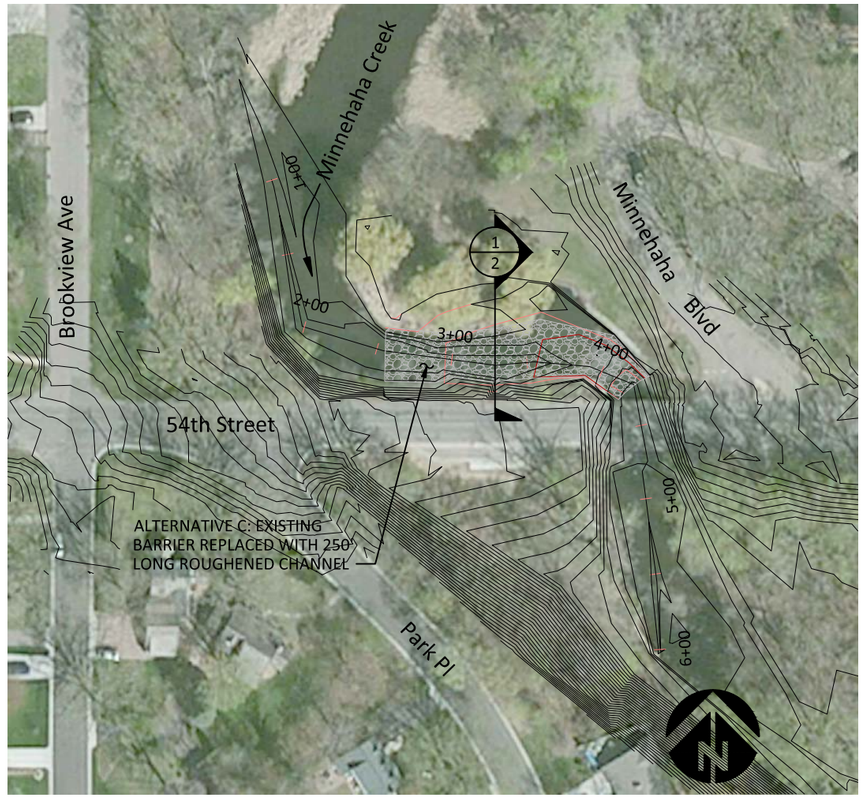
MINNEHAHA CREEK 54th STREET BARRIER REMOVAL
LOW FLOW CHANNEL ALTERNATIVES
PLAN, PROFILES, AND TYPICAL CROSS SECTIONS



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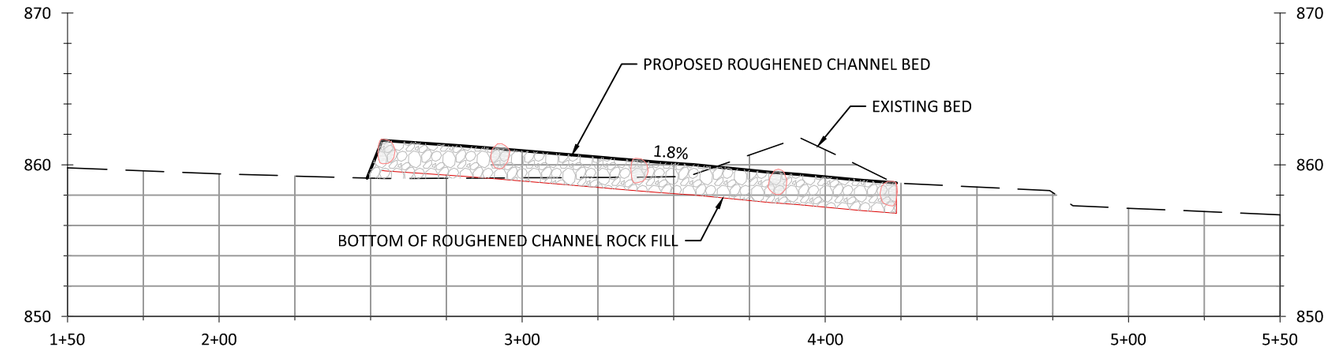
AERIAL PHOTO VIEW



PROFILE - ALTERNATIVE C

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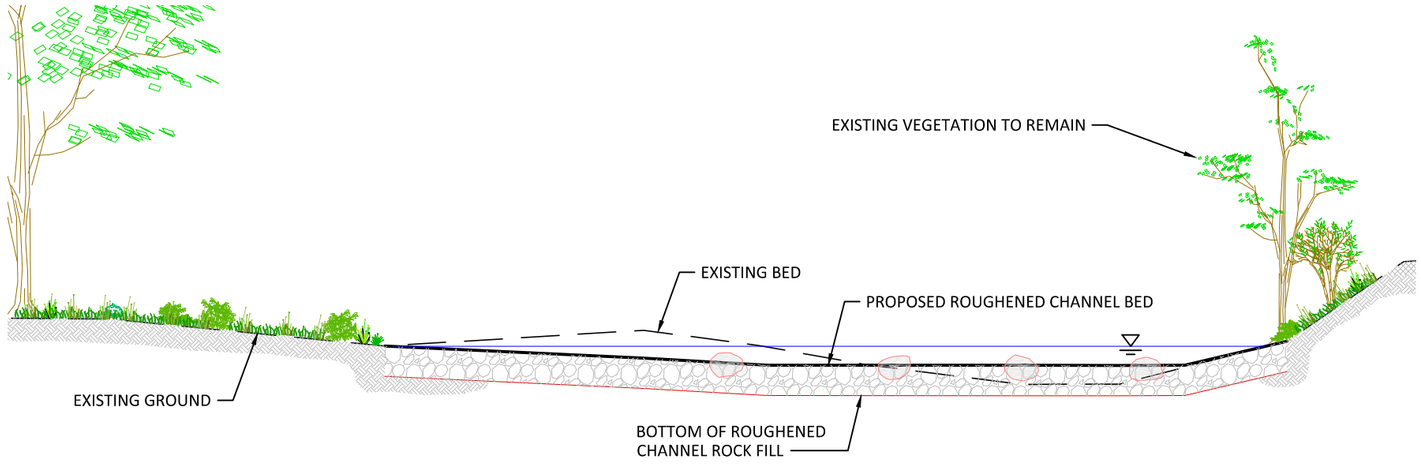
SCALE IN FEET

1 : 5 (5x VERTICAL EXAGGERATION)



1/2 SECTION - PROPOSED ROUGHENED CHANNEL

NOT TO SCALE

EXAMPLE OF 1.3% ROUGHENED CHANNEL

ROUGHENED CHANNEL STONE GRADATION	
Stone Size	Percent Passing
24"	100
18"	85
16"	50
3"	16
1/2" and smaller	5

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MINNEHAHA CREEK 54th STREET BARRIER REMOVAL
ROUGHENED CHANNEL ALTERNATIVE
PLAN, PROFILE, AND TYPICAL CROSS SECTION

Minnehaha Creek - 54th Street grade control fish passage: grade control removal.

November 18, 2013

Conceptual level - quantities and construction cost estimate

Item	Quantity	Units	Unit cost	Item cost	Comments/notes
Mobilization	1	LS	$ 7,000	$ 7,000	10%
Diversion/dewatering/Erosion control	1	LS	$ 15,000	$ 15,000	rough estimate: all work is in stream
Concrete demolition	40	HR	$ 500	$ 20,000	rough est. - operator/excavator/hammer & laborer
Concrete haul/disposal (20mi RT)	50	CY	$ 38	$ 1,900	32' x 30' x 1.5' // 2 * Means 02-41-16.17-4250
Excavation/haul/disposal (20mi RT)	50	CY	$ 40	$ 2,000	Assume none is suitable as Roughened Channel fines Haul: 2 * Means 02-41-16.17-4250 (10mi RT)
Revegetation	11	MSF	$ 230	$ 2,500	
Site restoration	1	LS	$ 80,000	$ 80,000	rough estimate for in-channel restoration and sediment management
			Subtotal =	$ 128,000	
			Contingency (25%) =	$ 32,000	
			Total =	**$ 160,000**	

Minnehaha Creek - 54th Street Grade Control fish passage.

November 18, 2013

Conceptual level - quantities and construction cost estimate

Item	Quantity	Units	Unit cost	Item cost	Comments/notes
Mobilization	1	LS	$ 12,000	$ 12,000	10%
Diversion/dewatering/Erosion control	1	LS	$ 15,000	$ 15,000	10%
Concrete demolition	8	HR	$ 500	$ 4,000	operator/excavator/hammer & laborer
Concrete haul/disposal (20mi RT)	50	CY	$ 38	$ 1,900	32' x 30' x 1.5' // 2 * Means 02-41-16.17-4250
					Assume none is suitable as Roughened Channel fines
Excavation/haul/disposal (20mi RT)	660	CY	$ 40	$ 26,400	Haul: 2 * Means 02-41-16.17-4250 (10mi RT)
Roughened channel placement	590	CY	$ 100	$ 59,000	Rock source? $100/cy PNW typical
Revegetation	11	MSF	$ 230	$ 2,500	
Site restoration	1	LS	$ 5,000	$ 5,000	rough estimate
			Subtotal =	$ 126,000	
			Contingency (20%) =	$ 25,200	
			Total =	**$ 151,000**	

Minnehaha Creek - 54th Street Low Flow Channel for Fish Passage.

March 6, 2014

Conceptual level - quantities and construction cost estimate

Item	Quantity	Units	Unit cost	Item cost	Comments/notes
Mobilization (10%)	1	LS	$ 10,800	$ 10,800	Estimate is likely high since project concurrent with larger roadway construction
Dewatering	1	LS	$ 5,000	$ 5,000	Dependent upon creek conditions during construction
Erosion control	1	LS	$ 5,000	$ 5,000	Estimate is likely high since project concurrent with larger roadway construction
Corrugated aluminum pipe arch culvert (49" span x 33" rise)	100	LF	$ 350	$ 35,000	May be required to use concrete pipe by City/MnDOT. May increase cost ~30%
Roughened channel placement in culvert (7" depth)	10	CY	$ 200	$ 2,000	
Excavation (low flow channel)	650	CY	$ 8	$ 5,200	Estimate is likely high since project concurrent with larger roadway construction
Haul/disposal (20mi RT)	265	CY	$ 38	$ 10,000	No information on material balance for site. Assume material will be hauled offsite.
Large Woody Debris in Low Flow Channel	8	Each	$ 600	$ 4,800	
Surface Fabric Treatment	600	SY	$ 15	$ 9,000	
Pedestrian stream crossing - basic wood bridge	1	Each	$ 2,000	$ 2,000	
Revegetation	5	MSF	$ 230	$ 1,200	
Site restoration	1	LS	$ 5,000	$ 5,000	Estimate is likely high since project concurrent with larger roadway construction
			Subtotal =	$ 95,000	
			Contingency (25%) =	$ 23,750	
			Total =	**$ 118,750**	

Technical Memorandum

Minnehaha Creek 54th St Fish Passage – Culvert Design

Date: May 18, 2014

To: Becky Houdek

Company: Minnehaha Creek Watershed District

From: Beth Wentzel, PE

Introduction

Inter-Fluve is under contract with Minnehaha Creek Watershed District (MCWD) to develop construction documents for installation of a culvert under the 54th St Bridge to serve as a portion of a fish passage channel around an existing concrete structure that impedes passage of fish through this reach of Minnehaha Creek. The design is based on analysis Inter-Fluve began as part of a feasibility study of alternatives for achieving fish passage at this location. Results of the feasibility study are detailed in the technical memorandum "Minnehaha Creek 54th Street Barrier Removal" dated November 22, 2013. The feasibility study included consideration of several alternatives including:

1. Leaving the barrier and channel in current condition (no change)
2. Removing the concrete barrier and restoring of the channel
3. Removing the barrier and replacing it with a stone riffle
4. Leaving the structure as is and constructing a bypass channel

Of these alternatives, MCWD selected to pursue design of a bypass channel. The route selected for the bypass channel requires placement of a new culvert through the 54th Street embankment west of the existing stream crossing and construction of an open channel south of 54th Street to connect to Minnehaha Creek downstream. MCWD elected to proceed with detailed design of the culvert but not the open channel at this time. This memo summarizes the analysis and results of the analyses that informed the design of the culvert.

Hydrology

Hydrology of Minnehaha Creek in the project reach is described in the feasibility study memo. XPSWMM model results had been provided for a range of statistical peak flow events shown in Table 1.

Table 1 – XPSWMM Derived Statistical Flows

Recurrence Interval (yr)	Peak Flow
1.5	133
10	460
50	490
100	500

Additionally, data from the gage USGS station 7.2 miles downstream of the project (gage 05289800 Minnehaha Creek at Hiawatha Ave) was reviewed to determine more typical flow ranges for the stream. From this analysis, a target range for fish passage flows for the feasibility study was selected as between 2.5 cfs and 230 cfs. This would allow fish passage an average of 225 to 240 days per year. In fact, a smaller window of passage flows would provide benefits. Fish typically are not migrating during the lowest flow conditions or during the highest flow conditions. At the Hiawatha Ave gage, flows exceeded 150 cfs less than 10% of the time between November 2005 and November 2013.

Because maintaining in this reach an opportunity for kayakers to play in a standing wave at the grade control structure is important, flows relevant to recreation were also considered. The estimated flows during which a standing wave develops in the river and is enjoyed by kayakers was provided by MCWD and is estimated to be between 100 cfs and 400 cfs.

To ensure that we understand conditions within this full range of flows, we modeled flows of 2.5, 25, 50, 100, 150, 200, 300, 400, and 500 cfs. Flows less than 150 cfs were the focus for the fish passage criteria. The full range of flows were considered for effects on aesthetics and recreation opportunities in the main stem of Minnehaha Creek and for considering materials necessary for fish passage system stability.

Design

Generally, we recommend creating fish bypass channels that simulate natural stream conditions to the extent possible. This includes incorporating natural rock substrate and natural materials to create the adjacent channel shape and a low flow channel within the culvert. This simulates the look and feel of a natural channel while also creating roughness to reduce flow velocities and

pinching low flows to increase depth, allowing larger fish to maximize the power of their tail strokes as they swim through. However, creating these features also requires having a large enough culvert to efficiently manipulate material inside during installation and maintenance.

In the design of the fish passage culvert at 54th St, culvert size was constrained for two primary reasons. First, there is a desire to maximize the flow rate of water that continues to go over the grade control structure in the stream for recreation purposes. Second, due to existing and proposed infrastructure constraints within the road right of way, we needed to maintain a pipe crown elevation as low as possible and limit the rise, or height, of the pipe. For the conceptual design during the feasibility study, we proposed a 49 inch by 33 inch pipe arch culvert to accommodate flows suitable for fish passage for a range of flows. The City of Edina, its consultants, and MCWD agreed that a reinforced concrete pipe would be best for this application. Locally available sizes for reinforced concrete arch pipes were reviewed and we determined that the closest match to the originally analyzed pipe is 51 inch by 31 inch.

This pipe size limits our ability to install very large material within the pipe. As described in the Hydraulics section of this memo, the shear stresses in the culvert range from approximately 0.12 lb/sf for the low flow condition to 0.89 lb/sf for the 100 yr event. Critical shear stresses on the order of 0.89 and 0.12 are capable of mobilizing a uniform bed of material that is on the order of 3.5 inches and 0.5 inches in diameter, respectively, based on Shields equation. In a bed of mixed material, larger material tends to move at lower shear stresses and smaller material tends to move at higher shear stresses. Therefore, it is recommended that the D50 of a well graded mix be equal to or larger than the size of material predicted to be mobile by Shields equation. To balance the need for large material to counter the flow forces with the need for small material due to the challenges of working with large material as we place sections of this proposed culvert, we propose using well graded rounded MNDOT Class 1 material which has a D25 of 1 inch, D50 of 3 inches, and D100 of 6 inches.

To provide additional stability to the material, we propose installing energy dissipater rings or baffles into the culvert to provide a backstop for material that may roll along the bottom of the culvert. The rings would extend 0.5 feet from the invert of the culvert. Energy dissipater rings have notches at the bottom that allow the culvert to drain completely. The dissipater ring at the entrance to the culvert should be installed so that it does not allow drainage of the impoundment below a desired level. If baffles are poured instead of using energy dissipater rings, a low flow notch should be incorporated into all baffles except the one at the entrance.

The channel invert proposed in the feasibility study was 0.3 ft below the crest elevation of the grade control barrier to ensure that low flows pass through the fish passage system. To provide a natural substrate within the culvert as described above, we set the invert of the inlet to the culvert

0.5 ft lower than the proposed channel invert. The resulting culvert invert and substrate elevations are 860.9 and 861.4 respectively. The final design slope of the culvert was set steeper than in the feasibility study to ensure that ultimately the channel downstream of the culvert would be able to tie into Minnehaha Creek without being too steep for passage. We estimated that the lowest elevation we may need to tie into the existing Minnehaha Creek is near 857.8 and we may only have a total bypass channel length of 250 ft due to area constraints within the park. To avoid exceeding the generally recommended average slope of 2%, we set the channel invert at the downstream end of the culvert at 860.3. The resulting slope within the culvert is 0.87%. This is a steeper slope in both the culvert and the open channel than was anticipated during the feasibility study, which will result in shallower and faster flows, which are less conducive to fish passage. If during final design of the bypass channel, there are opportunities for lengthening the bypass channel and/or increasing the tie in elevation, we can flatten the slope and increase the range of flows for which conditions are suitable for passage.

Hydraulics

We developed a one dimensional steady state computational model using HECRAS of the proposed culvert configuration described above as well as a preliminary option for the downstream open channel. There is not an option for including the energy dissipation rings in the culvert within the model. If they could be incorporated, the effect would be to increase roughness and decrease flow velocity and rate during high flows through the culvert. Because less water in the culvert at higher flows is preferred for recreation, and lower velocities are preferred for fish, omitting them from the model represents a conservative approach. If baffles are used, they will be flush with the substrate elevation, and are not expected to affect hydraulic conditions.

The downstream channel was modeled with the same dimensions as had been described in the feasibility study, with a 2 ft base width and 2:1 side slopes up to a top width of 6 ft and depth of 1 ft. Above that depth, the slope transitions to 3:1 to tie into existing grade. The details of this channel will be refined during final design of the open channel section of the fish passage system.

Manning's n values for Minnehaha Creek remained the same as they had been defined during the feasibility study. For the proposed culvert, the bottom of the culvert was assigned a Manning's n of 0.035, consistent with a straight channel with minor stone substrate, and Manning's n for the rest of the culvert was sent to 0.011 consistent with smooth concrete. The hydraulic model was set up with a split flow where the proposed culvert would draw water out of the impoundment. The model was run to iteratively determine the the flow split at this junction.

The hydraulic details of particular interest include:

1. The portion of flow that enters the bypass channel for a range of flows;

2. Shear stresses and stability of the material within the culvert;
3. Range of flows suitable for passage of fish; and
4. Change in water surface elevation in the impoundment for a range of flows.

FLOW SPLITTING

For the flows modeled, Table 2 shows the model predictions for the division of flow between the main stem of Minnehaha Creek and the bypass channel. As expected, during low flow conditions, most of the flow is routed into the fish passage system. As flow in the stream increases, the small size of the culvert restricts the portion of flow that can pass through that system. In the 100 to 150 cfs range when kayakers begin to expect a standing wave to develop, approximately 20 cfs is diverted to the bypass channel. The HECRAS model predicts a transition from supercritical to subcritical flow downstream of the grade control structure for all flow conditions in both the existing condition model and the proposed condition model. Therefore, a hydraulic jump of some magnitude is anticipated at all flows. However, the jump that is perceived by kayakers to represent a standing wave large enough to enjoy is subjective. Therefore, given that there is no change in the geometry of the main channel for the proposed condition we recommend using the flow rates as a surrogate for estimating change to the standing wave. For example, the wave historically produced at 100 cfs would be produced under proposed conditions at approximately 120 cfs.

Table 2 – Flow Splitting for Range of Stream Flows

Total Flow (cfs)	Fish Passage System (cfs)	Minnehaha Creek Main Stem (cfs)
2.5	2.4	0.1
25	7.3	17.7
50	11	39
100	17	83
150	23	127
200	27	173
300	36	264
400	40	360
500	43	457

SHEAR STRESSES AND MATERIAL STABILITY

It is important to understand the potential shear stresses within the system and understand how these stresses may affect the materials used to create the system. Shear stress can be calculated as

$\tau = \gamma R_h S$, where

τ = shear stress

γ = unit weight of water = 62.4 lb/ft^3

R_h = hydraulic radius = flow area/wetted perimeter

S = energy grade slope

Shear stress, hydraulic radius, wetted perimeter and flow area within the culvert are not output variables from HECRAS. Therefore we need to estimate shear stress within the culvert based on the variables that are output by the model. Water surface elevation is provided by the model at the inlet location and the outlet location. Based on the invert of the substrate at these locations, we can determine depth. To calculate hydraulic radius using water depth, we approximated the embedded pipe arch as a rectangular channel and calculated flow area (width * water depth) and wetted perimeter (width + 2*water depth). This conservatively under-predicts the shear stresses because in the arch pipe, the actual flow area would be smaller and the actual wetted perimeter would be larger, resulting in a smaller hydraulic radius. The energy grade slope was approximated by the average energy grade slope through the culvert based on inlet and outlet energy grade elevations predicted by the model.

Shields equation was used to predict the size of the stone that would be mobilized during under these estimated hydraulic conditions.

$D50 = \tau / [F_* * (\gamma_s - \gamma_w)]$, where

D50 = size of the median particle size

τ = shear stress

F_* = Shield's parameter = 0.03 for gravel and coarser material

γ_s = unit weight of stone = 165 lb/ft^3

γ_w = unit weight of water = 62.4 lb/ft^3

The resulting shear stresses and estimated median stone size for an immobile bed at the inlet and outlet locations are summarized in Table 3.

As described previously, installation of large stone material in a relatively small culvert would be challenging. Therefore, we propose installing rounded stone with gradation defined by MNDOT Class 1 riprap (D100= 6 inches, D50 = 3 inches, and D25 = 1 inch), and installing baffles or energy dissipating rings to provide a framework for holding the natural stone material in place. Because HECRAS can only predict one dimensional hydraulics, it is difficult to predict the effect that multidimensional flow patterns will have, but we can expect some material to become mobile during the highest flows. Even if there is some reorganization of material with the culvert, the

baffles and stone should continue to provide hydraulic conditions suitable for fish passage during a range of flows. If desired, additional baffles may be installed and/or the flow into the culvert could be further restricted to reduce shear stresses within the culvert.

Table 3 – Predicted Shear Stresses and Mobile Stone Size within Culvert

Total Flow (cfs)	Fish Passage System Flow (cfs)	Shear Stress at Inlet (lb/sf)	Shear Stress at Outlet (lb/sf)	Estimate of Mobile Stone Size at Inlet (inches)	Estimate of Mobile Stone Size at Outlet (inches)
2.5	2.4	0.12	0.19	0.5	0.7
25	7.3	0.20	0.27	0.8	1.1
50	11	0.25	0.32	1.0	1.2
100	17	0.33	0.37	1.3	1.5
150	23	0.41	0.43	1.6	1.7
200	27	0.48	0.48	1.9	1.9
300	36	0.61	0.58	2.4	2.3
400	40	0.77	0.71	3.0	2.8
500	43	0.89	0.84	3.5	3.3

FISH PASSAGE FLOWS

The important variables for fish passage through a channel and/or culvert are velocity and depth. If water is too shallow, fish cannot achieve their maximum swimming speeds. The recommended minimum depth for fish to achieve full swimming power is 1.5 * fish body depth. Velocity criteria are very species dependent. Northern pike are often used in streams where they are native as a target species when designing fishways due to their relatively poor swimming capacity. Though some individuals are capable of successfully swimming against greater speeds, a general guideline of 4 ft/sec for northern pike has been suggested. If resting areas are available passage at higher speeds is possible. Bass and sunfish generally can sustain much higher swimming speeds. Larger individuals within a species generally are capable of sustaining higher swimming speeds. Maximum velocity and minimum depth both within the culvert and within the preliminary open channel are summarized in Table 4. The configuration of the open channel can be refined during final design to improve hydraulic conditions there. However, we included it here because the slope of the culvert and resulting hydraulic conditions is dependent on the slope of the downstream channel for the assumed length. The downstream open channel is steeper than the culvert, which is important because if the fish cannot ascend the entire fishway, it is best if the fish doesn't enter it.

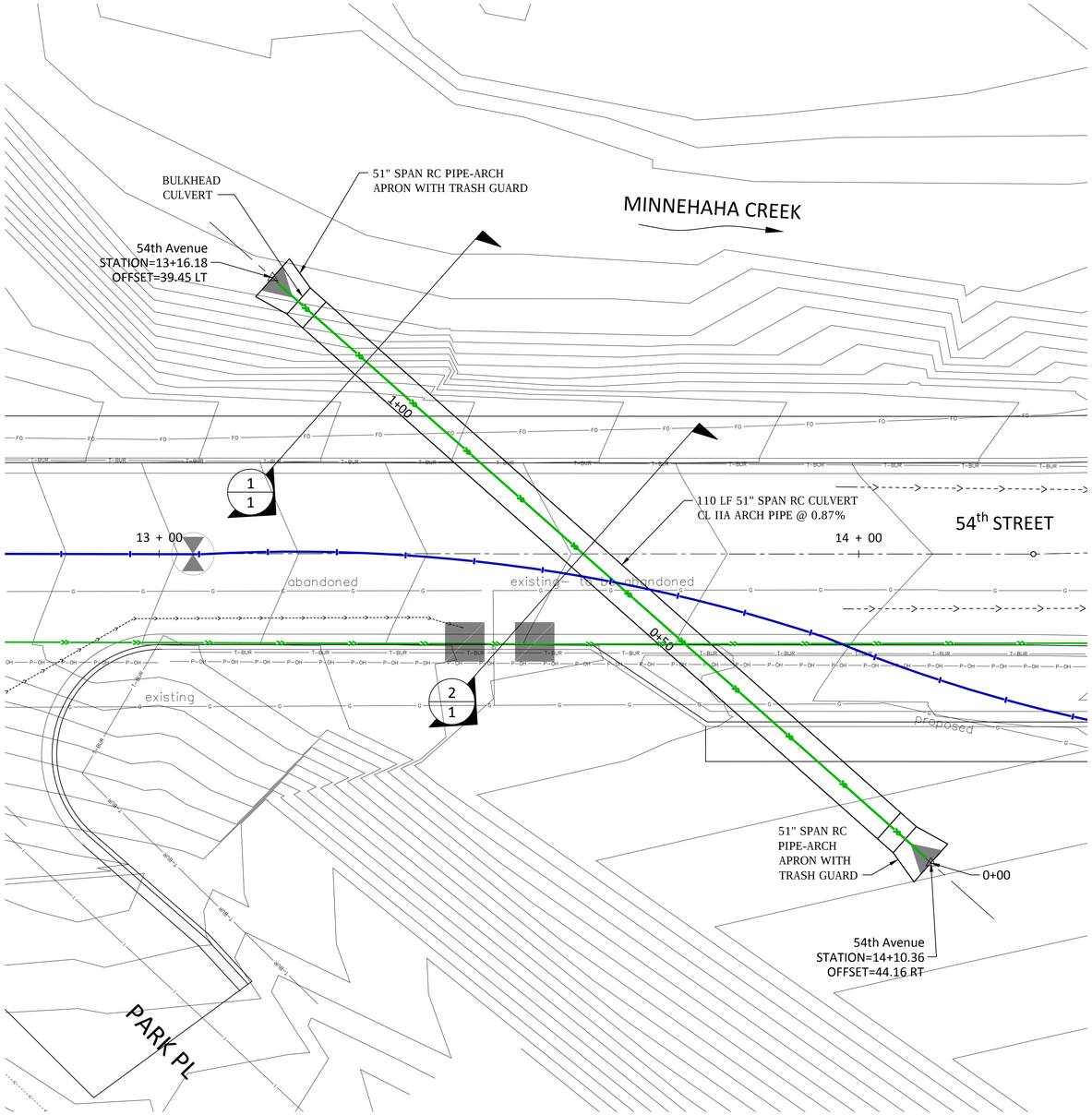
Table 4 – Maximum Velocity and Minimum Depth Anticipated in Fish Passage System

Total Flow (cfs)	Fish Passage System Flow (cfs)	Max Velocity in Culvert (ft/s)	Minimum Depth in Culvert (ft)	Max Velocity in Open Channel (ft/s)	Minimum Depth in Open Channel (ft)
2.5	2.4	0.71	0.3	2.86	0.34
25	7.3	1.69	0.6	3.77	0.62
50	11	2.25	0.78	4.16	0.77
100	17	3.03	1.07	4.59	0.98
150	23	3.75	1.31	4.91	1.12
200	27	4.25	1.51	5.09	1.23
300	36	5.96	1.73	5.45	1.4
400	40	7.49	1.82	5.63	1.48
500	43	8.08	1.89	5.74	1.54

Based on these values, it is clear that primarily smaller fish would be passing at flows as low as 2.5 cfs. This should not be a problem since adult fish migrations typically occur in the spring when flows are higher. At flows up to our target fish passage flow of 150 cfs, velocities in the culvert remain below the 4 ft/sec target. The predicted velocities within the open channel are higher, but refinement of the channel configuration during final design will improve conditions. Further, during final design, we can optimize the tie in elevation and channel length based on the typical fish migration season flows. For example, it is likely that we can increase the tie in elevation based on higher water elevations anticipated at the tie in location during times of year when fish will be moving. This may restrict passage at lower flows, but that may be preferred to improve passage conditions at higher flows.

IMPOUNDMENT WATER SURFACE ELEVATION

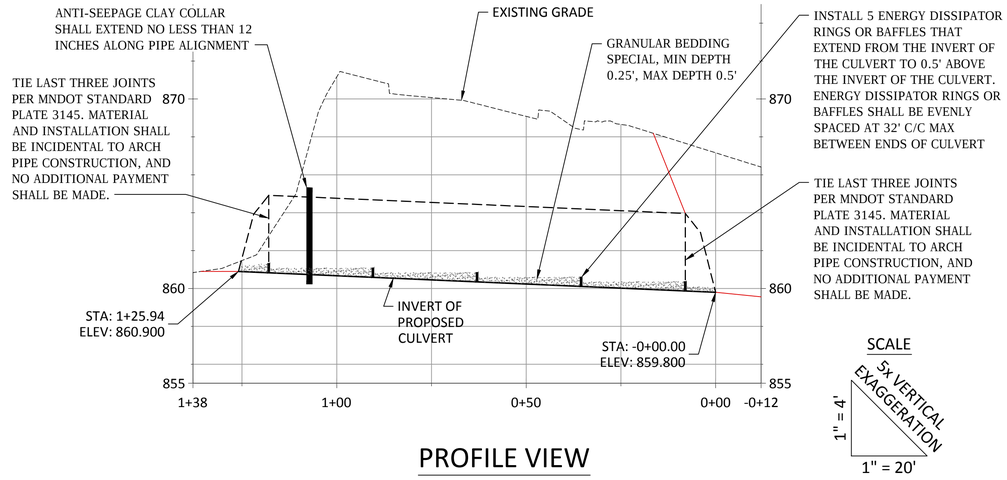
To estimate the effect that adding a culvert under 54th St would have on the aesthetics of the impoundment, we compared the predicted water surface elevations for the existing conditions model and for the proposed condition. The reduction in water level ranged from 0.08 ft for the 25 cfs flow to 0.17 for the 300 – 500 cfs range of flows. The visual impact of these water level reductions will depend on the bank slopes near the water surface. For example if the bank slope is 3:1 at the water surface, a water level reduction of 0.1 ft will reduce apparent width of the impoundment by 0.3 ft on that bank. If the bank slope is 10:1, a similar reduction in water surface elevation would result in a 1 ft reduction of impoundment width on that bank.



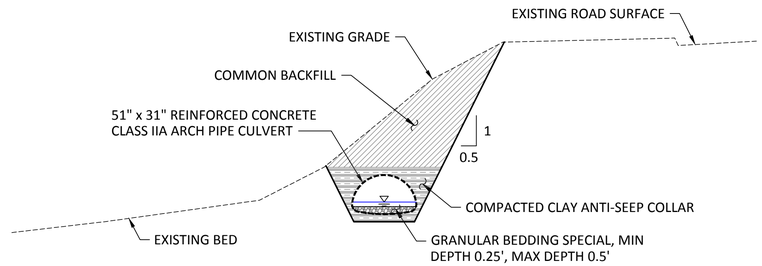
0 10 20

SCALE IN FEET

PLAN VIEW

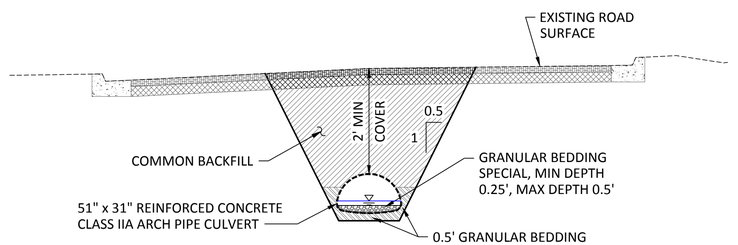


PROFILE VIEW



1/1 SECTION - PROPOSED CULVERT

NOT TO SCALE



2/1 SECTION - PROPOSED CULVERT

NOT TO SCALE

NOTES:

1. CULVERT SHALL BE PLACED PER CLASS B BEDDING REQUIREMENTS.
2. ANTI-SEEPAGE CLAY COLLAR MATERIAL AND INSTALLATION SHALL BE CONSIDERED INCIDENTAL TO ARCH PIPE CONSTRUCTION, AND NO ADDITIONAL PAYMENT SHALL BE MADE.
3. GRADING TO BE COMPLETED BY OTHERS AT FUTURE DATE.

G:\M-P\Minnehaha Ck 54th St Barrier_130245\8 Drawings\FI_Minnehaha_Concept.dwg 4/24/2014 9:08 AM dfield

DRAWN BY:
DESIGNER:
CHECKED BY:
DESIGN TEAM

NO.	BY	DATE	REVISIONS

I HEREBY CERTIFY THAT THIS PLAN 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.

SIGNATURE
MARJORIE BETH WENTZEL
PRINTED NAME

Date: 4/25/14
Lic. No. 51128

inter·fluve INC
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Hood River, OR 97031
541.386.9003
www.interfluve.com

EDINA 54TH STREET RECONSTRUCTION

CULVERT INSTALLATION

FILE NO. EDINA124747

DATE: 4/25/14

Inter-Fluve, Inc.
Draft Memorandum

TO:	Becky Houdek
FROM:	Marty Melchior, Beth Wentzel, Jonathon Kusa
DATE:	August 1, 2014
REGARDING:	Habitat improvement alternatives from 54th Street to Browndale Dam

1. Introduction

Minnehaha Creek Watershed District (MCWD) retained the services of Inter-Fluve, Inc. (Inter-Fluve) to review site conditions and existing data for the segment of Minnehaha Creek from 54th Street to Browndale Dam in Edina and develop recommendations for improving floodplain connectivity and fish and wildlife habitat. The stream segment includes the Upper half of Reach 15 and all of Reach 16 as previously delineated in the 2004 and 2012 Fluvial Geomorphic Assessments. This Tech Memo outlines the existing conditions, provides our professional opinion regarding potential improvements, and provides opinions of probable construction costs for those solutions.

2. Existing Conditions Summary

Existing conditions – The 2012 fluvial geomorphic assessment noted no significant changes in either Reach 15 or 16 when compared to the 2004 assessment. This is consistent with what we know about the segment as a stable section of stream with active riparian management and geomorphic process arrested by hard armoring and grade control. Reach 15, within the hydraulic influence of the 54th Street drop structure, is described as a slightly aggrading but stable backwater area. Upstream of the pond's influence to Browndale Dam, the stream is a riffle-pool channel with low gradient, moderate width to depth ratio, wide floodplain, gravel substrate and laterally meandering planform. Nearly the entire length of the channel upstream of Arden Park is lined with retaining walls, cobble or boulder riprap, and with a few exceptions, banks and floodplain are managed for turfgrass to the stream edge.

Habitat within the impoundment consists of coarse woody debris and small gravel patches. The impoundment is dominated by fines and exotic riparian grasses (eg. Reed canarygrass). Deep pool cover was noted only at culvert outfalls. Large wood is routinely cleared from the stream. Overhead, spawning, juvenile rearing and adult fish habitat and cover was limited.

The *riparian area* within Arden Park is good, with a 200-ft wide floodplain forest interrupted only by the hockey rink on river left. Riparian habitat is non-existent from Arden Park upstream to Wooddale Avenue, and also along the left bank from Wooddale through Utley Park up to the Browndale Dam. In these areas, turgrass is managed to the stream edge, and no native grasses, forbs, or shrubs are present (Figure 1). The right bank in Utley Park is not maintained, and is a mix of native and non-native shrubs, trees and forbs that provides shading to roughly half of the stream width.

Fine sediment, including silt and sand, is transported through the upper reaches and through the thalweg of the Arden Park pond. Some gravel is transported through the reach up to the Arden Park backwater during larger flood flows. However, the reach remains stable and perhaps slightly starved of sand and gravel due to the sediment trapping influence of the Browndale Dam. A comparison of aerial photographs of Arden Park from 1991 to 2013 suggest no significant change in cross section or vegetated depositional features within the impoundment (Figure 2). Most of the sediment impounded within the Arden Park pond is accumulated decaying organic matter and silt.

Figure 1. View of Minnehaha Creek looking west upstream of Arden Park

Figure 2. Minnehaha Creek in Arden Park circa 1991 (left) and 2013 (right)

3. <u>Restoration Potential</u>

Floodplain connectivity – The floodplain connectivity throughout Reach 16 may be slightly compromised by floodplain filling. The Utley Park parking lot comes within 38 ft of the existing channel bank. A 100ft wide floodplain bench would require moving the basketball court and the parking lot toward 50th Street. Hydraulic modeling of this segment could determine the extent of floodplain access that could be gained through floodplain grading, but it is highly unlikely that a small section of floodplain connectivity would result in appreciable flood storage or habitat benefit. There is some floodplain connectivity rom Wooddale Avenue South to the 54th Street drop structure.

In-stream fish habitat – The overwhelming limiting factor with regard to fish habitat in Minnehaha Creek is the flow regime, which varies from 2-4 months of flows well above bankfull in spring and summer to 2-4 months of extremely low or zero flow in the winter months. In the 2012 survey, the entire reach was dry with the exception of small pools within the Arden Park impoundment area. The existing Arden Park impoundment provides some marginal residual pool habitat that may allow fish to survive

low flow extremes in non-drought years, but the accumulation of sediment limits pool depths to less than 2.5 feet. Possible habitat actions include the following:

- Off channel habitat in the form of floodplain wood could provide habitat during large flood events. However, because floodplain wood is subject to frequent wetting and drying, typical Midwestern tree species used (oak, maple, white pine, red pine) would decay within 10-20 years of placement depending on wet-dry cycles experienced. Cedar and black locust could provide long term function, but would be 5-10 times the cost of the aforementioned species.
- Dredging of the right bank side channel and the two left bank backwater bays would provide additional deep water (>3ft) cover during extreme flow or drought. We do not recommend dredging the thalweg of the pond.
- In-stream wood within the Arden Park dredged areas could provide some short-term habitat (10-20 years) depending on the long term flow regime and the tree species used. Wood can be used to help keep backwater channels open and to provide habitat for fish migrating from other reaches. It should be noted that habitat work in this reach may not result in any significant change in the overall survivability or total population of fish in the reach, as these are limited by flow extremes. Wood protruding from channel margins provides important habitat for reptiles, amphibians and waterfowl.
- Narrowing of the channel is <u>not</u> recommended in this reach. If there were a continuing source of course grained sediment filling the Arden Park Pond, then converting the area to a lotic environment might be prudent. However, the current pond is a functioning wetland, has habitat for various wetland dependent species, and has a variety of submerged habitat features such as a side channel and backwater bays. Converting this pond to a narrower stream condition may not be geomorphically stable, and would reduce the amount of valuable deep water refugia, an element we stress as being critical to fish survival in the extremes of summer and winter.

Riparian/Wildlife habitat – Riparian habitat could be markedly improved through Reach 15 and 16 with more ecologically sound management of the riparian vegetation. Green corridors of native vegetation create important traffic routes for migratory birds and urban wildlife. We highly recommend a 30-100 ft buffer of native vegetation targeting a similar community to that seen downstream of 54th Street. This management scenario should also include active removal and monitoring of invasive vegetation

such as buckthorn, honeysuckle, garlic mustard and others. This buffer can be expanded in any areas where turfgrass is managed to the stream edge, including Utley Park and Arden Park.

We also recommend moving the Arden Park hockey rink to the other side of the river, where there is adequate room to move the rink away from the stream edge. There is currently a play area near the site, and on-street parking could be expanded and used for all park uses. The footbridge to Brookview Avenue could remain as park access for residents on the west side of Arden Park.

4. Conclusion

We recommend minimal dredging combined with backwater and/or floodplain wood treatments. We do not recommend narrowing of the channel or any large scale grading. In stream and floodplain wood placement will need to include engineering design considerations for longevity, stability during floods, trash deposition, and kayak/paddlers.

Riparian habitat could be improved by working with existing abutters to allow ecological riparian vegetation establishment, and by moving the hockey rink to the east side of Arden Park. The cost of this type of restoration includes long term monitoring and maintenance, which must be included in the overall cost versus benefit analysis. Riparian vegetation establishment would not improve fish survival or overall populations, as these are dependent on the flow regime. The largest benefits would be to songbirds, waterfowl, reptiles, amphibians and mammals.

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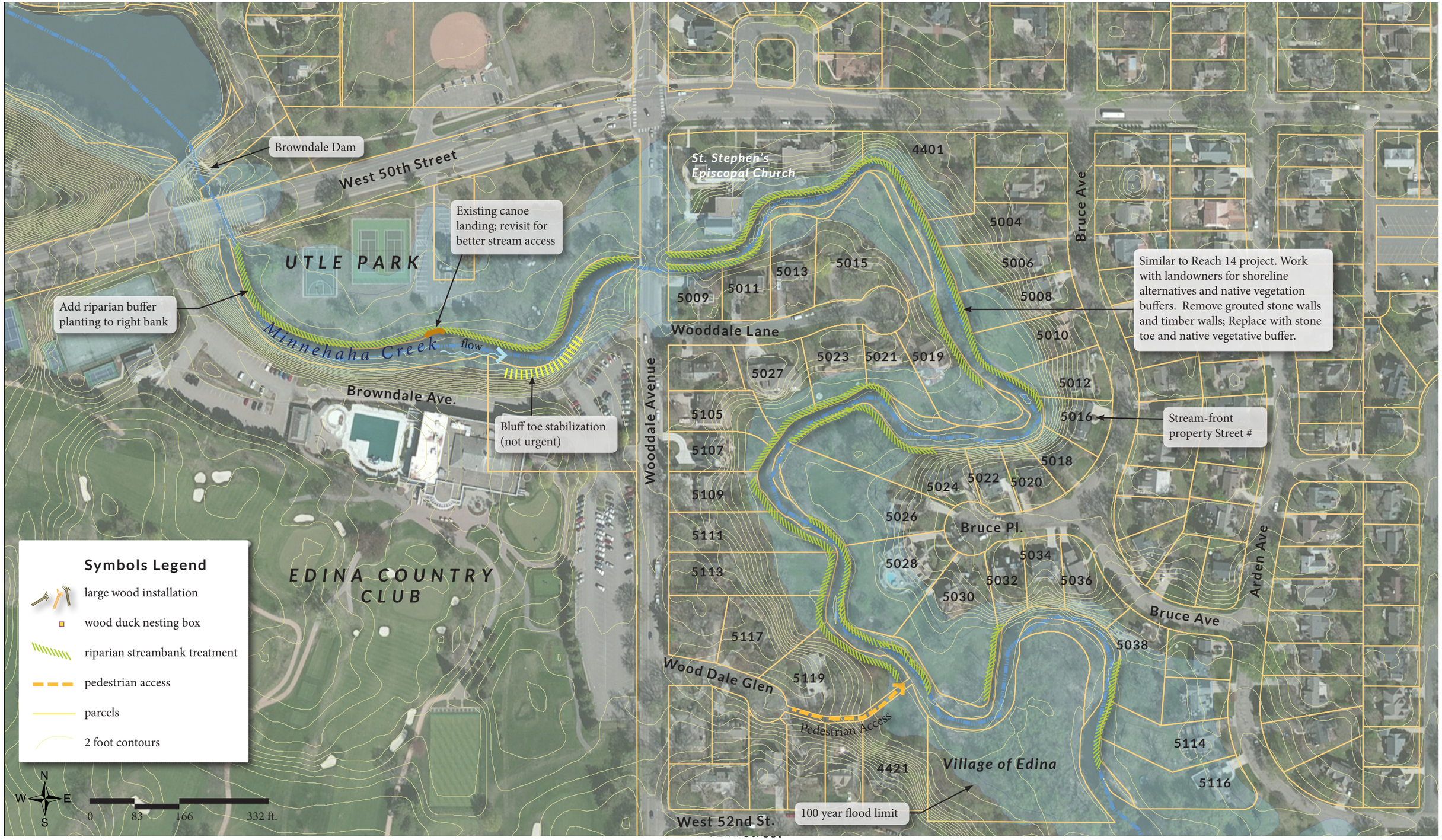
REACH 15 - Habitat Recommedation Concept Plan

Minnehaha Creek

Prepared for:
Minnehaha Creek Watershed District
August 4, 2014



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REACH 16 - Habitat Recommedation Concept Plan

Minnehaha Creek

Prepared for:
Minnehaha Creek Watershed District
August 4, 2014

Minnehaha Creek Reach 15-16
7/31/2014

Item	Task	Quantity	Unit	Unit Cost	Total Est. Cost	Notes
1	**Mobilization, Access, ESC**	1	LS		$ 93,884	15% of other items
2	**Grouted Riprap Removal**	1920	LF	$ 115	$ 220,800	(see and modify variables below)
3	**Earthwork - pool and side channel excavation**	3000	CY	$ 15	$ 45,000	Unit cost based on R20 bids; volume estimate sum described below
4	**Stone Toe**	1920	LF	$ 62	$ 119,467	$100/ton (See and modify variables below)
5	**FES Lifts**	1920	LF	$ 64	$ 122,880	Assumes 2 ft high bank (ie 2 face feet/one LF of bank)
6	**Riparian Buffer**	2180	LF	$ 41	$ 89,743	Assumes 15 ft wide buffer, 1 tree and 4 shrubs/10 ft of bank with trees @ $100 EA and shrubs @ $50 EA +$1/SY seed; 20% of residential banks + left bank through Utley Park
7	**Wood Installation**	40	EA	$ 500	$ 20,000	
8	**Canoe Launch Modification**	1	LS	$ 8,000	$ 8,000	
9	**Long Term Vegetation Mgmt**				$ -	TBD
	Contingency				30%	
	TotaL				$ 940,000.00	

Note: This estimate does not include moving the ice rink.

Utley Park stream length	900		
Ft of stream bank in residential area	6400	ft	(3200 ft of stream * 2 banks)
% of residential stream where existing hard armor will be removed and replaced with stone toe and FES lifts	30%		
% of residential stream bank where riparian buffer plantings will be installed	20%		

STONE

stone toe depth	4	
stone toe thickness	3	
stone volume/LF	0.4444444	cy/lf
unit weight	1.4	tons/cy
ton stone/lf	0.6222222	ton/lf

BANK ARMOR REMOVAL

treatment slope length/LF	10	ft	
Treatment thickness	3	ft	
volume/LF	1.1111111	cy	
removal cost/cy	100		Note: RSMeans has ~$70 for riprap removal, $120 for concrete removal
Removal cost/LF	111.11111		

EARTHWORK	L, ft	W, ft	D, ft	Volume, cy
pool near mouth of backwater channel	60	25	4	222.2222222
backwater channel, DS right side	290	30	4	1288.888889
backwater area, left side	130	60	4	1155.555556
backwater channel, US right side	70	25	4	259.2592593

March 11, 2014

Mr. James Wisker
Minnehaha Creek Watershed District
18202 Minnetonka Blvd
Deephaven, MN 55391

RE: 54th Street & Minnehaha Creek Project Understanding

Dear Mr. Wisker:

As you know, West 54th Street from Wooddale Avenue to France Avenue is being reconstructed by the City of Edina in 2014. The work includes the bridge over Minnehaha Creek. This project began with a robust stakeholder engagement process. Obviously a key stakeholder is the Minnehaha Creek Watershed District (District).

From past partnerships, ongoing collaboration with the District, and the recent success of the Reach 14 Streambank Project, the City of Edina understands and supports the District's goal of improving the Creek corridor. The 54th Street project creates another opportunity for the District and City to work together, to implement the West 54th project while enhancing corridor connectivity, addressing the biotic impairment of Minnehaha Creek. As part of this project, the City is also exploring opportunities to address area wide stormwater. Looking forward, habitat connection, stormwater management and the integration of the City and District goals through this corridor may also create future opportunities to enhance upstream habitat in Arden Park.

As part of this current project, the City is willing to create a partnership with the District to integrate the proposed habitat connection into the City's street project. If the District is able to provide design documents and funding related to this work, the City will include the work into its bid documents and construct it with the West 54th Street Project. The City understands that the District Board of Managers needs to consider this project for ordering and that formal agreements still need to be developed, but this letter is intended to state our general understanding to date.

The City looks forward to partnering with the District on this and future projects. Please feel free to contact me at 952-826-0318, or email cmillner@edinamn.gov with any questions or concerns.

Sincerely,

Chad A. Millner, PE
Director of Engineering

ENGINEERING DEPARTMENT
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