Two Carlson Parkway, Ste 110, Plymouth, MN
55447
P: 612.355.7726

Memorandum

Date: 12/2/2025

Prepared By: Quentin Scott, PE
Dan Elemes, PE
Jeff Madejczyk

Project: Plymouth Creek Restoration Phase 1

Subject: Plymouth Creek Restoration Design Memo

Narrative:

The City of Plymouth (City) contracted Moore Engineering, Inc. (Moore) to prepare construction plans for the restoration of Plymouth Creek from Dunkirk Lane to 38th Avenue North. The project is split into two phases with the first phase starting at Dunkirk Lane and ending downstream of a trail crossing at 41St Avenue North. This memo will discuss the project background and need, along with Moore's design approach in preparing the construction plans for the first phase of the restoration project.

Background

The Bassett Creek Watershed Management Commission (BCWMC) completed a feasibility study of Plymouth Creek between Dunkirk Lane and 38th Avenue reviewing the existing conditions of the stream and proposed restoration options. This feasibility study was presented to BCWMC and the City of Plymouth for their review and consideration. The feasibility study evaluated three options for restoration which were essentially broken out as completing restoration as Option 1 – High Priority Areas, Option 2 – High and Moderate Priority Areas, Options 3- All Identified Restoration Areas. BCWMC and the City decided to move forward with Option 3 in the feasibility study, which included completing all the proposed sediment removal, stream restoration, meander, and vegetation management presented in the feasibility study.

Upon review of the entire proposed project and the level of effort needed to complete the full Option 3 design, the City decided to break out the creek restoration into two phases. The first phase will focus on the stream from Dunkirk Lane to the trail crossing near 41st Avenue, see Figure 1 below. The second phase will start where the first phase ends and continue until 38th Avenue. The goal is to design and permit the first phase of the project in fall and winter of 2025 and construct the project in 2026. Currently the project manual and contract is structured to offer the contractor flexibility to construct in Winter 2026, or late Summer 2026, depending on weather conditions. Phase two would then be designed and permitted starting in spring of 2026 and constructed over the 2026/2027 winter.

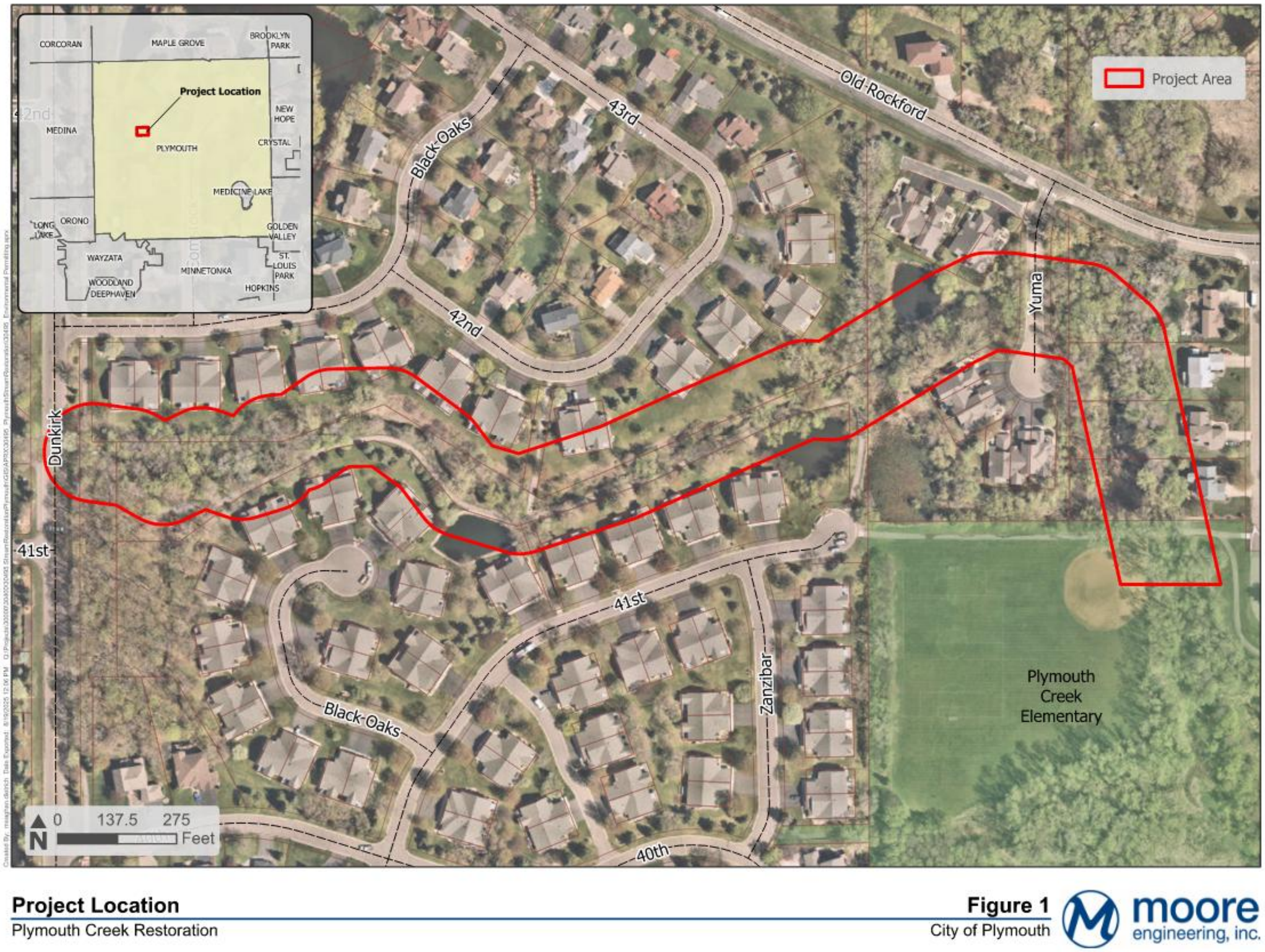

Figure 1: Project Location – Phase 1 Restoration from Dunkirk Ln to 41st Avenue Trail

Data Collection

Moore was provided feasibility study findings along with ArcGIS shapefiles of the proposed practices shown in the feasibility study figures by the Watershed. Velocity and flow information for the stream from BCWMC XPSWMM model was provided to Moore by Barr Engineering, the BCWMC District Engineer. The study was dated May 2024, and therefore it was assumed that the field investigation was completed in 2023. Both 2024 and 2025 were wetter years on average and had large rainfall events, so it was assumed some field conditions changed. It was determined that a field investigation was warranted to evaluate current channel conditions. The BCWMC shapefiles of the improvement practices identified in the feasibility study were added to an online web map to compare existing conditions with what was previously proposed. Along with the field evaluation to confirm existing conditions, a topographical survey of the stream was also completed. The survey collected cross sections of the stream including the centerline, toe, and top of the stream along with shots 75 feet past the top of the bank. These cross sections were taken approximately every 100 feet throughout the phase 1 reach; additional cross section density was added at channel bends. Stream centerline, toe and top of bank shots were taken approximately every 20 feet. A wetland delineation and desktop cultural review were also completed for this phase of the project.

Existing Conditions

Moore walked the extents of the first phase of the project multiple times, including documenting the entire channel through videos filmed while walking through the stream. For most of the stream, current conditions generally matched what was shown in the feasibility study. Stationing listed in the report refers to stationing listed in the plans. Existing flow rates, velocities, and flow depths are shown in Table 1 below. Velocities greater than two feet per second are highlighted in yellow and velocities greater than four feet per second are highlighted in red. Erosion of bare soil typically begins when channel velocities exceed two feet per second. When areas reach or exceed four feet per second, practices that include armoring are required to stabilize banks and address channel instability.

Station	2-year			10-year			100-year		
	Flow Rate (cfs)	Velocity (fps)	Flow Depth (ft)	Flow Rate (cfs)	Velocity (fps)	Flow Depth (ft)	Flow Rate (cfs)	Velocity (fps)	Flow Depth (ft)
1+10	46.2	2.1	1.8	56.2	2.1	2.0	144.8	2.1	3.3
3+50	46.2	4.4	2.1	56.2	4.7	2.2	144.8	5.3	3.3
5+70	46.2	4.0	3.5	56.2	4.3	3.9	144.8	5.3	5.4
7+50	46.2	1.6	3.5	56.2	1.8	4.0	144.8	2.7	5.4
8+00	46.3	1.2	3.5	56.3	1.4	4.0	144.9	2.3	5.3
9+00	51.5	1.4	3.4	65.9	1.6	3.9	145.6	2.6	5.1
13+50	59.4	2.7	3.0	79.2	2.9	3.4	103.8	3.1	4.0
18+20	60.9	4.1	1.6	119.9	4.5	2.0	105.3	5.0	2.8
23+00	53.4	2.0	2.8	85.1	2.6	3.3	206.3	5.8	4.8
Average	50.7	2.6	2.8	70.1	2.9	3.2	142.8	3.8	4.4

Table 1: Summary of Flows and Velocities

Station 0+00 to 9+50

The first 650 feet of phase one showed signs of erosion and instability. Banks in this section were near vertical or undercut with adjacent plant roots exposed. The channel has also widened in portions of this reach. The bank full width of the stream was determined to be 12 feet wide based on top of bank width and depth of flow information. There are portions of the channel that are over 20 feet wide between the banks. The upland area was mostly covered by tree canopy with vegetation coverage mainly being stinging nettle. After station 6+50 the canopy opens, the open area above the banks that had good vegetation establishment. From station 6+50 to the pedestrian bridge at station 9+70 the channel was more stable but still has incised banks. The channel cross section was more consistent in this section with the wetted perimeter consistently covering a larger portion of channel and more pools being present. The banks near the bends around station 8+50 were vertical with subsoil and roots exposed. Based on velocity information from BCWMC's model, the velocity in the 2-year event for the first 500 feet downstream of Dunkirk Lane was around four feet per second. From station 7+00 to 9+50 the velocity slowed to be around one and half feet per second.

Station 9+50 to 18+50

From station 10+00 to 15+00 the riparian area of the stream is dominated by a shrub and brush community with limited mature tree overstory. The creek runs very close to the City trail that is along the south side of the creek. There are sections of the stream that are within five feet of the trail from the top of bank. Eroded banks were observed where the creek encroached close to the trail. There were two outlet pipes from a nearby city stormwater pond at station 15+00 that are almost completely blocked by sediment. Near station 16+50 there is a sharp drop in the stream that has created an over widened pool area that extends to station 17+00. After this pool the creek narrows back to a typical width and is mostly stable, with the exception of some undercut banks on the south. The upland vegetation is mostly shrubs and brush from station 10+00 to 15+00, after station 15+00 it transitioned back to a wooded area with a thicker canopy. Velocities in this stretch range from two to four feet per second.

Station 19+25 to 25+00

Between station 19+25 and 20+50 the north bank is extremely eroded, at station 20+00 the north bank had nearly five feet of exposed subsoil. The south bank was in far better condition with just some bank under cutting near station 20+50. From station 20+50 to the trail crossing at station 24+00 the channel opened to wetland. After discussion with the City, it was determined that this area was intended to act as a pond and was meant to be completely open. The area last had sediment removed in 2004 and since has accumulated sediment deposits and with vegetation growing through the area. A channel is still present in this area but there is obvious sediment deltas spread throughout the area. Soil probes were completed in this section and found that a hard bottom was present around elevation 960 which matched the channel bottom in this area. Sediment deltas ranged from two to four feet deep. Downstream of the trail crossing a head cut has formed from the culvert invert to the channel bottom, this drop is about two and a half feet.

Proposed Conditions

After reviewing the proposed restoration best management practiced (BMP) shown in the feasibility study, channel velocities, and completing the evaluation of existing site conditions, Moore prepared preliminary construction plans for Plymouth Creek. The proposed BMPs shown in the construction plans generally follow what was presented in the feasibility study with updates based on the field review. Moore is proposing the same types of BMPs and channel improvements for the Phase 1 restoration project as the feasibility study, including bank grading with erosion control blanket, vegetated riprap, coir toe, and brush mattress. The limited differences in the proposed design compared to the feasibility study include either extending vegetated riprap further along an unstable bank or switching from a softer touch BMP, such as limited bank grading with vegetation enhancement, to a practice that will provide more stability based on current channel conditions, such as implementing coir toe or riprap toe to provide increased protection. The feasibility study did call for vegetated reinforced soil stabilization (VRSS) which closely matches the vegetated riprap detail that is called out in the current Moore plans. Due to the relatively narrow overall channel, Moore has recommended using vegetated riprap in the areas that had been identified for VRSS to simplify constructability. The vegetated riprap will adequately protect the stream banks within the sections of channel that are identified to have higher velocities from BCWD's stormwater model. Due to constructability concerns with the relatively narrow creek, J-hook riprap vanes were replaced with stream-width rock vanes.

No-Rise

In order to verify no rise conditions were met, Moore developed an HEC-RAS steady state model. A HEC-RAS model was selected, rather than utilizing BCWMC's XPSWMM model, as HEC-RAS has more options to model specific stream attributes that are not available in XPSWMM (such as bridge modeling, varied manning's n values, etc.). The model used Hennepin County lidar for elevation information outside of the stream banks, with Moore's survey data added into the model's cross sections within the stream for accurate elevations. 100 year flow rate data was taken from BCWMC's district wide XPSWMM model and used in Moore's model. Once the effective existing model was running, cross sections were updated to reflect proposed conditions. The updates to proposed conditions included resloping banks, adjusting stream bottom widths, and updating stream bottom elevations to match proposed grade controlling structures such as arch vanes. Moore followed direction from Minnesota Department of Natural Resources (MnDNR) that no rise would mean no increase in water surface elevation more than 0.004 feet and no decrease more than -0.1 feet. The table below shows the results for the modeled cross sections.

River Station	Total Flow	Channel Bottom Elevation		Channel Velocity		Water Surface Elevation		
		Existing	Proposed	Existing	Proposed	Existing	Proposed	Difference
2413	145	977.12	977.08	2.87	2.34	976.996	976.998	0.002
2331	145	976.97	976.96	2.62	2.40	976.866	976.869	0.003
2192	145	976.71	976.65	3.26	3.19	976.550	976.488	-0.062
2099	145	976.45	976.34	3.80	3.50	976.228	976.151	-0.077
1874	145	975.74	975.68	3.56	3.05	975.560	975.545	-0.015
1612	145	974.94	974.93	3.66	3.66	974.745	974.744	-0.001
1589	145	974.71	974.71	5.81	5.83	974.201	974.195	-0.006
1579	145	974.46	974.46	4.77	4.81	974.111	974.100	-0.011
1558	145	974.18	974.17	5.52	5.64	973.707	973.674	-0.033
1281	145	972.54	972.47	3.23	3.29	972.382	972.300	-0.082
1122	145	971.74	971.62	4.71	4.56	971.393	971.300	-0.093
1006	145	970.93	970.88	4.54	4.41	970.634	970.599	-0.035
950	145	970.44	970.43	5.11	5.51	970.122	970.026	-0.096
871	145	969.84	969.84	1.85	1.79	969.790	969.793	0.003
778	145	969.77	969.77	2.51	2.52	969.685	969.686	0.001
747	145	969.73	969.73	2.16	2.15	969.660	969.661	0.001
644	145	967.72	967.72	5.83	5.91	967.192	967.172	-0.020
603	145	967.43	967.43	1.39	1.24	967.404	967.402	-0.002
494	155	967.41	967.40	1.47	1.43	967.380	967.376	-0.004
368	155	967.39	967.38	0.71	0.92	967.385	967.378	-0.007
220	155	967.39	967.38	0.26	0.57	967.386	967.377	-0.009
192	206	967.39	967.38	0.56	0.83	967.383	967.374	-0.009
100	206	966.06	966.06	0.97	1.48	966.047	966.030	-0.017
69	206	966.05	966.05	1.49	1.53	966.020	966.020	0.000
27	206	966.04	966.04	1.31	1.31	966.020	966.020	0.000

Table 2: No-Rise Summary

Pollutant Reduction

Moore estimated pollutant removal using Natural Resources Conservation Service (NRCS) guidance. According to the NRCS Web Soil Survey, soils of the creek are clay loams. This was visually corroborated in the field, though no formal soil tests were performed. A widening rate was applied based on field observations corresponding to NRCS category descriptions to determine an assumed pounds of eroded sediment per year. It was then assumed that one ton of total suspended solids (TSS) would produce one pound of total phosphorus based on the Minnesota Board of Water and Soil Resources Stream and Ditch Stabilization Estimator. TSS and TP reduction assumes banks are in a stable state after the project. The tables below show pollutant loadings under both existing and proposed conditions.

Channel Station	Channel Length (ft)	Bank Height (ft)	Widening Rate	Soil Density	TSS Eroding (lb/yr)	TP Eroding (lb/yr)
1+00 to 6+00	500	4.5	0.4	87.4	78,659	39.3
6+00 to 10+00	400	4	0.1	87.4	13,984	7.0
10+00 to 18+40	840	3.5	0.1	87.4	25,695	12.8
19+20 to 20+20	100	5	0.5	87.4	21,850	10.9
20+20 to 23+85	365	1	0.05	87.4	1,595	0.8
24+40 to 25+27	87	5	0.3	87.4	11,406	5.7
				Total	153,189	76.6

Table 3: Existing Pollutant Loading

Channel Station	Channel Length (ft)	Bank Height (ft)	Widening Rate	Soil Density	TSS Eroding (lb/yr)	TP Eroding (lb/yr)
1+00 to 6+00	500	4	0.05	87.4	8,740	4.4
6+00 to 10+00	400	4.5	0.05	87.4	7,866	3.9
10+00 to 18+40	840	3.5	0.05	87.4	12,848	6.4
19+20 to 20+20	100	5	0.05	87.4	2,185	1.1
20+20 to 23+85	365	1	0.05	87.4	1,595	0.8
24+40 to 25+27	87	5	0.05	87.4	1,901	1.0
				Total	35,134	17.6
				Reduction (lb/yr)	118,054	59.0

Table 4: Proposed Pollutant Loading and Reduction

Recommendations

The practices shown in the plans follow both the recommendations of the BCWMC initial feasibility study and have been expanded to match the current conditions of the stream based on Moore’s field review. Comments from permitting agencies will then be incorporated into the final construction plans for the project.