Fargo, ND | HEI No. 8150-0002
May 3, 2023

May 2019 – Cart Creek Site 1 Flood Pool Looking Northwest

NORTH BRANCH PARK RIVER WATERSHED PLAN: APPENDIX D-7

Alternative 2 – Cart Creek Site 1 Environmental Quality Account Benefits Analysis

Natural Resources Conservation Service

NORTH BRANCH PARK RIVER WATERSHED PLAN

Alternative 2 – Cart Creek Site 1 Environmental Quality Account Benefits Analysis

May 3, 2023

Park River Joint Water Resource District
(Walsh and Pembina Counties, North Dakota)

PREPARED FOR:

Park River Joint Water Resource District
308 Courthouse Drive No. 5
Cavalier, North Dakota 58220

PREPARED BY:

Natural Resources Conservation Service
North Dakota State Office
220 East Rosser Avenue
Bismarck, North Dakota 58502

Houston Engineering, Inc.
1401 21st Avenue North
Fargo, North Dakota 58102
(HEI Proj. No. 8150-0002)

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Alternative 2 – Cart Creek Site 1 (project) is an off-channel, multipurpose water storage facility located in Section 24 of Thingvalla Township, Pembina County, North Dakota. The project is intended to provide flood prevention, wildlife habitat, enhance and restore wetlands, and improve downstream water quality. As outlined by economics guidance prepared for the Red River RCPP PL-566 projects by NRCS (2019), the Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies (P&G) of 1983 was utilized to evaluate alternatives under this plan. Flood prevention benefits of the proposed project were monetized under the P&G National Economic Development Account, as documented in the Economics Evaluation Technical Memorandum. The purpose of this report is to summarize the computation of benefits for the P&G Environmental Quality Account, following the general guidance provided by NRCS (2019) for computing non-monetized water quality and wetland functional benefits.

More information on the design of the project is available in the design report for Cart Creek Site 1 (Houston Engineering, Inc., 2023).

2 WATER QUALITY BENEFITS

As outlined in Sections 1.4.2, 2.2.2, and 2.2.6.2 of the Plan/EA, water quality concerns within the North Branch Park River Watershed, and in relation to downstream waterbodies, and related regional and international agreements, are a significant issue. Driven by eutrophication of Lake Winnipeg over the last two decades, research specifically related to phosphorus transport in the Red River Basin has been completed. The findings document why the form and seasonality of phosphorus transport from cropland in this watershed is uniquely difficult to address.

- Total dissolved phosphorus (DP) accounts for an average of 85% of total phosphorus (TP) on tributary rivers and 81% of TP on the mainstem Red River (McCullough, 2012). DP is comprised of 85-93% highly bioavailable inorganic orthophosphate derived from common agricultural fertilizers.
- Rattan et al (2017) found that 62% of annual TP was transported during the 12-18 day snowmelt period, and several studies determined that floods derived from snowmelt tend to have higher concentrations of DP due to the combination of frozen soils and contribution of dead vegetation (Kieta et al, 2018) (McCullough et al, 2012).
- Mobilization of phosphorus is more strongly correlated to peak flow events than to mean discharge. Several studies have shown that the highest TP concentrations are recorded on the falling limb of the hydrograph (McCullough, 2012), which indicates that initial surface runoff and channel erosion are not the main transport mechanisms.
- Soils consist largely of very fine silt and clay lacustrine sediments, therefore even particulate form phosphorus tends to remain suspended in the water column at relatively low velocity flows (Paakh et al, 2006).

Both crops and perennial vegetation actively incorporate dissolved inorganic phosphorus into above and below ground plant tissue via uptake of DP from the soil pore water during the growing season (Curie, 2017). Prior to winter die off, a substantial percentage is translocated to below-ground plant tissue, but the residual above-ground biomass is deposited on the soil surface where TP may be retained as it is incorporated into soil organic matter (Curie et al, 2017). In addition, during leaf senescence, phosphorus solubilizing exudates can be responsible for generation of soluble phosphorus as well as the freezing process itself causing intracellular phosphorus release from biomass within shoots (Kieta et al, 2018).

During the long duration flood inundations typical in this watershed, labile phosphorus from dead vegetation is converted to DP in the overlying water. The uniquely high volumes of DP, compared to particulate bound phosphorus, severely limits the effectiveness of conservation practices that are successful elsewhere in the Midwest due to their ability to intercept soil bound phosphorus. For example, filter strips and riparian buffers typically remove DP through plant and microbial uptake, as well as infiltration driven soil geochemical processes such as adsorption and immobilization. Vanrobaeys et al (2019) completed a study in the Manitoba portion of the Red River Basin utilizing three, 20-meter wide vegetative filter strips downstream of cropland. Data was taken for TP and DP above and below the strips for 22 runoff events that occurred over the course of two years. The mean DP/TP for all events and sites was 0.71, the mean TP reduction was 9% for growing season events (summer), and there was no TP reduction found for non-growing season (spring) events. Conservation tillage, reduced tillage, and cover crops that increase soil organic matter serve to increase infiltration rates thereby reducing overall runoff and creating an armor on the soil surface that reduces soil erosion from fields. However, the stratification of the crop residue and associated nutrients has been shown to be a source of dissolved nutrients in spring runoff events over frozen soils and has the effect of increasing downstream phosphorus loads (Baulsh, 2019).

One of few conservation practices that has been found to be effective for water quality improvements in the Red River Basin are constructed temporary detention structures, such as that proposed with this project, with incorporated depressional areas or water management “cells” dedicated to growing wetland vegetation. The function of wetland biologic and soil geochemical phosphorus cycling is similar to that of filter strips and riparian buffers, however the addition of 1-2 ft of temporary retention allows those processes to work over a longer time period, after spring runoff and into the growing season. Water quality monitoring at the North Ottawa impoundment, a 16,000 ac-ft multicell detention structure constructed on the MN side of the Red River Basin with a 75 square mile drainage area, found an annual TP reduction of 66%, Total Nitrogen (TN) reduction of 73%, and Total Suspended Solids (TSS) reduction of 42% (Guzner, 2017) in the first three years after construction. To ensure that the portion of the impoundment bottom dedicated to wetlands does not become a source of DP over time, it is managed to optimize cattail production and that is then harvested, baled, and removed off site in the late fall. The harvest will take place prior to the first hard freeze to prevent nutrients form migrating out of the plant biomass and back into the soil. Based on the P content of harvested cattails, 300 acres of them would be required to maintain a long-term equilibrium for phosphorus at that particular site. Manitoba has also been engaged in large scale “cattail farming” to reduce phosphorus deliveries to Lake Winnipeg and has developed production facilities and governmental imposed market drivers for processed fuel pellets from that biomass (Svedarsky et al, 2016). The Pelly Lake Project in Manitoba is a 1,200 ac-ft detention structure built in 2015 and managed with the goal of maximizing phosphorus removal by growing and harvesting cattails. Results indicated phosphorus removal rates of 18-54 lbs/ac and economically viable production costs (IISD, 2014). The final design and Operation and Maintenance Plan for the Cart Creek Site 1 will be developed to ensure that the capacity for biomass harvesting and related soil/vegetation monitoring is incorporated. The preliminary biomass harvest area identified for the proposed site is shown in **Figure D-7-4** and **Figure D-7-5** near the end of this appendix.

The proposed project will generate water quality improvements through the following processes:

- Transport of sediment and nutrients (DP most critically) from cropland downstream of the proposed structure is proportional to the acreage of cropland inundated by the river at flood stage. The water quality analysis was based on empirical equations developed specifically for the Park River Watershed. USGS Gage 05090000 Park River at Grafton, ND was utilized to develop nutrient-discharge relationships for the Park River Watershed. Those relationships were then used to obtain nutrient loadings at specific locations for existing and proposed (with project) conditions.

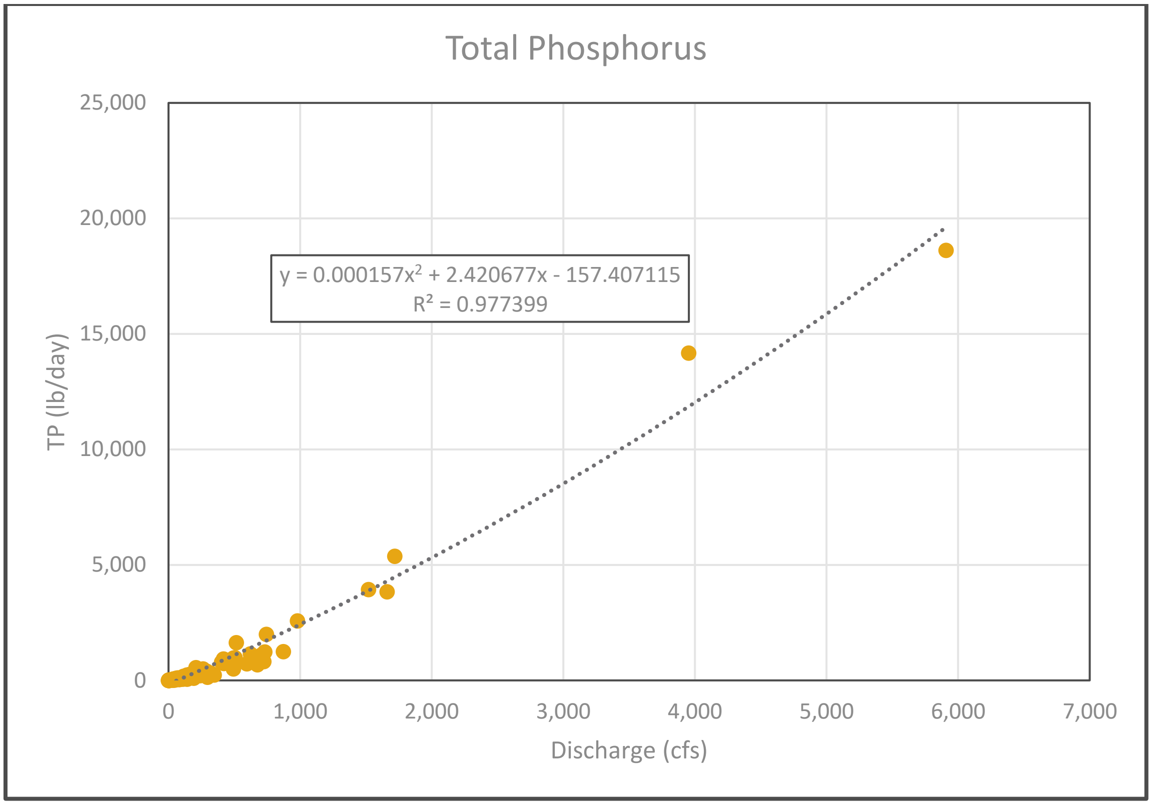
- Reduction of sediment and nutrients from the watershed upstream of the proposed structure through wetland biologic and soil geochemical phosphorus cycling, and biomass removal, in the temporary flood pool area of the detention structure. Nutrient loads were determined from the empirical equations noted above, and reductions applied based on the North Ottawa project research.

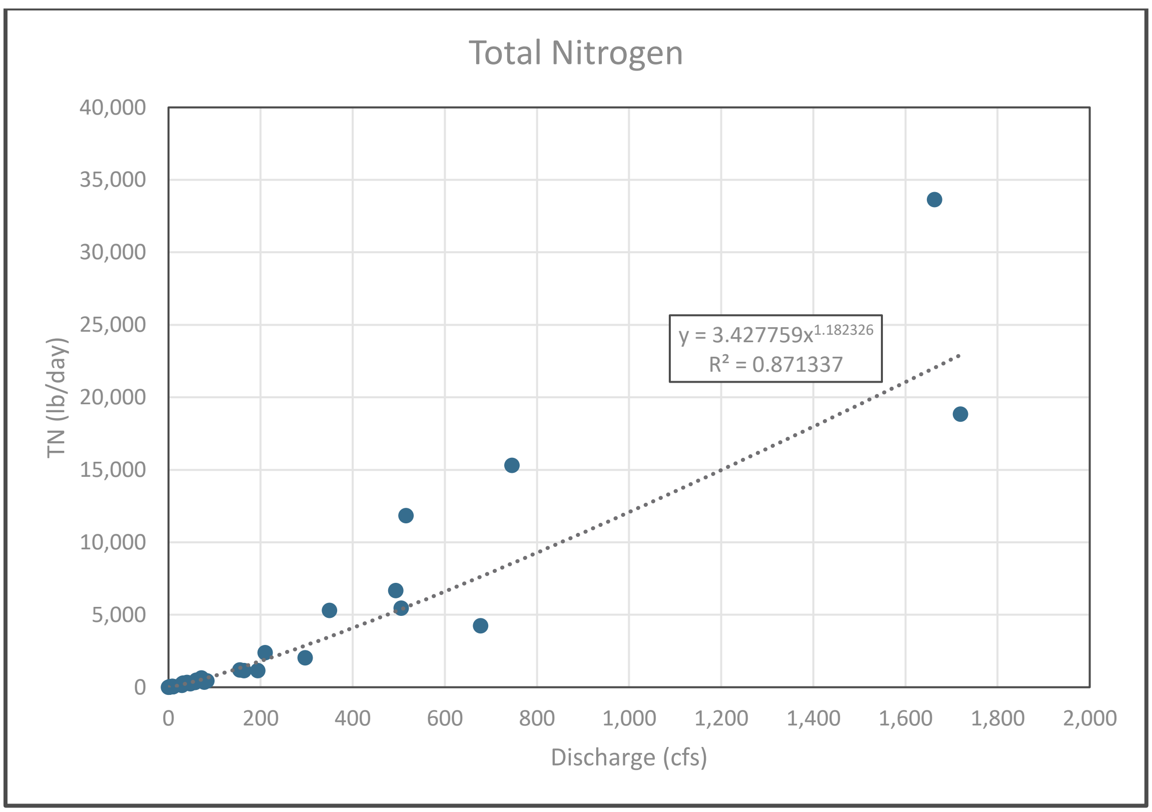
Two reporting locations were analyzed for water quality benefits. One of the locations analyzed was at the Cart Creek crossing with 86th Street NE, which is downstream of the confluence of Cart Creek and Pembina County Drain 28, and approximately 1 mile downstream of the proposed Cart Creek Site 1. The second location analyzed was near the outlet of the North Branch Park River. This reporting location accounts for both the channel flows measured at the BNSF Railroad crossing, and all breakout/overland flows near the outlet of the North Branch Park River. Flows measured at this location span an approximate 9 mile long transect. The location of the project, USGS Gage 05090000 Park River at Grafton, ND, and the two reporting locations are shown on **Figure D-7-2** near the end of this appendix.

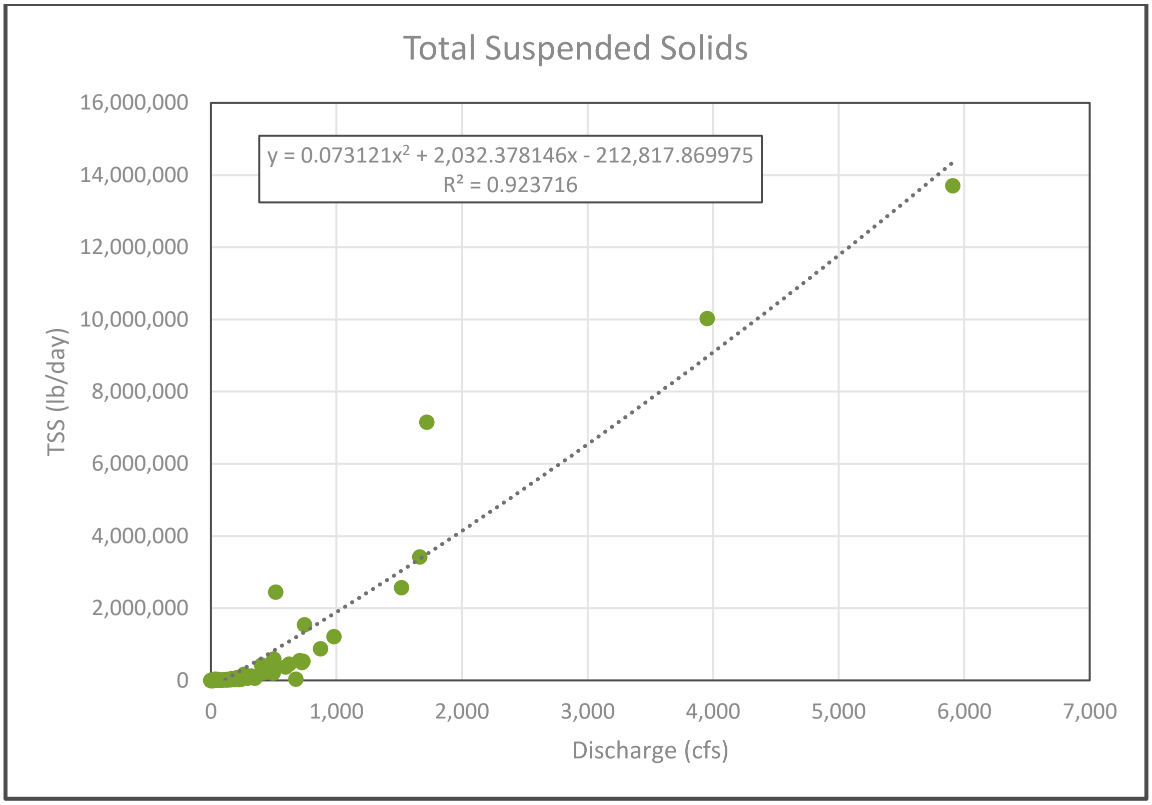
2.1 NUTRIENT-DISCHARGE RELATIONSHIPS

Total phosphorus, nitrogen, and suspended solids concentrations in the Park River at Grafton were obtained on specific dates and times from the North Dakota Department of Health Water Quality Data Portal from 1994 to 2006. Concentrations for the same parameters and at the same location were obtained from USGS water quality data from 2005 to 2020. Discharges at USGS Gage 05090000 Park River at Grafton, ND were obtained at the same date and time that each of the concentration values were obtained. The total phosphorus, nitrogen, and suspended solids concentrations relative to discharge at USGS Gage 05090000 at Grafton, ND are shown in the following charts. Empirical equations specific to the Park River Watershed were developed based on this data. The empirical or best-fit equations can then be used to predict nutrient and sediment loading at the gage site based on a specific discharge. The best-fit equations for each of the relationships are also displayed on the charts that follow.

An analysis was also completed on the proportion of phosphorus by form based on 120 water quality samples at USGS Gage 05090000 for the 2005-2020 time period. The average ratio of dissolved phosphorus to total phosphorus was 73%, with the median value at 78%. From a seasonal perspective, it does not appear that DP is substantially lower in precipitation driven runoff events as opposed to spring runoff in this watershed.


Total Phosphorus
y = 0.000157x2 + 2.420677x - 157.407115
R² = 0.977399
TP (lb/day)
25,000
20,000
15,000
10,000
5,000
0
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Discharge (cfs)


Total Nitrogen
y = 3.427759x1.182326
R² = 0.871337
TN (lb/day)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Discharge (cfs)



2.2 ANNUAL WATER QUALITY BENEFIT

Daily discharges at USGS Gage 05090000 Park River at Grafton, ND were obtained from 1994 through 2019. The empirical equations discussed in Section 2.1 were then used to compute a daily load of TP, TN, and TSS. All daily loads were summed for each year to get an annual sediment loading at the gage site in pounds. The resulting annual nutrient and sediment loads from 1994 through 2019 are shown in **Table 1**. Some simple statistics are included at the bottom of **Table 1** to show minimum, maximum, and average annual nutrient and sediment deliveries during the time period analyzed. Additionally, the final value listed in **Table 1** was calculated by taking the average annual loading to the gage site and dividing by the drainage area (695 square miles). This value represents the average annual nutrient or sediment loading per square mile of drainage area to the USGS gage and can be used to determine nutrient and sediment loading at other locations within the watershed.

Table 1: Annual Nutrient and Sediment Loading for Daily Discharge Data from 1994 through 2019

Year	Annual Loading Based on Data from 1994 to 2019		
	Total Phosphorus (lb)	Total Nitrogen (lb)	Total Suspended Sediment (tons)
1994	29,393	172,839	10,173
1995	83,686	450,504	31,076
1996	123,677	651,360	46,679
1997	212,855	1,109,377	79,420
1998	101,478	553,064	36,904
1999	67,935	369,161	24,542
2000	1,269	20,431	378
2001	62,852	344,304	22,825
2002	37,143	223,514	13,370
2003	39,315	223,248	12,809
2004	145,047	775,478	53,261
2005	92,901	509,008	33,642
2006	76,077	405,190	28,746
2007	86,605	476,339	31,334
2008	44,102	257,219	14,498
2009	288,560	1,510,143	109,309
2010	127,389	696,148	45,209
2011	145,691	776,588	54,157
2012	6,479	59,884	2,023
2013	271,229	1,406,379	102,510
2014	61,753	338,338	21,325
2015	24,903	178,451	7,533
2016	100,151	563,667	34,661
2017	121,998	665,626	44,937
2018	9,459	73,673	3,097
2019	65,891	360,831	24,255
Minimum:	1,269	20,431	378
Maximum:	288,560	1,510,143	109,309
Average:	93,378	506,568	34,180
Average Annual Loading per Sq. Mile	**134**	**729**	**49**

Nutrient and sediment loss from physical, chemical, and biological processes is expected to occur throughout the system. For this reason, first order loss equations were used to estimate the nutrient and sediment delivery ratios to the USGS gage at Grafton, ND using a program called PTMApp (Houston Engineering Inc., 2016). PTMapp provides detailed output information at several priority resource points within the watershed. Output information on nutrient and sediment delivery ratios is available at the USGS Gage, and near the two reporting locations shown on **Figure D-7-2**. The nutrient and sediment delivery ratios at the proposed site, downstream of the site at 86th Street NE, and near the outlet of the North Branch Park River were used to obtain average annual delivery per square mile at each location. For example, the average annual phosphorus loading found from empirical data at the USGS gage is approximately 134 pounds per square mile. The TP nutrient delivery ratio at that location (from PTMApp outputs) is approximately 0.47, or 47% of the original loading rate. Therefore, the average annual phosphorus loading per square mile for all individual catchments upstream of the USGS gage is approximately 285 pounds per square mile. That rate can then be used at a different location in watershed, such as the reporting location at 86th Street NE. If the reporting location at 86th Street NE has a TP delivery ratio of 0.89, that would then be multiplied by the TP delivery rate and then multiplied by the drainage area to the site to get total annual mass of TP at the crossing with Cart Creek and 86th Street NE.

The drainage area to Cart Creek Site 1 is approximately 33.8 square miles. The average annual TP, TN, and TSS loadings per square mile were multiplied by the drainage area to Cart Creek Site 1 and then by the appropriate delivery ratios to obtain the values in the second column of **Table 2**, which represent the nutrient and sediment loadings entering the site. To compute the water quality benefits at the site, nutrient and sediment reductions were estimated based on the North Ottawa impoundment study discussed previously (Guzner, 2017). For the North Ottawa impoundment, annual reductions of 66%, 73% and 42% were estimated for TP, TN, and TSS, respectively. The annualized nutrient and sediment loadings entering the site were then reduced by the percentages determined for the North Ottawa impoundment study. The results are shown in **Table 2**.

Table 2: Annualized Nutrient Reduction at Cart Creek Site 1

Parameter	Incoming Nutrient/Sediment Delivery	% Reduction (Guzner, 2017)	Nutrient/Sediment Loading Retained within the Site	Nutrient/Sediment Loading Leaving the Site
Total Phosphorus (lb/year)	8,499	66%	5,609	2,890
Total Nitrogen (lb/year)	46,106	73%	33,657	12,449
Total Suspended Solids (ton/year)	1,845	42%	775	1,070

Flood control provided by Cart Creek Site 1 also reduces peak flows and resultant nutrient and sediment loads from the North Branch Park River watershed. The impact on nutrient and sediment loads were estimated using HEC-RAS modeling results to scale observed average daily discharges at the USGS gage at Grafton, ND upstream to the North Branch Park River confluence. Peak flow rates for synthetic events computed with HEC-RAS were compared at each location to estimate a 0.52 reduction factor. The reduction factor was applied to the observed average daily discharges from the USGS gage at Grafton, ND to estimate existing conditions average daily discharges at the North Branch Park River confluence. The estimated average daily discharges for the existing conditions at the North Branch Park River confluence were then reduced to reflect the proposed conditions using HEC-RAS modeling results with Cart Creek Site 1 incorporated. Relationships developed in Section 2.1 were then applied to the existing and proposed conditions at the North Branch Park River confluence to estimate nutrient and sediment reduction resulting from flood control provided by Cart Creek Site 1, shown in **Table 3.**

Table 3: Annualized Nutrient and Sediment Load Reduction Due to Flood Control at North Branch Park River Confluence

*Total Phosphorus **(lb/year)***	*Total Nitrogen **(lb/year)***	*Total Suspended Solids **(tons/year)***
1,914	9,988	716

Values for the with-project scenario at locations downstream of the proposed site were computed by removing the drainage area upstream of Cart Creek Site 1 and adding the nutrient and sediment loading leaving the site to get the total annual mass. Nutrient and sediment loadings leaving Cart Creek Site 1 can be found in column five of **Table 2**. Nutrient and sediment loads for the proposed condition were also reduced by the nutrient and sediment loads due to flood control shown in **Table 3**. The resulting annual nutrient and sediment delivery for both existing and proposed conditions is shown in **Table 4**.

Table 4: Nutrient and Sediment Load Reductions at and Downstream of Cart Creek Site 1

Location	Drainage Area (Square Miles)	Scenario	Annual TP Delivery (lb/year)	Annual TN Delivery (lb/year)	Annual TSS Delivery (Ton/year)
Site Outlet	33.8	Existing	8,499	46,106	1,845
		Proposed	2,890	12,449	1,070
		% Reduction	66%	73%	42%
86th Street NE	37.4	Existing	9,404	51,017	2,042
		Proposed	3,795	17,359	1,267
		% Reduction	60%	66%	38%
North Branch Outlet	257	Existing	36,412	197,533	12,752
		Proposed	32,599	182,089	10,231
		% Reduction	10%	8%	20%
USGS Gage 05090000 Park River at Grafton, ND	695	Existing	93,378	506,568	34,180
		Proposed	89,812	492,466	31,673
		% Reduction	4%	3%	7%

The computed values were compared with other values obtained at retention sites in the area. A total maximum daily load (TMDL) study was completed for Homme Dam in Walsh County, North Dakota (Hargiss, 2012). Homme Dam, which has a drainage area of approximately 206 square miles, is located along the south branch of the Park River. The TMDL shows an average annual phosphorus yield of 179 pounds per square mile compared to the 134 pounds per square mile obtained at the USGS gage, and 251 pounds per square mile at Cart Creek Site 1. A similar value was also noted for a TMDL completed on Matejcek Dam (Husband & Hargiss, 2017) which had an average annual phosphorus yield of 180 pounds per square mile. While Matejcek Dam is not within the Park River Watershed, it is located in an adjacent watershed with similar landuse and topographical features that are common throughout the region. The drainage area to Matejcek Dam is listed as 138 square miles in the TMDL. In addition to the two TMDL studies, the values obtained also compare favorably with the analysis completed in Appendix C of the Red River Regional Conservationist Partnership Program Selection Criteria under PL 566 (NRCS, 2019).

2.3 SUMMARY

Water quality benefits are expected because of pollutant capture in the site with associated biomass removal to maintain capacity, and decreased extents and frequency of inundation in downstream agricultural fields during large runoff events. Pollutant capture within the site is estimated based on the study of the North Ottawa impoundment which is also located in the Red River Basin. Retention of phosphorus, nitrogen, and suspended solids within the site is estimated to be 5,609 pounds per year, 33,657 pounds per year, and 775 tons per year, respectively.

Reductions to nutrient loading immediately downstream of the proposed site is expected because of the pollutant capture within the site. As the Cart Creek progresses downstream and eventually flows into the North Branch Park River, the relative water quality benefits will begin to diminish because of the accumulated discharge. At the outlet of the North Branch Park River Watershed the water quality benefits are significantly lower in terms of percent reduction than the benefit immediately downstream of the site.

3 WETLAND BENEFITS

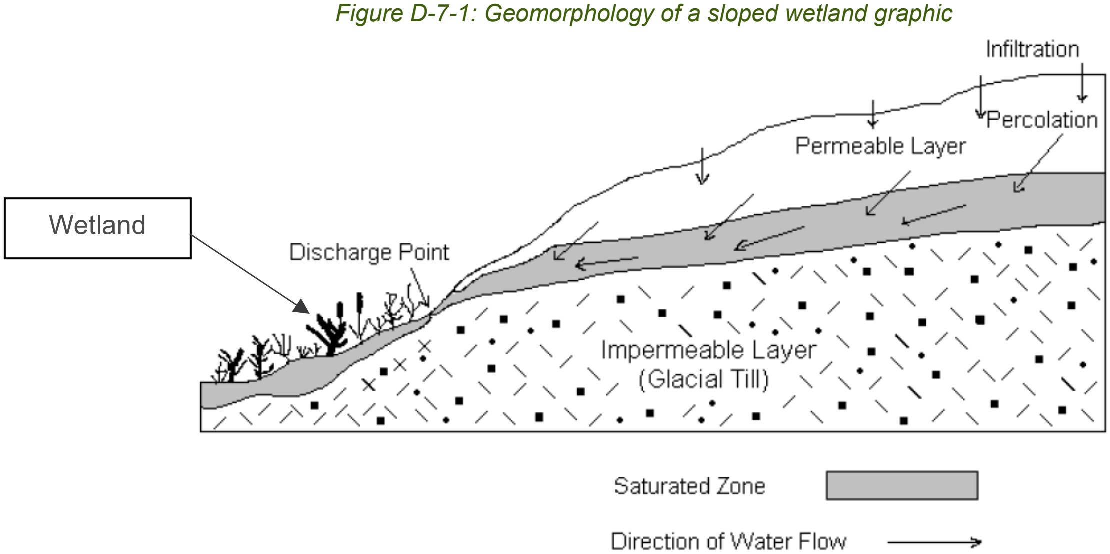
The Preferred Alternative will involve a net positive impact on wetland functions and wildlife habitat as a result of planned restoration work. It does, however, result in loss of wetland acreage and function from filling and drainage in some locations. Calculation of Environmental Quality (EQ) account wetland benefits for existing and proposed project alternatives was completed utilizing the NRCS Hydrogeomorphic Functional Assessment Model for Groundwater Discharge, Low Permeability (Glacial till) Substrate, Slope (Linear) Wetlands in the Northern Plains in order to enumerate that required wetland mitigation will be provided, as well as to quantify what the net improvement to wetland functions and acreage will be. Functional improvements are based on wetland indices, which measure ability of the wetland to perform a specific function relative to a regional reference standard; indices are then multiplied by the wetland area to generate Functional Capacity Units (FCU) (USDA-NRCS, 2008).

3.1 EXISTING WETLAND EXTENTS

With the exception of non-hydric soils on the north end, the entire impoundment bottom consists of HGM Class sloped wetlands that result from groundwater discharge from higher elevation areas to the west at ground surface, as illustrated in **Figure D-7-1**. Hydrology in the form of groundwater recharge has likely been limited due to more efficient surface drainage in the upper watershed, as well as the current road ditch to the west side of the project that intercepts and diverts water away from the site, and the east-west ditch within the project area. Historic aerial photography illustrates periods of widespread saturation. As an example, NAIP aerial imagery from year 2003 is shown in **Figure D-7-3**.

NRCS soils data was used to estimate historic wetland boundaries within the project footprint that have a hydric soil map unit (SMU) greater than 66%. Historic wetlands were assumed to be present in the project footprint if they are on an upslope or on side slopes, given that hydric components are considered endosaturated in those locations. The locations of historic wetlands are shown on **Figure D-7-3**.

Figure D-7-1: Geomorphology of a sloped wetland graphic



There is a 150-acre portion of the project area that includes permitted subsurface drains. Of this area, approximately 70.7 acres would have met the sloped wetland classification previously discussed, prior to drainage. The drain tiled area is identified on **Figure D-7-3.** Field wetland delineation work also identified biological communities, which were used to score the HGM functions for existing wetlands, the summary for which is included in **Tables 4-6**.

Existing wetlands within the project area were identified and are described in **Appendix D-5: Aquatic Resource Delineation Report**. The wetlands that were identified in the field are shown on **Figure C-13.** 17 different wetlands were identified in the project area. The total area of existing wetlands identified through field delineation is 28.6 acres.

3.2 PERMANENTLY IMPACTED WETLANDS

The proposed project is a multipurpose flood water retention structure with a biomass harvest area that will provide watershed protection. The site will include dam embankments, principle and auxiliary spillways, diversion structures, and inlet channels. Wetlands are impacted through placement of fill or excavation occurring within wetland boundaries. In total, 2.96 acres are permanently impacted due to excavation and 2.13 acres are permanently impacted due to fill placement. This results in 5.09 acres of permanently impacted wetlands due to fill placement and excavation. The extents of excavation and fill placement are overlaid with the existing wetland boundaries in **Figure C-14**. The embankment and excavation areas cause negative impacts to existing wetland functions and area. The overall goal of “avoid, minimize, and mitigate” is best served with the combined approach of minimize and mitigate within the project site.

3.3 WETLAND FUNCTIONAL IMPROVEMENTS

Multiple wetland improvements will be made to the project area, including wetland restoration of the drain tiled tract and functional improvements to currently degraded (cropped) wetlands elsewhere in the section. Restoration will include breaking tile and grouting mains to bring back wetland area and functions and restoring existing cropland to perennial vegetation. Proposed work to make improvements to existing wetland functions will include:

- The east/west drainage ditch that currently drains the site would be filled in to create the biomass harvest areas used for watershed protection.
- The first stage inlet of the principal spillway would be raised approximately 1.4 feet over the current excavated ditch channel.
- The north and south inlets are designed to induce shallow sheet flow across the flood pool.
- The in-place one line of 36” culvert through 131st Avenue NE will be enhanced to provide three lines of culverts at varying locations to avoid concentrated flow entering the site from the upper watershed.
- Decommission the in-place perforated tile system in the northern portion of the flood pool.
- Vegetation re-establishment of tilled portions of the flood pool.
- Embankments used to promote biomass growth for nutrient reduction will result in a constructed wetland by ponding shallow water.

The proposed improvements will result in the following benefits to wetland and upland habitats:

- Wetland restoration of upslope wetlands via tile decommissioning, natural hydrology, and vegetation re-establishment (71.5 ac)
- Upland habitat creation via tile decommissioning and natural vegetation re-establishment (36.3 ac)
- Upland habitat protection of established vegetation (3.9 ac)
- Wetland restoration of upslope wetlands via natural hydrology and vegetation re-establishment (57.7 ac)
- Wetland restoration of upslope wetlands via natural hydrology re-establishment (208.0 ac)
- Wetland enhancement via natural hydrology re-establishment (18.5 ac)

- Constructed wetland for water quality treatment (133.6 ac)

The restored functionality to 489.35 acres of sloped wetlands will offset the anticipated impacts of 5.09 acres and result in a net gain of 468.70 acres of additional wetlands from the existing condition. Wetlands that are currently within ditches and will remain within ditches after the project is completed are assumed to have equivalent function post-project (there are approximately 2.96 acres of existing wetlands within ditches that would be restored to the original condition post-project). **Table 5** provides a summary of impacted acres under Alternative 2. Refer to **Figure C-14** for a map of wetlands impacted by the proposed features of the project. See **Figure D-7-4** for a display showing the location of restored and enhanced wetlands.

The wetland functionality under Alternative 2 was scored using the NRCS Hydrogeomorphic Functional Assessment Model for sloped wetlands. These values were then compared to the existing condition FCU to assess increases in wetland functionality as a result of Alternative 2. Based on this assessment, wetland functionality is expected to increase by approximately 300% - 350% for each of the analyzed functions. A summary of the calculated FCU increases for each wetland under the proposed condition is provided in

Table 6. A breakdown for each wetland is provided in **Table 7**.

3.4 SUMMARY

The proposed project has an estimated 468.7 acres of wetland area improvement to existing conditions. However, the Functional Capacity Unit (FCU) increase is even more substantial than acreage indicates due to the current degraded condition of all existing wetlands at the site. The minimum gain is a score of 265 (Elemental and Nutrient Cycling), while the maximum gain is 408 (Organic Carbon Export). The most notable improvements are to the currently tilled fields, which will have major improvements to all wetland functions as natural hydrology is restored, and plant community reestablished to perennial vegetation. The watershed has limited existing wetland areas, and the ones that do remain are in a degraded condition similar to the ones at the project site. Functional capacities of these wetlands have been severely limited due to strong anthropogenic influence. The proposed project has great potential to substantially improve wetland habitat at this site and along Cart Creek, which has been straightened leaving very limited floodplain and wetland functions.

Table 5: Summary of Wetland Acreages*

Wetland Area	Existing and No-Action Conditions (Acres)	Alternative 2 Condition (Acres)	Gain (+) or Loss (-) (Acres)
Enhanced Existing Wetlands Summary			
1b	0.01	0.00	-0.01
3	0.06	0.00	-0.06
4 - Prairie	0.13	0.13	0.00
5	0.25	0.00	-0.25
7	0.17	0.17	0.00
8	1.21	1.21	0.00
9	1.86	1.86	0.00
10	0.18	0.18	0.00
11	15.76	14.25	-1.51
12	0.06	0.06	0.00
13	0.19	0.00	-0.19
14	0.11	0.00	-0.11
17	0.60	0.60	0.00
Enhanced Existing Wetlands Subtotal	***20.59***	***18.46***	***-2.13***
Restored Wetlands Subtotal			
Biomass Harvest Area	0	133.64	133.64
Restoration of Tilled Land (Tile drained)	0.06	71.53	71.47
Restoration of Tilled Land (Not tile drained)	0	57.70	57.70
Restoration of Prairie Land	0	208.02	208.02
Restored Wetlands Subtotal	***0.06***	***470.89***	***470.83***
Total	**20.65**	**489.35**	**468.70**

Note: Wetland acreages exclude portions of wetlands outside of the project footprint that are not impacted by the project.

Table 6: Composite Wetland Function Gaines and Losses

Function	Description	Existing and No-Action Conditions (FCU)	Alternative 2 Condition (FCU)	Functional Gain (+) or Loss (-) (FCU)
Moderation of Groundwater Flow	the capacity of the wetland to regulate the outflow of groundwater	13.34	371.09	+357.75
Velocity Reduction of Surface Water Flow	the reduction in the velocity of surface water movement through the wetland from storm events and/or snowmelt runoff	10.77	395.08	+384.31
Elemental and Nutrient Cycling	short- and long-term cycling and removal of elements and compounds on site through the abiotic and biotic processes that convert elements from one form to another	8.21	273.23	+265.02
Retention of Particulates and Organic Matter	deposition and retention of inorganic and organic particulate (>45 um) from the water column, primarily through physical processes	11.31	343.3	+331.99
Organic Carbon Export	export of dissolved and particulate organic carbon and detritus from the wetland	15.74	423.79	+408.05
Maintenance of Characteristic Plant Community	species composition and physical characteristics of living plant biomass	14.16	392.41	+378.25
Maintenance of habitat interspersion and connectivity among wetlands	the spatial relationship of an individual wetland with respect to adjacent wetlands in the complex	12.42	343.39	+330.97

Table 7: Wetland HMG Results

Wetland ID	Pre Project				Post Project Acreage			Gain Or Loss	
	Functions	Wetland Acreage	FCI	FCU	Wetland Acreage	FCI	FCU	FCI	FCU
1b	Mod. Groundwater Flow	0.01	0.65	0.01	0.00	0.65	0.00	0.00	-0.01
	Vel. Reduc. Surf. Water		0.21	0.00		0.21	0.00	0.00	0.00
	Elemental & Nutr. Cycling		0.57	0.01		0.57	0.00	0.00	-0.01
	Retention of Particulates		0.24	0.00		0.24	0.00	0.00	0.00
	Organic Carbon Export		0.66	0.01		0.66	0.00	0.00	-0.01
	Maint. of Plant Comm.		0.41	0.00		0.41	0.00	0.00	0.00
	Habitat Interspersion		0.31	0.00		0.31	0.00	0.00	0.00
3	Functions								
	Mod. Groundwater Flow	0.06	0.45	0.03	0.00	0.00	0.00	-0.45	-0.03
	Vel. Reduc. Surf. Water		0.36	0.02		0.14	0.00	-0.23	-0.02
	Elemental & Nutr. Cycling		0.16	0.01		0.00	0.00	-0.16	-0.01
	Retention of Particulates		0.37	0.02		0.12	0.00	-0.25	-0.02
	Organic Carbon Export		0.42	0.03		0.13	0.00	-0.30	-0.03
	Maint. of Plant Comm.		0.35	0.02		0.50	0.00	0.15	-0.02
	Habitat Interspersion		0.33	0.02		0.18	0.00	-0.16	-0.02
4 - Prairie	Functions								
	Mod. Groundwater Flow	0.13	0.65	0.08	0.13	0.77	0.10	0.11	0.01
	Vel. Reduc. Surf. Water		0.53	0.07		0.84	0.11	0.32	0.04
	Elemental & Nutr. Cycling		0.40	0.05		0.55	0.07	0.15	0.02
	Retention of Particulates		0.55	0.07		0.70	0.09	0.15	0.02
	Organic Carbon Export		0.77	0.10		0.92	0.12	0.15	0.02
	Maint. of Plant Comm.		0.69	0.09		0.86	0.11	0.17	0.02
	Habitat Interspersion		0.61	0.08		0.71	0.09	0.10	0.01
5	Functions								
	Mod. Groundwater Flow	0.25	0.45	0.11	0.00	0.45	0.00	0.00	-0.11
	Vel. Reduc. Surf. Water		0.36	0.09		0.36	0.00	0.00	-0.09
	Elemental & Nutr. Cycling		0.16	0.04		0.16	0.00	0.00	-0.04
	Retention of Particulates		0.37	0.09		0.37	0.00	0.00	-0.09
	Organic Carbon Export		0.42	0.11		0.42	0.00	0.00	-0.11
	Maint. of Plant Comm.		0.35	0.09		0.35	0.00	0.00	-0.09
	Habitat Interspersion		0.33	0.08		0.33	0.00	0.00	-0.08
7	Functions								
	Mod. Groundwater Flow	0.17	0.65	0.11	0.17	0.77	0.13	0.11	0.02
	Vel. Reduc. Surf. Water		0.53	0.09		0.84	0.14	0.32	0.05
	Elemental & Nutr. Cycling		0.40	0.07		0.55	0.09	0.15	0.02
	Retention of Particulates		0.55	0.09		0.70	0.12	0.15	0.03
	Organic Carbon Export		0.77	0.13		0.92	0.16	0.15	0.02
	Maint. of Plant Comm.		0.69	0.12		0.86	0.15	0.17	0.03
	Habitat Interspersion		0.61	0.10		0.71	0.12	0.10	0.02
8	Functions								
	Mod. Groundwater Flow	1.21	0.65	0.79	1.21	0.77	0.93	0.11	0.14
	Vel. Reduc. Surf. Water		0.53	0.64		0.84	1.02	0.32	0.38
	Elemental & Nutr. Cycling		0.40	0.49		0.55	0.66	0.15	0.18
	Retention of Particulates		0.55	0.67		0.70	0.85	0.15	0.18
	Organic Carbon Export		0.77	0.93		0.92	1.11	0.15	0.18
	Maint. of Plant Comm.		0.69	0.84		0.86	1.04	0.17	0.20
	Habitat Interspersion		0.61	0.74		0.71	0.86	0.10	0.12
9	Functions								
	Mod. Groundwater Flow	1.86	0.65	1.21	1.86	0.77	1.43	0.11	0.21
	Vel. Reduc. Surf. Water		0.53	0.98		0.84	1.57	0.32	0.59
	Elemental & Nutr. Cycling		0.40	0.75		0.55	1.02	0.15	0.27
	Retention of Particulates		0.55	1.03		0.70	1.31	0.15	0.28
	Organic Carbon Export		0.77	1.43		0.92	1.71	0.15	0.27
	Maint. of Plant Comm.		0.69	1.29		0.86	1.60	0.17	0.31
	Habitat Interspersion		0.61	1.13		0.71	1.32	0.10	0.19
10	Functions								
	Mod. Groundwater Flow	0.18	0.65	0.12	0.18	0.77	0.14	0.11	0.02
	Vel. Reduc. Surf. Water		0.53	0.09		0.84	0.15	0.32	0.06
	Elemental & Nutr. Cycling		0.40	0.07		0.55	0.10	0.15	0.03
	Retention of Particulates		0.55	0.10		0.70	0.13	0.15	0.03
	Organic Carbon Export		0.77	0.14		0.92	0.17	0.15	0.03
	Maint. of Plant Comm.		0.69	0.13		0.86	0.16	0.17	0.03
	Habitat Interspersion		0.61	0.11		0.71	0.13	0.10	0.02
11	Functions								
	Mod. Groundwater Flow	15.76	0.65	10.27	14.25	0.77	10.92	0.11	0.65
	Vel. Reduc. Surf. Water		0.53	8.28		0.84	11.99	0.32	3.71
	Elemental & Nutr. Cycling		0.40	6.35		0.55	7.82	0.15	1.47
	Retention of Particulates		0.55	8.69		0.70	10.01	0.15	1.33
	Organic Carbon Export		0.77	12.15		0.92	13.06	0.15	0.91
	Maint. of Plant Comm.		0.69	10.94		0.86	12.29	0.17	1.34

	Habitat Interspersion		0.61	9.58		0.71	10.12	0.10	0.54
12	Functions								
	Mod. Groundwater Flow	0.06	0.65	0.04	0.06	0.77	0.05	0.11	0.01
	Vel. Reduc. Surf. Water		0.53	0.03		0.84	0.05	0.32	0.02
	Elemental & Nutr. Cycling		0.40	0.02		0.55	0.03	0.15	0.01
	Retention of Particulates		0.55	0.03		0.70	0.04	0.15	0.01
	Organic Carbon Export		0.77	0.05		0.92	0.06	0.15	0.01
	Maint. of Plant Comm.		0.69	0.04		0.86	0.05	0.17	0.01
	Habitat Interspersion		0.61	0.04		0.71	0.04	0.10	0.01
13	Functions								
	Mod. Groundwater Flow	0.19	0.65	0.12	0.00	0.65	0.00	0.00	-0.12
	Vel. Reduc. Surf. Water		0.54	0.10		0.54	0.00	0.00	-0.10
	Elemental & Nutr. Cycling		0.40	0.08		0.40	0.00	0.00	-0.08
	Retention of Particulates		0.58	0.11		0.58	0.00	0.00	-0.11
	Organic Carbon Export		0.77	0.15		0.77	0.00	0.00	-0.15
	Maint. of Plant Comm.		0.69	0.13		0.69	0.00	0.00	-0.13
	Habitat Interspersion		0.65	0.12		0.65	0.00	0.00	-0.12
14	Functions								
	Mod. Groundwater Flow	0.11	0.45	0.05	0.00	0.45	0.00	0.00	-0.05
	Vel. Reduc. Surf. Water		0.36	0.04		0.36	0.00	0.00	-0.04
	Elemental & Nutr. Cycling		0.16	0.02		0.16	0.00	0.00	-0.02
	Retention of Particulates		0.37	0.04		0.37	0.00	0.00	-0.04
	Organic Carbon Export		0.42	0.05		0.42	0.00	0.00	-0.05
	Maint. of Plant Comm.		0.35	0.04		0.35	0.00	0.00	-0.04
	Habitat Interspersion		0.33	0.04		0.33	0.00	0.00	-0.04
17	Functions								
	Mod. Groundwater Flow	0.60	0.65	0.39	0.60	0.77	0.46	0.11	0.07
	Vel. Reduc. Surf. Water		0.53	0.32		0.84	0.50	0.32	0.19
	Elemental & Nutr. Cycling		0.40	0.24		0.55	0.33	0.15	0.09
	Retention of Particulates		0.55	0.33		0.70	0.42	0.15	0.09
	Organic Carbon Export		0.77	0.46		0.92	0.55	0.15	0.09
	Maint. of Plant Comm.		0.69	0.42		0.86	0.52	0.17	0.10
	Habitat Interspersion		0.61	0.36		0.71	0.43	0.10	0.06
Prairie Restoration	Functions								
	Mod. Groundwater Flow	0.00	0.65	0.00	208.02	0.77	159.44	0.11	159.44
	Vel. Reduc. Surf. Water		0.53	0.00		0.84	175.08	0.32	175.08
	Elemental & Nutr. Cycling		0.40	0.00		0.55	114.20	0.15	114.20
	Retention of Particulates		0.55	0.00		0.70	146.17	0.15	146.17
	Organic Carbon Export		0.77	0.00		0.92	190.69	0.15	190.69
	Maint. of Plant Comm.		0.69	0.00		0.86	179.34	0.17	179.34
	Habitat Interspersion		0.61	0.00		0.71	147.75	0.10	147.75
Biomass Harvest Area	Functions								
	Mod. Groundwater Flow	0	0.00	0.00	133.64	0.70	93.31	0.70	93.31
	Vel. Reduc. Surf. Water		0.41	0.00		0.70	93.68	0.29	93.68
	Elemental & Nutr. Cycling		0.20	0.00		0.57	75.70	0.36	75.70
	Retention of Particulates		0.53	0.00		0.58	77.20	0.04	77.20
	Organic Carbon Export		0.28	0.00		0.79	105.80	0.51	105.80
	Maint. of Plant Comm.		0.16	0.00		0.59	78.70	0.43	78.70
	Habitat Interspersion		0.14	0.00		0.68	90.74	0.54	90.74
Tilled Land Restoration (Includes Wetland 4 - Tilled)	Functions								
	Mod. Groundwater Flow	0.06	0.00	0.00	129.23	0.81	104.19	0.81	104.19
	Vel. Reduc. Surf. Water		0.41	0.02		0.86	110.78	0.44	110.76
	Elemental & Nutr. Cycling		0.20	0.01		0.57	73.20	0.36	73.19
	Retention of Particulates		0.53	0.03		0.83	106.96	0.29	106.93
	Organic Carbon Export		0.28	0.02		0.85	110.38	0.58	110.37
	Maint. of Plant Comm.		0.16	0.01		0.92	118.46	0.76	118.45
	Habitat Interspersion		0.14	0.01		0.71	91.79	0.57	91.78
Total	Functions								
	Mod. Groundwater Flow	**20.65**		13.34	**489.35**		371.09	2.09	357.75
	Vel. Reduc. Surf. Water			10.77			395.08	3.35	384.30
	Elemental & Nutr. Cycling			8.21			273.23	1.88	265.02
	Retention of Particulates			11.31			343.30	1.45	332.00
	Organic Carbon Export			15.74			423.79	2.10	408.05
	Maint. of Plant Comm.			14.16			392.41	2.84	378.25
	Habitat Interspersion			12.42			343.39	1.87	330.97

4 WILDLIFE HABITAT

Wildlife habitat improvement that is not specifically captured via HGM scoring is expected due to conversion of cropland to perennial vegetation. During the design phase of the project, an interagency team will develop a detailed revegetation plan. Restoration of wetlands will improve wildlife habitat that will be beneficial to insects, large and small mammals, waterfowl, grassland nesting birds, reptiles and amphibians. Through the course of the final design for the project, a management plan will also be developed to balance biomass removal needs related to water quality versus management practices such as grazing and prescribed fire to assure plant diversity and plant vigor are maintained for wildlife habitat. These practices will also help to promote a healthy upland and wetland plant community needed to meet long-term HGM success criteria. No threatened or endangered species are likely to make use of the area in the near-term, however, some more transient individuals may make temporary use of the site.

The total area of upland/wetland wildlife habitat provided by the project is 529.5 acres, shown in **Figure D-7-5**. Opportunities to provide a large, contiguous tract of wildlife habitat in this region is rare. The area is noted for relatively high agricultural production, along with associated land values. Grassland habitat currently available in the planning area consists of fragmented habitats that coincide with areas that are difficult to farm.

5 CONCLUSION

The project provides an opportunity to implement a multipurpose project to attain local objectives and provide watershed protection benefits to water quality and wildlife habitat at a scale typically not experienced on other watershed protection initiatives in the planning region.

6 REFERENCES

Baulch, H. et al, 2019. Soil and water management: opportunities to mitigate nutrient losses to surface waters in the Northern Great Plains. Env. Rev. 27:447-477. https://www.nrcresearchpress.com/doi/pdf/10.1139/er-2018-0101

Currie, S., et al, 2017. Utilizing wetlands for phosphorus reductions in Great Lakes watersheds: a review of available literature examining soil properties and phosphorus removal. U.S. Army Corps of Engineers, ERDC/EL SR-17-4. https://apps.dtic.mil/dtic/tr/fulltext/u2/1040511.pdf

Guzner, M., 2017. Water quality benefits of a MN floodwater storage impoundment. University of Minnesota, unpublished thesis.

Kieta, K. et al, 2018. Phosphorus dynamics in vegetated buffer strips in cold climates: a review. Environ. Rev. 26: 255-272. https://www.researchgate.net/publication/325052747_Phosphorus_dynamics_in_vegetated_buffer_strips_in_cold_climates_A_review

Hargiss, M., 2012. Nutrient TMDL for Homme Dam in Walsh County, North Dakota. Bismarck, ND: North Dakota Department of Health Division of Water Quality. https://deq.nd.gov/publications/WQ/3_WM/TMDL/East/Final%20Homme%20Dam%20TMDL%20Report-20120925.pdf

Houston Engineering, Inc. (2016). (PTMApp): Theory and Development Documentation. Maple Grove, MN: IWI.

Hargiss, M. (2012). *Nutrient TMDL for Homme Dam in Walsh County, North Dakota.* Bismarck, ND: North Dakota Department of Health Division of Water Quality.

Houston Engineering Inc. (2016). *(PTMApp): Theory and Development Documentation.* Maple Grove, MN: IWI.

Houston Engineering, Inc. (2023, 04 28). Cart Creek Site 1 Concept Design Report. Fargo, ND.

Husband, H., & Hargiss, M. (2017). *Nutrient and Dissolved Oxygen TMDL for Matejcek Dam, Walsh County, North Dakota.* Bismarck, ND: North Dakota Department of Health Divsion of Water Quality.

North Dakota NRCS. (2019). *Red River Regional Conservationist Parternship Program Selction Criteria under PL 83-566.* Bismarck, ND.

USDA-NRCS. (2008, February). Technical Note 190-8-76: Hydrogeomorphic Wetland Classification System: An overview and Modification to Better Meet the Needs of the Natural Resource Conservation Service.

USDA-NRCS Web Soil Survey. (2019, Jan 27). Web Soil Survey. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/.

Figure D-7-2: Water Quality Reporting Locations

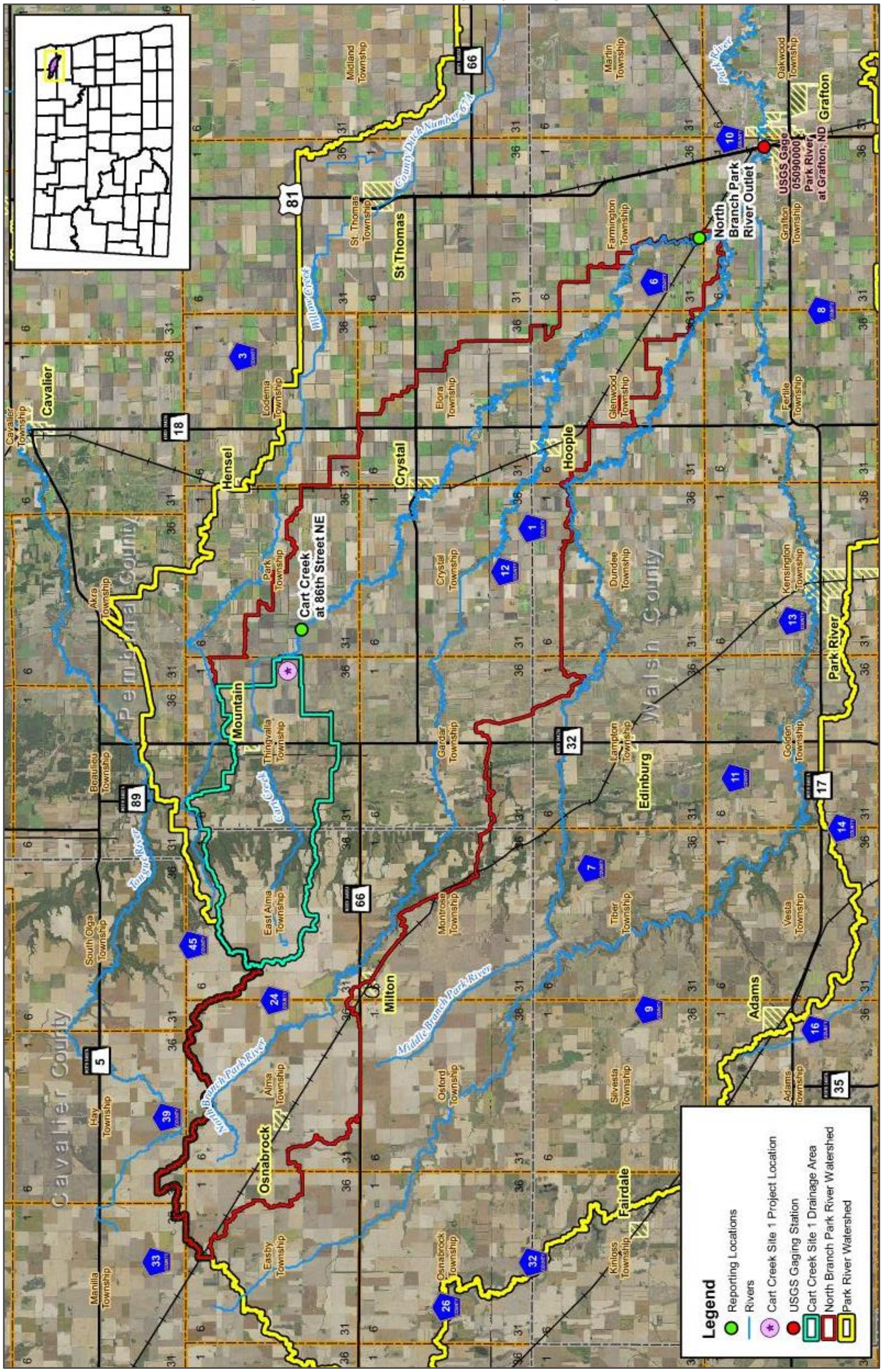


Figure D-7-3: 2003 NAIP Aerial Imagery and Historic Wetlands

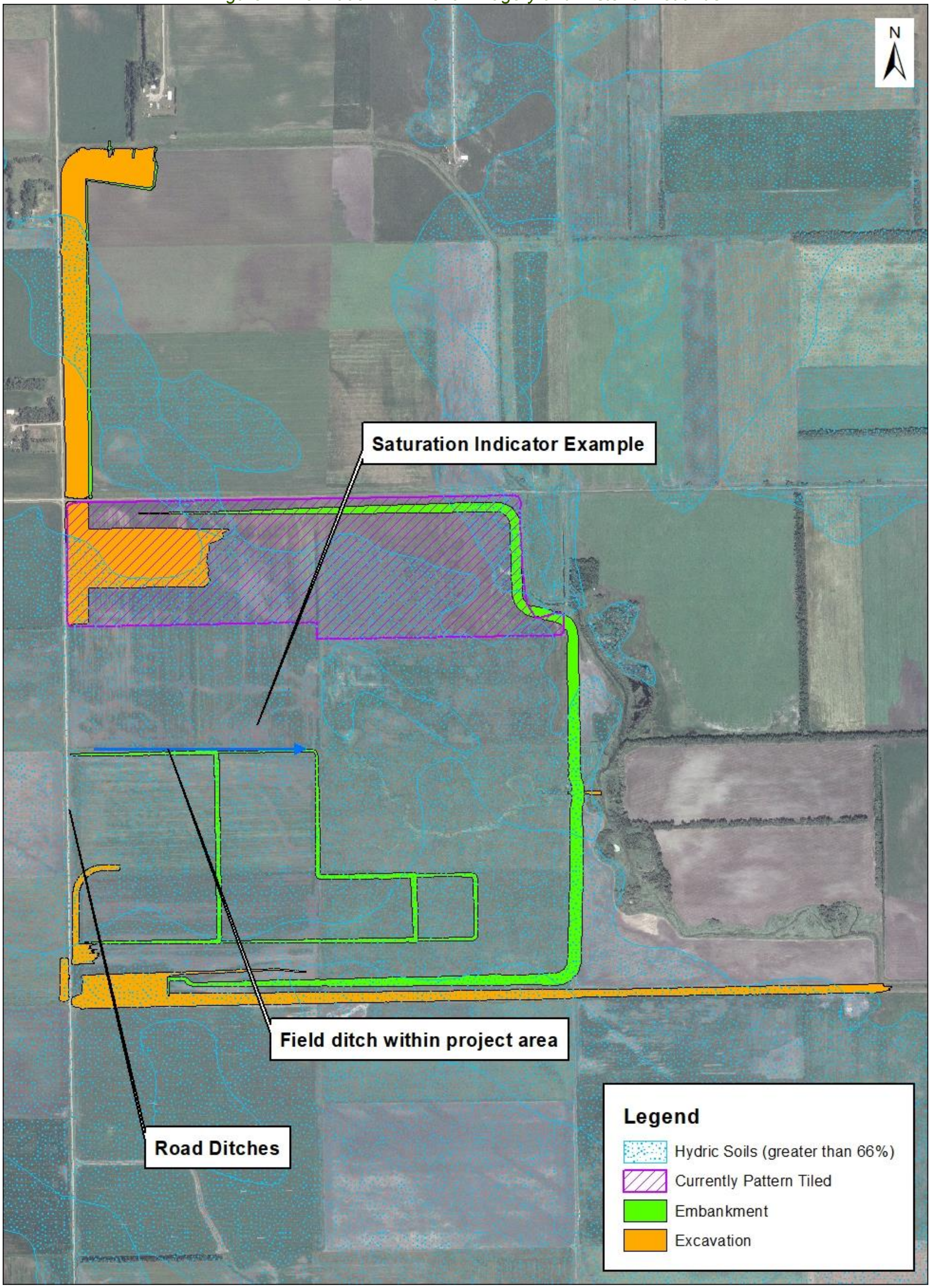


Figure D-7-4: Wetland Restoration and Enhancement Areas

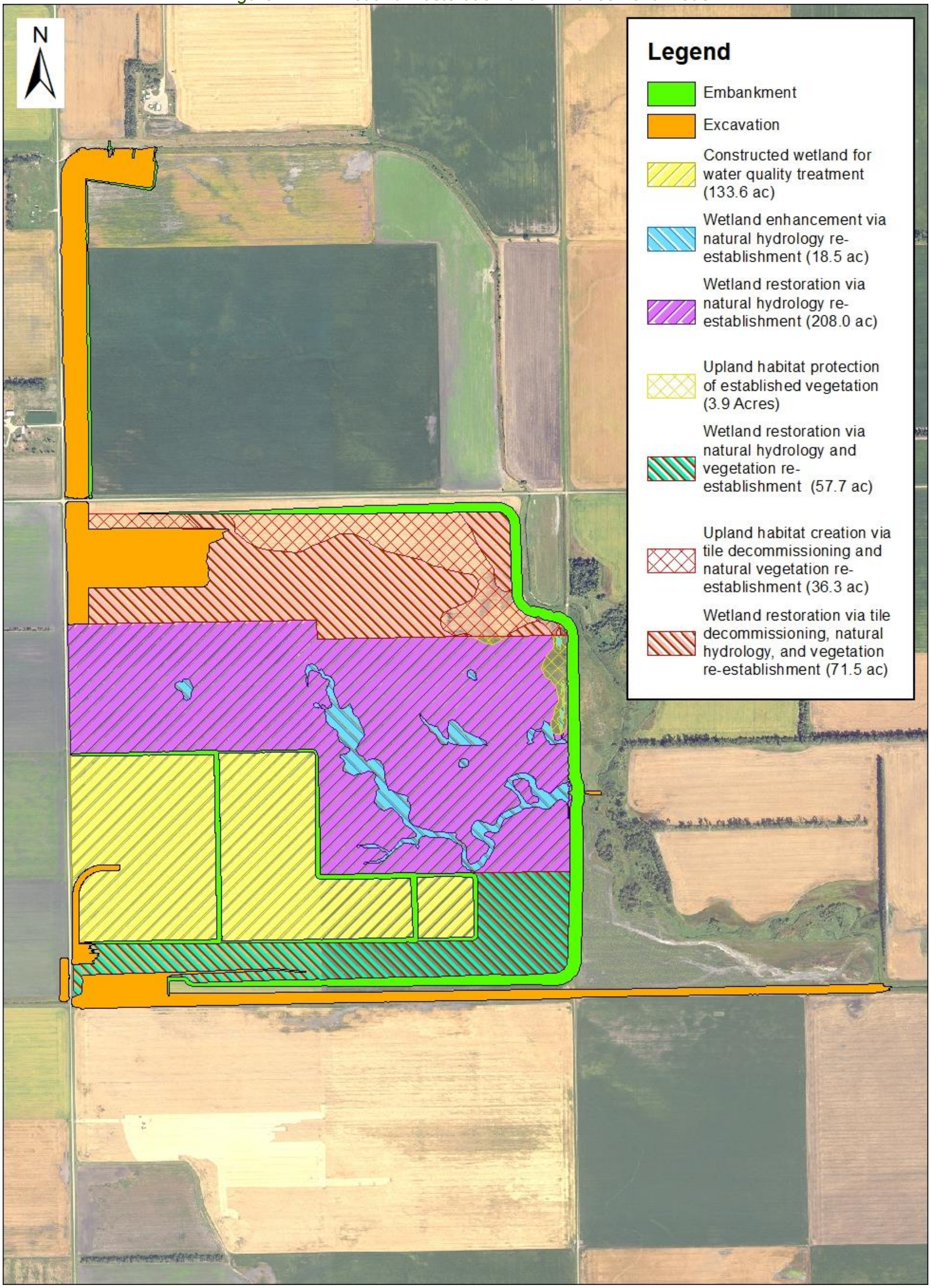


Figure D-7-5: Wildlife Habitat Location Map