Draft Technical Memo

Responsive partner.
Exceptional outcomes.

To: Ms. Tera Guetter
Administrator
Pelican River Watershed District
211 Holmes St. W, Detroit Lakes, MN 56501

From: Marlon Mackowick, P.E. (MN, ND), Wenck Associates, Inc.
Eric Osterdyk, E.I.T., Wenck Associates, Inc.

Date: April 25, 2019

Subject: Washington Square Mall Stormwater Feasibility Study

INTRODUCTION

Pelican River Watershed District (PRWD) retained Wenck Associates, Inc. (Wenck) to evaluate the feasibility of implementing three stormwater best management practices (BMPs) within the City-owned parking lot adjacent to the Washington Square Mall to manage stormwater quality in the Holmes Street Pond sub-watershed that is approximately 165.5 acres of which approximately 103 acres is impervious or approximately 62% impervious. This study was focused on maximizing removal of total suspended solids (TSS) and total phosphorus (TP). This study was not focused on reducing discharge rates.

BACKGROUND

Wenck understands that the City of Detroit Lakes (City) plans to reconstruct select streets within the Holmes Street Pond sub-watershed area over the next few years. However, all the areas within this sub-watershed have been developed and leave minimal room to implement new BMPs. Furthermore, the existing Holmes Street Pond has reached its design capacity, so additional BMPs will need to accompany street reconstruction to comply with PRWD rules and help reduce TP to meet the Total Maximum Daily Load (TMDL) approved for that area (St. Claire Lake). BMPs can be difficult to implement on linear projects in fully developed areas, so the PRWD is interested in investigating whether a BMP in the Washington Square Mall parking lot can create a bank system for the City in exchange for BMPs within the street reconstruction projects of the Holmes Street sub-watershed (Figure 1). See attached Attachment 1 for an overall site map showing the Holmes Street sub-watershed boundary along with the boundaries showing which areas we are evaluating for BMPs.

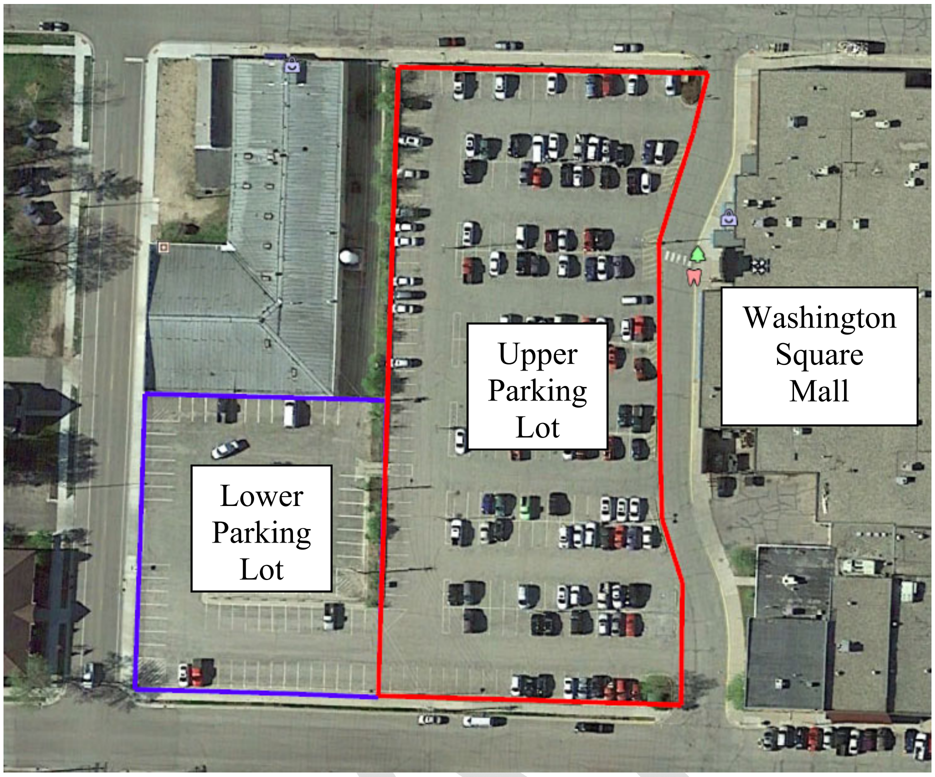

Figure 1. Map showing upper and lower parking lot or Washington Square Mall.

EXISTING HOLMES STREET POND - POLLUTANT LOADING ANALYSIS

Wenck used the water quality modeling software P8 to predict pollutant loading and transport within the existing Holmes Street Pond watershed. The area draining to the pond was modeled as one watershed. Review of existing documentation indicated that the pond has a total drainage area of 165.516 ac, 102.986 ac of which is impervious. Wenck assumed that all impervious area draining to the pond was directly connected since a majority of this area is collected via storm sewer and directly piped to the pond. The pervious curve number was assumed to be 39 based on Type A soils.

The pond was modeled as device type "Pond" with no infiltration and a 13' weir as the outlet. Bottom area, permanent pool, and flood pool parameters were determined by measuring the stage-storage relationship from preliminary construction plans dated January 2009 (Table 1). Pond normal water level (NWL) is 1,340.5'.

Table 1. Holmes Pond Stage-Storage Relationship.

Elevation (ft)	Area (sf)	Cumulative Volume (ac-ft)
1,330.5	11,833	0
1,331.0	12,913	0.142
1,340.0	35,308	5.124
1,341.0	44,616	6.041
1,343.0	52,644	8.274

WENCK
Responsive partner.
Exceptional outcomes.

The model was allowed to warm-up for one year (1/1/2005 to 1/1/2006) and was then run for ten years (1/1/2006 to 12/31/2016) using MSP precipitation and temperature data and the default NURP 50 particle distribution file. The warm-up period allows the pond to fill up with water to the NWL but does not take into account any pollutant removal during that time period. MSP precipitation data was adjusted for the Detroit Lakes area by decreasing the precipitation scale factor. According to US Climate Data, Detroit Lakes and Minneapolis have annual average precipitation depths of 27.43" and 30.64" respectively. The precipitation scale factor in the P8 model was set at .895 (27.43"/30.64") to account for less precipitation occurring in the Detroit Lakes region. Pollutant removals as designed are shown in Table *2*.

Table 2. Holmes Pond pollutant removals as designed.

Pollutant	Removal (lbs/yr)	Removal (%)
TP	74.3	35.6%
TSS	42,236	66.8%

The Holmes Street P8 model indicates that the pond does not meet PRWD rules for TP and TSS removal efficiencies of 50% and 90% respectively, catalyzing a need for additional treatment within the watershed.

Diligent maintenance of the Holmes Pond is critical to preserving designed removal efficiencies. Sedimentation rates in stormwater ponds vary greatly depending on the watershed. Some ponds may need to be cleaned out every five years, while others may go 15 years. If maintenance is not performed, the removal efficiency and retention time are greatly decreased. Routine pond maintenance should follow the operation and maintenance plan designed for the pond.

PRELIMINARY DESIGN ALTERNATIVES

Design Assumptions. Wenck evaluated three design alternatives for the Washington Square Mall parking lots. All options utilize an underground StormTrap SingleTrap 3'6" infiltration system (Figure 2). StormTrap was chosen due to the large watershed discharging to the site. StormTrap, or any vault system, has a higher storage efficiency than a dome (i.e., StormTech) or CMP pipe system as it can manage/treat larger volumes within smaller footprints and will reduce overall annual maintenance costs.

The StormTrap system height was determined based on an assumed infiltration rate of 0.8 in/hr (Type A – SP soils). Soil borings from a nearby PRWD permitted site (18-17 Thrifty White Pharmacy) indicate SP soils. Borings on the mall site will need to be taken to confirm infiltration rates prior to final design. During the borings, soil types will be confirmed and the actual infiltration rate will be determined by examining soils and completing an in-place infiltration rate test. The actual infiltration rate could either make the system smaller (if the infiltration rate is higher) or larger if the actual infiltration rate is lower. The maximum height below the low outlet of the system is 3.2' based on 0.8 in/hr and the 48-hour drawdown requirement. The 3'6" StormTrap was the smallest chamber type that was greater than 3.2', minimizing the system footprint. The additional height can be utilized for rate control.

Groundwater elevation was assumed to be 1,343' based on the PRWD IPb monitoring station (near the Industrial Park) for the Pelican River and normal water level of the Holmes Street Basin. The bottom of each system will be set at 1,346' to achieve the required 3' offset from the seasonal high-water table. Groundwater elevation onsite will be determined when soil borings are taken prior to final design and adjustments to the system invert will be made if necessary. See Figure 2 below for a typical section of StormTrap.

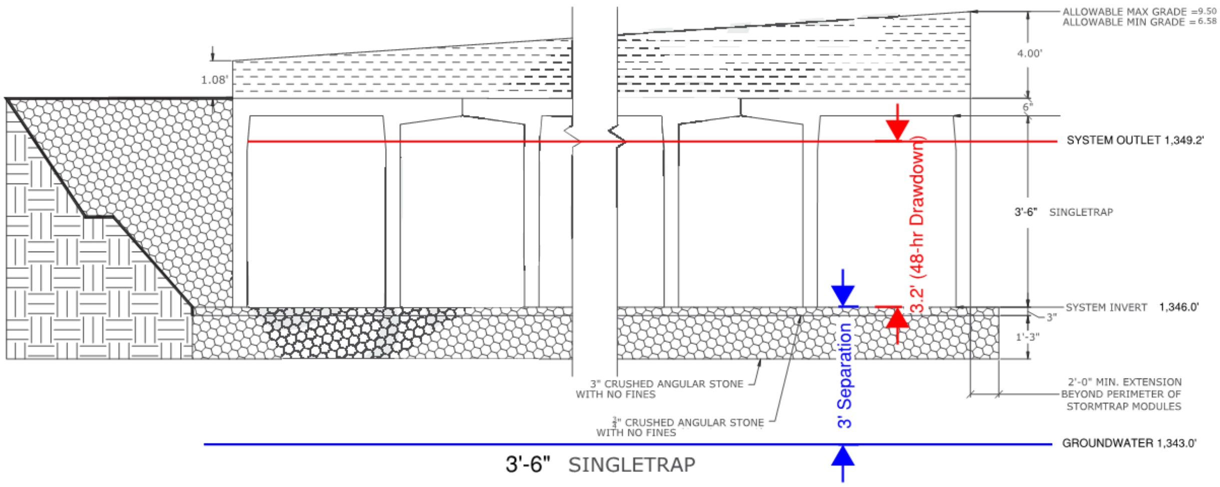

Figure 2. StormTrap 3'-6" cross-section.

The design goal for each option below is based on the Minnesota Pollution Control Agency's (MPCA's) Minimum Impact Design Standards (MIDS). The MPCA's MIDS were developed in 2011 with funds from the Minnesota Legislature to promote implementation of low impact development, or development that mimics a site's natural hydrology. The MIDS study concluded that infiltrating 1.1 inches of rainfall over the area of impervious surface at a site will allow developed site hydrology to mimic native hydrology. With this principle in mind, for redevelopment projects that create one or more acres of new and/or reconstructed impervious surface, the MIDS require that a volume of stormwater equivalent to 1.1 inches of rainfall over the area of new and/or reconstructed impervious surface is captured and retained on site. Each option described below meets the MIDS required volume for impervious surfaces draining to the site unless limited by space. The following three options were evaluated:

- Option 1 – Install StormTrap System in the lower mall parking lot to collect stormwater from approximately 9.59 acre (ac).
- Option 2 – Install StormTrap System in the upper mall parking lot located in between the mall building structure and existing storm sewer infrastructure. This would treat approximately 0.93 inches of stormwater from approximately 37.25 ac.
- Option 3 – Install StormTrap System in the upper mall parking lot to treat the MIDS required 1.1 inches from the 37.25 ac area. This option would require the existing stormwater infrastructure to be relocated further West in the parking lot.

A summary of each option can be found below:

Option 1. This option utilizes the 3'6" StormTrap system described above in the lower parking lot (Figure 3). This underground system would be located on the South side of the parking lot and capture runoff from existing storm sewer to the North and South along Minnesota Avenue. Existing storm sewer information was provided by Apex Engineering. This system would tie into existing storm sewer from the north at MH-2 (Figure 4). A backflow preventor would need to be installed on this diversion pipe to prevent water from bypassing the system at a lower elevation than desired. The system would also tie into the storm sewer on Minnesota Avenue south of CB-1 at the necessary elevation to convey stormwater into the StormTrap system. Approximately 240 LF of storm sewer will need to be reinstalled to prevent pipe crossing conflicts and to keep the invert above the elevation 1346.0 or bottom of the system. The total drainage area able to be diverted to the underground system is 9.59 ac, of which 7.12 ac is impervious. See attached Attachment 1 for overall treatment boundary.

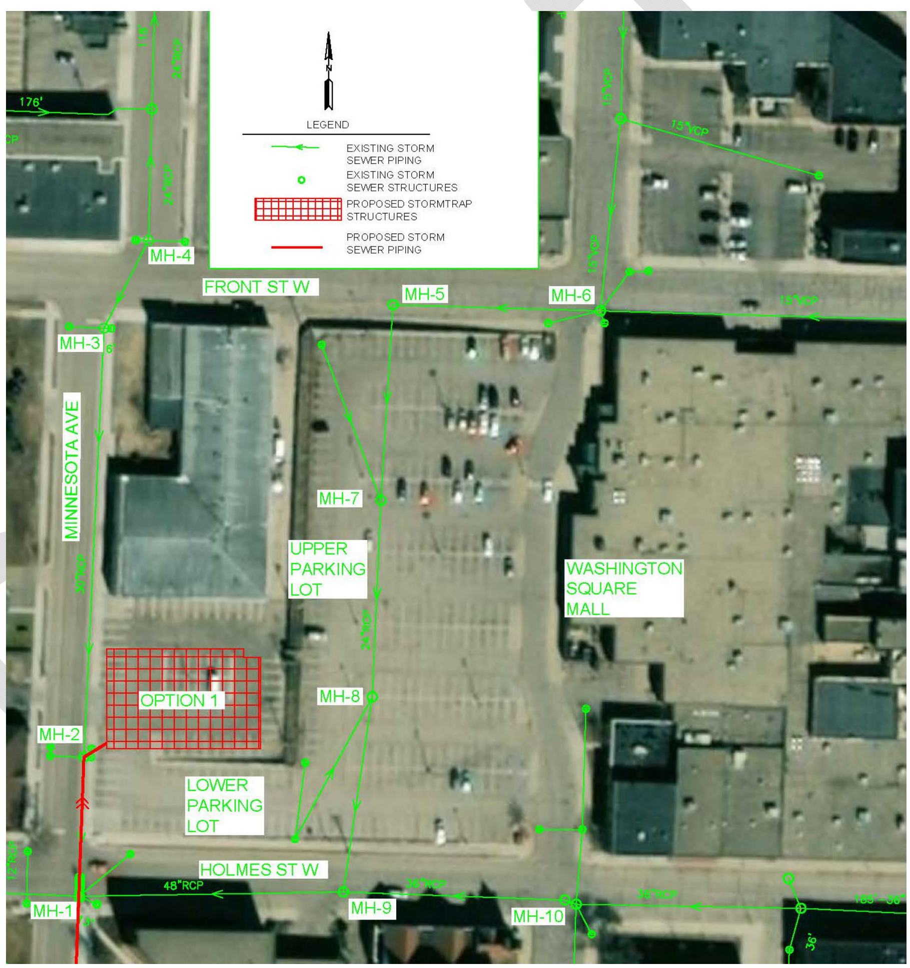

Figure 3. Option 1 layout footprint.

Based on the MIDS standard, the 7.12 ac of impervious drainage area would require a 1.1" volume of 28,430 cubic feet (cf). The outlet was set at 3.2' above the invert of the vault to allow the system to drawdown within 48 hours. This system was modeled in HydroCAD to verify volume below the outlet (Figure 5). The minimum number of chambers required to meet the 1.1" volume is 107. The system has a total footprint of 10,459 sf with a layout of 11 rows of 9 chambers and 1 row of 8 chambers. The system has a total volume of 31,297 cf and a water quality volume below the outlet of 28,615 cf, which is greater than the 1.1" required volume.

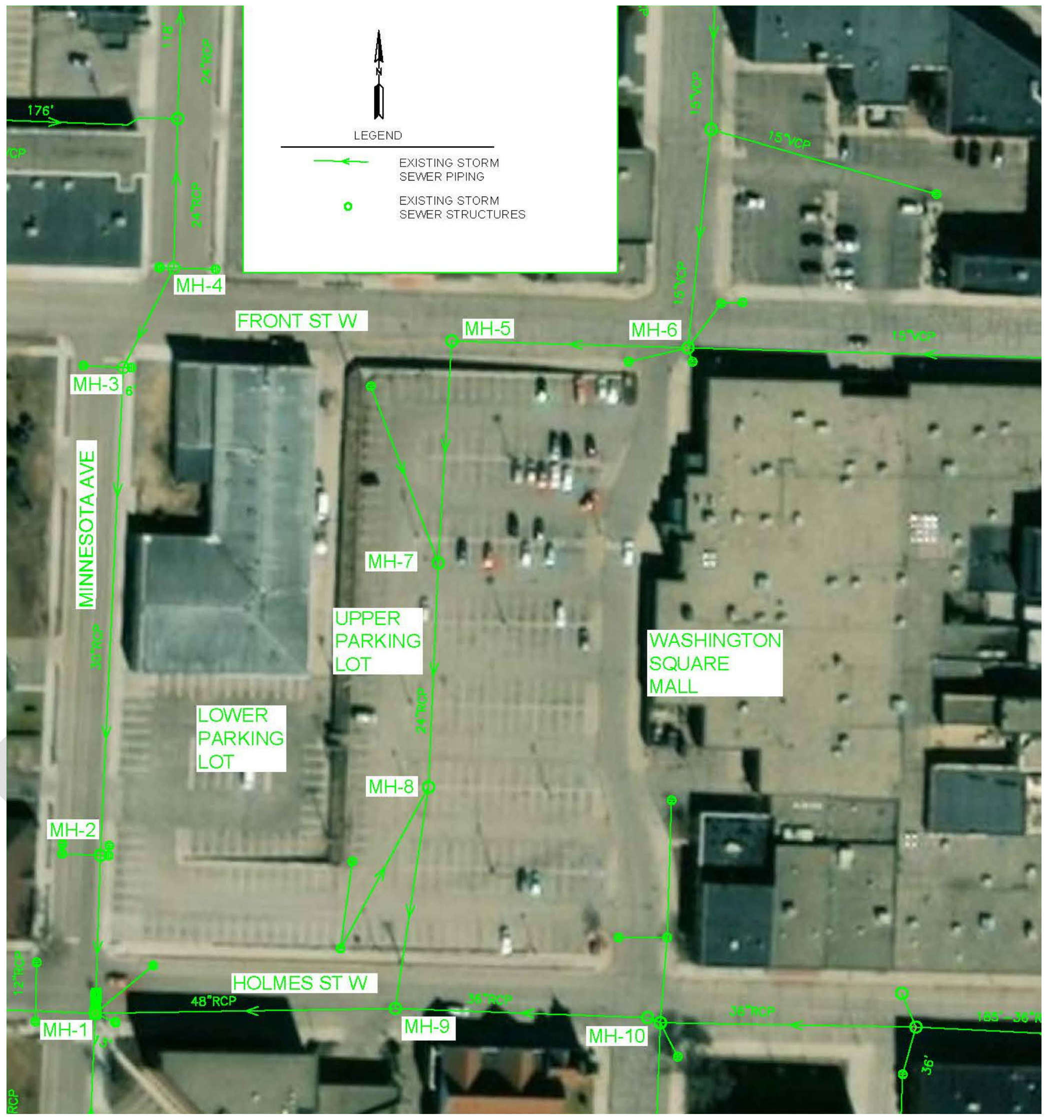

Figure 4. Existing storm sewer layout.

Volume	Invert	Avail.Storage	Storage Description
#1A	1,346.00'	0 cf	**75.85'W x 127.56'L x 4.17'H Field A**
			40,317 cf Overall - 40,317 cf Embedded = 0 cf x 40.0% Voids
#2A	1,346.00'	28,957 cf	**StormTrap ST1 SingleTrap 3-6** x 99 Inside #1
			Inside= 82.7"W x 42.0"H => 20.80 sf x 14.06'L = 292.5 cf
			Outside= 82.7"W x 50.0"H => 28.73 sf x 14.06'L = 404.1 cf
			11 Rows of 9 Chambers
			75.85' x 126.56' Core + 0.00' x 0.50' Border = 75.85' x 127.56' Syst
#3B	1,346.00'	0 cf	**6.90'W x 113.50'L x 4.17'H Field B**
			3,261 cf Overall - 3,261 cf Embedded = 0 cf x 40.0% Voids
#4B	1,346.00'	2,340 cf	**StormTrap ST1 SingleTrap 3-6** x 8 Inside #3
			Inside= 82.7"W x 42.0"H => 20.80 sf x 14.06'L = 292.5 cf
			Outside= 82.7"W x 50.0"H => 28.73 sf x 14.06'L = 404.1 cf
			6.90' x 112.50' Core + 0.00' x 0.50' Border = 6.90' x 113.50' Systen
		31,297 cf	Total Available Storage

Figure 5. Option 1 HydroCAD layout.

Option 2. The second option utilizes a 3’6” StormTrap in the upper parking lot (Figure 6). This system would capture runoff from the existing storm sewer to the north and east. In this scenario, Wenck assumed that the existing storm sewer onsite would not be reconstructed, and the underground system would need to be located such that it would not impact the existing storm sewer. If other utilities are located under the parking lot, the cost to relocate these utilities is not covered in this option. This system would tie into the existing storm sewer at MHs 8 and 10 (Figure 4 above). MHs 8 and 10 would need to be replaced with low outlets (below 1,349.2’) to divert stormwater to the underground system. The next lowest outlet in MHs 8 and 10 would be set at 1,349.2’ directing stormwater to MH 9. Water from the existing storm sewer would enter the underground system and fill up to an elevation of 1,349.2’. Once the water level in the system reaches this outlet, stormwater would then bypass the underground system and continue to MH 9. The total drainage area able to be diverted to this system is 37.25 ac, of which 34.55 ac is impervious. See attached Attachment 1 for overall treatment boundary.

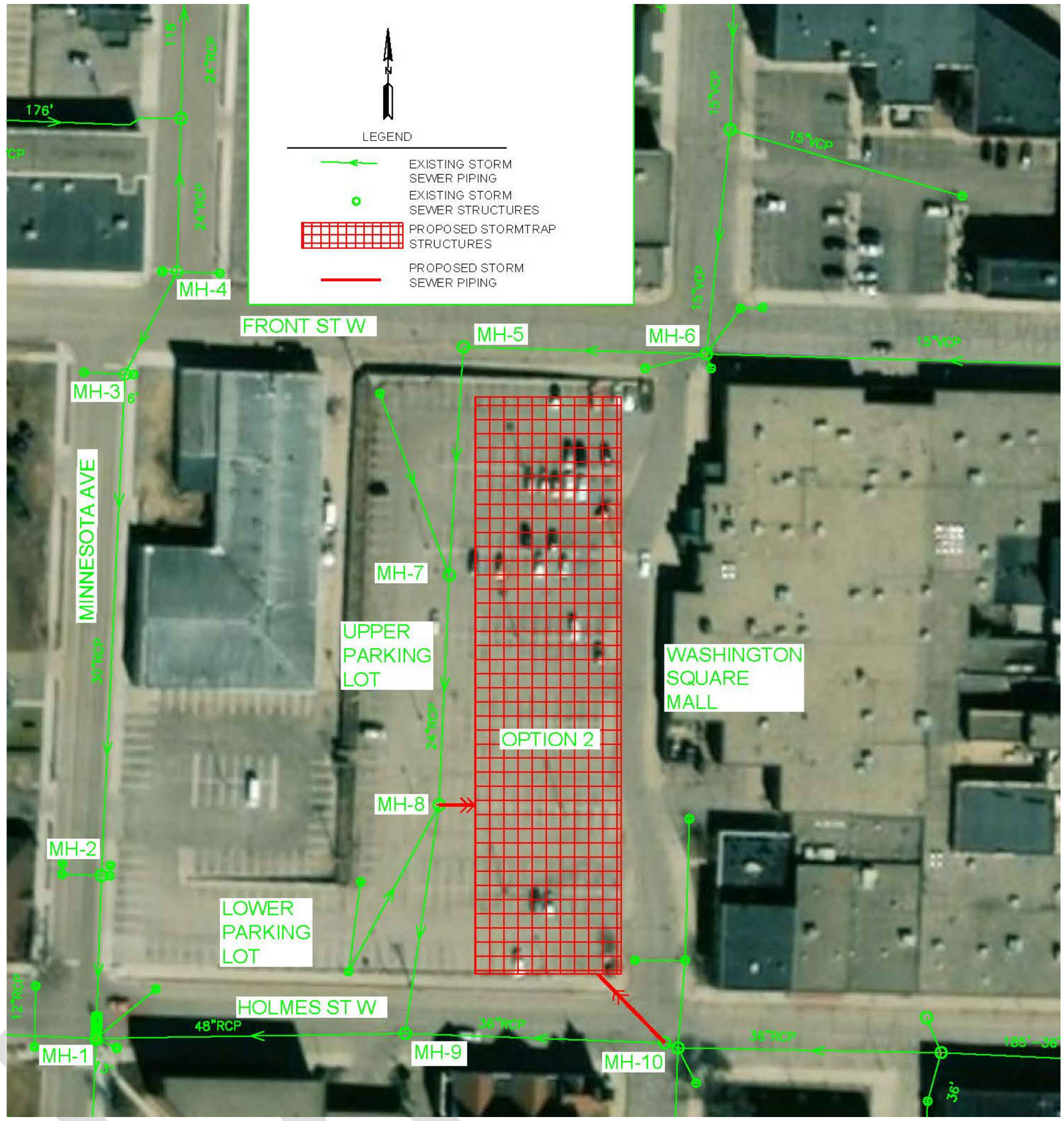

Figure 6. Option 2 layout footprint.

Based on the MIDS standard, the 34.55 ac of impervious drainage area would require a 1.1" volume of 137,958 cf. Due to layout restrictions from existing storm sewer and height restrictions from drawdown requirements, a system could not be located within the parking lot footprint and achieve the total MIDS volume. However, the system footprint in this scenario was maximized onsite to capture and treat as much water as possible.

This system was modeled in HydroCAD to verify volume below the outlet (Figure 7). This system utilizes 435 chambers and has a footprint of 42,287 sf, located just to the east of the existing storm sewer and spans the entire length of the parking lot. The system has a total volume of 127,237 cf and a water quality volume below the outlet of 116,331 cf. This volume equates to 0.93" over the impervious surfaces draining to the site.

Volume	Invert	Avail.Storage	Storage Description
#1A	1,346.00'	0 cf	**103.44'W x 408.81'L x 4.17'H Field A**
			176,194 cf Overall - 176,194 cf Embedded = 0 cf x 40.0% Voids
#2A	1,346.00'	127,237 cf	**StormTrap ST1 SingleTrap 3-6** x 435 Inside #1
			Inside= 82.7"W x 42.0"H => 20.80 sf x 14.06'L = 292.5 cf
			Outside= 82.7"W x 50.0"H => 28.73 sf x 14.06'L = 404.1 cf
			15 Rows of 29 Chambers
			103.44' x 407.81' Core + 0.00' x 0.50' Border = 103.44' x 408.81' Sy
		127,237 cf	Total Available Storage

Figure 7. Option 2 HydroCAD layout.

Option 3. The third option utilizes a 3'6" StormTrap located in the upper parking lot, similar to Option 2. However, in Option 3, Wenck assumed that the existing storm sewer onsite would be reconstructed and moved to the west side of the upper parking lot, allowing more space for an underground system (Figure 8). The drainage area collected in Option 3 is the same as Option 2 and has 34.55 ac of impervious surface. This system would tie into the relocated storm sewer on the west side of the system in a similar location to existing MH-8 (Figure 4 above). This system would tie into the existing storm sewer from the east at MH 10. Area drains will be placed in the reconstructed parking lot to collect onsite runoff. Outlet elevation would function identically to Option 2. See attached Attachment 1 for overall treatment boundary.

Based on the MIDS standard, the 34.55 ac of impervious drainage area would require a 1.1" volume of 137,958 cf. The outlet was set at 3.2' above the invert of the vault to allow the system to drawdown within 48 hours. This system was modeled in HydroCAD to verify volume below the outlet (Figure 9). The minimum number of chambers required to meet the 1.1" volume is 516. The system has a total footprint of 50,174 sf with a layout of 16 rows of 26 chambers and 4 rows of 25 chambers. The system has a total volume of 150,929 cf and a water quality volume below the outlet of 137,992 cf, which is greater than the 1.1" required volume.

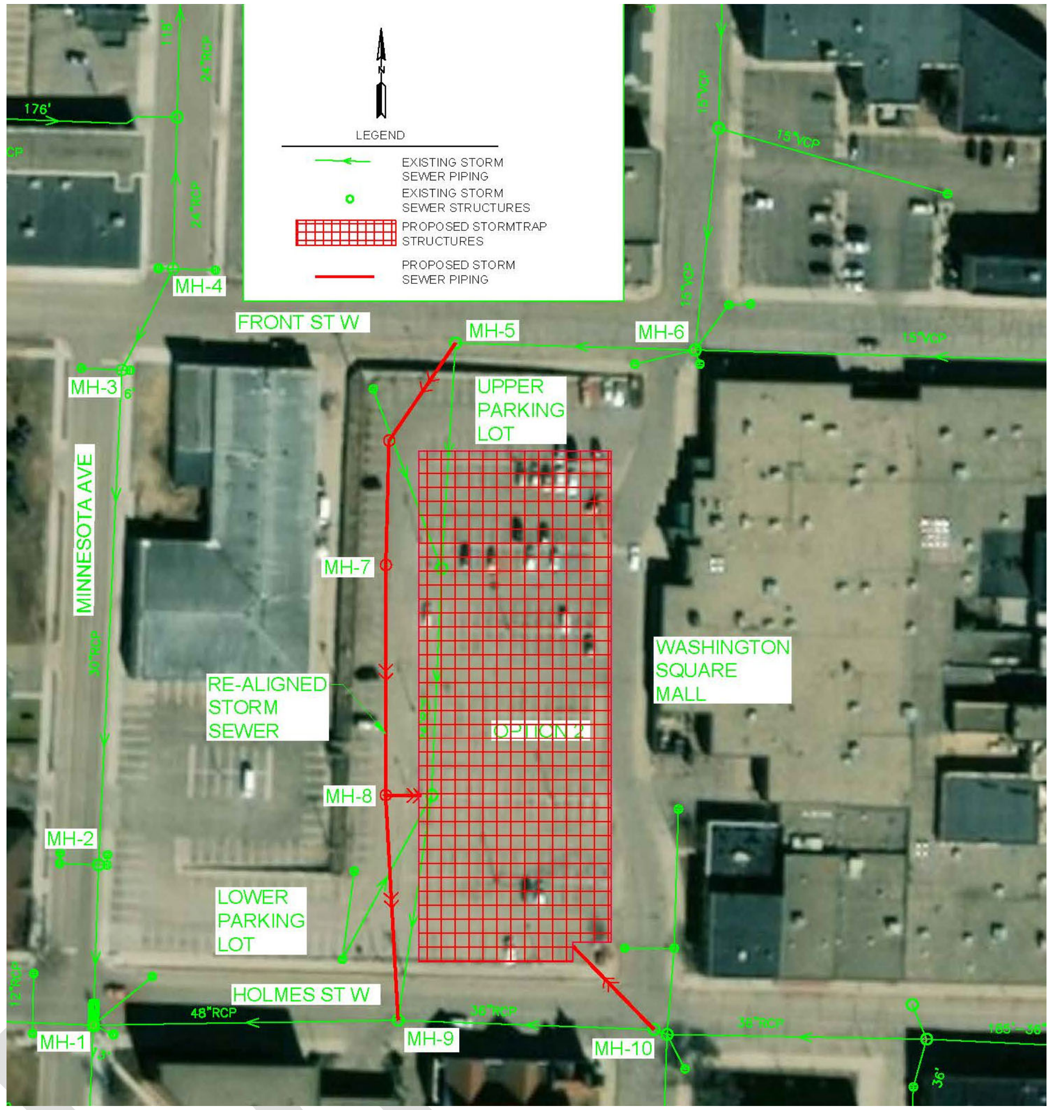

Figure 8. Option 3 layout footprint.

Volume	Invert	Avail.Storage	Storage Description
#1A	1,346.00'	0 cf	**110.33'W x 366.63'L x 4.17'H Field A**
			168,546 cf Overall - 168,546 cf Embedded = 0 cf x 40.0% Voids
#2A	1,346.00'	121,679 cf	**StormTrap ST1 SingleTrap 3-6** x 416 Inside #1
			Inside= 82.7"W x 42.0"H => 20.80 sf x 14.06'L = 292.5 cf
			Outside= 82.7"W x 50.0"H => 28.73 sf x 14.06'L = 404.1 cf
			16 Rows of 26 Chambers
			110.33' x 365.63' Core + 0.00' x 0.50' Border = 110.33' x 366.63' S
#3B	1,346.00'	0 cf	**27.58'W x 352.56'L x 4.17'H Field B**
			40,520 cf Overall - 40,520 cf Embedded = 0 cf x 40.0% Voids
#4B	1,346.00'	29,250 cf	**StormTrap ST1 SingleTrap 3-6** x 100 Inside #3
			Inside= 82.7"W x 42.0"H => 20.80 sf x 14.06'L = 292.5 cf
			Outside= 82.7"W x 50.0"H => 28.73 sf x 14.06'L = 404.1 cf
			4 Rows of 25 Chambers
			27.58' x 351.56' Core + 0.00' x 0.50' Border = 27.58' x 352.56' Syst
		150,929 cf	Total Available Storage

Figure 9. Option 3 HydroCAD layout.

PROPOSED CONDITIONS - POLLUTANT LOADING ANALYSIS

Wenck used the water quality modeling software P8 to predict pollutant loading and transport within the watersheds of each proposed condition option. Wenck used identical inputs as the Holmes Street Pond P8 model for warm-up time and run time, pervious areas curve number, precipitation data, temperature data, and particle file.

Each option was modeled as device type "Inf Basin" with an infiltration rate of 0.8 in/hr (Type A – SP soils). Predicted pollutant removals for each option are shown in Table 3.

Table 3. Proposed conditions pollutant removals.

Option	TP Removal (lbs/yr)	TP Removal (%)	TSS Removal (lbs/yr)	TSS Removal (%)
1 – Lower Lot	13.4	93.1%	4,299	98.3%
2 – Avoid Existing Storm Sewer	63.5	90.8%	20,586	97.1%
3 – Move Existing Storm Sewer	65.1	93.1%	20,850	98.3%

Options 1 and 3 have similar removal efficiencies since they both infiltrate the MIDS required volumes. Option 2 has a lower removal efficiency since it does not infiltrate the MIDS required volume due to space limitations. All options listed are more efficient at removing TP and TSS than the Holmes Street Pond. Note, removal efficiencies could decrease if in-situ soils are Type B soils that do not have a minimum infiltration rate of 0.8 in/hr as the parking lots are not large enough to expand the treatment system to get a volume close to 1-inch of run-off.

COST ESTIMATES

Cost estimates are shown below in Table 4. The assumed cost of an installed StormTrap system is $8/cf based on total volume of the system. This estimate is based on a recent quote from a similar StormTrap design. The capital investment column represents the sum of both the StormTech system and the necessary storm sewer modifications needed to connect the system to existing storm sewer. The estimated costs include construction cost estimate plus a 20% construction contingency. Cost estimates also include associated maintenance over 20 years of the system. Over this time period, only routine annual maintenance is expected. Maintenance costs in Table 4 are shown in present day value, considering inflation and discount rate. The cost of the system over 20 years was used to determine a cost per pound of TP removed over that time period.

Table 4. Cost estimates for each design alternative.

Option	Capital Investment ($)	Construction Contingency ($)	Maintenance ($/20 yrs)	Total Lifecyle Cost ($)	Cost (TP lb removed/20 yrs)
1 – Lower Lot	$317,000	$63,000	$44,000	$424,000	$1,580
2 – Avoid Existing Storm Sewer	$1,050,000	$210,000	$89,000	$1,349,000	$1,060
3 – Move Existing Storm Sewer*	$1,240,000*	$248,000*	$89,000*	$1,577,000*	$1,210*

*Cost associated with relocating the existing storm sewer would be included in the price of the parking lot renovation.

Option 1 is the least costly option but is the most expensive in terms of cost per pound of TP removed. Option 2 is the most cost effective in terms of cost per pound of TP removed. Lastly, Option 3 is the costliest option, but in between Options 1 and 2 in terms of cost per pound of TP removed.

LEGEND

- WASHINGTON SQUARE MALL
- HOLMES STREET SUB-WATERSHED BOUNDARY
- UPPER PARKING LOT TREATMENT AREA
- LOWER PARKING LOT TREATMENT AREA
- WASHINGTON SQUARE MALL LOWER PARKING LOT
- WASHINGTON SQUARE MALL UPPER PARKING LOT

REV	REVISION DESCRIPTION	DWN	APP	REV DATE

WENCK ASSOCIATES
3303 FIECHTNER DR, SUITE 100
FARGO, NORTH DAKOTA 58103
(701) 297-9600
(701) 297-9601
Responsive partner. Exceptional outcomes.

DWN BY	MPM
CHK'D	EO
APP'D	MPM
DWG DATE	APRIL 2019
SCALE	AS NOTED
PROJECT	WASHINGTON SQUARE MALL STORMWATER FEASIBILITY STUDY
CLIENT	PELICAN RIVER WATERSHED DISTRICT DETROIT LAKES, MN
SHEET TITLE	OVERALL SITE MAP
PROJECT NO.	1311-0029
SHEET NO.	ATTACHMENT 1
REV NO.	A

T:\1311 PRWD\29 Washington Square Mall Stormwater Feasibility\CAD\Attachment 1.dwg Plot Date & Time: 26 April 2019 7:59 AM