MINNEHAHA CREEK
WATERSHED DISTRICT
QUALITY OF WATER, QUALITY OF LIFE

**Meeting:** Operations and Programs Committee
**Meeting date:** 3/14/2024
**Agenda Item #:** 4.1
**Item type**: Discussion Item

| | |
|---|---|
| **Title:** | County Road 6 Pond Retrofit Feasibility Outcomes |
| **Prepared by:** | Name: Kailey Cermak<br>Phone: 952.641.4501<br>kcermak@minnehahacreek.org |

**Purpose:**
At the March 14, 2024, Minnehaha Creek Watershed District (MCWD) Operations and Programs Committee (OPC) meeting, MCWD staff will provide an overview of the County Road 6 (CR-6) pond feasibility study, which looked to evaluate retrofit opportunities to improve the ponds performance and further reduce phosphorus export to Long Lake. This information will serve to re-ground the Board of Managers in the project goals and recommended design alternative(s) ahead of its project ordering consideration later this month.

**Background:**
In 1989, the Minnehaha Creek Watershed District (MCWD) with assistance from the Minnesota Pollution Control Agency (MPCA), through a Clean Water Partnership (CWP) grant, conducted a diagnostic study of Long Lake that characterized and quantified the causes contributing to the decline in water quality in the lake, developed numerical water quality goals, and determined performance standards for a plan to improve water quality and achieve the desired goals. This study, done with the support of local municipalities, laid the foundation for the projects undertaken by MCWD in the Long Lake area in the 1990s.

As a result of this study, the CR-6 pond, along with MCWD's Deerhill pond, were identified as regional treatment opportunities to reduce sediment and nutrient loading to Long Lake. The CR-6 pond was constructed in 1998 and captures the drainage from two northern tributaries, treating 3,370 acres of runoff. The 2.5-acre pond was designed to remove approximately 50% of the total phosphorus load, when considered in conjunction with Deerhill pond, which was constructed upstream of the CR-6 pond in 1996. An easement, encompassing the full pond footprint, was obtained from the private landowner to ensure long-term maintenance, monitoring, and/or retrofits to the pond could be conducted.

<u>Long Lake Creek Roadmap</u>

Since 2018, MCWD, Long Lake Waters Association, and the cities of Long Lake, Medina, and Orono have been working together toward a common goal of addressing nutrient impairments in the Long Lake Creek Subwatershed. To support this mutual effort, MCWD obtained state grant funding in 2018 and led a subwatershed assessment to (1) provide a scientific understanding of the system, (2) identify cost-effective projects and strategies, and (3) develop an actionable roadmap for implementation for the municipal partners.

The roadmap identified 34 projects for advancement based on their cost-effectiveness and ability to implement. To prioritize these projects, a three-tiered strategy was developed:

1. Regional Stormwater Treatment
2. Landscape Projects
3. Internal Load Management

The enhancement or addition of regional stormwater facilities is recommended as the top priority due its ability to immediately and cost-effectively treat a large drainage area, while localized projects can continue to be implemented over time. The CR-6 pond was identified as one of two top-priority projects for near-term implementation.

Supporting the Roadmap's inclusion of the CR-6 pond as a priority opportunity, is the recent monitoring data that indicates the CR-6 pond has not been performing as originally designed. Despite being constructed 25 years ago, the pond has never been dredged and is currently approximately 12% full, suggesting a sediment accumulation rate of around 0.5% per year. Additionally, water quality sampling results show high phosphorus concentrations both entering and exiting the pond. These datapoints underscore the necessity to assess the CR-6 pond for potential retrofit opportunities to improve its effectiveness in nutrient removal.

**Feasibility Summary:**
In 2023, MCWD contracted with Stantec to conduct a feasibility study to evaluate potential retrofit opportunities. The scope of work included the refinement of the area's P8 model, on-site data collection, the identification of project concepts, and modeling of the project concepts. Retrofit methods explored through feasibility focused on maximizing particulate phosphorus removal, while maintaining the current easement footprint.

12 initial concepts were considered, with five concepts carried forward for full evaluation, modeling, and cost development. An evaluation matrix was established to support a shared understanding of the strengths and weaknesses of each retrofit option and provide a clear recommendation. Key evaluation metrics included phosphorus reduction potential, capital costs and cost-effectiveness, operations and maintenance, and regulatory considerations. The implementation of a gravity sand filter bench emerged as the most cost-effective solution.

At the March 14$^{th}$ OPC meeting, staff will provide a presentation of the feasibility evaluation and recommendation, followed by an overview of next steps as the project prepares to move into design.

**Supporting documents (list attachments):**

- County Road 6 Pond Retrofit Feasibility Study

Stantec

# Memo

| | | | |
|---|---|---|---|
| To: | Josh Wolf, Project and Land Program Manager (MCWD) | From: | Chris Meehan (PE), Tom Beneke, Sylvia Doerr, Nick Wyers (PE), Rena Weis<br>Stantec |
| Project/File: | 227706022 | Date: | September 25, 2023 |

**Reference: County Road 6 Pond Retrofit Feasibility Study**

# 1 Introduction

Minnehaha Creek Watershed (MCWD) identified the Long Lake Creek – County Road 6 Pond (CR6 Pond) in Orono, MN as a candidate for performance improvements via engineered retrofits, based on nutrient and sedimentation monitoring. The CR 6 Pond is downstream from Holy Name and Wolsfeld Lakes, and upstream from Long Lake. All three lakes are impaired by excess nutrients. The CR6 Pond is strategically located in the subwatershed, with recent monitoring and analysis of the pond and subwatershed indicating opportunities for further improvements in the pond's effectiveness in total phosphorus load reduction. MCWD Research & Monitoring has shown that Long Lake requires a 62% reduction in phosphorus (742 lbs.) to meet state water quality standards, which includes 411 lbs/yr from watershed sources. Due to the significant load reductions required to progress towards Long Lake's goal, this study sought to consider retrofit practices and sizes that would maximize TP removals.

This study seeks to identify and evaluate retrofit opportunities at the CR6 pond, with a primary focus on total phosphorus (TP) removal potential. The study evaluates opportunities based on water quality benefits, water quantity benefits, ecological integrity, project costs, regulatory hurdles, site constraints, and project complexity.

# 2 Water Quality (P8) Modeling Updates

## 2.1 Streamflow Calibration

The combined P8 model detailed in Stantec's March 27, 2023, Memo to Brian Beck (MCWD) was first re-calibrated for streamflow after updating live storage volume values in upstream ponds. Updates to streamflow calibration parameters focused on better matching the following aspects of observed and simulated streamflow:

- Storm event magnitude
- Storm event timing
- Baseflow magnitude

Figure 1 below demonstrates the P8 model fit described in the March 27, 2023, Memo. While this model meets general performance criteria for total flow volume percent bias (PBIAS) during the growing season (0.2%), the timing and magnitude of simulated events does not accurately describe the observations.

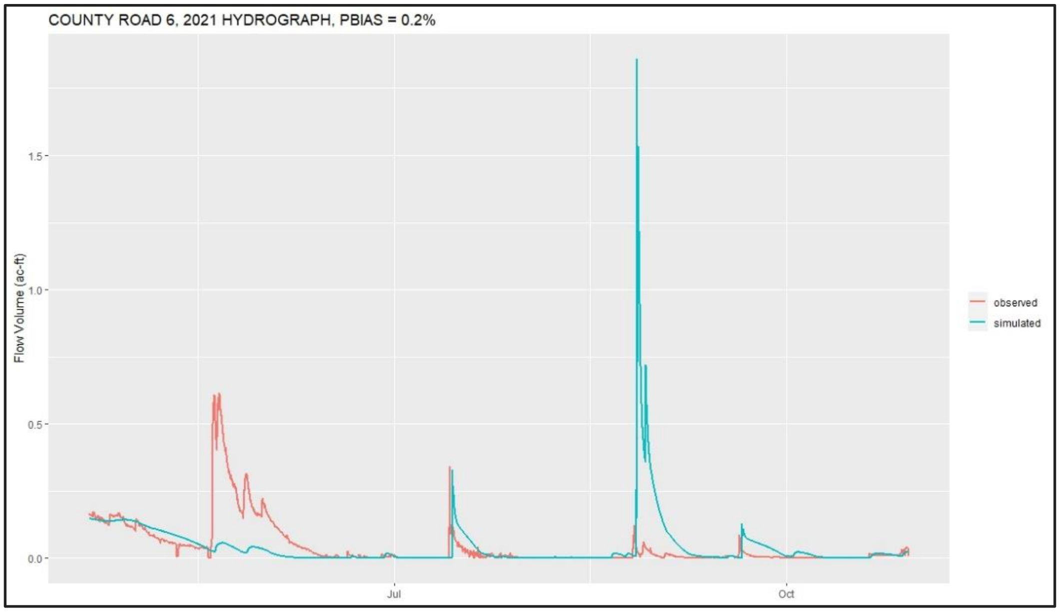



*Figure 1. Streamflow hydrograph results from the March 2023 P8 model. Hydrograph demonstrates hourly observed and simulated flow volume at the County Road 6 pond inlet for the 2021 growing season.*

Figure 2 below demonstrates the P8 model fit after updating the previous model in Figure 1 with more accurate upstream live storage volumes, but prior to re-calibration (i.e., the March 2023 version plus updated live storage). This hydrograph, again illustrating the same 2021 growing season, demonstrates a poor model fit for storm event magnitude, storm event timing, and baseflow magnitude. As shown, the most notable change is a large increase in baseflow.

**Reference: County Road 6 Pond Retrofit Feasibility Study**

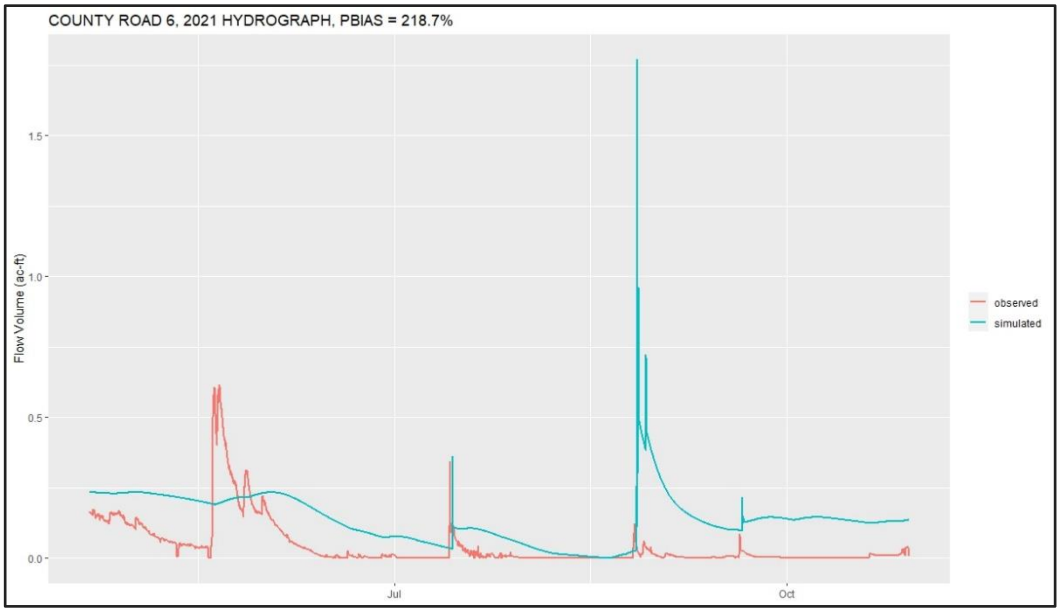



*Figure 2. Streamflow hydrograph results from the March 2023 P8 model with updated live storage pond volumes (prior to re-calibration). Hydrograph demonstrates hourly observed and simulated flow volume at the County Road 6 pond inlet for the 2021 growing season.*

To address these issues, P8 model parameters for antecedent moisture condition, connected impervious extent, evapotranspiration, and aquifer device time of concentration were adjusted. Table 1 below summarizes parameters adjusted in the re-calibrated P8 model.

*Table 1. P8 streamflow parameter adjustments made to re-calibrated model.*

| Parameter Name | Value | Unit |
|---|---|---|
| Growing Season Month (start) | 6 | Month Index |
| Growing Season Month (end) | 10 | Month Index |
| Antecedent Moisture Condition II (growing season) | 4 | Inches |
| Antecedent Moisture Condition III (growing season) | 4.5 | Inches |
| Antecedent Moisture Condition II (non-growing season) | 0.02 | Inches |
| Antecedent Moisture Condition III (non-growing season) | 0.11 | Inches |
| Connected Impervious Fraction | 0 | Percent |
| Evapo-Transpiration Calibration Factor | 1.4 | Unitless |
| Time of Concentration (aquifers) | Increased by a factor of 4 for all aquifer devices | Unitless |

The results of the re-calibrated P8 model are illustrated in Figure 3. Storm event timing, storm event magnitude, and baseflow magnitude are an improvement from the prior iteration of the model, while also meeting low percent bias model performance criteria for total flow volume. The re-calibrated P8 model under simulates total flow volume for the 2021 growing season by approximately 5%.

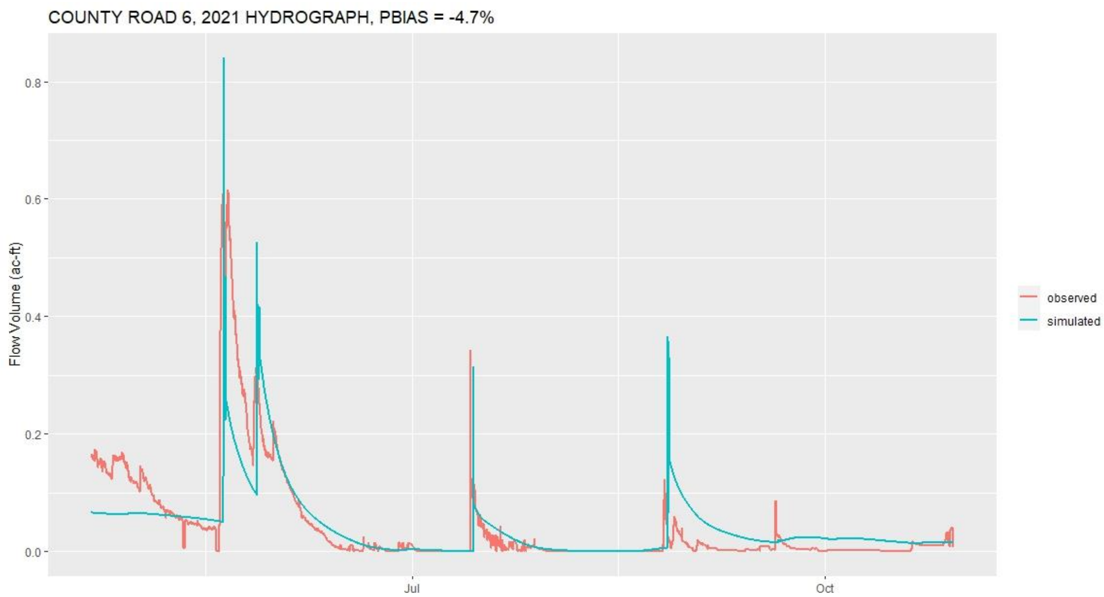



*Figure 3. Streamflow hydrograph results from the re-calibrated model. Hydrograph demonstrates hourly observed and simulated flow volume at the County Road 6 pond inlet for the 2021 growing season.*

## 2.2 Pollutant Calibration

The P8 model that was re-calibrated for streamflow was then calibrated for total suspended solids (TSS) and total phosphorus (TP). Initial attempts at calibration demonstrated that sediment and particulate phosphorus at the County Road 6 pond inlet were low. Particulate phosphorus loads were so low that this configuration of the model could not be adjusted to accurately describe observed conditions.

Based on model sensitivity analysis, it is Stantec's view that the upstream ponds in the P8 model are overestimating pollutant removals, resulting in a very small particulate pollutant load at the County Road 6 inlet. Stantec developed an additional version of the P8 model with zero pond or pipe devices upstream of the County Road 6 inlet, where all watersheds were combined to a single upstream basin using the same streamflow calibration parameters from the full model version (Figure 3). This was done to calibrate the pollutant load entering the County Road 6 pond more accurately and facilitate more realistic estimates of the various engineered pollutant removal scenarios.

Table 2 summarizes load estimates at the County Road 6 inlet and outlet. These loads were estimated using the USGS LOADEST regression software, from observed streamflow and TP concentration data for the 2021 and 2022 growing seasons. Based on this analysis, the County Road 6 ponds remove approximately 28% of the TP on an annual basis.

*Table 2. Annual TP loads at the Country Road 6 Inlet and Outlet.*

| Year | Annual TP Load (lbs) | | % Removal |
|---|---|---|---|
| | Inlet | Outlet | |
| 2021 | 235.5 | 198.7 | 15.6% |
| 2022 | 301.1 | 189.1 | 37.2% |
| Average | 268.4 | 193.9 | 27.8% |

In practice, applying these observed reductions under the current (baseline) condition meant adjusting the “Scale Factor” for TSS and TP until the incoming pollutant concentrations closely matched the observed pollutant concentrations at the inlet. For the 2021 growing season the observed and simulated TSS concentrations at the County Road 6 inlet were 91.6 mg/L and 91.8 mg/L, respectively. The observed and simulated TP concentrations were 0.365 mg/L and 0.363 mg/L, respectively.

Once pollutant loads at the inlet were accurately simulated the “Particle Removal Scale Factor” was adjusted globally for both pond segments/devices. This value was adjusted to 0.1 for both devices, resulting in a TP removal of 34% from inlet to outlet (compared with the estimated average of ~28% in Table 2).

# 3 Existing Pond Conditions

The existing pond is a 2-acre, dual-celled system, with a submerged berm separating the cells. The existing pond outlet is comprised of a sheet pile weir with five 1x2 ft rectangular orifices that control the normal water level.

Survey was completed to inform critical elevations at the pond, as well as to document utility locations.

MCWD’s Research & Monitoring (R&M) Program has monitored influent and effluent phosphorus concentrations at the CR6 pond. Results have indicated that particulate phosphorus dominates the effluent TP. Therefore, the primary goal of the retrofit feasibility study it to identify solutions to improve removal of particulate phosphorus, while providing enhanced dissolved phosphorus removal.

# 4 Opportunity Identification

A comprehensive list of wet pond retrofit types was developed and reviewed in collaboration with MCWD staff to select preferred project types. Each of the retrofit types is listed below, with justification for either continuing or discontinuing evaluation of each retrofit type.

## 4.1 Retrofit Types Selected for Further Analysis

The following five alternatives were selected by Stantec and MCWD staff for evaluation within this study.

### 4.1.1 GRAVITY SAND FILTER BENCH

Gravity sand filter benches utilize vertical depth capacity (head) available in ponds between the normal water level and the overflow outlet (live storage) to filter water through a filter media along a portion of a pond’s perimeter, before discharging filtered water downgradient. Filter benches can be active or passive, utilizing pumps or gravity, which drives cost and the quantity of water that can be treated. Gravity systems rely on rainfall events to pass water through filters, while active systems regularly direct water through filters regardless of precipitation patterns. The CR6 pond has sufficient head difference available to make a gravity filter bench a feasible option. Additionally, the existing access corridor along the east side of the pond would provide for less intrusive construction and operations & maintenance of a filter bench located on the eastern perimeter of the southern cell. Water quality treatment capacity is driven by the surface area of a filter; therefore, encroachment of the conceptual filter bench footprint into the existing water surface area of the pond was considered, to maximize treatment potential within existing land access rights agreements.

### 4.1.2 WEIR ACROSS EXISTING BERM

The CR6 pond is a two-celled system, with the cells separated by a submerged earthen berm. Physical separation between cells has the potential to concentrate sedimentation within the first cell, while continuing to utilize the full residence time that the second cell provides to maximize fine particulate sedimentation. Since the CR6 pond is already configured as a two-celled system, modifications to reinforce functionality as a multi-celled system were considered. Modifications to raise the elevation of the separation between cells has the potential to maximize settling capability in the upgradient cell, before water flows into the downgradient cell. This would also maximize ponding within the existing easement area. Two types of weirs were considered: (1) sheet pile weir and (2) earthen berm with riprap reinforced overflow. The material selected will drive the cost associated with the this retrofit alternative.

### 4.1.3 PUMPED SAND FILTER BENCH W/ FLOAT SWITCH

Pumped sand filters provide the same benefits as gravity filter benches, except they are able to overcome limitations that gravity filters experience. Pumped sand filters can be located at higher elevations than the water storage system that is used as source water and pumped filters do not need to rely on natural storm events to route water through the filter. This alternative considers the use of a float switch, which would activate pumping between specific, programmed water levels. This allows periodic treatment of pond water via filtration, as the pond fills with stormwater runoff and/or baseflow. The existing access corridor along the east side of the pond would provide for less intrusive construction and operations & maintenance of a filter bench located on the eastern perimeter of the southern cell. Water quality treatment capacity is driven by the surface area of a filter; therefore, encroachment of the conceptual filter bench footprint into the existing water surface area of the pond was considered, to maximize treatment potential within existing land access rights agreements.

### 4.1.4 PUMPED SAND FILTER BENCH W/ REAL TIME SENSOR

Pumped sand filters provide the same benefits as gravity filter benches, except they are able to overcome limitations that gravity filters experience. Pumped sand filters can be located at higher elevations than the water storage system that is used as source water and pumped filters do not need to rely on natural storm events to route water through the filter. This alternative considers the use of a real time sensor, which would activate pumping between specific, programmed water levels and in advance of rainfall events forecasted by the National Weather Service. This allows periodic treatment of pond water via filtration, as the pond fills with stormwater runoff and/or baseflow. The predictive nature of the real time sensor allows further system manipulation, such as drawing down water levels in a pond prior to a runoff event, to maximize available storage capacity in the pond and maximize capacity for settling and sedimentation of storm runoff within the pond. The existing access corridor along the east side of the pond would provide for less intrusive construction and operations & maintenance of a filter bench located on the eastern perimeter of the southern cell. Water quality treatment capacity is driven by the surface area of a filter; therefore, encroachment of the conceptual filter bench footprint into the existing water surface area of the pond was considered, to maximize treatment potential within existing land access rights agreements. Real time sensors for stormwater management are an emerging technology, which allow water resource managers to leverage facilities at a system scale to maximize water quality and quantity benefits.

### 4.1.5 ALUM DOSING STATION WITH INTERCEPTION OF GOLF COURSE RUNOFF

Alum is a coagulant which binds to dissolved phosphorus. Its most common use in surface water resource management is to apply alum to waterbodies that are experiencing high dissolved phosphorus load from sediment (internal load). The dissolved phosphorus load is then bound to the alum in a layer at the bottom of the waterbody. The internal load in CR6 pond is unknown, so the applicability of alum dosing the sediment is not well defined at this time.

Another method of using alum to bind and settle dissolved phosphorus is to construct a dosing station that pumps water out of an upstream storage reservoir, injects the water with alum, and allows the floc of alum-bound-phosphorus to settle in a second storage / settling reservoir. The alum injection is ongoing, as water is routinely or continuously pumped out of the first reservoir as the it fills with stormwater runoff and/or baseflow.

The CR6 pond is a candidate for an alum dosing station due to its existing physical configuration as a two-celled system. Modifications to the pond's existing submerged berm would be required, to create a more distinct separation between pond cells. Once floc settles in the downgradient cell, clean water would discharge from the pond's outlet.

MCWD Research & Monitoring (R&M) data indicates that there is significant phosphorus load from the Spring Hill Golf Club east of the CR6 pond and north of County Road 6. The golf course does not naturally drain to the CR6 pond, and instead directly drains to Long Lake without water quality treatment. Assessment of this alternative considered the additional load generated from the golf course and project components that would be required to convey water from the golf course to the CR6 pond. Note that the data provided by MCWD consisted of 12 grab samples collected in 2018, and further monitoring is recommended prior to further pursuing interception of golf course runoff.

This alternative represents the most aggressive feasible option evaluated, and serves to represent an upper limit of phosphorus load reductions that could be achieved by retrofits at and near the CR6 Pond. The interception of golf course runoff was not paired with other retrofit alternatives in the scope of this study, but could be paired with any of the other evaluated options such as filter benches.

## 4.2 Retrofit Types Not Selected for Further Analysis

### 4.2.1 DEAD POOL VOLUME MODIFICATIONS TO ALTER RESIDENCE TIME

Dead pool volume of ponds impacts the residence time of ponds and subsequently, the settling of particulates within the water column. Significant changes to the grading and bathymetry of CR6 pond were deemed infeasible due to land rights restrictions and the existing easement footprint. Dead pool volume modifications were instead considered within the retrofit type of weir modifications.

### 4.2.2 OUTLET MODIFICATIONS TO ALTER RESIDENCE TIME

The outlet control structure of a pond controls the normal water level and spillway elevations of the basin. It was decided that outlet modifications would not be considered as an alternative for this study, but would instead be considered as a component of other evaluated options including the sand filter benches and weir modifications.

### 4.2.3 ADDITION OF PRE-TREATMENT

CR 6 pond sits just downstream of the confluence of two streams, which convey discharge from Wolsfeld Lake and Holy Name Lake. Depending on the condition of the streams upstream of CR6 pond, runoff may experience sediment and phosphorus loading from the erosion of the streams. Relatively low sediment accumulation rates observed in CR6 pond during routine pond sedimentation surveys indicates that this is likely not a primary issue. However, the incorporation of pre-treatment practices at the influent of stormwater management facilities, such as ponds, is a strategy that is shown to reduce nutrient and sediment accumulation within the ponds themselves. Pre-treatment can include construction of wet forebays, manhole sumps with or without energy dissipation or floatable material capture devices, etc. Due to the lack of space on site to construct a pre-treatment forebay, and lack of storm sewer infrastructure to retrofit a manhole sump, the addition or pre-treatment devices was not pursued further at CR6 ponds.

### 4.2.4 ALUM APPLICATION TO POND SEDIMENTS

The application of alum is an established practice within lakes, to chemically bind dissolved phosphorus that is released by lake sediments, to stop internal loading. Alum application to pond sediments is a potentially emerging technology that is being considered by practitioners in the state of Minnesota. Alum applications rely on site access to facilitate access of alum application equipment, which is problematic at many ponds. CR6 pond has existing access via the easement to the east of the pond. However, data does not exist to indicate whether the CR6 pond experiences internal loading significant enough to warrant alum applications. Furthermore, alum applications essentially “lock” phosphorus from being released from sediments within the sediment surface layer. Since ponds are designed to experience sediment loading and settle those loads, the longevity of alum applications within ponds is dependent on the rate of sediment accumulation within ponds. For these reasons, alum application to the sediments of the CR6 pond were not further explored.

### 4.2.5 IRON FILINGS APPLICATION TO POND SEDIMENTS

The application of iron filings to lake sediments is an emerging technology that is being explored by researchers, to chemically bind dissolved phosphorus that is released by lake sediments, to stop internal loading. Alum application to pond sediments is a potentially emerging technology that is being considered by practitioners in the state of Minnesota. Alum applications rely on site access to facilitate access of alum application equipment, which is problematic at many ponds. CR6 pond has existing access via the easement to the east of the pond. However, data does not exist to indicate whether the CR6 pond experiences internal loading significant enough to warrant alum applications. Furthermore, alum applications essentially “lock” phosphorus from being released from sediments within the sediment surface layer. Since ponds are designed to experience sediment loading and settle those loads, the longevity of alum applications within ponds is dependent on the rate of sediment accumulation within ponds. For these reasons, alum application to the sediments of the CR6 pond were not further explored.

### 4.2.6 AERATION

Aeration is most commonly employed in stormwater ponds for aesthetic purposes, which are not a priority at the CR6 Pond. However, the stormwater management industry has recently posed the question of whether mechanical aeration (i.e. fountain or bubbler) can limit or prevent ponds from experiencing dissolved oxygen (DO) stratification, and in turn, reduce sediment P loads. The impacts of aeration on controlling sediment P loads in ponds are not well understood by the industry, and MCWD has a lack of information about the significance of internal sediment loading of P within the CR6 Pond, therefore, aeration was not further evaluated within this study.

### 4.2.7 PROPRIETARY CARTRIDGE FILTER SYSTEM; PUMPED

Proprietary cartridge filters, such as Jellyfish, StormFilter, etc.; are a relatively new technology that are being implemented more widely within the landscape. With regular maintenance, data shows that they are capable of removing 50% of TP from the water that is directed to them. These systems can be either gravity fed or receive water pumped from a storage area. A proprietary cartridge filter system could be leveraged at CR6 Pond, paired with a pump to overcome pressure head. Due to the watershed size draining to the CR6 pond, a significant quantity of cartridge filters would be required to collect a majority of discharge from the pond during water quality events and/or to maximize TP removal. The cost of cartridge filter systems is primarily driven by the quantity of filters and cartridge filters require regular (typically 1-2 times per year) maintenance or replacement of cartridges. Due to the significant costs and maintenance required support proprietary cartridge filter systems, this retrofit type was not selected for further analysis.

# 5 Alternatives Assessment

Concept design, water quality modeling, and planning level opinion of probable cost was completed for each alternative. This information is used to evaluate cost efficiency of TP removal associated with each alternative, as well as to provide insight into the physical configuration and operations & maintenance requirements of each alternative. Itemized opinion of probable cost and concept design schematics for each alternative are included in the appendix. The alternatives evaluated could be implemented in an a-la-carte type manner, whereas a weir further defining separation between the two pond cells could be paired with a gravity or pumped filter bench, interception of golf course runoff could be paired with any of the evaluated alternatives, etc. The opinion of probable costs and estimated phosphorus load removals are generally additive at the feasibility level, when considering implementation of a combination of options.

## 5.1.1 CONCEPT DESIGN

Concept design and sizing was completed for each alternative, utilizing understanding of physical space constraints, informed by survey data. Concept design was used to inform key parameters for water quality modeling, preparation of opinion of probable cost, and to provide a visual understanding of retrofit size and extent.

### 5.1.1.1 Gravity Sand Filter Bench

The following assumptions and design choices were made for the concept design of a gravity sand filter bench:

- Bench would be located on the eastern portion of the southern cell, with access for construction & maintenance via the existing access corridor within the easement.
- Bench would be graded into the pond, to ensure it is contained within the limits of the existing easement. Therefore, some wet detention area will be lost within the pond.
- Clean sand (not iron enhanced) was assumed, to target particulate phosphorus.
- Outlet modifications to change normal water level (NWL) from 949.3 ft to 951.5 ft.
- Top of filter bench at elevation 951.5 ft.
- 14,000 sf filter bench area.

### 5.1.1.2 Weir (Sheet Pile or Earthen)

The following assumptions and design choices were made for the concept design of a weir:

- Top of weir at 952 ft, with overflow notch at 951.5 ft.
- Outlet modifications to change normal water level (NWL) from 949.3 ft to 951.5 ft.

### 5.1.1.3 Pumped Sand Filter Bench w/ Float Switch

The following assumptions and design choices were made for the concept design of a pumped sand filter bench with float switch:

- Bench would be located on the eastern portion of the southern cell, with access for construction & maintenance via the existing access corridor within the easement.
- Bench would be graded into the pond, to ensure it is contained within the limits of the existing easement. Therefore, some wet detention area will be lost within the pond.
- Clean sand (not iron enhanced) was assumed, to target particulate phosphorus.
- Outlet modifications to change normal water level (NWL) from 949.3 ft to 951.5 ft.
- Top of filter bench at elevation 953.5 ft.
- 14,000 sf filter bench area.
- Electrical service to tie-in at County Road 6, to run along existing access corridor.

#### 5.1.1.4 Pumped Sand Filter Bench w/ Real Time Sensor

The following assumptions and design choices were made for the concept design of a pumped sand filter bench with float switch:

- Bench would be located on the eastern portion of the southern cell, with access for construction & maintenance via the existing access corridor within the easement.
- Bench would be graded into the pond, to ensure it is contained within the limits of the existing easement. Therefore, some wet detention area will be lost within the pond.
- Clean sand (not iron enhanced) was assumed, to target particulate phosphorus.
- Outlet modifications to change normal water level (NWL) from 949.3 ft to 951.5 ft.
- Top of filter bench at elevation 953.5 ft.
- 14,000 sf filter bench area.
- Electrical service to tie-in at County Road 6, to run along existing access corridor.

#### 5.1.1.5 Alum Dosing w/ Golf Course Interception

- Construction of lift station south of County Road 6 at existing culvert, with new directionally drilled 6-inch HDPE forcemain to convey water west to CR6 Pond.
- First cell of CR6 pond used as reservoir for water prior to treatment.
- Weir construction to better define distinction between pond cells.
- Alum dosing building located on east side of CR6 pond, between cells.
- Second cell of CR6 pond used as settling basin for alum-bound P floc.

- Electrical service to tie-in at County Road 6, to run along existing access corridor.

### 5.1.2 WATER QUALITY MODELING

TP removals were estimated in the pollutant calibrated P8 for the following scenarios:

- The current/baseline scenario
- Weir improvement at the outlet of the north cell
- Gravity filter bench addition to the south cell
- Pumped filter bench addition to the south cell

Generally, these scenarios were simulated by applying the hydraulically-relevant design specifications to the simulated devices in P8. These elements can include pond elevation, permanent pool area and volume, flood pool area and volume, infiltration rate, outlet type, and weir length/discharge coefficient. Table 3 summarizes how each scenario was simulated in P8.

A fifth scenario, automated alum dosing, was estimated outside of P8, using an assumed annual TP removal of 75% based on research outlined in Wagner (2017). Under this scenario, runoff originating from the 61-acre Spring Hill Golf Course drainage (north of County Road 6) would be piped to the inlet of the north cell of the ponds for treatment. This additional TP load was estimated from the 2018 monitoring record (12 samples). For each grab sample, a daily TP load was calculated from measured streamflow and TP concentration. Then, the median daily load across all samples was multiplied by 365, yielding an estimated annual load delivered to the north cell of the pond. It is estimated that 22.7 pounds of TP would be added to the County Road 6 pond under this scenario.

*Table 3. Summary of P8 device conceptualization for pollutant removal scenario analysis.*

| Option ID | Scenario | Device Type | | Description |
|---|---|---|---|---|
| | | North Cell | South Cell | |
| -- | Baseline | Pond | Pond | Pond dimensions reflect current pond design specs. |
| 1 | Gravity Filter Bench | Pond | General | P8 infiltration rate set to filter bench estimated infiltration rate (1.6-3.0 in/hr), upon activation. Normal spillway outflow set to HydroCAD simulated outflows. |
| 2A & 2B | Weir | Pond | Pond | Adjusted weir dimensions based on engineering spec. |
| 3 & 4 | Pumped Filter Bench | Pond | General | P8 infiltration rate set to filter bench estimated infiltration rate (1.6-3.0 in/hr), pumping continuously. Normal spillway outflow set to HydroCAD simulated outflows. |

The removal estimates for these scenarios are summarized below in Table 4. Note the tables distinguishes between the annual TP removal (total removal) and the annual TP removal gained from each scenario (total removal – baseline removal).

*Table 4. TP removal scenarios.*

| Option ID | Scenario | TP (lbs/year) | | Annual TP Removal | Annual TP Removal (Gained) | |
|---|---|---|---|---|---|---|
| | | Inlet (north cell) | Outlet (south cell) | % | lbs/yr | % |
| -- | Baseline | 273 | 180 | 34% | 0 | 0% |
| 1 | Gravity Filter Bench (1.6 - 3.0 in/hr) | 273 | 113-132 | 52-59% | 48-67 | 27-37% |
| 2A & 2B | Weir (sheet pile or earthen) | 273 | 174-176 | 36% | 4-6 | 2-4% |
| 3 | Pumped Filter Bench w/ Float Switch (1.6 - 3.0 in/hr) | 273 | 96-122 | 55-65% | 58-84 | 32-47% |
| 4 | Pumped Filter Bench w/ Real Time Sensor (1.6 - 3.0 in/hr) | 273 | 90-122 | 55-67% | 58-90 | 32-50% |
| 5 | Alum Dosing Station* | 296 | 51-102 | 66-83% | 102-152 | 50-75% |

*Total inlet load calculated as [273 lbs (current condition) + 23 lbs (golf course drainage)]

### 5.1.3 CONCEPT-LEVEL OPINION OF PROBABLE COST

Concept-level opinion of probable cost was prepared for each evaluated alternative. Itemized opinion of probable cost is included in the appendix, for reference and understanding of drivers of cost within each alternative. General and alternative specific assumptions made for each alternative are also detailed in the appendix.

#### 5.1.3.1 Capital Costs

Capital costs were estimated for each alternative, including 30% contingency and 30% for engineering, legal, admin, and finance. Results are tabulated below.

| Option ID | Alternative | Capital Cost *(construction, contingency, legal, admin, finance)* |
|---|---|---|
| 1 | Gravity Sand Filter Bench | $664,000 |
| 2A | Weir – Sheet Pile | $956,000 |
| 2B | Weir – Earthen | $206,000 |
| 3 | Pumped Sand Filter Bench w/ Float Switch | $1,011,000 |
| 4 | Pumped Sand Filter Bench w/ Real Time Sensor | $1,349,000 |
| 5 | Alum Dosing | $3,628,000 |

#### 5.1.3.2 Operations & Maintenance Costs

Operations & maintenance (O&M) costs were estimated for each evaluated alternative, considering key activities required to ensure functionality over an assumed 30-year project lifecycle. The cost of regular inspections was not included. Itemized estimates are included in Table 5 below, which show components and frequency of maintenance activities. Assumptions are also included in the Appendix.

*Table 5. O&M OPC*

**(1) GRAVITY FILTER BENCH OPERATIONS AND MAINTENANCE COST SCHEDULE**

| NO. | ITEM DESCRIPTION | FREQUENCY | | UNIT PRICE | 30 YEAR COST |
|---|---|---|---|---|---|
| **O&M COST SCHEDULE** | | | | | |
| 1 | FILTER MEDIA REPLACEMENT | 10 | YEARS | $ 200,000 | $ 600,000 |
| | **30 YEAR MAINTENACE COST TOTAL** | | | | $ 600,000 |

**(2A and 2B) WEIR/BERM OPERATIONS AND MAINTENANCE COST SCHEDULE**

ASSUME NO OPERATIONS AND MAINTENACE COSTS

**(3) PUMPED FILTER BENCH W/ FLOAT SWITCH OPERATIONS AND MAINTENANCE COST SCHEDULE**

| NO. | ITEM DESCRIPTION | FREQUENCY | | UNIT PRICE | 30 YEAR COST |
|---|---|---|---|---|---|
| **O&M COST SCHEDULE** | | | | | |
| 1 | FILTER MEDIA REPLACEMENT | 10 | YEARS | $ 200,000 | $ 600,000 |
| 2 | PUMP REPLACEMENT | 10 | YEARS | $ 100,000 | $ 300,000 |
| | **30 YEAR MAINTENACE COST TOTAL** | | | | $ 900,000 |

**(4) PUMPED FILTER BENCH W/ REAL TIME SENSOR OPERATIONS AND MAINTENANCE COST SCHEDULE**

| NO. | ITEM DESCRIPTION | FREQUENCY | | UNIT PRICE | 30 YEAR COST |
|---|---|---|---|---|---|
| **O&M COST SCHEDULE** | | | | | |
| 1 | FILTER MEDIA REPLACEMENT | 10 | YEARS | $ 200,000 | $ 600,000 |
| 2 | PUMP REPLACEMENT | 10 | YEARS | $ 100,000 | $ 300,000 |
| 3 | OPTI-RTC SYSTEM MAINTENANCE | 10 | YEARS | $ 30,000 | $ 90,000 |
| | **30 YEAR MAINTENACE COST TOTAL** | | | | $ 990,000 |

**(5) ALUM DOSING FACILITY OPERATIONS AND MAINTENANCE COST SCHEDULE**

| NO. | ITEM DESCRIPTION | FREQUENCY | | UNIT PRICE | 30 YEAR COST |
|---|---|---|---|---|---|
| **O&M COST SCHEDULE** | | | | | |
| 1 | ALUM FACILITY MAINTENANCE | 1 | YEAR | $ 30,000 | $ 900,000 |
| 2 | LIFT STATION PUMP REPLACEMENT (GOLF COURSE INTERCEPTION) | 10 | YEARS | $ 60,000 | $ 180,000 |
| | **30 YEAR MAINTENACE COST TOTAL** | | | | $ 1,080,000 |

#### 5.1.3.3 Lifecycle Costs

Lifecycle costs were estimated by summing estimated project capital costs and O&M costs and are shown in Table 6. Inflation and discount rates were not considered. A 30-year lifecycle was assumed for all retrofit types.

*Table 6. Lifecycle Costs*

| Option ID | Alternative | Capital Cost | Maintenance Cost (30-year) | Lifecycle Cost |
|---|---|---|---|---|
| 1 | Gravity Sand Filter Bench | $ 664,000 | $ 600,000 | $ 1,264,000 |
| 2A | Weir - Sheet Pile | $ 956,000 | $ - | $ 956,000 |
| 2B | Weir - Earthen | $ 206,000 | $ - | $ 206,000 |
| 3 | Pumped Sand Filter Bench w/ Float Switch | $ 1,011,000 | $ 900,000 | $ 1,911,000 |
| 4 | Pumped Sand Filter Bench w/ Real Time Sensor | $ 1,349,000 | $ 990,000 | $ 2,339,000 |
| 5 | Alum Dosing Station w/ Golf Course Drainage | $ 3,628,000 | 1,080,000 | $ 4,708,000 |

# 6 Evaluation of Alternatives

Qualitative and quantitative evaluation criteria were considered to compare the alternatives and inform recommendations.

## 6.1 Evaluation Criteria

Criteria were discussed and prioritized, in collaboration with MCWD staff. Potential project options were evaluated against criteria including: the ability of the project to achieve MCWD goals, estimated project capital and operation & maintenance costs, permitting needs and hurdles, site constraints, data needs for final design, and engineering complexity. Criteria are outlined in more detail below.

### 6.1.1 TOTAL PHOSPHORUS REMOVALS

The ability of alternatives to remove total phosphorus and reduce the effluent load from the CR6 Pond was identified as the primary goal of the feasibility study, and a overarching goal of MCWD. To address this goal, concept design of alternatives sought to maximize TP removal capacity of each evaluated option. Evaluation of TP removal capacity was completed via P8 water quality modeling, using a refined version of the District's P8 model for the CR6 Pond.

### 6.1.2 DISCHARGE RATE AND FLOOD CONTROL

To address MCWD's goals for water quantity management, this study looked at the potential to manage and maintain discharge rates, and the estimated impact on upstream and downstream flood elevations. Potential project alternatives were evaluated qualitatively for impact on discharge rate and flooding.

### 6.1.3 ECOLOGICAL INTEGRITY

The ability of project alternatives to support MCWD's goal to maintain and build ecological integrity through habitat restoration and preservation was evaluated qualitatively.

### 6.1.4 PROMOTING THRIVING COMMUNITIES

Promoting thriving communities is one of MCWD's goals. MCWD staff indicated that this goal is not a priority or applicable at the CR6 site. The pond exists on private property, with an easement that grants MCWD the ability to own and operate the pond; promoting public access at the site is not feasible under the current agreement. Furthermore, the site does not have space for safe public access or incorporation of amenities, and public access to the pond itself is not desired due to the risk of damage to engineered infrastructure and safety risks to the public due to the pond not being intended for swimming or boating. Implementing projects that will reduce TP loads to Long Lake are anticipated to have a cascade effect and improve the quality of water for the users of Long Lake.

### 6.1.5 CAPITAL COSTS

The capital cost to build each project alternative is a key factor in determining which project option to install so that District funds are targeted effectively to projects with the highest impact for the cost. Capital costs for each alternative were estimated based on recent bids Stantec has reviewed from similar projects in nearby geographies and further supported by engineering judgement and/or discussions with local contractors. Capital costs assumed constant percentages for Contingency (30%) and Legal, Engineering, Admin & Finance (30%). The appendix includes a summary of assumptions made to estimate costs for each project alternative.

### 6.1.6 OPERATION & MAINTENANCE COSTS

The operation and maintenance costs are another key factor in determining which project option to install as operation and maintenance costs can vary widely across different types of projects. Operation and maintenance costs for each alternative were estimated based on filtration media replacement costs and schedules. The appendix includes a summary of assumptions made to estimate costs for each project alternative.

### 6.1.7 LIFE CYCLE COSTS

The life cycle cost of a project totals expenditures over the life of the project to reflect the total cost of a project. Project lifecycles were assumed to be 30 years.

### 6.1.8 PERMITTING NEEDS AND HURDLES

Permitting needs and hurdles for each project were estimated based on the project site location on a public waterway and based on the proposed activity or potential impact for each alternative.

### 6.1.9 SITE CONSTRAINTS

Project site constraints include land rights, site access, and utilities. These site factors were evaluated for each project option.

### 6.1.10 ENGINEERING COMPLEXITY & DATA NEEDS

Engineering complexity and challenges as well as the level of additional data needed to move a project to final design were evaluated for each project alternative.

## 6.2 Evaluation Matrix

*Table 7. Alternatives Evaluation Matrix*

| Option ID | Retrofit | Water quality benefit (TP lbs/yr) | Rate & Flood Control | Capital Costs ($) / O&M Costs ($/lifespan) | Lifecycle Cost ($/lifespan) | Cost Efficiency ($/lb TP) | O&M Requirements | Potential Regulatory Considerations | Site Constraints | Design complexity & Data needs |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Gravity sand filter bench | 48-67 | Decreased pond storage & outlet modifications could impact rates and flood elevations | $664,000 / $600,000 | $1,264,000 | $600-900 | • Raking & replacement of media | - Public Waters Work Permit<br>- May require No-Rise Certification | - Expands basin area | Low |
| 2A | Weir (sheet pile) | 4-6 | Weir could impact rates and flood elevations | $956,000 / $0 | $956,000 | $5,300-8,000 | • Inspections & general maintenance | - Public Waters Work Permit<br>- Floodplain No-Rise Certification | - Ponding area limited to existing easement | Medium |
| 2B | Weir (earthen) | 4-6 | Weir could impact rates and flood elevations | $206,000 / $0 | $206,000 | $1,100-1,700 | • Inspections & general maintenance | - Public Waters Work Permit<br>- Floodplain No-Rise Certification | - Ponding area limited to existing easement | Medium |
| 3 | Pumped sand filter bench w/ float switch | 58-84 | Decreased pond storage & outlet modifications could impact rates and flood elevations | $1,011,000 / $900,000 | $1,911,000 | $800-1,100 | • Raking & replacement of media<br>• Maintenance of pump | - Public Waters Work Permit<br>- Floodplain No-Rise Certification | - Expands basin area<br>- Electrical service to pump | Medium |
| 4 | Pumped sand filter bench w/ real time sensor | 58-90 | Decreased pond storage & outlet modifications could impact rates and flood elevations | $1,349,000 / $990,000 | $2,339,000 | $900-1,300 | • Raking & replacement of media<br>• Maintenance of pump<br>• Setup and programming of sensor<br>• Maintenance of sensor | - Public Waters Work Permit<br>- Floodplain No-Rise Certification | - Expands basin area<br>- Electrical service to pump | High |
| 5 | Alum dosing station | 102-152 | No impact | $3,628,000 / $1,080,000 | $4,708,000 | $1,000-1,500 | • Operation of alum station<br>• Removal of settled floc<br>• Maintenance of golf course interception pump | - Public Waters Work Permit<br>- NPDES/SDS permit with renewals required every 5 years<br>- Road authority permit | - Coordination with Road Authority and Golf Course<br>- Electrical service to dosing station | High |

# 7 Recommendations

The goal of this study was to define retrofit options for implementation at the County Road 6 Pond, to maximize TP removal prior to discharge to Long Lake. A suite of retrofit options was considered, some of which can be combined to create additional options. Construction of a gravity sand filter bench would be the most cost effective in terms of $/lb TP, but the gravity bench has lower TP removal potential than either of the two pumped filter bench options and the alum dosing station. The pumped filter bench provides a median option in terms of cost and removal potential, compared to the gravity filter bench and the alum dosing station. The alum dosing station provides the highest TP removal potential but requires extensive operations & maintenance efforts.

Construction of a more defined berm between the two pond cells is anticipated to remove 4-6 lb/yr of TP by increasing the separation between cells, forcing more sedimentation in the northern cell. Addition of a berm and focusing sedimentation within the northern cell has the potential to streamline future sediment maintenance efforts.

Implementation of a pumped sand filter bench at CR6 Pond is expected to provide 10-17 lb/yr of additional TP removal, compared to a gravity sand filter bench, due to the ability of the pump to circulate more water through the filter media, without relying on natural rain events to drive runoff through the system. Utilization of a real time sensor to control pump operations is not recommended at this time, as pre-storm drawdown and flood mitigation is not a priority in this location, and real time sensors introduce significant complexity to design and operation of a pumped system.

A blend of the gravity and pumped filter bench options is suggested, such that a pumped filter bench is designed and constructed in a way that the system would continue to function via gravity in the event the pump needs to be repaired or replaced, or if future upstream load reduction projects are completed upstream of the CR6 project and the pump is deemed unnecessary. This approach limits the risk of owning and operating a pumped stormwater system, as this site is particularly well suited for an organizational pilot of pump ownership due to the lack of risk to surrounding infrastructure and the ability to implement a system that can continue to operate effectively without a pump. Note that a concept schematic representing this blended solution of a gravity bench supplemented by pumping is not provided in the attached figures, nor were load removal estimates of the exact proposed configuration developed, though load removals are expected to be consistent with the “pumped sand filter bench w/ float switch” option, which is Option 3 as presented in Table 7. Selection of this option is dependent on MCWD’s organizational preferences and capabilities to manage a pumped system, and if a pumped system is deemed undesirable, a gravity system would also provide progress towards subwatershed goals.

Concept design for a pumped sand filter assumes a submersible pump would be located on the east side of the pond near the convergence of the two cells. The pump and controls would be housed within a 5-8 ft diameter manhole. The pump would draw water from the southern cell, lowering the water level below the normal water level, and apply the water over the surface area of the filter bench. Concept design assumes that the pump flow rate would be equivalent to the filtration rate of the filter media, between 230 and 440 gpm. The pump would require an initial investment of District staff time to gain familiarity with the functionality of the pump and to establish monitoring and maintenance protocols. In general, staff should routinely confirm functionality of the pump, either via physical site visits or remote monitoring. The system would need to be winterized (i.e. remove pump), and pump replacement is anticipated to be required approximately every 8-12 years.

In combination, Options 2B (earthen weir) and 3 (pumped sand filter bench with float switch) are anticipated to facilitate retention of between 62 and 90 lb of TP per year within CR6 Pond. Assuming construction in 2024, capital costs, including soft costs, for the project are estimated at about $1.2M based at this feasibility stage of the project. Total lifecycle cost, assuming a 30-year project lifespan, is estimated at about $2.1M. Therefore, cost-benefit of the suggested project is between $700 and $1,130/lb TP.

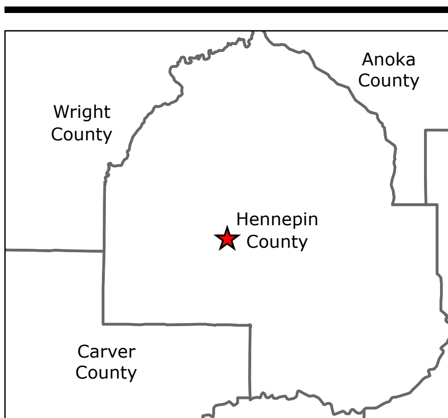
Construction of a sand filter bench with earthen berm between pond cells could be completed at any time throughout the year, with rain presenting the most significant risk to site management and construction schedule. Therefore, it is recommended that the construction window include winter months, so the selected contractor has the option to complete the work under frozen winter conditions. If construction occurs in the summer, dewatering will be required.

Based on cost-benefit and ease of implementation, a filter bench paired with an earthen berm to better define the two cells is the recommended retrofit for the CR6 Pond.

Future efforts to address sources of unaddressed loads in the Long Lake watershed include stabilization of bank erosion in Wolsfeld creek and interception and treatment of runoff from Spring Hill Golf Club. Stabilization of the Wolsfeld creek has the potential to significantly reduce nutrient loads to the CR6 Pond and subsequently, Long Lake, but substantial regulatory hurdles exist that make stabilization infeasible in the immediate future.

Additional monitoring may be completed to further inform TP loads from the Spring Hills Golf Course, at which time interception of golf course nutrient loads could be further pursued via development of a lift station and forcemain to route runoff along CR6 to the CR6 Pond for treatment. Both opportunities have the potential to measurably impact the loading to Long Lake and should continue to be pursued.

# OPTION 1: Gravity Sand Filter Bench


Legend

- Proposed Filter Bench Footprint (14,000 sqft)
- Easement Boundary
- Contours (2ft)
- Hennepin Co. Parcels

0 30 60 Feet

(At original document size of 11x17)
1:720

N

**Notes**
1. Coordinate System: NAD 1983 HARN Adj MN Hennepin Feet
2. Data Sources: Stantec, Hennepin Co.
3. Background: 2020 color 7-county

Stantec

*Project Location* Prepared by KJM on 2022-04-15
T118N, R23W, S26
Orono, Hennepin Co., MN

*Client/Project* 22770xxxx
Minnehaha Creek Watershed District
CR6 Pond Easement

*Figure No.*
**1**

*Title*
**CR6 Pond Easement**



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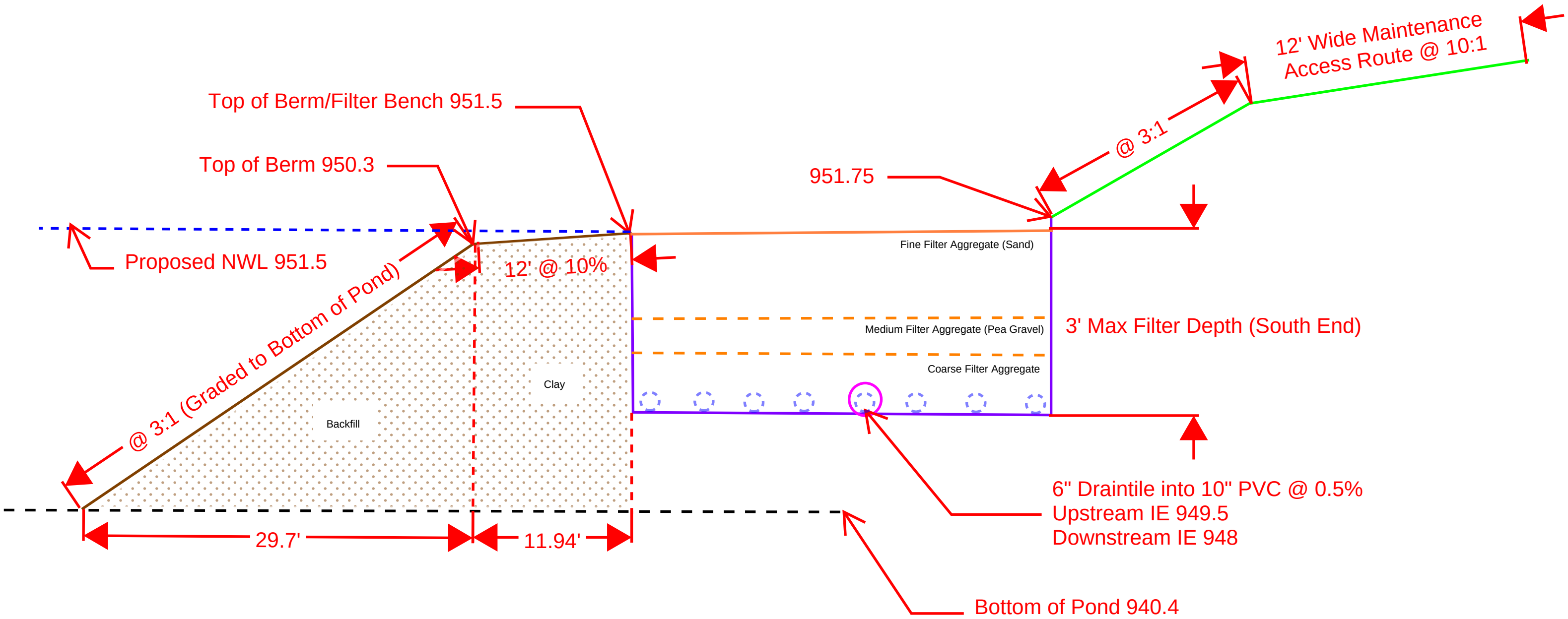
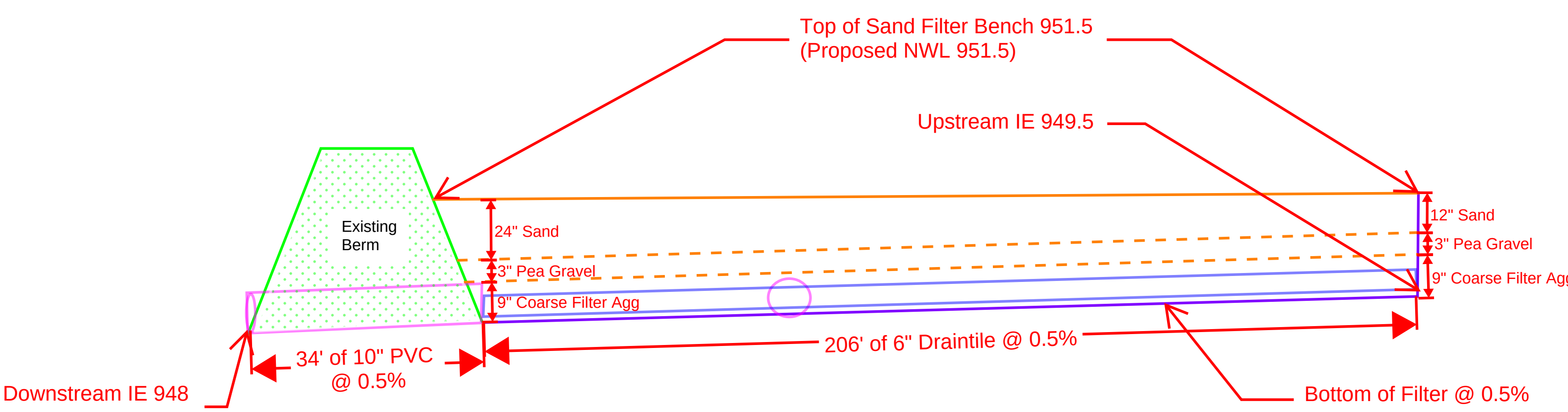
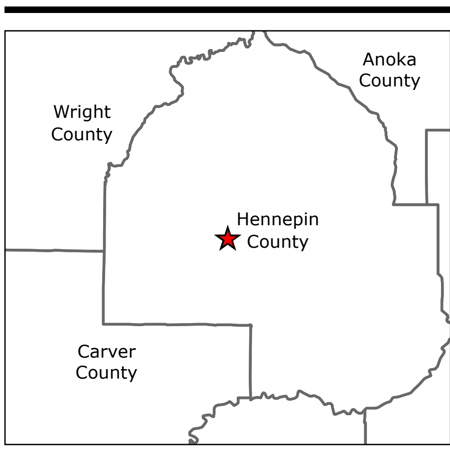
# OPTION 1: Gravity Sand Filter Bench



# OPTION 2: Weir Across Existing Berm


Legend

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- Easement Boundary
- Contours (2ft)
- Hennepin Co. Parcels

0 30 60 Feet

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Stantec

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Prepared by KJM on 2022-04-15

*Client/Project*
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Minnehaha Creek Watershed District
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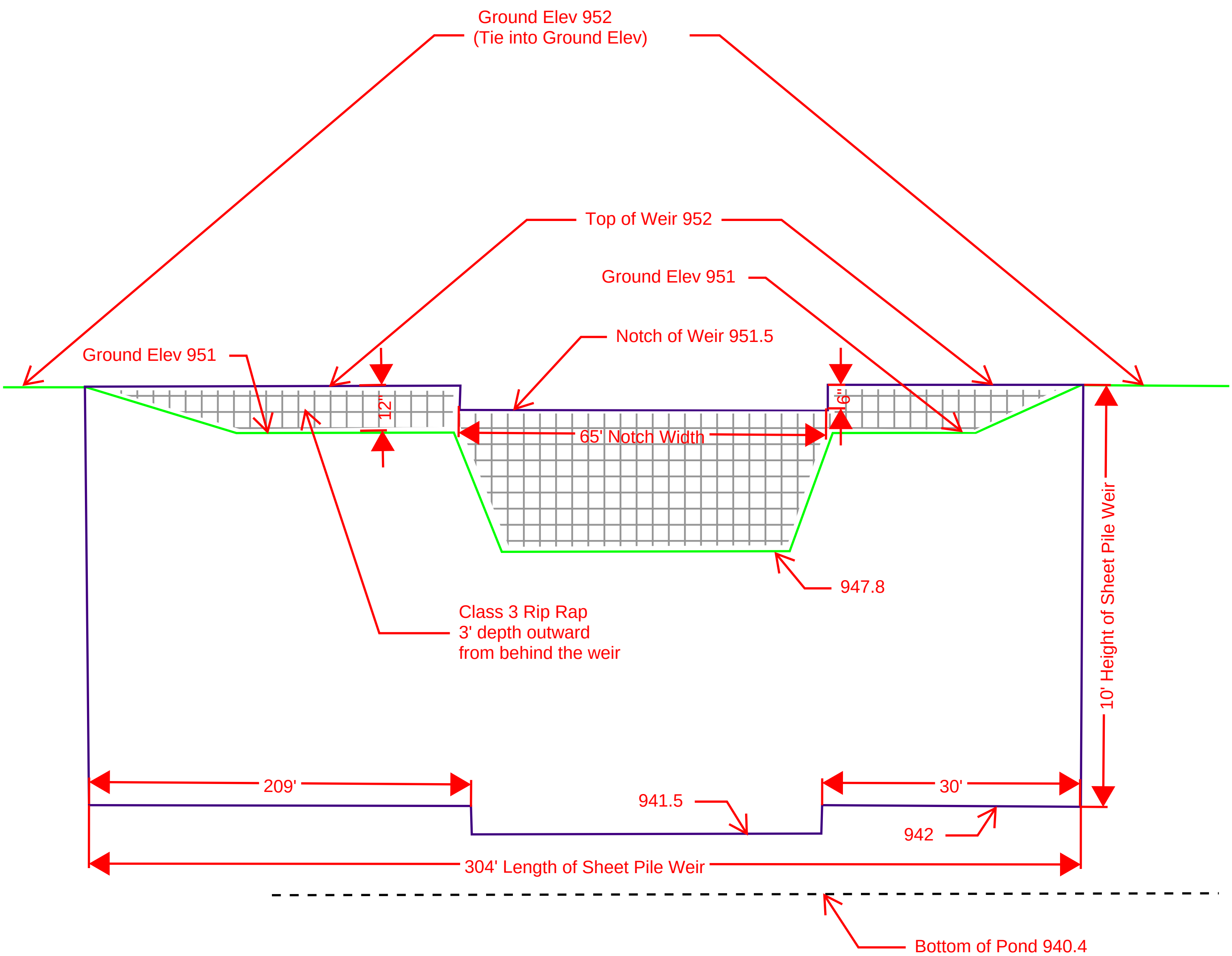
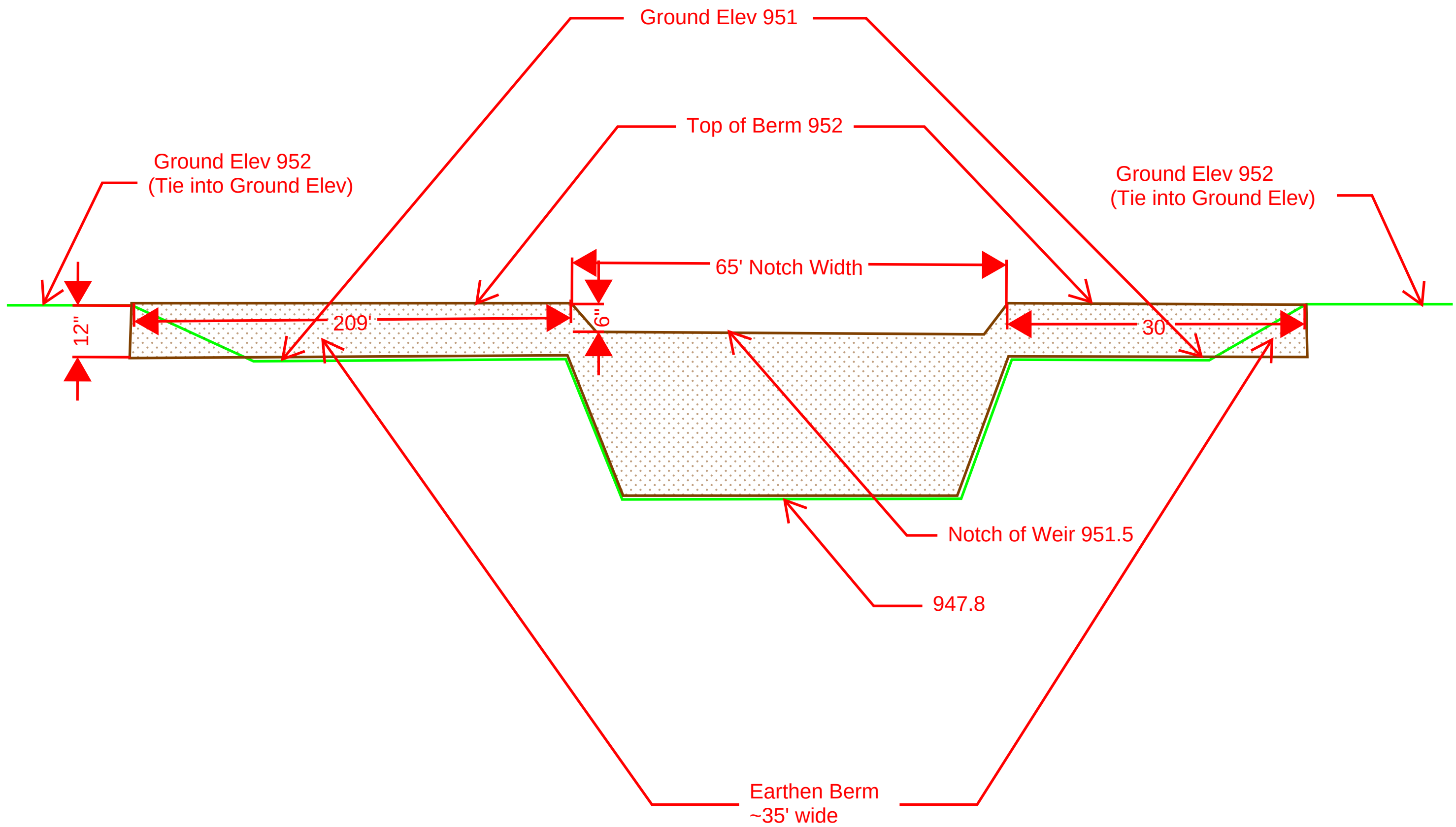
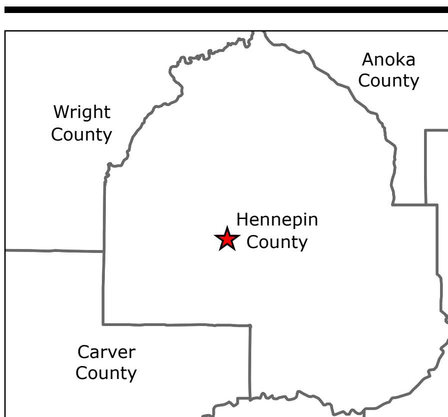
# OPTION 2a: Sheet Pile Weir Across Existing Berm



# OPTION 2b: Earthen Embankment



# OPTION 3: Pumped Sand Filter Bench
### w/ floater to engage pump at set water elevation
# &
# OPTION 4: Pumped Sand Filter Bench
### w/ real time sensor to engage pump before storm event


Legend

- Proposed Filter Bench Footprint (14,000 sqft)
- Easement Boundary
- Contours (2ft)
- Hennepin Co. Parcels

0 30 60 Feet

(At original document size of 11x17)
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Stantec

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Minnehaha Creek Watershed District
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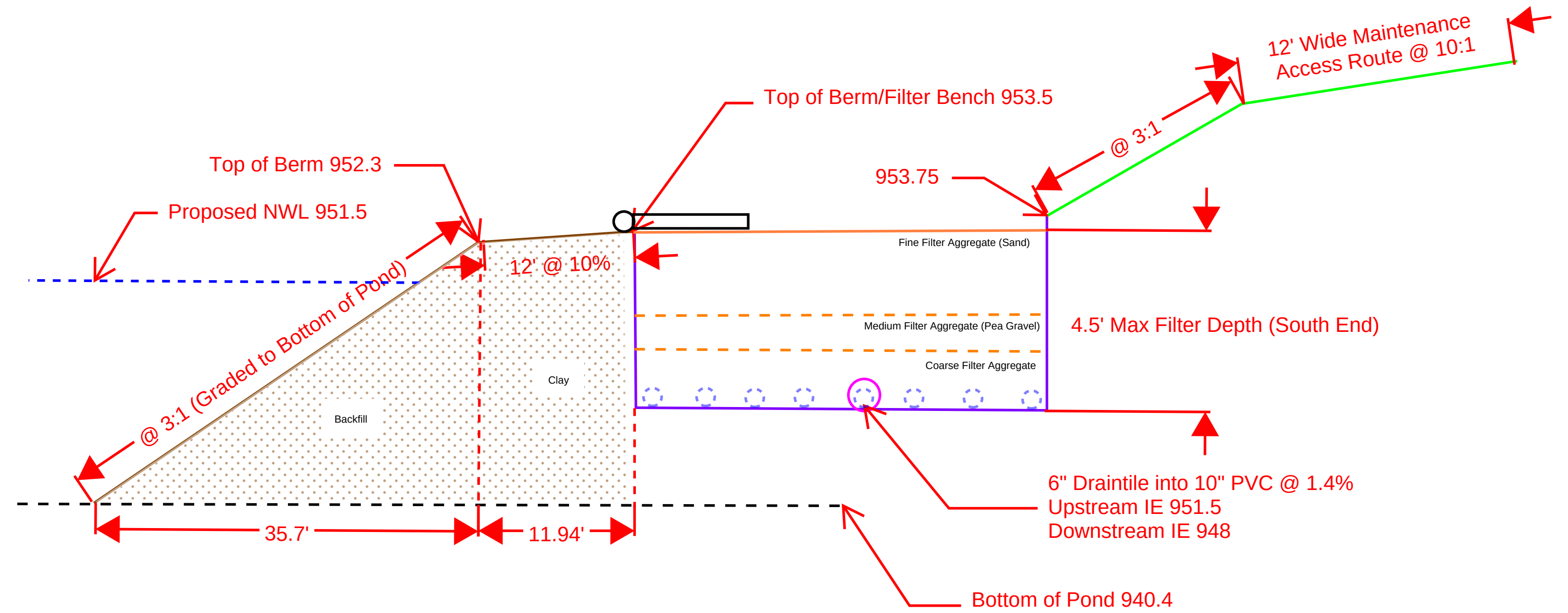
# OPTION 3: Pumped Sand Filter Bench

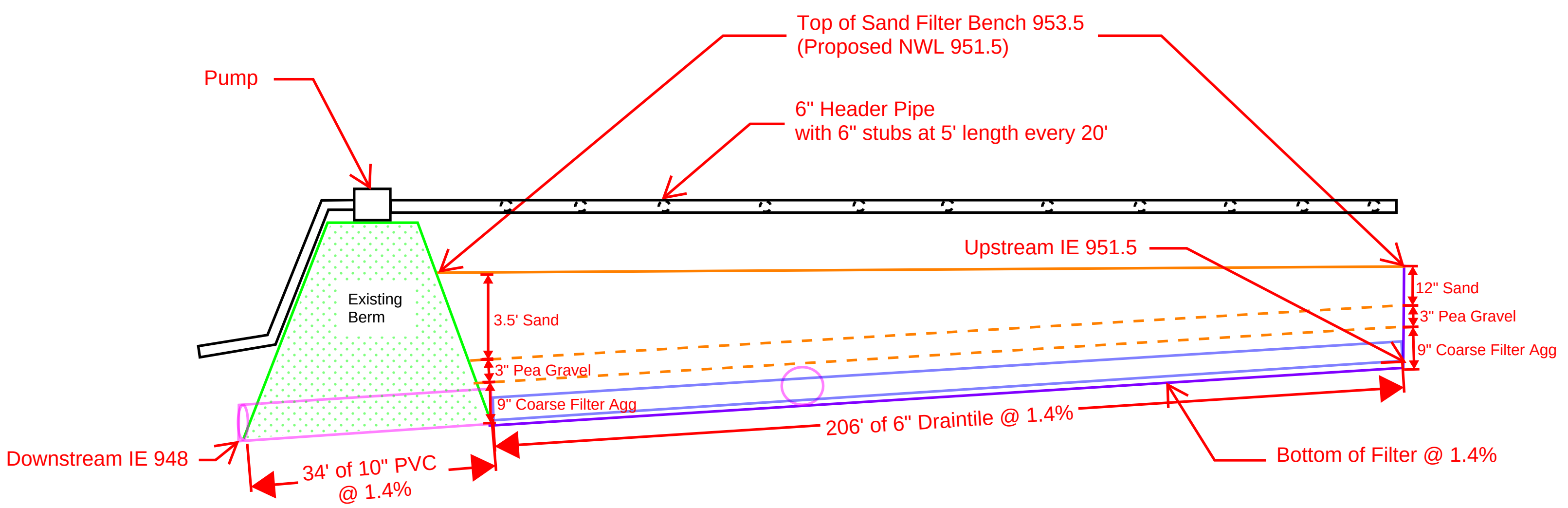
**w/ floater to engage pump at set water elevation**

# &

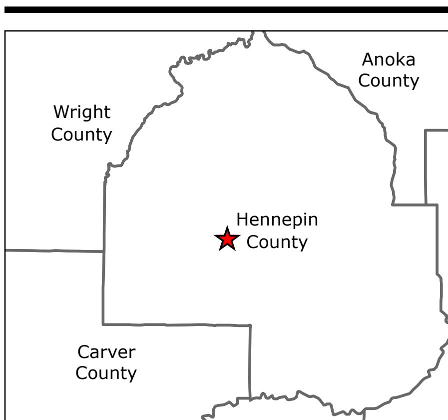
# OPTION 4: Pumped Sand Filter Bench

**w/ real time sensor to engage pump before storm event**



# OPTION 5: Alum Dosing Station


Legend

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- Easement Boundary
- Contours (2ft)
- Hennepin Co. Parcels

0 30 60 Feet

(At original document size of 11x17)
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Stantec

*Project Location*
T118N, R23W, S26
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Prepared by KJM on 2022-04-15

*Client/Project*
Minnehaha Creek Watershed District
CR6 Pond Easement

22770xxxx

*Figure No.*
**1**

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3. Background: 2020 color 7-county

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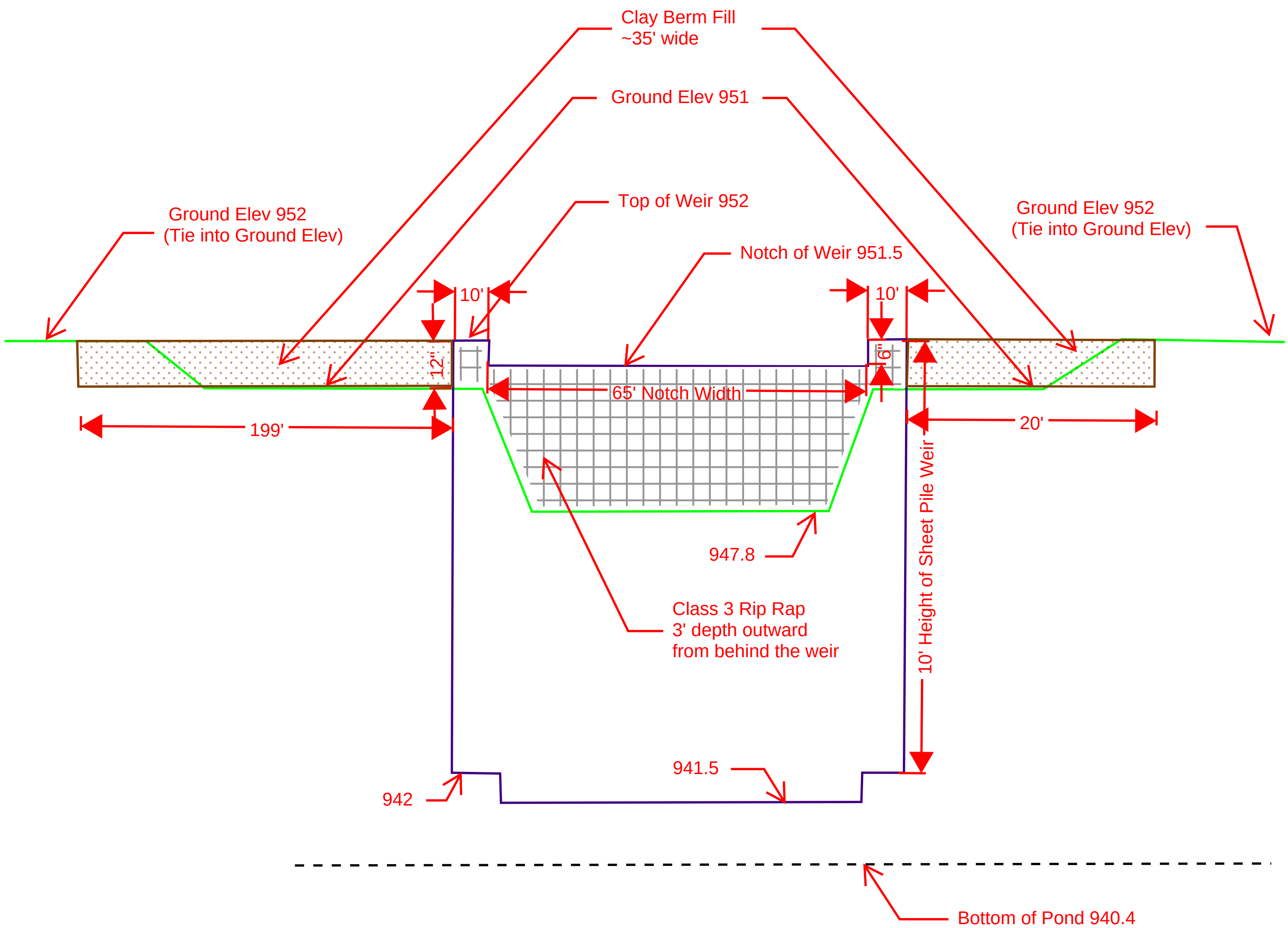
# OPTION 5: Alum Dosing Station



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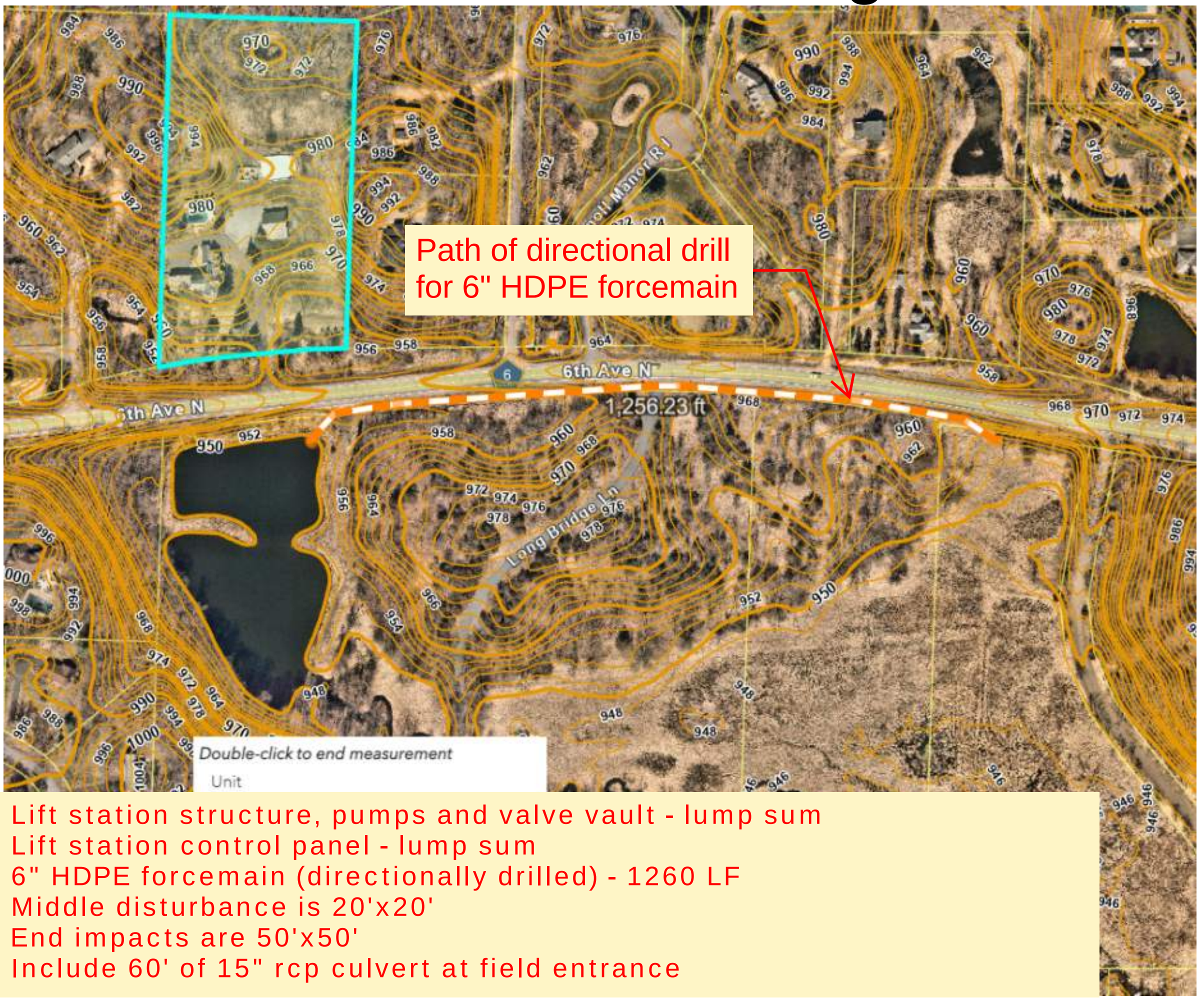
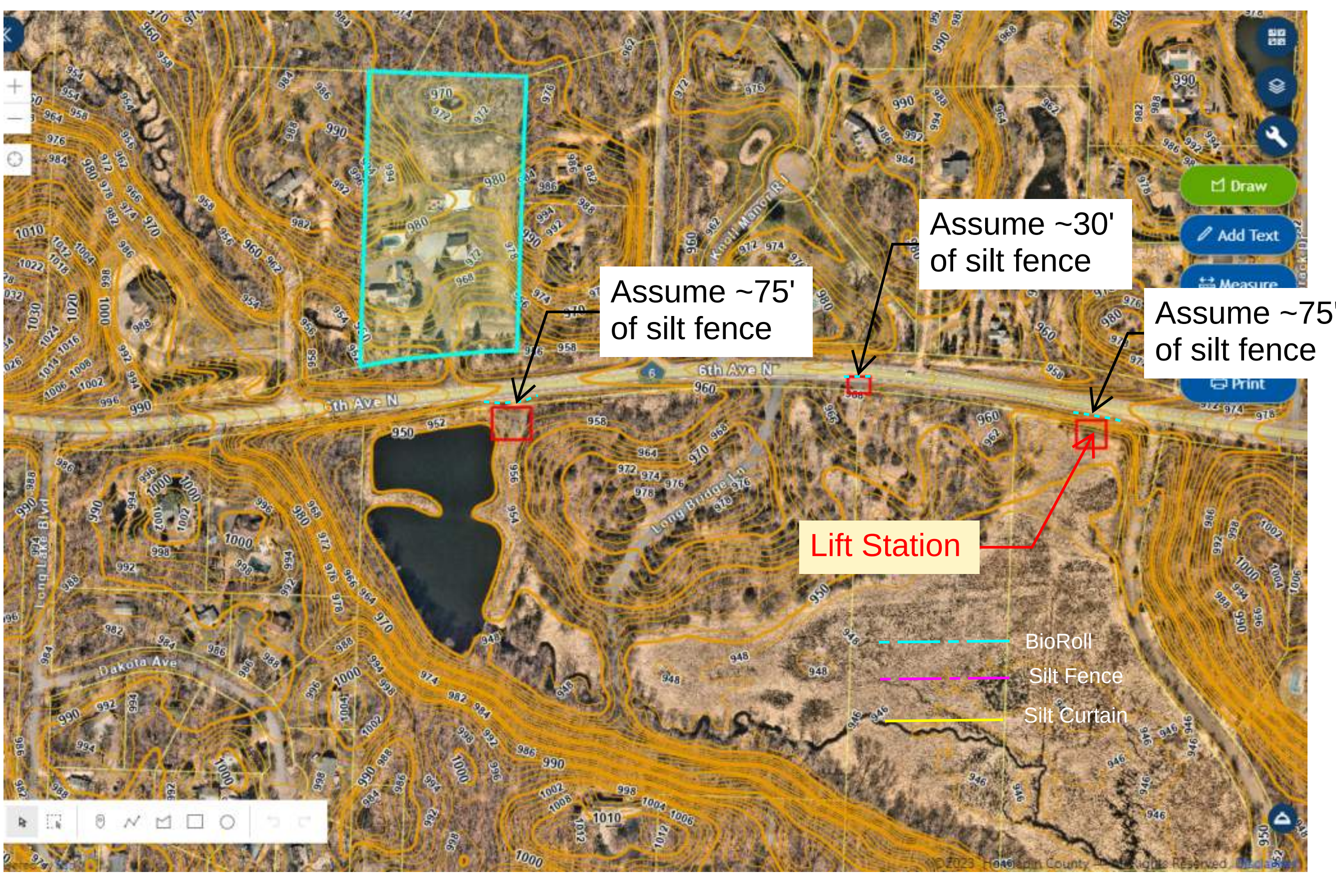



Lift station structure, pumps and valve vault - lump sum
Lift station control panel - lump sum
6" HDPE forcemain (directionally drilled) - 1260 LF
Middle disturbance is 20'x20'
End impacts are 50'x50'
Include 60' of 15" rcp culvert at field entrance



**OPINION OF PROBABLE COST**
**Minnehaha Creek Watershed District (MCWD)**
**County Road 6 Pond - Retrofit Study**
**227706022**
**CONCEPT DESIGN - Gravity Sand Filter Bench**
**June 13th, 2023**

| NO. | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| **BASE BID SCHEDULE** | | | | | |
| 1 | MOBILIZATION | LUMP SUM | 1 | $ 19,000.00 | $ 19,000.00 |
| 2 | TRAFFIC CONTROL | LUMP SUM | 1 | $ 4,000.00 | $ 4,000.00 |
| 3 | CLEARING AND GRUBBING | TREE | 10 | $ 800.00 | $ 8,000.00 |
| 4 | CONSTRUCTION ENTRANCE | LUMP SUM | 1 | $ 5,000.00 | $ 5,000.00 |
| 5 | INLET PROTECTION | EACH | 0 | $ 300.00 | $ - |
| 6 | FLOTATION SILT CURTAIN | LIN FT | 320 | $ 40.00 | $ 12,800.00 |
| 5 | SEDIMENT CONTROL LOG TYPE STRAW (OR BIOROLL) | LIN FT | 910 | $ 5.00 | $ 4,550.00 |
| 7 | SILT FENCE - MAINTAINED | LIN FT | 250 | $ 5.00 | $ 1,250.00 |
| 9 | TEMPORARY SEED MIX (MnDOT 21-111 OATS COVER CROP) | SQ YD | 490 | $ 0.30 | $ 147.00 |
| 10 | PERMANENT SEED MIX (MnDOT 33-261 STORMWATER SOUTHWEST MIX) | SQ YD | 490 | $ 0.50 | $ 245.00 |
| 11 | CATEGORY 3N TYPE 2S EROSION CONTROL BLANKET | SQ YD | 490 | $ 2.00 | $ 980.00 |
| 12 | DEWATERING AND TEMPORARY STORMWATER MANAGEMENT | LUMP SUM | 1 | $ 45,000.00 | $ 45,000.00 |
| 13 | COMMON EXCAVATION AND OFFSITE DISPOSAL (P) (CV) | CU YD | 80 | $ 30.00 | $ 2,400.00 |
| 11 | COMMON EXCAVATION - ONSITE (P) (CV) | CU YD | 1310 | $ 25.00 | $ 32,750.00 |
| 12 | TOPSOIL BORROW (CV) | CU YD | 0 | $ 45.00 | $ - |
| 13 | COMMON BORROW - IMPORT (CV) | CU YD | 2550 | $ 30.00 | $ 76,500.00 |
| 14 | GEOTEXTILE FABRIC TYPE 4 NON-WOVEN | SQ YD | 570 | $ 5.00 | $ 2,850.00 |
| 15 | FINE FILTER AGGREGATE | CU YD | 780 | $ 100.00 | $ 78,000.00 |
| 16 | MEDIUM FILTER AGGREGATE | CU YD | 130 | $ 75.00 | $ 9,750.00 |
| 17 | COARSE AGGREGATE | CU YD | 390 | $ 85.00 | $ 33,150.00 |
| 18 | 6" DRAINTILE | LIN FT | 1340 | $ 30.00 | $ 40,200.00 |
| 19 | 10" PVC PIPE | LIN FT | 120 | $ 60.00 | $ 7,200.00 |
| 20 | 6" PVC CLEANOUT | EACH | 13 | $ 600.00 | $ 7,800.00 |
| 21 | 10" PVC CLEANOUT | EACH | 1 | $ 1,500.00 | $ 1,500.00 |
| | | | | **SUBTOTAL** | $ 393,080.00 |
| | | | | **[30%] CONTINGENCY** | $ 117,930.00 |
| | | | | **TOTAL CONSTRUCTION COST** | $ 511,010.00 |
| | | | | **30% LEGAL, ENGINEERING, ADMIN, FINANCE** | $ 153,310.00 |
| | | | | **TOTAL PROJECT COSTS** | $ 664,320.00 |

**OPINION OF PROBABLE COST**
**Minnehaha Creek Watershed District (MCWD)**
**County Road 6 Pond - Retrofit Study**
**227706022**
**CONCEPT DESIGN - Sheet Pile Weir**
**June 13th, 2023**

| NO. | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| **BASE BID SCHEDULE** | | | | | |
| 1 | MOBILIZATION | LUMP SUM | 1 | $ 27,000.00 | $ 27,000.00 |
| 2 | TRAFFIC CONTROL | LUMP SUM | 1 | $ 6,000.00 | $ 6,000.00 |
| 3 | CLEARING AND GRUBBING | TREE | 3 | $ 800.00 | $ 2,400.00 |
| 4 | CONSTRUCTION ENTRANCE | LUMP SUM | 1 | $ 5,000.00 | $ 5,000.00 |
| 5 | INLET PROTECTION | EACH | 0 | $ 300.00 | $ - |
| 6 | FLOTATION SILT CURTAIN | LIN FT | 290 | $ 40.00 | $ 11,600.00 |
| 5 | SEDIMENT CONTROL LOG TYPE STRAW (OR BIOROLL) | LIN FT | 570 | $ 5.00 | $ 2,850.00 |
| 7 | SILT FENCE - MAINTAINED | LIN FT | 180 | $ 5.00 | $ 900.00 |
| 9 | TEMPORARY SEED MIX (MnDOT 21-111 OATS COVER CROP) | SQ YD | 230 | $ 0.30 | $ 69.00 |
| 10 | PERMANENT SEED MIX (MnDOT 33-261 STORMWATER SOUTHWEST MIX) | SQ YD | 230 | $ 0.50 | $ 115.00 |
| 11 | CATEGORY 3N TYPE 2S EROSION CONTROL BLANKET | SQ YD | 230 | $ 2.00 | $ 460.00 |
| 12 | DEWATERING AND TEMPORARY STORMWATER MANAGEMENT | LUMP SUM | 1 | $ 45,000.00 | $ 45,000.00 |
| 13 | COMMON EXCAVATION AND OFFSITE DISPOSAL (P) (CV) | CU YD | 0 | $ 30.00 | $ - |
| 14 | COMMON BORROW - IMPORT (CV) | CU YD | 0 | $ 30.00 | $ - |
| 15 | SHEET PILE WEIR (304') | SQ FT | 3040 | $ 150.00 | $ 456,000.00 |
| 16 | RANDOM RIPRAP CLASS III | CU YD | 60 | $ 140.00 | $ 8,400.00 |
| | **SUBTOTAL** | | | | $ 565,800.00 |
| | **[30%] CONTINGENCY** | | | | $ 169,740.00 |
| | **TOTAL CONSTRUCTION COST** | | | | $ 735,540.00 |
| | **30% LEGAL, ENGINEERING, ADMIN, FINANCE** | | | | $ 220,670.00 |
| | **TOTAL PROJECT COSTS** | | | | $ 956,210.00 |

**OPINION OF PROBABLE COST**
**Minnehaha Creek Watershed District (MCWD)**
**County Road 6 Pond - Retrofit Study**
**227706022**
**CONCEPT DESIGN - Earthen Berm**
**June 13th, 2023**

| NO. | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| **BASE BID SCHEDULE** | | | | | |
| 1 | MOBILIZATION | LUMP SUM | 1 | $ 25,000.00 | $ 25,000.00 |
| 2 | TRAFFIC CONTROL | LUMP SUM | 1 | $ 5,000.00 | $ 5,000.00 |
| 3 | CLEARING AND GRUBBING | TREE | 3 | $ 800.00 | $ 2,400.00 |
| 4 | CONSTRUCTION ENTRANCE | LUMP SUM | 1 | $ 5,000.00 | $ 5,000.00 |
| 5 | INLET PROTECTION | EACH | 0 | $ 300.00 | $ - |
| 6 | FLOTATION SILT CURTAIN | LIN FT | 290 | $ 40.00 | $ 11,600.00 |
| 5 | SEDIMENT CONTROL LOG TYPE STRAW (OR BIOROLL) | LIN FT | 570 | $ 5.00 | $ 2,850.00 |
| 7 | SILT FENCE - MAINTAINED | LIN FT | 180 | $ 5.00 | $ 900.00 |
| 9 | TEMPORARY SEED MIX (MnDOT 21-111 OATS COVER CROP) | SQ YD | 230 | $ 0.30 | $ 69.00 |
| 10 | PERMANENT SEED MIX (MnDOT 33-261 STORMWATER SOUTHWEST MIX) | SQ YD | 230 | $ 0.50 | $ 115.00 |
| 11 | CATEGORY 3N TYPE 2S EROSION CONTROL BLANKET | SQ YD | 230 | $ 2.00 | $ 460.00 |
| 12 | DEWATERING AND TEMPORARY STORMWATER MANAGEMENT | LUMP SUM | 1 | $ 45,000.00 | $ 45,000.00 |
| 13 | COMMON EXCAVATION AND OFFSITE DISPOSAL (P) (CV) | CU YD | 0 | $ 30.00 | $ - |
| 14 | COMMON EXCAVATION-ONSITE (P) (CV) | CU YD | 0 | $ 25.00 | $ - |
| 15 | COMMON BORROW - IMPORT (CV) | CU YD | 630 | $ 30.00 | $ 18,900.00 |
| 16 | TURF REINFORCEMENT MAT (MNDOT CAT 76, GRASS PAVE 2) | SQ YD | 100 | $ 45.00 | $ 4,500.00 |
| | **SUBTOTAL** | | | | $ 121,800.00 |
| | **[30%] CONTINGENCY** | | | | $ 36,540.00 |
| | **TOTAL CONSTRUCTION COST** | | | | $ 158,340.00 |
| | **30% LEGAL, ENGINEERING, ADMIN, FINANCE** | | | | $ 47,510.00 |
| | **TOTAL PROJECT COSTS** | | | | $ 205,850.00 |

**OPINION OF PROBABLE COST**
**Minnehaha Creek Watershed District (MCWD)**
**County Road 6 Pond - Retrofit Study**
**227706022**
**CONCEPT DESIGN - Pumped Sand Filter Bench w/ and w/o real time sensor**
**June 13th, 2023**

| NO. | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| **BASE BID SCHEDULE** | | | | | |
| 1 | MOBILIZATION | LUMP SUM | 1 | $ 29,000.00 | $ 29,000.00 |
| 2 | TRAFFIC CONTROL | LUMP SUM | 1 | $ 6,000.00 | $ 6,000.00 |
| 3 | CLEARING AND GRUBBING | TREE | 10 | $ 800.00 | $ 8,000.00 |
| 4 | CONSTRUCTION ENTRANCE | LUMP SUM | 1 | $ 5,000.00 | $ 5,000.00 |
| 5 | INLET PROTECTION | EACH | 0 | $ 300.00 | $ - |
| 6 | FLOTATION SILT CURTAIN | LIN FT | 320 | $ 40.00 | $ 12,800.00 |
| 5 | SEDIMENT CONTROL LOG TYPE STRAW (OR BIOROLL) | LIN FT | 910 | $ 5.00 | $ 4,550.00 |
| 7 | SILT FENCE - MAINTAINED | LIN FT | 250 | $ 5.00 | $ 1,250.00 |
| 9 | TEMPORARY SEED MIX (MnDOT 21-111 OATS COVER CROP) | SQ YD | 490 | $ 0.30 | $ 147.00 |
| 10 | PERMANENT SEED MIX (MnDOT 33-261 STORMWATER SOUTHWEST MIX) | SQ YD | 490 | $ 0.50 | $ 245.00 |
| 11 | CATEGORY 3N TYPE 2S EROSION CONTROL BLANKET | SQ YD | 490 | $ 2.00 | $ 980.00 |
| 12 | DEWATERING AND TEMPORARY STORMWATER MANAGEMENT | LUMP SUM | 1 | $ 45,000.00 | $ 45,000.00 |
| 13 | COMMON EXCAVATION AND OFFSITE DISPOSAL (P) (CV) | CU YD | 90 | $ 30.00 | $ 2,700.00 |
| 11 | COMMON EXCAVATION - ONSITE (P) (CV) | CU YD | 1680 | $ 25.00 | $ 42,000.00 |
| 12 | TOPSOIL BORROW (CV) | CU YD | 0 | $ 45.00 | $ - |
| 13 | COMMON BORROW - IMPORT (CV) | CU YD | 2340 | $ 30.00 | $ 70,200.00 |
| 14 | GEOTEXTILE FABRIC TYPE 4 NON-WOVEN | SQ YD | 580 | $ 5.00 | $ 2,900.00 |
| 15 | FINE FILTER AGGREGATE | CU YD | 1170 | $ 100.00 | $ 117,000.00 |
| 16 | MEDIUM FILTER AGGREGATE | CU YD | 130 | $ 75.00 | $ 9,750.00 |
| 17 | COARSE AGGREGATE | CU YD | 390 | $ 85.00 | $ 33,150.00 |
| 18 | 6" DRAINTILE | LIN FT | 1340 | $ 35.00 | $ 46,900.00 |
| 19 | 10" PVC PIPE | LIN FT | 120 | $ 60.00 | $ 7,200.00 |
| 20 | 6" PVC CLEANOUT | EACH | 13 | $ 600.00 | $ 7,800.00 |
| 21 | 10" PVC CLEANOUT | EACH | 1 | $ 1,500.00 | $ 1,500.00 |
| 22 | 6" PVC PIPE | LIN FT | 310 | $ 40.00 | $ 12,400.00 |
| 23 | SUBMERSIBLE PUMP WITH CONTROLS | EACH | 1 | $ 80,000.00 | $ 80,000.00 |
| 24 | ELECTRICAL SERVICE | LIN FT | 500 | $ 100.00 | $ 22,000.00 |
| 25 | PUMP MANHOLE STRUCTURE (5' DIAMETER) | EACH | 1 | $ 30,000.00 | $ 30,000.00 |
| | **SUBTOTAL** | | | | $ 598,480.00 |
| | **[30%] CONTINGENCY** | | | | $ 179,550.00 |
| | **TOTAL CONSTRUCTION COST** | | | | $ 778,030.00 |
| | **30% LEGAL, ENGINEERING, ADMIN, FINANCE** | | | | $ 233,410.00 |
| | **TOTAL PROJECT COSTS** | | | | $ 1,011,440.00 |

| NO. | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| **ALTERNATE BID SCHEDULE** | | | | | |
| A.1 | OPTI RTC SYSTEM | EACH | 1.00 | $ 200,000.00 | $ 200,000.00 |
| | **SUBTOTAL** | | | | $ 200,000.00 |
| | **[30%] CONTINGENCY** | | | | $ 60,000.00 |
| | **TOTAL CONSTRUCTION COST** | | | | $ 260,000.00 |
| | **30% LEGAL, ENGINEERING, ADMIN, FINANCE** | | | | $ 78,000.00 |
| | **TOTAL ALTERNATE BID** | | | | $ 338,000.00 |

| | | |
|---|---|---|
| | **TOTAL BASE + ALTERNATE BID** | $ 1,349,440.00 |

**OPINION OF PROBABLE COST**
**Minnehaha Creek Watershed District (MCWD)**
**County Road 6 Pond - Retrofit Study**
**227706022**
**CONCEPT DESIGN - Alum Dosing w/ Interception of Golf Course Load**
**June 13th, 2023**

| NO. | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| **BASE BID SCHEDULE** | | | | | |
| 1 | MOBILIZATION | LUMP SUM | 1 | $ 102,000.00 | $ 102,000.00 |
| 2 | TRAFFIC CONTROL | LUMP SUM | 1 | $ 21,000.00 | $ 21,000.00 |
| 3 | CLEARING AND GRUBBING | TREE | 3 | $ 800.00 | $ 2,400.00 |
| 4 | CONSTRUCTION ENTRANCE | LUMP SUM | 1 | $ 5,000.00 | $ 5,000.00 |
| 5 | INLET PROTECTION | EACH | 0 | $ 300.00 | $ - |
| 6 | FLOTATION SILT CURTAIN | LIN FT | 290 | $ 40.00 | $ 11,600.00 |
| 5 | SEDIMENT CONTROL LOG TYPE STRAW (OR BIOROLL) | LIN FT | 570 | $ 5.00 | $ 2,850.00 |
| 7 | SILT FENCE - MAINTAINED | LIN FT | 180 | $ 5.00 | $ 900.00 |
| 9 | TEMPORARY SEED MIX (MnDOT 21-111 OATS COVER CROP) | SQ YD | 430 | $ 0.30 | $ 129.00 |
| 10 | PERMANENT SEED MIX (MnDOT 33-261 STORMWATER SOUTHWEST MIX) | SQ YD | 430 | $ 0.50 | $ 215.00 |
| 11 | CATEGORY 3N TYPE 2S EROSION CONTROL BLANKET | SQ YD | 430 | $ 2.00 | $ 860.00 |
| 12 | DEWATERING AND TEMPORARY STORMWATER MANAGEMENT | LUMP SUM | 1 | $ 45,000.00 | $ 45,000.00 |
| 13 | COMMON EXCAVATION AND OFFSITE DISPOSAL (P) (CV) | CU YD | 0 | $ 30.00 | $ - |
| 14 | COMMON BORROW - IMPORT (CV) | CU YD | 430 | $ 30.00 | $ 12,900.00 |
| 15 | SHEET PILE WEIR (75') | SQ FT | 850 | $ 150.00 | $ 127,500.00 |
| 16 | RANDOM RIPRAP CLASS III | CU YD | 30 | $ 140.00 | $ 4,200.00 |
| 17 | ELECTRICAL SERVICE | LIN FT | 220 | $ 100.00 | $ 22,000.00 |
| 18 | LIFT STATION - STRUCTURE, PUMPS, AND VALVE VAULT | LUMP SUM | 1 | $ 160,000.00 | $ 160,000.00 |
| 19 | LIFT STATION CONTROL PANEL | LUMP SUM | 1 | $ 40,000.00 | $ 40,000.00 |
| 20 | 6" HDPE FORCEMAIN (DIRECTIONALLY DIRLLED) | LIN FT | 1260 | $ 65.00 | $ 81,900.00 |
| 21 | 18" CM PIPE CULVERT | LIN FT | 60 | $ 100.00 | $ 6,000.00 |
| 22 | ALUM DOSING FACILITY | LUMP SUM | 1 | $ 1,500,000.00 | $ 1,500,000.00 |
| | **SUBTOTAL** | | | | $ 2,146,460.00 |
| | **[30%] CONTINGENCY** | | | | $ 643,940.00 |
| | **TOTAL CONSTRUCTION COST** | | | | $ 2,790,400.00 |
| | **30% LEGAL, ENGINEERING, ADMIN, FINANCE** | | | | $ 837,120.00 |
| | **TOTAL PROJECT COSTS** | | | | $ 3,627,520.00 |

# Assumptions for All Alternatives

- **Mobilization** was assumed to be 5% of the subtotal, with the subtotal excluding traffic control and mobilization.
- **Traffic Control** was assumed to be 1% of the subtotal because the access road to the site already exists, with the subtotal excluding traffic control and mobilization.
- **Contingency** was assumed to be 30% of the subtotal, with the subtotal including traffic control and mobilization.
- **Legal, Engineering, Admin & Finance** were lumped together and assumed to be 30% of the subtotal, with the subtotal including traffic control, mobilization, and contingency.
- **Clearing and Grubbing** was estimated based on the number of trees to be removed for access and construction. Aerial imagery and Google Earth were used to roughly estimate the number of trees to be removed. The number of trees to be removed varies across alternatives.
- **Dewatering** was assumed to be able to construct within the pond and the lump sum cost was based on dewatering for similar ponds. Extent or purpose of dewatering is variable across alternatives but a constant value was assumed.

# 1) Gravity Filter Sand Bench

- **Erosion Control**
  - One construction entrance was assumed at the site entrance to prevent track out. The lump sum cost was based on construction entrances for similar projects.
  - Inlet protection was not included in the cost estimate because no catch basins were seen in the aerial imagery along County Rd 6 near the site.
  - One row of silt curtain was assumed to be installed along the berm that borders the filter.
  - Two rows of bio roll along the access road to protect the water body and one row of bio roll the perimeter of the filter along the bank. It was assumed two rows of bio roll were required to protect the water body.
  - Two rows of silt fence were assumed to be installed along the south end of the filter, extending from the edge of the pond to the easement boundary. It was assumed two rows of silt fence were required to protect the water body.
- **Restoration**
  - Temporary and permanent seed were assumed to cover the access road and the excavation limits of the outlet pipe south of the filter. Erosion control blanket was also assumed to cover these areas.
- **Excavation**
  - Total excavation volume was calculated from the filter volume excavated from the bank and the volume excavated to install the outlet pipe south of the filter. No contamination was assumed.
  - The backfill required onsite was assumed to be the backfill required to construct the berm bordering the filter. The excavated backfill volume to be disposed off-site was calculated from the difference between the excavation volume and the backfill required onsite.

    - The common borrow volume was calculated from the clay required to construct the berm bordering the filter and the clay required to fill the shelf underneath the filter. The shelf was assumed to be necessary because the filter will extend outward into the pond but does not extend to the bottom of the pond.
- **Filter**
    - Assuming the bottom of the filter will be sloped at 0.5%, the depth of fine aggregate in the filter would range from 1 ft to 2 ft. To calculate the volume of fine aggregate required, the filter footprint area of 14,000 sf was multiplied by an average fine aggregate depth of 1.5 ft. To calculate the volume of medium aggregate and the volume of coarse aggregate required, the filter footprint area was multiplied by the medium aggregate depth of 0.25 ft and the coarse aggregate depth of 0.75 ft, respectively.
    - Geotextile fabric was assumed to cover the bottom of the filter, assumed to be 14,000 sf, and the sides of the filter, assumed to be an average of total depth of 2.5 ft around a 508 ft perimeter.
- **Pipes**
    - 6 in PVC drain tile was assumed to run north to south along the filter footprint. Each run was spaced approximately 10 ft apart. A 6 in PVC cleanout was assumed to be installed at the upstream end of every pipe run and spaced every 100 ft from the downstream end for pipes greater than 150 ft long.
    - One 10 in PVC cross pipe was assumed across the maximum width of the filter, plus an additional 10 in PVC pipe as an outlet pipe. The outlet pipe was assumed to extend from the south end of the filter to the stream. One 10 in PVC cleanout was assumed to be installed at the upstream end of the 10 in cross pipe.
- **Operations & Maintenance**
    - Filter media was assumed to be replaced once every 10 years. The cost of replacement was estimated to be $200,000 based on filter media replacement for similar projects.

# 2a) Sheet Pile Weir Across the Existing Berm

- **Erosion Control**
    - One construction entrance was assumed at the site entrance to prevent track out. The lump sum cost was based on construction entrances for similar projects.
    - Inlet protection was not included in the cost estimate because no catch basins were seen in the aerial imagery along County Rd 6 near the site.
    - One row of silt curtain was assumed to be installed along the south side of the existing berm.
    - Two rows of bio roll were assumed to be installed along the access road and two rows of bio roll were assumed to be installed along south side of the eastern end of the existing berm. It was assumed two rows of bio roll were required to protect the water body.
    - Two rows of silt fence were assumed to be installed along the north and south side of the western end of the existing berm. It was assumed two rows of silt fence were required to protect the water body.
- **Restoration**
    - Temporary and permanent seed were assumed to cover the access road. Erosion control blanket was also assumed to cover these areas.

- **Excavation**
  - Total excavation volume was assumed to be zero because it was assumed that no additional excavation would be needed to construct the weir.
  - The common and topsoil borrow volumes were assumed to be zero because it was assumed that the sheet pile weir would extend across the entire length of the berm.
- **Weir**
  - Sheet pile was assumed to extend an average of 10 ft down across the entire length of the berm.
  - Rip rap was assumed to fill 3' outward from the south side of the sheet pile weir across the entire length of the sheet pile. The area of the sheet pile weir covered by rip rap was assumed to the area of the sheet pile weir exposed above ground.
- **Operations & Maintenance**
  - No operations and maintenance costs were assumed.

# 2b) Earthen Embankment

- **Erosion Control**
  - One construction entrance was assumed at the site entrance to prevent track out. The lump sum cost was based on construction entrances for similar projects.
  - Inlet protection was not included in the cost estimate because no catch basins were seen in the aerial imagery along County Rd 6 near the site.
  - One row of silt curtain was assumed to be installed along the south side of the existing berm.
  - Two rows of bio roll were assumed to be installed along the access road and two rows of bio roll were assumed to be installed along south side of the eastern end of the existing berm. It was assumed two rows of bio roll were required to protect the water body.
  - Two rows of silt fence were assumed to be installed along the north and south side of the western end of the existing berm. It was assumed two rows of silt fence were required to protect the water body.
- **Restoration**
  - Temporary and permanent seed were assumed to cover the access road. Erosion control blanket was also assumed to cover these areas.
- **Excavation**
  - Total excavation volume was assumed to be zero because it was assumed that no additional excavation would be needed to construct the earthen embankment.
  - The topsoil borrow volume was assumed to zero because it was assumed that the earthen embankment would be constructed entirely of common borrow.
- **Earthen Embankment**
  - Common borrow was assumed to fill from the existing ground elevation to the proposed top of embankment elevation. The common borrow fill was assumed to be an average width of 35 ft, based on the average width of the existing berm, and extend along the entire length of the existing berm.
  - Turf reinforcement mat was assumed across the notch of the earthen embankment, plus an additional 5 ft at each end of the notch. The width of the turf reinforcement mat was assumed to match the 35 ft average width of the existing berm.

- **Operations & Maintenance**
  - No operations and maintenance costs were assumed.

## 3) Pump and Filter

- **Erosion Control**
  - One construction entrance was assumed at the site entrance to prevent track out. The lump sum cost was based on construction entrances for similar projects.
  - Inlet protection was not included in the cost estimate because no catch basins were seen in the aerial imagery along County Rd 6 near the site.
  - One row of silt curtain was assumed to be installed along the berm that borders the filter.
  - Two rows of bio roll along the access road to protect the water body and one row of bio roll the perimeter of the filter along the bank. It was assumed two rows of bio roll were required to protect the water body.
  - Two rows of silt fence were assumed to be installed along the south end of the filter, extending from the edge of the pond to the easement boundary. It was assumed two rows of silt fence were required to protect the water body.
- **Restoration**
  - Temporary and permanent seed were assumed to cover the access road and the excavation limits of the outlet pipe south of the filter. Erosion control blanket was also assumed to cover these areas.
- **Excavation**
  - Temporary and permanent seed were assumed to cover the access road and the excavation limits of the outlet pipe south of the filter. Erosion control blanket was also assumed to cover these areas.
  - The backfill required onsite was assumed to be the backfill required to construct the berm bordering the filter. The excavated backfill volume to be disposed off-site was calculated from the difference between the excavation volume and the backfill required onsite.
  - The common borrow volume was calculated from the clay required to construct the berm bordering the filter and the clay required to fill the shelf underneath the filter. The shelf was assumed to be necessary because the filter will extend outward into the pond but does not extend to the bottom of the pond.
- **Filter**
  - Assuming the bottom of the filter will be sloped at 1.4%, the depth of fine aggregate in the filter would range from 1 ft to 3.5 ft. To calculate the volume of fine aggregate required, the filter footprint area of 14,000 sf was multiplied by an average fine aggregate depth of 2.25 ft. To calculate the volume of medium aggregate and the volume of coarse aggregate required, the filter footprint area was multiplied by the medium aggregate depth of 0.25 ft and the coarse aggregate depth of 0.75 ft, respectively.

- Geotextile fabric was assumed to cover the bottom of the filter, assumed to be 14,000 sf, and the sides of the filter, assumed to be an average of total depth of 3.25 ft around a 508 ft perimeter.

- **Pipes**
    - 6 in PVC drain tile was assumed to run north to south along the filter footprint. Each run was spaced approximately 10 ft apart. A 6 in PVC cleanout was assumed to be installed at the upstream end of every pipe run and spaced every 100 ft from the downstream end for pipes greater than 150 ft long.
    - One 10 in PVC cross pipe was assumed across the maximum width of the filter, plus an additional 10 in PVC pipe as an outlet pipe. The outlet pipe was assumed to extend from the south end of the filter to the stream. One 10 in PVC cleanout was assumed to be installed at the upstream end of the 10 in cross pipe.
- **Pump System**
    - The cost for a submersible pump with controls was based on pump costs for similar projects.
    - The manhole structure for the pump was assumed to be 5 ft diameter.
    - The electrical service was assumed to run from the access road entrance, along the access road, and connect to the pump, located at the berm north of the filter.
    - It was assumed one main 6 in PVC header pipe would extend from the pump to the south end of the filter. It was assumed 6 in diameter, 5 ft long stubs would be placed every 20 ft along the main header pipe. The inlet pipe for the pump to draw water from the pond was assumed to be 6 in PVC with a length of 40 ft.
- **Operations & Maintenance**
    - Filter media was assumed to be replaced once every 10 years. The cost of replacement was estimated to be $200,000 based on filter media replacement for similar projects.
    - Pump was assumed to be replaced every 10 years. The cost of replacement was estimated to be $100,000 based on pump replacement for similar projects.

# 4) Pump and Filter with Real Time Sensor

- **Erosion Control**
    - One construction entrance was assumed at the site entrance to prevent track out. The lump sum cost was based on construction entrances for similar projects.
    - Inlet protection was not included in the cost estimate because no catch basins were seen in the aerial imagery along County Rd 6 near the site.
    - One row of silt curtain was assumed to be installed along the berm that borders the filter.
    - Two rows of bio roll along the access road to protect the water body and one row of bio roll the perimeter of the filter along the bank. It was assumed two rows of bio roll were required to protect the water body.
    - Two rows of silt fence were assumed to be installed along the south end of the filter, extending from the edge of the pond to the easement boundary. It was assumed two rows of silt fence were required to protect the water body.

- **Restoration**
    - Temporary and permanent seed were assumed to cover the access road and the excavation limits of the outlet pipe south of the filter. Erosion control blanket was also assumed to cover these areas.
- **Excavation**
    - Temporary and permanent seed were assumed to cover the access road and the excavation limits of the outlet pipe south of the filter. Erosion control blanket was also assumed to cover these areas.
    - The backfill required onsite was assumed to be the backfill required to construct the berm bordering the filter. The excavated backfill volume to be disposed off-site was calculated from the difference between the excavation volume and the backfill required onsite.
    - The common borrow volume was calculated from the clay required to construct the berm bordering the filter and the clay required to fill the shelf underneath the filter. The shelf was assumed to be necessary because the filter will extend outward into the pond but does not extend to the bottom of the pond.
- **Filter**
    - Assuming the bottom of the filter will be sloped at 1.4%, the depth of fine aggregate in the filter would range from 1 ft to 3.5 ft. To calculate the volume of fine aggregate required, the filter footprint area of 14,000 sf was multiplied by an average fine aggregate depth of 2.25 ft. To calculate the volume of medium aggregate and the volume of coarse aggregate required, the filter footprint area was multiplied by the medium aggregate depth of 0.25 ft and the coarse aggregate depth of 0.75 ft, respectively.
    - Geotextile fabric was assumed to cover the bottom of the filter, assumed to be 14,000 sf, and the sides of the filter, assumed to be an average of total depth of 3.25 ft around a 508 ft perimeter.
- **Pipes**
    - 6 in PVC drain tile was assumed to run north to south along the filter footprint. Each run was spaced approximately 10 ft apart. A 6 in PVC cleanout was assumed to be installed at the upstream end of every pipe run and spaced every 100 ft from the downstream end for pipes greater than 150 ft long.
    - One 10 in PVC cross pipe was assumed across the maximum width of the filter, plus an additional 10 in PVC pipe as an outlet pipe. The outlet pipe was assumed to extend from the south end of the filter to the stream. One 10 in PVC cleanout was assumed to be installed at the upstream end of the 10 in cross pipe.
- **Pump System**
    - The cost for a submersible pump with controls was based on pump costs for similar projects. An additional cost of $200,000 was assumed for the real time sensor, such as an OptiRTC system.
    - The manhole structure for the pump was assumed to be 5 ft diameter.
    - The electrical service was assumed to run from the access road entrance, along the access road, and connect to the pump, located at the berm north of the filter.

- It was assumed one main 6 in PVC header pipe would extend from the pump to the south end of the filter. It was assumed 6 in diameter, 5 ft long stubs would be placed every 20 ft along the main header pipe. The inlet pipe for the pump to draw water from the pond was assumed to be 6 in PVC with a length of 40 ft.

- **Operations & Maintenance**
  - Filter media was assumed to be replaced once every 10 years. The cost of replacement was estimated to be $200,000 based on filter media replacement for similar projects.
  - Pump was assumed to be replaced every 10 years. The cost of replacement was estimated to be $100,000 based on pump replacement for similar projects. Real time sensor, such as OptiRTC, maintenance was assumed to occur every 10 years at a cost of $30,000.

# 5) Alum Dosing Facility

- **Erosion Control**
  - One construction entrance was assumed at the site entrance to prevent track out. The lump sum cost was based on construction entrances for similar projects.
  - Inlet protection was not included in the cost estimate because no catch basins were seen in the aerial imagery along County Rd 6 near the site.
  - One row of silt curtain was assumed to be installed along the south side of the existing berm.
  - Two rows of bio roll were assumed to be installed along the access road and two rows of bio roll were assumed to be installed along south side of the eastern end of the existing berm. It was assumed two rows of bio roll were required to protect the water body. One row of bio roll was assumed to be installed on the down gradient side of each drilling disturbance area.
  - Two rows of silt fence were assumed to be installed along the north and south side of the western end of the existing berm. It was assumed two rows of silt fence were required to protect the water body.
- **Restoration**
  - Temporary and permanent seed were assumed to cover the access road, as well as the one middle and two end drilling disturbances. The middle drill disturbance was assumed to be 20 ft by 20 ft and the two end disturbances were assumed to be 50 ft by 50 ft each. Erosion control blanket was also assumed to cover these areas.
- **Excavation**
  - Total excavation volume was assumed to be zero because it was assumed that no additional excavation would be needed to construct the earthen embankment.
  - The topsoil borrow volume was assumed to zero because it was assumed that the earthen portion of weird would be constructed entirely of common borrow.
- **Weir**
  - Sheet pile was assumed to extend an average of 10 ft down across the notch of the weir, plus an additional 5 ft at each end of the notch.
  - Common borrow was assumed to fill from the existing ground elevation to the proposed top of embankment elevation. The common borrow fill was assumed to be an average width of 35 ft, based on the average width of the existing berm, and extend from each

  - end of the sheet pile notch to the western and eastern ends of the existing berm, respectively.
  - Rip rap was assumed to fill 3' outward from the south side of the sheet pile notch across the length of the sheet pile notch. The area of the sheet pile notch covered by rip rap was assumed to the area of the sheet pile notch exposed above ground.
- **Lift Station & Force Main**
  - The assumed cost for the lift station cost included the cost of the structure, pumps and valve vault. The lump sum cost was based on lift station costs for similar projects.
  - The lift station control panel was considered separately. The lump sum cost was based on lift station control panel costs for similar projects.
  - Force main connecting the lift station to the pond was assumed to run from the lift station to the northeast corner of the pond, a total distance of 1,260 ft. Force main was assumed to be 6 in HDPE and directionally drilled.
  - One 18 in corrugated metal pipe culvert was assumed to be installed under the entrance to the access road. The culvert was assumed to be 60 ft long based on the 1997 plan set.
- **Alum Dosing Facility**
  - The electrical service was assumed to run from the access road entrance, along the access road, and to the alum dosing facility, located at the eastern end of the berm.
  - The assumed cost of the alum dosing facility included the cost of the structure and all internal components. The lump sum cost was based on a similar 1997 project, Tanners Lake Alum Treatment Facility. The costs from the 1997 project were projected to present-day costs.
- **Operations & Maintenance**
  - Maintenance costs for the alum dosing facility was assumed to be $30,000 each year based on the present-day maintenance costs for the Tanners Lake Alum Treatment Facility.
  - Pump was assumed to be replaced every 10 years. The cost of replacement was estimated to be $60,000 based on pump replacement for similar projects.