Fargo, ND | HEI No. 9311_0001
November 15, 2022

STURGEON LAKE HIGH WATER OUTLET INVESTIGATION ENGINEER'S CONCEPTUAL REPORT

Windemere Township, Pine County, MN

Sturgeon Lake High Water Outlet Investigation

ENGINEER'S CONCEPTUAL SUMMARY REPORT

November 15, 2022

Windemere Township

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Randy G. Engelstad
Registration No. 48967

11/15/2022
Date

Houston Engineering, Inc.
1401 21st Ave. N
Fargo, ND 58102
Phone # 701.237.5065

TABLE OF CONTENTS

FIGURES

1 INTRODUCTION

1.1 BACKGROUND

Sturgeon Lake (ID# 58-0067-00) is located in Windemere Township near the community of Sturgeon Lake in northern Pine County, Minnesota (**Figure 1**). The lake is part of the Kettle River watershed and has a surface area of approximately 2.6 square miles (1,700 acres), 9.5 miles of shoreline, and has a mean depth of 22 feet with a maximum depth of 40 feet. There are approximately 322 individual parcels of property with shoreline on the lake, including two commercial resorts and a YMCA camp.

Sturgeon Lake is a closed basin lake with no natural outlet and properties around the lake have been prone to flooding when water levels in the lake are at or above the Ordinary High Water Level (OHWL) of 1069.1 feet (NGVD 29 vertical datum). Water levels in the lake have fluctuated approximately five feet over the past 77 years according to records maintained by the Minnesota Department of Natural Resources (DNR). The DNR's highest recorded water surface elevation of 1070.84 feet (NGVD 29) was reported in October of 2019, with the lowest water surface elevation of 1066.07 feet (NGVD 29) reported in September of 1967. As of September 10, 2022, Sturgeon Lake's water surface elevation was at elevation 1069.21 (NGVD 29), which is slightly above the OHWL.

Historical documentation indicates that various entities have pursued solutions for addressing the periodic flooding around Sturgeon Lake over the years, including a proposal in the 1950s to outlet the lake into the Willow River, and a cursory analysis completed by the United States Department of Agriculture in 1974 that looked at multiple surface outlets. Neither of those efforts, or any subsequent attempts to implement a permanent solution to the problem, have been successful. As water levels in the lake rose in 2019, a large number of property owners approached the Windemere Township Lakes Association (WTLA) and expressed concerns about increased damages to property as a result of the high water levels. The WTLA formed an ad hoc committee to investigate the situation and provide recommendations to the WTLA for a course of action moving forward. The Sturgeon Lake High-Water Committee submitted a report in December of 2019 that documented the past history of the high water issue, the damages that had been identified by current property owners, and climatic information. The report concluded with a recommendation that the Windemere Township Board of Supervisors and the Pine County Board of Commissioners proceed with an engineering study that would investigate potential future water levels, potential future infrastructure and personal property damage, and mitigation strategies and plans to address those concerns.

In 2021, Houston Engineering, Inc. (HEI) had a series of informal discussions with representatives from Windemere Township and the WTLA regarding the situation at Sturgeon Lake and HEI's extensive experience addressing similar challenges on other closed basin lakes throughout Minnesota and the Upper Midwest. In 2022, Windemere Township, with financial support provided by Pine County, initiated a feasibility study to identify potential solutions to mitigate the damages caused by high water levels on Sturgeon Lake. Windemere Township hired HEI in May of 2022 to complete the feasibility study.

1.1.1 SCOPE

The scope of the feasibility study covers a preliminary review of potential solutions to the high water levels on Sturgeon Lake. This includes a cursory review of the estimated flows in and out of the lake to estimate the magnitude of the outlet capacity needed to address the problem along with scenarios covering a range of drawdown periods. The scope also includes a preliminary analysis of multiple outlet routes and concepts, including considerations for gravity and pumped discharges, and filtration options that will address DNR requirements for transferring water from lakes infested with aquatic invasive species (AIS). The preliminary study also addresses permitting and regulatory requirements, right of way needs, potential project costs, and potential limitations associated with downstream waterways being able to accept additional water. It is assumed that any solution would be designed to artificially lower the water surface elevation down to the OHWL elevation of 1069.1 feet (NGVD 29) and maintain the elevation at that elevation unless water levels naturally drop to lower elevations.

Given the limited budget allocated toward the feasibility study, Windemere Township has acknowledged that the scope is very preliminary in nature and does not involve a high level of detail and is intended to provide stakeholders with initial information to help guide discussions on future actions that will ultimately provide more detailed information and results. It is also understood that the preliminary study is largely based on the analysis of information that is available in the public domain, such as aerial imagery, LiDAR topography, wetland maps, soil information, DNR supplied information, etc., with a limited amount of on-site work completed. Furthermore, Windemere Township understands that HEI has completed the study using sound engineering judgement and prior experience on similar projects to develop the recommendations included in this report. It is also assumed that all necessary permits, regulatory approvals, and right of way can be acquired.

1.1.2 GOALS

The goals associated with the preliminary Sturgeon Lake outlet feasibility study include potential solutions that address the following:

a) provide an artificial outlet for Sturgeon Lake that will allow stakeholders to manage water surface levels at the OHWL.
b) improve lake shore land management.
c) reduce lake shore erosion.
d) reduce damages to public and private property around the lake
e) protect fish, wildlife, and vegetative habitats

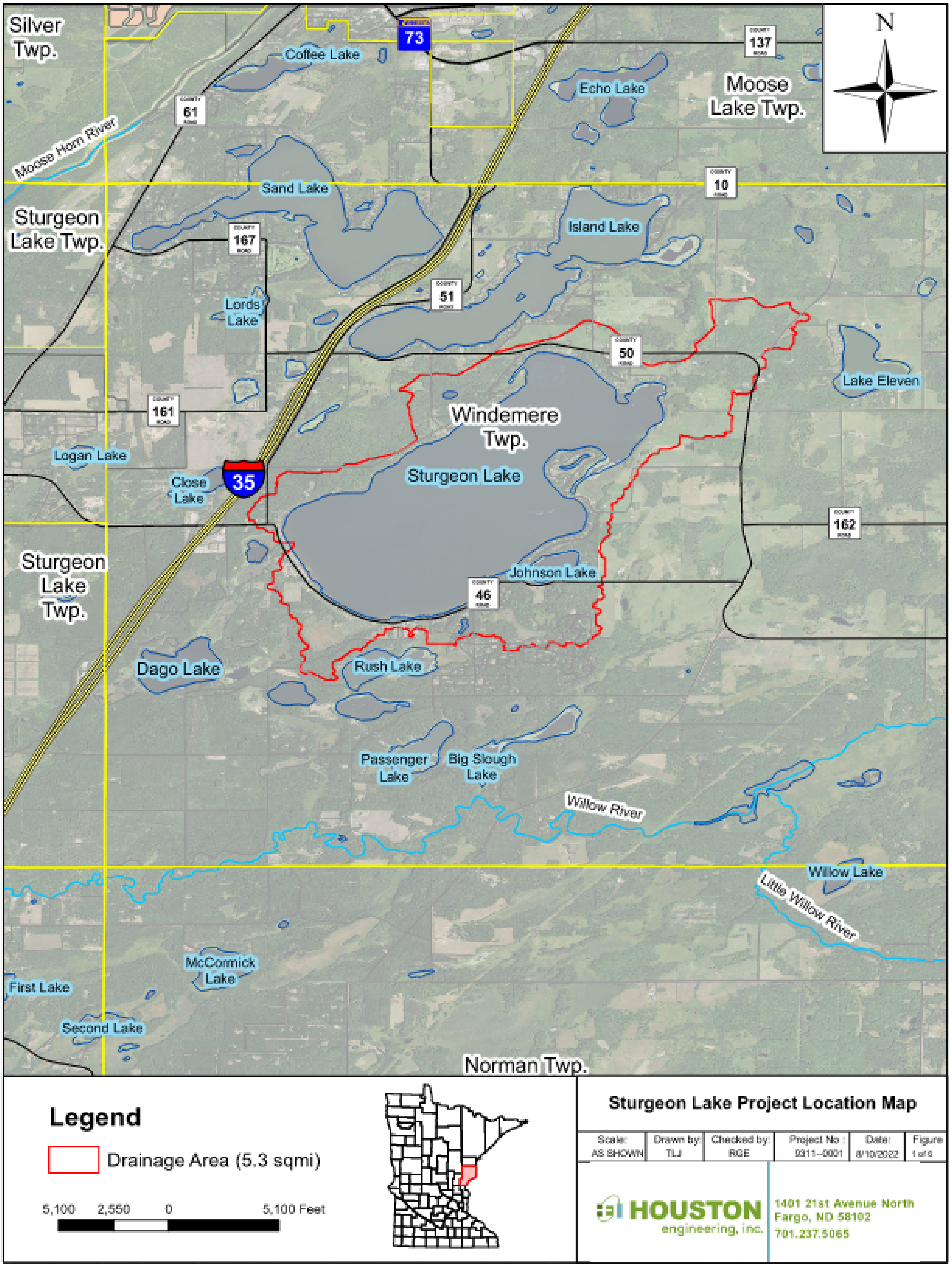

Figure 1 - Sturgeon Lake Site Location and Drainage Area

2 EXISTING CONDITIONS

2.1 HYDROLOGIC AND HYDRAULIC DATA

Sturgeon Lake has a water surface area of approximately 1,700 acres (2.6 square miles) with a total contributing drainage area of 5.3 square miles (including the surface area of the lake), as shown in Figure 1. Since a natural outlet does not exist for Sturgeon Lake, the water surface elevation (WSE) of the lake is driven by precipitation, groundwater movement, evaporation, and evapotranspiration. During the more recent wet hydrologic period, inflows from runoff and groundwater have exceeded the outflows and have caused Sturgeon Lake's WSE to rise, as described in more detail below. As of September 10, 2022, DNR records show that the WSE of Sturgeon Lake is 1069.21 feet (NGVD 29).

2.1.1 HYDROLOGIC CONDITIONS

2.1.1.1 PRECIPITATION

Per the DNR's Climatology Office, the annual normal precipitation (1991-2020) for the Sturgeon Lake drainage area is approximately 32 inches (**Figure 2**). Comparing this data to similar data from the 1981-2010 time period indicates that the long-term trend shows an increase in precipitation. With reference to the Sturgeon Lake High-Water Committee's December 2019 report, the Committee noted that the DNR's precipitation records appear to reflect a strong correlation between annual precipitation and water levels on Sturgeon Lake.

2.1.1.2 RUNOFF

While the estimated annual precipitation discussed above is directly relevant to the surface area of the lake where each inch of precipitation that falls over the lake translates to a one-inch increase in the WSE (at least temporarily), the lake does not see a corresponding 1:1 increase in WSE from precipitation that falls elsewhere in the contributing watershed area. An estimation of the amount of precipitation that reaches the lake in the form of runoff can be made by referencing generalized mean annual runoff values included in the USGS' guidance document tiled *Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005*. The generalized mean annual runoff values found in that document are shown in Figure 3 of this report. With reference to Figure 3, the generalized mean annual runoff for the Sturgeon Lake watershed is approximately 10 inches. As indicated by the title of the USGS's guidance document, the generalized mean annual runoff values are reflective of data collected through 2005. The USGS has not provided updated guidance based on the current period of record, and the DNR's Climatology Office does not have more recent data or guidance on this topic. Due to the increasing trend in precipitation noted above, it appears likely that future updates to the mean annual runoff values will show a similar increase. With the assumption that current site conditions (i.e., soil type, soil retention) reflect similar conditions to those found in 2005, a simple model was developed using the most recent annual precipitation data. Model simulations suggest that 32 inches of annual precipitation over Sturgeon Lake's contributing drainage area can generate 10.66 inches of annual runoff. This is a conservative approach considering that annual precipitation increased by 3.2% while annual runoff increased by 6.6%. For the purposes of this analysis, the generalized mean annual runoff was increased to 10.66 inches to correlate with the increase of annual precipitation recognized between 2010 and 2020.

Related to runoff, a cursory review of land use around Sturgeon Lake was done to determine whether land use changes, specifically development, around the lake and within the watershed area have had a significant impact on runoff and water levels in the lake. After adjusting the land use parameters in the model to compare pre-development conditions to current land use around the perimeter of the lake, it was determined that development around the lake had a minimal impact on the runoff to the lake.

2.1.1.3 EVAPORATION

According to a study conducted by the University of Minnesota: *Lake Level Response to Climate in Minnesota*, it can reasonably be concluded that the volume of water lost to evaporation over the surface of a lake in Minnesota, including Sturgeon Lake, will usually be greater than the volume of water added to the lake due to precipitation falling directly onto the surface of the lake over a given year.

2.1.1.4 GROUNDWATER

This study included a cursory look at potential groundwater flows, but this was done without the aid of soil testing, groundwater monitoring or modeling. Without detailed data on the sediment composition of the entire bottom of the lake, or hydraulic conductivity rates of the lake bottom or the surrounding groundwater system, it was assumed that approximately half the lake bottom consists of sand and gravel soil types with a relatively high rate of conductivity that allows for efficient flow of groundwater, and the other half being a clay bottom with low conductivity. Given these assumptions and simple estimates for hydraulic conductivity, it was estimated that up to 1 cfs of groundwater would flow into the lake through the bottom sediments as an artificial outlet lowered the surface level of the lake. This rate would vary depending on the discharge rate, the rate of drop in the water surface elevations, the length of pumping, and other factors, but it provides a general estimate when accounting for groundwater inflows.

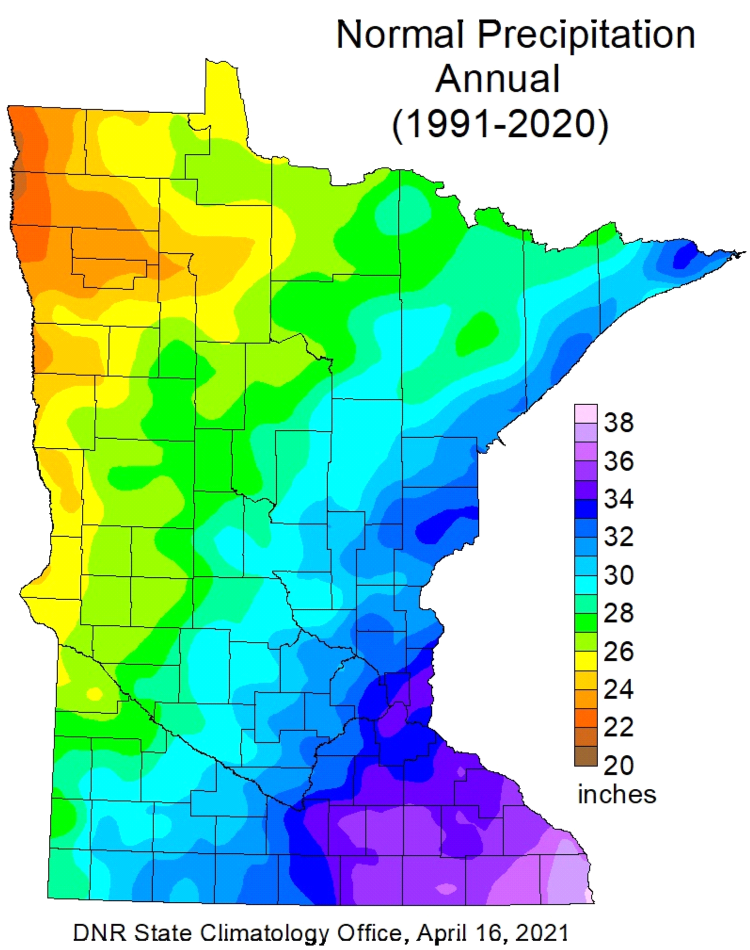

Figure 2 - Annual Normal Precipitation (1991-2020) (MnDNR State Climatology Office, 2021)

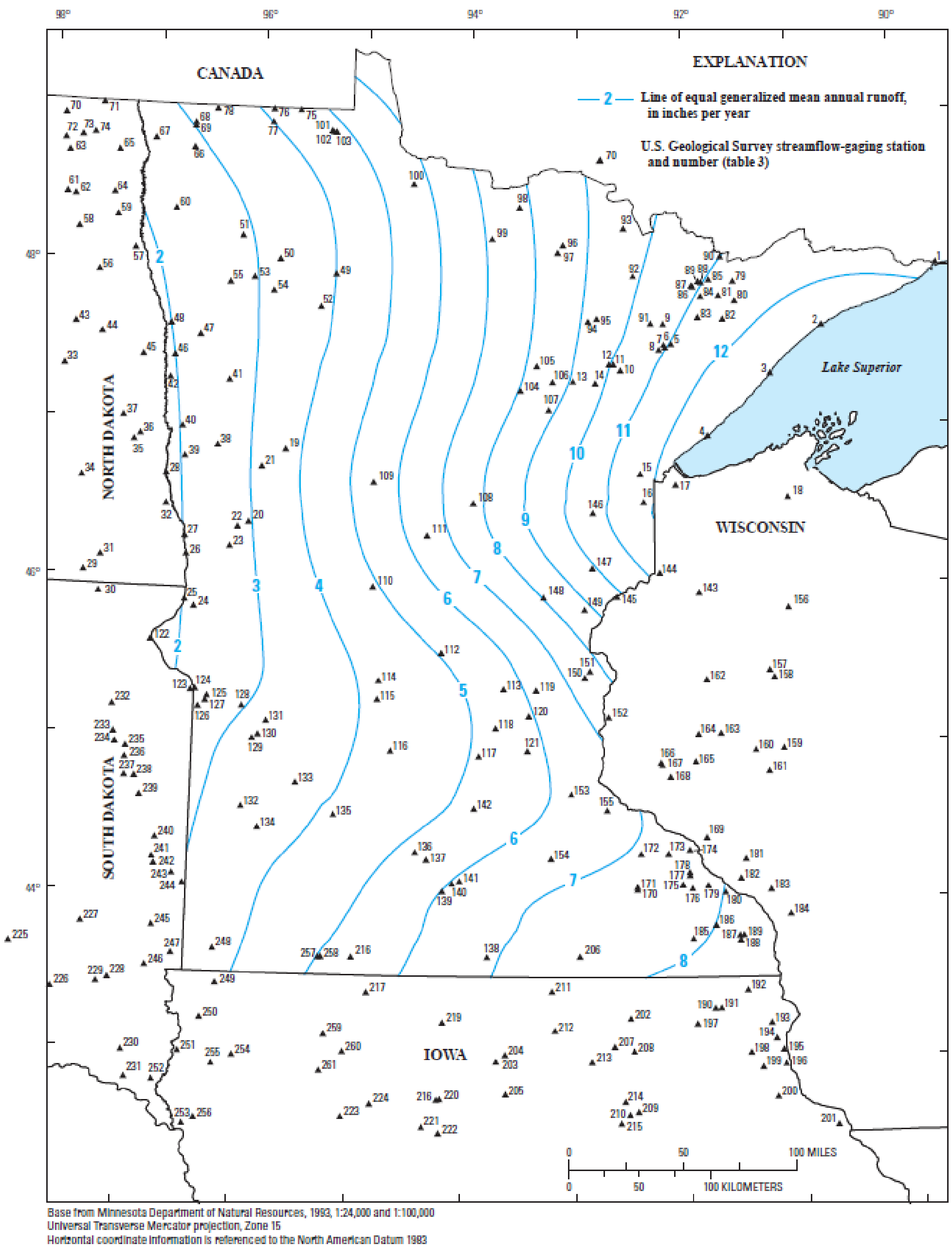

Figure 3 - Generalized Mean Annual Runoff (United States Geological Survey, 2009)

2.2 WATER QUALITY

According to the Minnesota Pollution Control Agency (MPCA), Sturgeon Lake is classified as a mesotrophic lake, with an Overall Trophic State Index rating of 41. Based on data collected from 2008 through 2017, the MCPA reports a 10-year average transparency of four meters, an average chlorophyll-a level of 4 parts per billion, and an average total phosphorous level of 13 parts per billion. These values noted to be within the expected range for lakes in the same ecoregion. The MPCA also notes that Sturgeon Lake is suitable for swimming and wading, with good clarity and low algae levels throughout the open water season. Available data indicate a thriving community of fish and other aquatic organisms. Concentrations of Mercury in fish tissue exceed the standard; fish and aquatic organisms are not always suitable for consumption by humans or wildlife.

Dago Lake, which is often hydraulically connected to Sturgeon Lake, has a similar water quality to Sturgeon Lake with an Overall Trophic State Index of 42 and similar individual parameter values according to the MPCA.

2.3 AQUATIC INVASIVE SPECIES

Sturgeon Lake is currently included on the DNR's infested waters list due to the presence of Eurasian watermilfoil in the lake. The DNR requires a special permit to transport, appropriate or divert water from infested waters. Based on experiences with similar projects and discussions with DNR staff, the DNR will not allow infested water to be conveyed out of Sturgeon Lake into other bodies of water unless it is treated or filtered to remove the AIS. This will require some form of natural or mechanical filtration of the water before it can be transferred. At the present time Eurasian watermilfoil has not been found in Dago Lake or the Willow River.

2.4 HYDRAULICS

2.4.1 BEAVER DAMS

At the time of the field survey conducted by HEI on June 23rd, 2022, there was a beaver dam located in the natural waterway between Sturgeon Lake and Dago Lake. At that time, the water on the Sturgeon Lake side of the dam was at elevation 1069.68 feet (NGVD 29) and the water surface elevation on the Dago Lake side of the dam was 1066.71 feet (NGVD 29). While the difference in elevations appears significant, the impact of the beaver dam on water levels in Sturgeon Lake is likely minimal. Similar to Sturgeon Lake, Dago Lake has no known natural outlet and the storage volume in the basin around Dago Lake is considerably smaller than the storage volume in the Sturgeon Lake basin. Given these parameters, the beaver dam simply blocked off a relatively small portion of the combined storage volume in the Sturgeon Lake-Dago Lake basin and that would correlate to a very small impact on the water surface elevation in Sturgeon Lake. It is assumed that that water surface elevation in Dago Lake was able to drop once the flow from the larger Sturgeon Lake watershed was blocked off and evaporation and the drought conditions of 2021 came into effect.

2.4.2 LAKELAND ROAD

The existing culvert under Lakeland Road allowing water to discharge out of Sturgeon Lake and flow into the adjacent waterbody connected to Dago Lake has been the source of debate and some controversy over the years. The culvert, located between the residences at 35237 and 35255 Lakeland Road, is a 38”x57” CMPA (corrugated metal arch pipe) with an east invert of 1167.06 feet (NGVD 29) and a west invert of 1166.87 feet (NGVD 29). DNR staff informed HEI that the installation of this culvert and associated ditching activities may have been completed in the 1950s without proper permits and approvals. DNR staff also indicated that there was an attempt to remove the culvert in the 1970s, but no action was taken after significant opposition was raised by residents around the lake. Even if modifications to the culvert or any adjacent ditches are not necessary as part of an outlet project, it may be prudent, if not required, to address this culvert and the adjacent ditches through the DNR permitting process in order to formally resolve this matter. As noted above, for the purposes of this study it is assumed that such a permit would be issued by the DNR and that the existing culvert and ditches can remain in place.

3 WATER BALANCE & SYSTEM SIZIGN ANALYSIS

In order to develop potential solutions involving gravity discharge or pumped outlets, the required and desired discharge rates must be identified. The required rate would be the minimum discharge rate needed to address the high water problem over an extended period of time, as determined through scientific calculations. The desired discharge rate is selected by project stakeholders and often includes considerations for costs, political factors, and the time required to fully address the high water conditions. The first step in this analysis is to determine the estimated baseline discharge rate required to maintain water surface elevations at a given elevation given the inflows and outflows described in Section 2. Once the baseline condition is established, various scenarios can be analyzed to determine the discharge rate required to draw the lake down to the desired level within any given time period.

3.1 WATER BALANCE

In this case, for reasons discussed above, it was assumed that evaporation and annual precipitation volumes within the footprint of the lake would cancel each other out, which still reflects a conservative approach as the amount of evaporation in excess of the precipitation volume is not accounted for. The baseline discharge rate is then calculated by converting the adjusted annual volume of runoff from the contributing watershed beyond the boundary of the lake to an average annual discharge rate of 3.1 cfs and adding it to the estimated hydraulic conductivity (i.e., groundwater contribution) of 1 cfs as explained below. Using this approach, it was determined that an outflow of up to 4.1 cfs (3.1 cfs + 1 cfs) or 1,840 gpm for a period of 12 months would be required to maintain the same water surface elevation.

With reference to the hydraulic conductivity assumption discussed above, a maximum groundwater inflow rate of 1 cfs would result in 724 acre-feet of water flowing into the lake from the surrounding groundwater system on an annual basis when the lake is being drained. Eventually the volume of water in storage will be depleted as discharges from the lake continue. Selection of a shorter drawdown period (i.e., 1 year) will require a larger pumping rate that will more quickly draw the lake levels down, but the lake may see some gradual bounce in water surface elevations as the groundwater surrounding the lake slowly flows into the lake. This can be controlled by periodic or sustained pumping operations if desired. Under scenarios with longer drawdown periods (i.e. 3 years), inclusion of at least 0.5 cfs in the total pumping rate to account for groundwater inflows over the drawdown period will account for a large portion of the volume of groundwater that will flow into the lake over that period of time and supplemental pumping beyond the initial drawdown period will be minimized.

3.2 SYSTEM SIZING ANALYSIS

With the above assumptions and variables accounted for, a series of calculations were conducted to provide Windemere Township with a range of options for potential drawdown periods associated with removing the excess water from the lake. For the purposes of this analysis, the drawdown period is presented in one-year increments (i.e., 1 year, 2 years, 3 years), each representing the overall length of time it would take to draw the water level down to the target elevation of 1069.1 feet (NGVD). Within each time period, it assumed that there will be periods of time when the project cannot be operated due to maintenance, downstream flooding, permitting restrictions, or other factors, so the sizing calculations need to take this into account. There are countless scenarios and many unknowns, so two scenarios are presented to provide stakeholders with some context for the impact of the actual pumping period on the size of the project and the impact on the drawdown time. With reference to Figure 4, scenarios are presented with the project operating for six months or nine months each year for one year, two years, or three years to lower the lake to the OHWL. For purposes of these calculations, it was assumed that the WSE on Sturgeon Lake was one foot above the OHWL and the volume of excess water to be removed from the lake would be the volume between the OHWL elevation of 1069.1 feet (NGVD 29) and 1070.1 feet (NGVD 29).

Windemere Township can reference this range of options and weigh the cost of various pumping options against the associated drawdown benefits and potential downstream concerns. It should be noted that these design and operating values are based on average annual rainfall, runoff, and evaporation within the drainage basin, and variations from these averages will result in decreased or increased pumping time to drawdown and maintain the lake to the target elevation. **Figure 4** below summarizes the drawdown of the lake by pumping rate and the estimated time to reach the desired lake elevation.

Lake Elevation Drawdown						
	1-Year Operation		2-Year Operation		3-Year Operation	
	6 months/yr	9 months/yr	6 months/yr	9 months/yr	6 months/yr	9 months/yr
Days of Operation	180	270	360	540	540	810
Runoff Reduction	6.3 cfs	4.2 cfs	6.3 cfs	4.2 cfs	6.3 cfs	4.2 cfs
Ground Water	1 cfs	1 cfs	0.75 cfs	0.75 cfs	0.5 cfs	0.5 cfs
1-foot level reduction	4.8 cfs	3.2 cfs	2.4 cfs	1.6 cfs	1.6 cfs	1.1 cfs
Total Pump Rate	12.1 cfs	8.4 cfs	9.5 cfs	6.6 cfs	8.4 cfs	5.8 cfs

Figure 4 – Lake Elevation Drawdown vs. Pumping Rates

4 PRELIMINARY ALTERNATIVES ANALYSIS

As noted in Section 1, various stakeholders have investigated solutions to the high water problems on Sturgeon Lake over the years. HEI reviewed many of the previously studied alternatives for further consideration. Many of the pertinent regulatory requirements have changed over the years, and Sturgeon Lake is now infested with Eurasian watermilfoil, so some of those previous alternatives are no longer viable or may require significant modifications to become feasible. Once the system sizing analysis was complete and the magnitude of a potential project was known, HEI reviewed potential limitations that may result due to the capacity of downstream outlets, AIS filtration, and other constructability concerns. With those paraments in place, HEI then developed alternatives based on recent experience with similar projects, factoring in potential regulatory requirements, right of way requirements, cost, and overall feasibility. These key factors and the recommended alternative are discussed in more detail below.

4.1 GENERAL CONSIDERATIONS

4.1.1 AIS FILTRATION

As previously discussed, Sturgeon Lake is currently included on the DNR's infested waters list due to the presence of Eurasian watermilfoil (EWM) in the lake. The DNR requires a special permit to transport, appropriate or divert water from infested waters. Based on experiences with similar projects and discussions with DNR staff, the DNR will not allow infested water to be conveyed out of Sturgeon Lake into other bodies of water unless it has been appropriately filtered through a DNR-approved filtration system. HEI's experience with similar projects involving the filtration of water infested with AIS has included the analysis of mechanical and natural filtration options and the DNR has recently approved permits for projects with mechanical filtration of water infested with EWM. These filtration systems can have a significant impact on the overall solution alternatives given their specific design and operation requirements.

When water levels are elevated in both lakes, Sturgeon Lake and Dago Lake are hydraulically connected and water moves between the two lakes. While Sturgeon Lake is currently listed as infested for EWM, Dago Lake is not yet listed as being infested. HEI has consulted the DNR for a decision on transferring unfiltered water out of Dago Lake without first filtering water entering the lake from Sturgeon Lake. At the time of this report the DNR was still reviewing this approach. Given this uncertainty, alternatives were included in this initial study with water being withdrawn directly from Sturgeon Lake and with water being withdrawn from Dago Lake, but all of the alternatives include filtration. Should the DNR allow for water to be transferred out of Dago Lake without being filtered, the alternatives can be updated during future phases of the project. Alternatives involving direct connections to other nearby lakes, similar to many of the options that were previously proposed, were not carried forward due to the risk involved with those lakes eventually becoming infested with an AIS, thus requiring filtration systems to be added before filtered water from Sturgeon Lake could continue to flow through them.

4.1.1.1 MECHANICAL FILTRATION SYSTEMS

Mechanical filtration of EWM and other AIS generally means that infested water is first passed through an appropriately size screen before it is conveyed downstream. Current DNR guidance requires a filter of 0.5mm or less for EWM and the DNR recently issued a permit for an outlet on Lake Shamineau in Morrison County that includes a 0.5mm filter for filtering EWM. Similar filters have also been permitted for projects involving waters infested with other AIS, including zebra mussels (e.g., Little McDonald Lake and Devils Lake in Otter Tail County).

In most applications, mechanical filtration also requires mechanical movement of the water (i.e., pumping systems) to move the water through the mechanical filter at the desired flow rate and to maintain necessary pressures in the system to facilitate backwashing and operation of the filtration system. Mechanical filtration presents more certainty in terms of operation, cost, and regulatory approval than natural filtration. The mechanical filtration options also offer some advantages in term of the required construction footprint, constructability, and long-term viability. An additional advantage with the mechanical filters is that they can potentially be repurposed if filtration is no longer required in the future.

4.1.1.2 NATURAL FILTER SYSTEMS

Natural filtration generally involves using native soils and lake bottom substrates or engineered materials to filter the lake water before it is transferred downstream. This can be accomplished by using angle wells, Ranney wells or other measures that collect water out of the ground either under or adjacent to the lake. Artificial filtration beds can also be constructed to filter lake water through natural materials (i.e., sand and gravel) or engineered materials before it is collected and transferred downstream.

Generally speaking, the larger the desired discharge rate the larger the required footprint for the natural filtration system. This can present challenges in terms of available right of way and available materials needed to produce enough yield. Additionally, natural filters can be impacted by ice and frozen ground, limiting the ability for systems to work year around. They can also be prone to clogging and reduced efficiency as AIS and other debris fill the open pores in the filter material.

One advantage with natural filters is that they may not require mechanical movement of water (i.e., pumping) if the topography allows for a gravity outlet system to move water downstream. This eliminates the capital and operating costs associated with a pumping system.

Additional soil testing and analysis will be required during future phases of the project in order to further vet the natural filtration options. At this current conceptual phase, it is assumed that the mechanical filtration options are more cost effective from an initial capital standpoint given the estimated size and cost of the conceptual natural filters. Natural filters may become more desirable if long term operating costs show an advantage over mechanical filtration and the associated operating conditions (i.e., cold weather limitations, maintenance, etc.) are acceptable.

4.1.1.3 SIPHONS

A siphon is a tube that can be used to lift flowing water above the surface of reservoir without the use of a pump, provided that the discharge is at a lower elevation than surface of the reservoir. One clear advantage of using a siphon is that it does not require a pump, thus saving on initial capital costs and reducing the cost ongoing operation. That said, siphons are limited as far as how much lift that they can provide (i.e., the topography between the reservoir and the discharge point can be a limiting factor) and siphons can require added operational effort related to priming and maintaining the siphon. More specifically to Sturgeon Lake, the use of a siphon becomes more challenging given the need to filter the water before it is discharged into a downstream water body. A cursory review of siphon options was completed, but no viable options were identified.

4.1.2 DOWNSTREAM WATERBODIES

4.1.2.1 WILLOW RIVER

All of the options presented in this report utilize the Willow River as an outlet, either directly or indirectly. The scope for this study did not include a detailed analysis of any downstream water bodies, but HEI conducted a cursory analysis of the Willow River. This cursory analysis involving a hydraulic model derived from cross sections of the channel surveyed at a few key locations. The model showed that the impacts to the existing Willow River will be minimal, and the project can be operated in a fashion that will not exceed the maximum water levels and flow rates that exceed the capacity of the river. Figure 5 summarizes the hydraulic impacts to the Willow River. The table does not include results for each potential discharge rate shown in Figure 4. The results shown reflect a discharge rate of 10 cfs being added to the river, which is on the higher end of the discharge rates shown in Figure 4.

The results shown in Figure 5 indicate that any of the proposed discharges shown in Figure 4 will have a very minimal impact on the Willow River. That said, further coordination with stakeholders, and others along the route, will continue as the project is developed. Downstream concerns can be addressed through design modifications and conditions included in the operating plan that will be required as a condition to the permit issued by the DNR. At a minimum, an outlet project would likely not be operated when any downstream water body is at or above its OHWL or are otherwise experiencing flooding conditions.

Willow River @ I-35	Water Surface Elevation (ft)
2-yr (32.9 cfs)	1035.70
2-year + 10 cfs (42.9 cfs)	1035.80
Difference (ft)	0.1
4-yr (93.2 cfs)	1036.13
4-yr + 10 cfs (103.2 cfs)	1036.19
Difference (ft)	0.06
20-yr (375 cfs)	1036.98
20-yr + 10 cfs (385cfs)	1037.01
Difference (ft)	0.03
50-yr (590 cfs)	1037.46
50-yr + 10 cfs (600 cfs)	1037.49
Difference (ft)	0.03
100-yr (1,470 cfs)	1038.73
100-yr + 10 cfs (1,480 cfs)	1038.74
Difference (ft)	0.01

Figure 5 – Willow River Capacity

Additionally, the water quality in the Willow River is relatively good, but the water quality in Sturgeon and Dago lakes is of higher quality, so the addition of water from those lakes into the Willow River will not have adverse effects on water quality.

4.1.2.2 BIG SLOUGH LAKE/WILLOW RIVER TRIBUTARY

One option presented in this report utilizes a tributary of the Willow River that extends through Big Slough Lake and then east of Sturgeon Lake as an outlet. Access and budget limitations did not allow for an analysis of the capacity of this tributary as part of this study. Given the magnitude of the discharge rates identified in Figure 4, it is assumed that this tributary can at least accommodate discharges on the lower end of the range shown, and higher discharges may be possible during times when the tributary is experiencing lower natural flows. Further study of this tributary system will need to be conducted to verify the capacity of tributary and its ability to accept additional flows from Sturgeon Lake, but at the current conceptual stage it is assumed that this tributary system is a viable outlet, with the caveat that the size of the outlet project and the amount of time it can be operated may be limited by the capacity of the tributary.

4.1.2.3 KETTLE RIVER

None of the alternatives presented in this report would directly utilize the Kettle River as an outlet, but any water discharged into the Willow River will eventually reach the Kettle River. As noted above, the scope for this study did not include a detailed analysis of any downstream water bodies, but HEI conducted a cursory analysis of the Willow River. The Kettle River is larger than the Willow River, so it can reasonably be assumed that the hydraulic impacts to the Kettle River will be even smaller than those on the Willow River, as described in Section 4.1.2.1. Further coordination with stakeholders along the Kettle River will take place as the project is developed, and downstream concerns can be addressed through design modifications and conditions included in the operating plan that will be required as a condition to the permit issued by the DNR. At a minimum, an outlet project would likely not be operated when any downstream water body is at or above its OHWL or are otherwise experiencing flooding conditions. Additionally, the water quality in the Kettle River is relatively good, but the water quality in Sturgeon and Dago lakes is of higher quality, so the addition of water from those lakes into the Kettle River will not have adverse effects on water quality.

4.1.3 CONSTRUCTABILITY

Construction of the project will involve challenges associated with working in the lake and handling groundwater conditions in the area. Installation of inlet pipes and associated inlet screens will involve construction out into the lake with construction activities taking place as far as 100 feet from the shoreline. Further investigation as to the limits of the inlet will need to be conducted as the design progresses. The means and methods for constructing these features will generally be left to the contractor hired to build the project, but a significant effort to confine and dewater the construction area will likely be required, particularly if the construction timeframe precludes them from working through ice in the winter months. Any option to drain the lake will come with certain challenges with regard to road and utility crossings. These conflicts are often unavoidable, and the routes will need to be designed in a way that reduces the potential impact to utilities and the traveling public as much as possible. With some of the proposed options, it may be possible to utilize either open ditches or buried pipe to convey the water, depending on right of way concerns, environmental issues, or other factors. This often comes down to a financial decision and these issues can be further analyzed and resolved during the design phase.

Potential cost saving measures will be further investigated during the design phase. Further considerations may be made by project stakeholders in terms of the construction time period and whether potential cost savings can be realized by allowing contractors to work through the ice if the associated delays that could result by accommodating this schedule are acceptable.

4.2 PROPOSED OUTLET ROUTES

Windemere Township requested an analysis of at least two pumping alternatives and at least one non-pumping alternative. The township did not request an analysis of options involving property buyouts, so buyouts of structures around Sturgeon Lake were not considered for this study. HEI developed alternatives based on recent experience with similar projects, factoring in potential regulatory requirements, right of way requirements, cost, and overall feasibility. Figure 6 below shows these proposed routes and general project features. Given the uncertainty involved with the DNR's requirements involved with utilizing Dago Lake, and the possibility of utilizing either natural or mechanical AIS filtration, some alternatives are presented with more than one route for at least a portion of the alignment between the inlet and the outlet.

At the conceptual stage, the options presented are intended to provide stakeholders with examples of potential viable solutions and a comparative estimate of the potential costs involved to assist in further decision making. If a particular option is pursued, specific alignments and locations for project components (e.g., lake inlets, pump stations, filters, channels, pipes, outlets, etc.) will be identified and refined during future phases of the design.

In addition to the alternatives presented below, many other options and potential routes were considered, at least on a cursory level. Wetlands, existing home locations, topography, other environmental factors, and estimated costs, among other factors, led to the options shown below. As noted above, at the present time there is some uncertainty as far as whether the DNR will allow water to be transferred out of Dago Lake without first being filtered before it leaves Sturgeon Lake. A decision from the DNR on that item could change some of these options, but those changes would be favorable in terms of cost (i.e., less pipe or ditching required) and would not negatively affect the feasibility of those options. All of the options presented below utilize the Willow River as the outlet, but an option was explored to pump the water from the west side of Sturgeon Lake directly west, under Interstate 35, directly to the Kettle River. This option proved to be very costly and would involve a larger number of easements over private and public properties between Sturgeon Lake and the Kettle River. This option could be explored further if desired, but it was omitted from this report given the estimated cost and existence of other options that appeared to be more feasible at the present time.

As shown in Figure 6, routes 1A and 1B utilize Dago Lake and involve either mechanical or natural filtration on the south side of Dago Lake with the water then conveyed south to the Willow River. Route 1A involves a filter, pumping system, and a buried forcemain. Route 1B involves a pump and filter with a combination of open channels and buried pipes flowing under gravity conditions. Routes 2A and 2B would involve water being withdrawn from Sturgeon Lake and then conveyed to the Willow River after being filtered, with one option including some reaches with gravity flows and the other option involving pressurized flow the entire route. Route 3 is a pumped outlet located in the southeast quadrant of Sturgeon Lake that utilizes the Big Slough Lake tributary as the outlet. Each option is described in further detail below, including a summary of the key project features, advantages and disadvantages, potential risks, and additional analysis that may be required.

After analyzing numerous scenarios, the only viable gravity system (i.e., one requiring no pumping at all) that was clearly identified was another option along Route 1, which would again require the DNR to permit water to be transferred through Dago Lake without being filtered first. Assuming that would be allowed, there is the potential for a gravity flow option involving a natural sand filter that would then utilize a deeper gravity pipe and/or ditch system to collect and transfer the water to the Willow River. Additional geotechnical testing and analysis would be required to confirm the viability of a natural or engineered filter system on the south side Dago Lake before this option could be considered feasible. In addition to the potential disadvantages of the natural filer discussed previously, replacing the pump station and mechanical filter with a non-mechanical filter would increase the proposed cost as the cost of the non-mechanical filter could be 3 to 4 times the cost of the proposed pump station and mechanical filter.

4.2.1 ROUTE 1A: DAGO LAKE OUTLET TO WILLOW RIVER - PIPED

Route 1A involves a proposed pumping and filtration facility on the south side of Dago Lake, with water withdrawn from Dago Lake and then filtered before being conveyed through a buried pipe installed almost entirely through state owned property to the Willow River, as shown in Figure 6. Water would flow from Dago Lake through a non-pressurized buried pipe leading to a wet well structure supplying water to the pump, which is assumed to be approximately 140 horsepower. A small building would house the pump, mechanical filtration system, control panels, and other related equipment. Filtered water would then leave the building through the forcemain pipe. The system will require 3-phase electrical service to the building.

The viability of this option is tied to the assumption that the existing culvert under Lakeland Road (see Section 2.4.2 for more details) remains in place. This option would also require DNR approval to withdraw water from Dago Lake without filtering water from Sturgeon Lake first. One advantage of this option is that it utilizes the existing connection between Sturgeon and Dago lakes to reduce the amount of pipe required; however, beaver activity will need to be managed to maintain the hydraulic connection between the two lakes. This option also outlets into the Willow River, which is one of the shortest distances to a suitable outlet from the pump station, thus minimizing construction costs. Another potential advantage of this option is that most of the land involved is owned by the state, minimizing real estate negotiations. Additionally, the proposed location of the pumping and filtration facility may allow for a natural filtration system with a large footprint to be constructed, if that is determined to be preferrable to a mechanical filter.

4.2.2 ROUTE 1B: DAGO LAKE OUTLET TO WILLOW - DITCHED

Route 1B is similar to Route 1A (see Section 4.2.1), with the difference being that the alignment for the outlet from the proposed pump station would involve an open cut channel and/or gravity flow pipe south to the Willow River. The ditch and/or pipe would run south along State Forest Road 340D either directly to the Willow River, or potentially into a wetland just west of the road which should drain to the Willow River. If this wetland is utilized, it will reduce the amount of ditching required and also provide a means of dissipating flow velocities before the water reaches the river. A beaver management plan will be strongly suggested to ensure the selected route will function as intended. The advantage of this option is that it utilizes the existing pipes under Lakeland Road, and it reduces pipe length by using the existing drainage path through to Dago Lake. Route 1B also prevents a potential cost savings over Route A because the ditching reduces the amount of pipe required and a smaller pump can be used due to the shorter length of forcemain.

4.2.3 ROUTE 2A: STURGEON LAKE OUTLET TO WILLOW RIVER – PIPED AND DITCHED

Route 2A proposes the installation of an intake pipe and structure in Sturgeon Lake. This pipe would be installed approximately five feet below the OHWL elevation for safety reasons and to allow for water to flow out of the lake during the winter months. The pipe would flow under gravity conditions to a pump station, which would likely be located near Sturgeon Lake as shown in Figure 6, but in theory could be located anywhere along the route between the lake and State Forest Road 340E, although a deeper wet well will be required as the pump station is moved farther from Sturgeon Lake. The pump station would require a +/- 140 horsepower pump and a mechanical filter. From there, a gravity flow system similar to Route 1B would convey the water to the Willow River.

This option will require snaking a long pipe through private property and around wetlands and the route is the longest of any of the options presented. If this option is chosen for further consideration, an analysis will need to be completed to balance the location of the pump station with the gravity inlet piping and forcemain outlet pipe to ensure the most efficient location, while also factoring in access and electrical supply. The downstream end of Route 2A involving the open ditch was not located farther east (i.e., along a shorter alignment) due to existence of higher topography and water bodies that make the excavation and permitting of an open ditch less feasible.

4.2.4 ROUTE 2B: STURGEON LAKE OUTLET TO WILLOW RIVER – PIPED

Route 2B is similar to Route 2A with respect to the alignment between Sturgeon Lake and State Forest Road 340E, as described in Section 4.2.3. Due to the topographic and water related obstructions along State Forest Road 340E, Route 2B would involve a pressured forcemain that would follow the road through state-owned land to the Willow River. Similar to Route 2A, this option would require an estimated 140 horsepower pump station and a mechanical filter.

This option will require snaking a long pipe through private property and around wetlands, but the overall length is shorter compared to Route 2A. This option provides additional flexibility over Route 2A as far as utilizing the forcemain to avoid environmentally sensitive areas, private property that cannot be accessed. It also results in a smaller permanent footprint when compared to an open channel option and it eliminates the need to maintain open ditches.

4.2.5 ROUTE 3: EAST BOUND OUTLET TO WILLOW RIVER TRIBUTARY

Route 3 involves a pump and mechanical filtration system that would transfer water out of the southeast part of Sturgeon Lake and discharge it into a tributary of Big Slough Lake and the Willow River. For the current concept level study, it was assumed that the +/- 140 horsepower pump station, which would be similar to the system described for Routes 1 and 2, would be located near the intersection of Lakeland Road and Marina Beach Way. This location was selected because the open space available for the construction of the pump station and because the existing right of way for Lakeland Road would provide a relatively short path between the lake and the tributary, as shown in Figure 6. Other locations for the pump station and routes for the forcemain can be further considered during the design phase, but the concept will largely remain the same and the option presented provides a reasonable representation of the feasibility and cost of this concept.

As noted in Section 4.1.2.2, the tributary has a more limited capacity than the Willow River and this option may come with restrictions on discharge capacity and operating times. This will require further analysis during the next step of the project development process if this option is selected to move forward. In addition to permits and right of way that may be needed along Lakeland Road, this option might also require private flowage easements along the tributary. Similar to some of the other options, beaver activity will also need to be managed to ensure the selected route will function as intended.

One of the advantages with this option is relatively short length of pipe required, as compared to other options. Big Slough Lake is already directly connected to the Willow River, so once the water from Sturgeon Lake is filtered for AIS, the water can be discharged through Big Slough Lake without further concerns for AIS impacting the operation of the project.

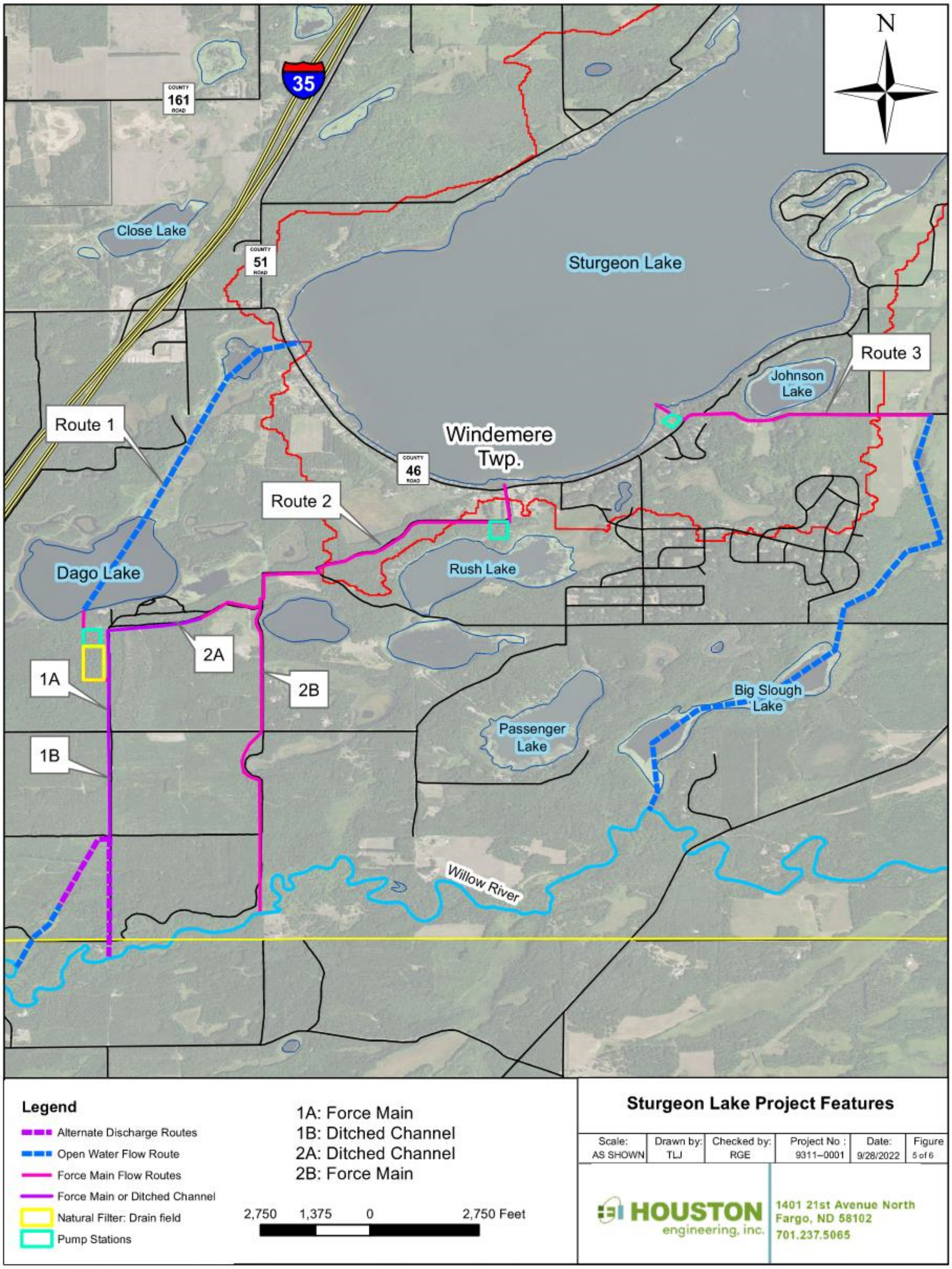

Figure 6 – Project Features

5 PERMITTING, RIGHT OF WAY & RISK CONSIDERATIONS

5.1 PERMITS & REGULATORY APPROVALS

Specific permitting requirements and regulatory approvals may be different for each of the alternatives presented and those details may not be known until a project is advanced further into the design phase, but many of the requirements will be similar for each option. Recently constructed or permitted projects can provide good references for what these requirements will likely entail. Below is summary of the anticipated permitting and regulatory requirements associated with the alternatives presented.

5.1.1 LOCAL

At a local level, required permits and approvals typically pertain to zoning requirements for buildings (i.e., pump station construction) or modifications to the shoreline. Impacts to public roadways may also require permissions from the impacted road authorities. In most cases, the project can be designed to address specific requests and requirements stipulated by local authorities. The proposed alternatives do not appear to impact any public ditches, so approvals do not appear necessary from a local drainage authority. The Pine County SWCD will also be involved in any wetland permitting that may be required for the project.

5.1.2 STATE

A DNR Public Waters Work Permit will be required for construction activities that will take place below the OHWL of any lake or waterbody. The DNR is also likely to include a condition on this permit requiring an approved operating plan that addresses downstream concerns and other concerns that that may arise during the permit review process. The DNR will also address the transfer of water from a lake infested with AIS. Project stakeholders are advised to coordinate with DNR personnel beginning early in the process in order to identify and address concerns as quickly as possible to help expedite the permit review and approval process. Given the assumption that an outlet project on Sturgeon Lake would not artificially drain the lake below the OWHL, a water appropriation permit is not expected to be required. Should that assumption change, stakeholders may need an appropriation permit, and potentially other approvals, if the project would artificially lower the lake to a greater extent. Depending on the construction contractor's chosen dewatering methods (if any), the contractor may be required to obtain additional permits associated with those activities.

The Minnesota Board of Water and Soil Resources (BWSR) may be involved in any wetland related permitting that might be involved, but no other permits from that agency are required.

The proposed alternatives do not appear to impact any roadways under the jurisdiction of the Minnesota Department of Transportation (MnDOT), so no permits or approvals will be necessary from MnDOT.

A Stormwater Pollution Prevention Plan (SWPPP) will need to be developed and a NPDES Construction Stormwater Permit will be required from the Minnesota Pollution Control Agency (MPCA), since construction activities will disturb more than one acre of land. The SWPPP and the NPDES permit are standard components of a project like this and the design for the project will address these requirements, so this is not expected to be an area of concern. The MPCA could be indirectly involved in the wetland permitting process, but that process is generally very straight forward, and no significant issues are anticipated.

5.1.3 FEDERAL

A US Army Corps of Engineers (USACE) Section 404 permit may be required for this improvement project, particularly if fill will be placed in wetland areas. The USACE permit will likely include a review of any endangered or threatened species in the area and a review for archaeological or historical sites eligible for the National Register exist within the project area may also be required. The formal permit process will be initiated during the design phase of the project. No other federal permits are anticipated.

5.1.4 ENVIRONMENTAL REVIEW

An outlet project on Sturgeon Lake is not likely to require a mandatory Environmental Assessment Worksheet (EAW) to be completed, but sponsors of similar projects in Minnesota have completed discretionary EAWs, often as a means of addressing concerns that were raised by downstream entities or other concerned parties.

The land use within the proposed drainage routes is in the form of farmsteads, residences, roads, lakes, wetlands, natural coulees, drainage ditches, and woodlands. It is anticipated that the primary use of the impacted land will continue with little change due to development or growth.

The occurrence of an extreme runoff condition during project construction should not cause an increased sediment load into downstream channels or Sturgeon Lake. Minimal changes to land use and cover type will result from the project. When the project is completed, the sediment load to receiving waterbodies from the project will not increase significantly from pre-project conditions. Erosion reduction techniques will also be incorporated into the project design, including a riprap outfall structure. Erosion problems caused by high lake levels and overland flows will be reduced. The construction and operation of the improvement project is not expected to have a negative effect on the identified water quality parameters.

A LiDAR mapping study conducted in 1976 by the University of Iowa in collaboration with the Cultural Heritage Fund of Minnesota suggested that there are potentially several known cultural or archaeological sites around Sturgeon Lake. Therefore, a more in-depth archaeology investigation will need to be conducted. In addition, multiple threatened plant species including autumn fimbry, slender naiad, and lance-leaf violet potentially grow within the proposed project alignment. A Minnesota native seed mix will be used for seeding upon the completion of this project to ensure the growth of any native and threatened vegetation.

5.2 RIGHT OF WAY CONSIDERATIONS

Permanent and temporary right-of-way will be required to be obtained along the proposed routes discussed above. Permanent right-of-way will be required for the installation of the new lake outlet structures and any pipe or drainage channels. Temporary right-of-way is required for the placement of topsoil and required construction activities. The land required for temporary right-of-way will likely be impacted for one or two construction seasons. After completion of the project construction, the permanent right-of-way can generally be used for agricultural and forestry uses or other purposes as was prior to the project, with noted conditions. Temporary right-of-way will revert to original pre-project land uses with no conditions.

Project sponsors will need to negotiate with public and private entities for the required land rights, and property acquisition can often be the most challenging part of developing a project. HEI has not contacted any of the landowners along any of the proposed routes to discuss a potential outlet project or any potential impacts to their property. It is recommended that project stakeholders begin discussions with potentially impacted property owners and road authorities early on in the project development process. Stakeholders should also review their legal authorities when it comes to acquiring private property for public infrastructure projects when private parties are unwilling to sell their property or grant necessary easements. The ability to utilize eminent domain as a means of acquiring property rights from unwilling sellers is often thought of as viable option by some entities; however, not all entities are granted such powers in Minnesota. Project stakeholders should consult with their legal counsels to determine their property acquisition authorities and limitations and take that into consideration before pursuing a given route or alternative.

6 ECONOMICS

6.1 ECONOMIC ANALYSIS OF PRIVATE AND PUBLIC BENEFITS OF THE PROJECT

6.1.1 STURGEON LAKE

Lakeshore owners that will be provided with flood damage reduction, improved shoreline management benefits, and increased property values. The results from a damage assessment conducted by the Sturgeon Lake High-Water Committee in 2019 provide some context to these benefits. To summarize the damages identified in the Committee's 2019 report, the Committee received responses from 93 of the 277 individual lakeshore property owners that received surveys. Of those 93 responses, the vast majority indicated some sort of damage caused by the high water conditions, but only 54 provided some form of an estimated cost associated with those damages. Total value of the estimated damage submitted by those 54 respondents was approximately $1.2 million.

6.1.2 PUBLIC BENEFITS

The public and recreational users will be provided with benefits tied to improved access and water quality. The public may also benefit as a result of reduced impacts to public roadways and other infrastructure, but these benefits have not been analyzed or quantified. In addition, there are other non-quantifiable factors to be considered. These include impacts to the environment, social costs, and cultural costs.

6.2 ESTIMATED PROJECT COSTS

Preliminary cost estimates were developed to provide stakeholders with possible costs associated with the alternatives discussed above. Cost estimates were not prepared for each scenario presented in Figure 4. Rather, a discharge rate of 6.6 cfs, corresponding to a 2-year draw down period with nine months of annual operation, was selected from Figure 4 and mid-range discharge. Selection of a different discharge rate could result in higher or lower project costs. Given the correlation between the draw down period and the magnitude of the required discharge rate, it is estimated that costs for the scenarios presented in Figure could span anywhere from +/- 10% lower to +/-30-40% higher than the estimated costs presented below.

The estimated costs are reflective of current (i.e., 2022) market conditions, which have resulted in escalated costs for materials, fuel, labor, and other items due to inflation and significant supply chain issues. The actual cost of any of these alternatives will not be known until the bidding documents for the project are created and bids are received. Stakeholders must consider these factors when considering these cost estimates and making decisions on how to proceed. In general, these estimates are more appropriate in terms in comparing the alternatives to each other, whereas there is more risk in relying upon the estimates as accurate reflections of what the actual cost of the project will be. Estimated costs can continue to be refined as the level of detail in a design increases, and current and anticipated market conditions can be reflected in future cost estimates. The total estimated costs include costs for construction, engineering, permitting and all other anticipated costs, unless otherwise noted.

1. For Route 1A with a mechanical filter the total estimated cost is $3.8 million, which includes an estimated $650,000 in preconstruction costs and $3.15 million in construction phase costs. The construction phase costs include a contingency amount of $390,000 which is approximately 15% of the estimated construction cost. The contingency is included to account for uncertainties involved with conceptual nature of the estimate and to account for unknowns that may arise. No land acquisition was included in these cost estimates.

2. For Route 1B with a mechanical filter the total estimated cost is $3.05 million, which includes an estimated $650,000 in preconstruction costs and $2.4 million in construction phase costs. The construction phase costs include a contingency amount of $293,000 which is approximately 15% of the estimated construction cost. The contingency is included to account for uncertainties involved with conceptual nature of the estimate and to account for unknowns that may arise. No land acquisition was included in these cost estimates.

3. For Route 2A with a mechanical filter the total estimated cost is $5.55 million with an estimated $650,000 in preconstruction costs and $4.9 million in construction phase costs. The construction phase costs include a contingency amount of $622,000 which is approximately 15% of the estimated construction cost. The contingency is included to account for uncertainties involved with conceptual nature of the estimate and to account for unknowns that may arise. No land acquisition was included in these cost estimates.

4. For Route 2B with a mechanical filter the total estimated cost is $4.85 million with an estimated $650,000 in preconstruction costs and $4.2 million in construction phase costs. The construction phase costs include a contingency amount of $525,000 which is approximately 15% of the estimated construction cost. The contingency is included to account for uncertainties involved with conceptual nature of the estimate and to account for unknowns that may arise. No land acquisition was included in these cost estimates.

5. For Route 3 with a mechanical filter the total estimated cost is $3.75 million with an estimated $650,000 in preconstruction costs and $3.1 million in construction phase costs. The construction phase costs include a contingency amount of $385,000 which is approximately 15% of the estimated construction cost. The contingency is included to account for uncertainties involved with conceptual nature of the estimate and to account for unknowns that may arise. No land acquisition was included in these cost estimates.

	Route 1A	Route 1B	Route 2A	Route 2B	Route 3
Cost Estimate	$3,800,000	$3,050,000	$5,550,000	$4,850,000	$3,7504,000

Figure 7 – Preliminary Cost Estimates

6.3 PROJECT FUNDING & FINANCING

Similar lake water management projects have been funded in various ways, but they are typically funded through a combination of public and private funding. State funding may be available through DNR issued flood damage reduction grants, and possibly through legislatively ear marked funding that would also be issued through the DNR. There may be other state or federal funding opportunities that could be applied for, but the DNR funding is the most common. The DNR funding typically requires a local match, and the grant process is competitive. Stakeholders are encouraged to contact the DNR very early in the project development process to get in the queue. Counties and townships have also provided some level of funding for similar projects, particularly if roadways or other public infrastructure are being impacted by high water levels. Any remaining local share is often assessed to benefiting property owners. This is often administered by a county, township, lake improvement district, or other legally recognized entity with the authority to levy special assessments for public improvement projects. The assessment process typically follows Chapter 429 of Minnesota Statutes, and the assessing authority typically secures a long-term bond to finance the project and spread the assessments over a 10–20-year period to help their constitutes cover their share of the assessments.

7 POTENTIAL PROJECT SCHEDULE

Task Order	Task	Description	Number of Months Required *(Estimated*[1])*
1	Feasibility Study and Outreach	• Determine most feasible, cost-effective and timely alternative. • Outreach with agencies, landowners, and public • Submit report to DNR for grant funding • Township meeting presentation	Feasibility study complete, Outreach 1-3 months
2	Planning, Design, and Project Development	• Detailed topographic and legal surveys • Geotechnical evaluation • Final alignment determination • Develop plan and detail sheets • Operation and maintenance plans • Wetland delineation	*4-6 Months after Task 1*
3	Permitting	• EAW and Phase 1 Archeological • Permits	*3-6 Months concurrent/ after Task 2*
4	Final Plans and Specifications (90% and 100% Stages)	• Design and develop final construction details • Prepare • Intake, outfall structure, forcemain, and lift station design • Prepare final specifications and contract documents • Right of Way	*2 Months after Task 3*
5	Bidding Process	• Coordination of bid process • Bidder questions • Prebid meeting, preconstruction meeting • Award contract	*1 Month after Task 4*
6	Construction Management, Staking, and Observation	• Construction staking • Geotechnical testing services • Construction observation • Process contractor pay applications • Walk throughs/inspections • System start up and initial operation	*8-16 Months after Task 5*
7	Final Completion and closeout	• Punchlist Items • Turf Establishment	*1 Month after Task 6*

Figure 8 - Project Schedule

****The estimated timeline indicates tasks completion timeframes that will depend on the timing of receipt of funds, permitting, right of way easements, weather, and other unforeseeable conditions.***