

GVSU AWRI

Cost Categories	Same as 2022 (Adding April)	Additional chlorophyll samples	Include Trib sampling (baseflow and storm events)	Include Fenner Ditch "wells"
Direct Cost	\$19,235	\$4,133	\$6,033	\$3,830
Indirect Cost	\$5,694	\$1,223	\$1,786	\$1,134
Total Estimated Cost	\$24,929	\$5,364	\$7,819	\$4,964

Paul's Comments

We asked Dr. Steinman for some additional ala carte options for some of the items he had as recommendations in his yearend report (Summary attached). Below are some comments for each item on his chart above.

Similar to 2022: See attached scope of services from our 2022 contract with GVSU. The approved contract included monthly testing from May-Oct for \$18,238. Continuing this option, but with the addition of April testing works out to \$24,929 and includes cost increases for materials and the additional labor for the extra month.

Additional Chlorophyll Samples: Chlorophyll levels last year were higher than in the past. These can vary drastically depending on the weather and other factors like algaecide treatments. This Option adds additional sampling to help get a truer picture of our chlorophyll situation. Price: Additional **\$5,364**.

Tributary Sampling: This includes testing baseline/low flow for both Bear Creek and the small creek into Fenner's Ditch (possibly some other sites). This would help identify or rule these sources as possible trouble points. Additional **\$7,819**.

Fenner's Ditch Wells: This method is to get samples from non-filtered ground water wells from residents in Fenner's ditch. This would help determine if groundwater (including septic) is a source of issues. This approach of using existing wells is much less expensive than digging actual wells like they did in Silver Lake. Price: Additional **\$4,964**.

Summary:

Bear Lake TP concentrations remain above the 30 µg/L threshold established in the TMDL. While the 2022 spring and summer TP concentrations do not exceed historical highs, they average 10 to 20 µg/L higher than meeting the goal. This is a concern not only for the ecological health of Bear Lake, but it also potentially creates a barrier for delisting the Muskegon Lake AOC, as the eutrophication and nuisance algae BUI (beneficial use impairment) targets are not being met.

Internal phosphorus and nitrogen loading is limited overall in Bear Lake, with Site 1 (the deepest site) contributing the highest internal loads. Nonetheless, the bottom water concentrations at Site 1 are still relatively modest compared to other lakes in the region, although above the TMDL threshold so should not be ignored (see recommendations).

The chlorophyll *a* concentrations are higher than what have been measured in the past; it is unclear if this is a response to the high nutrient concentrations, the variability of chlorophyll levels (e.g., sampling after a few warm, calm days when blooms will form vs. days after algicide has been applied), or some other factor. Only more consistent and regular sampling will resolve this question (see recommendations). Despite the high chlorophyll levels, the cyanotoxin concentrations measured in Bear Lake are far below the thresholds developed by EPA for recreational lake usage. In addition, the *E. coli* levels measured indicate that fecal coliform concentrations are not currently a problem in Bear Lake. The phytoplankton composition has shifted over the past 10 years from dominance by *Microcystis* in summer/fall to dominance by *Planktothrix* and *Limnithrix*. All three genera are capable of producing cyanotoxins but at least in 2022, they were not doing so at levels of concern.

In summary, Bear Lake is still dealing with too much phosphorus and algae, and additional efforts are needed to address these concerns.

Recommendations:

- 1) **Expanded nutrient monitoring:** It is unclear if the high TP and chlorophyll concentrations were anomalies or part of a trend of higher values. While it is believed that the flow-through marsh created at the Willbrandt site will, in time, help reduce TP loads coming from upstream in the watershed, it is important to determine if there are other sources contributing nutrients to Bear Lake. The only way to parse out this question is through continued monitoring. Indeed, we recommend for nutrients to continue the 4 in-lake sites, as well as sample nutrients from the major inflows to Bear Lake (Bear Creek and Fenners Ditch, and possibly Bear Lake Direct 1 and Bear Lake Direct 2) and the outflow of Bear Lake to Muskegon Lake in order to improve our understanding of temporal and spatial trends.
- 2) **Other P sources:** Examine possible sources of P from direct runoff into lake (seepage, yard runoff, restored ponds);
- 3) **More frequent chlorophyll monitoring:** The high chlorophyll concentrations also may be a function of infrequent sampling, when low chlorophyll conditions in summer and fall are missed. While no additional sites are recommended for sampling, there are several ways to increase observations without collecting water samples and processing them in the lab.
 - 3a) For example, citizens can get involved in doing qualitative surveys of lake color and bloom conditions to provide daily data. This would involve a training session to ensure data quality but

involving citizens in the data collection is a great way for them to feel included and invested in lake health.

3b) Alternatively, new lower-cost water quality sensors can be purchased and deployed in the lake to provide near real-time data. These need to be maintained and there is an upfront cost to purchase them, but it is an alternative the Lake Board may want to consider. More information is available at this website: <https://www.nexsens.com/>.

- 4) The application of Phoslock to strip P from the water column and create a benthic cap to limit internal loading makes good sense for Fenners Ditch (and possibly other inflows depending on P concentrations) as well as the deeper portions of Bear Lake. Based on our prior analysis (Steinman and Ogdahl 2015), we recommend application at depths greater than 10 ft; if the Lake Board wants to be highly protective, application can be expanded to areas deeper than 9 ft (see Fig. 32) although prior data indicate internal loading from sediment at depths shallower than 10 ft is very limited.
- 5) Finally, we recommend conducting a watershed survey to determine lake user priorities (target future monitoring around priorities). While including one in a mailing to residents is certainly cost-effective, it is not scientifically valid and based on our experience, interpretation of the data can be confounded. Hence, we recommend using a professional who is well-versed in watershed surveys (such as Dr. Amanda Buday at GVSU).

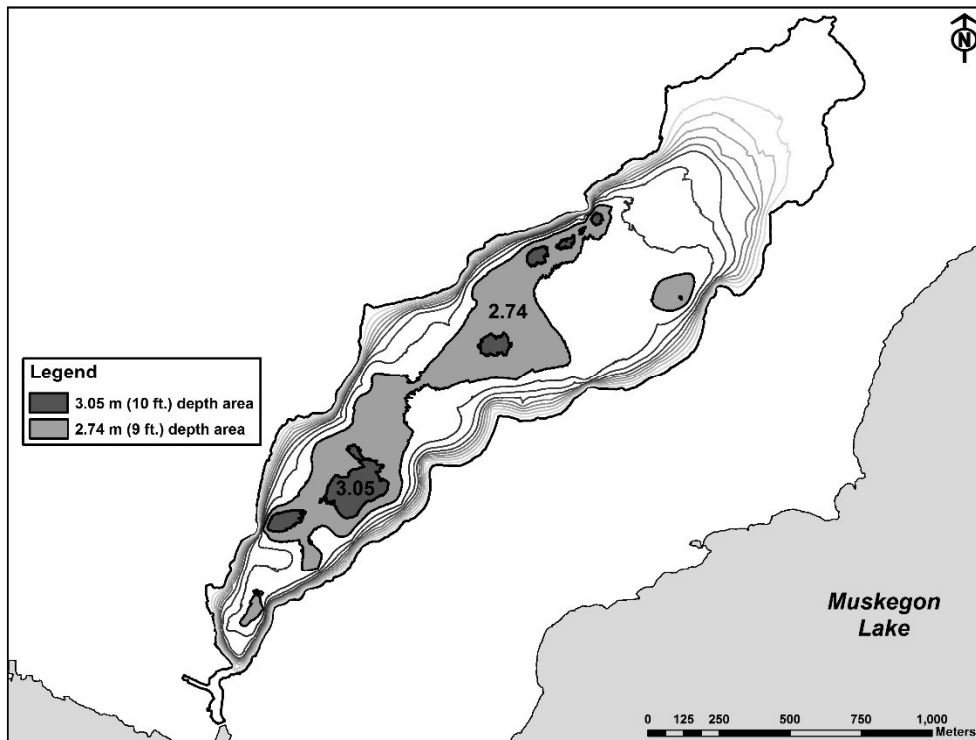


Figure 32. Sampling locations and bathymetry of Bear Lake. Light and dark gray shading show depths >2.7 m and >3 m, respectively. From Steinman and Ogdahl (2015).

EXHIBIT A

Scope of Services

Bear Lake Improvement Project: 2022

Annis Water Resources Institute (AWRI) – GVSU

AWRI will provide the following services related to monitoring Bear Lake during the 2022 sampling season:

A. Monitoring

The following parameters will be sampled on a monthly basis from May through October at 4 sites and at 2 depths (0.5 m below water surface and 0.5 m above sediment):

- Temperature, DO, turbidity, conductivity, and pH using a YSI Sonde
- Chlorophyll *a* via spectrophotometry
- TP (total phosphorus), SRP (soluble reactive phosphorus), NH₃ (ammonia), NO₃ (nitrate), and TKN (total Kjeldahl nitrogen) using Standard Methods
- Total fecal coliform via Colilert methodology
- Microcystin concentration using ELISA
- Phytoplankton community structure to finest possible taxonomic level (collection via Van Dorn bottles; analysis via light microscopy)

B. Reporting

A final report will be provided to the Bear Lake – Lake Board by 31 January 2023 (assuming sampling is completed in October 2022). The report will summarize the data and results, identify possible threats to Bear Lake, and offer recommendations.

If desired, a presentation will be given to the Lake Board on our findings and results.

C. Compensation

Total compensation for task elements listed above is \$18,238 to be billed on a quarterly basis.

Payment Schedule

BLLB shall pay the UNIVERSITY for basic services rendered under this Agreement on a fee-for-service basis according to the following schedule:

June 30
September 30
December 31
March 31