Memo

Date: Monday, March 10, 2025

Project: Ellsworth Hydroelectric Project (FERC No. 2727)

To: Laura Paye (Maine Department of Environmental Protection)

From: Randy Dorman (Black Bear Hydro Partners, LLC); Peter Browne, Dawn Cousens, and Jenn Gagnon (HDR)

Subject: Graham Lake - 75% Wetted Littoral Zone Calculation

Introduction

The elevation at which 75% of the littoral area is wetted in Graham Lake was previously calculated in the 2015 Updated Study Report (USR) for the Ellsworth Hydroelectric Project (FERC No. 2727) (Project) from the existing licensed maximum normal full pond elevation of 104.2 feet[1].

On July 29, 2019, the Federal Energy Regulatory Commission (FERC) issued a Final Environmental Assessment (FEA) for the Project and recommended that Graham Lake operate to a maximum elevation of 103.0 feet during normal operation. Black Bear has calculated the elevation at which 75% of the littoral area is wetted in Graham Lake for the FERC-recommended maximum elevation of 103.0 feet. The method and results of this calculation are summarized below.

Methods

In Section 3.2.1.4 of the USR, the previous 75% wetted littoral area analysis was summarized as follows:

> *"Using a depth of twice the mean 2013 summer sampling Secchi disk transparency (1.77 meters or 5.8 feet) as a measure of the bottom of the littoral zone, the littoral zone depth at Graham Lake is 11.6 feet. This calculates to an elevation of approximately 92.6'. Extrapolating, at its deepest the littoral zone of Graham Lake at elevation 92.6' has an area of approximately 7,232 acres. Similarly extrapolating from known bathymetric data, Graham Lake at full pond elevation of 104.2' has a surface area of 10,042 acres. Thus the approximate area of the littoral zone is: 10,042 acres – 7,232 acres =2,810 acres. Based upon the limited bathymetric data available, a lake level of approximately 102.5' would provide about 9,340 acres of wetted area, which would wet approximately ¾ of the littoral zone of the full impoundment."*

[1] All elevations reference the National Geodetic Vertical Datum of 1929 (NGVD29).

The Maine Department of Environmental Protection (MDEP) agreed with this analysis in its Denial of Water Quality Certification issued for the Project on March 19, 2020.

To conduct an updated 75% wetted littoral area analysis, HDR digitized the available spot depth readings from the Graham Lake depth soundings map developed by the Maine Department of Inland Fisheries and Wildlife (MDIFW) in 1980 and estimated contours to associate lake elevations to use GIS tools to calculate the surface area of the elevation contours. Using the elevation-surface area relationships, HDR estimated the elevation at which 75% of the littoral zone is expected to be inundated based on an impoundment elevation of 103.0 feet following the same MDEP-approved calculation that was used in the USR.

Wetted littoral zone areas were calculated at specified elevations using ArcGIS Pro v3.3.2 software. To perform this task, two input data sources were used; the Graham Lake MDIFW bathymetry soundings map (1980) and the U.S. Geological Survey National Elevation Dataset (USGS NED) one-meter Digital Elevation Model (DEM) 2019. The USGS NED data was used to generate the full pond elevation contour at elevation 104.2 feet (NGVD29). The sounding depths were consulted as a guide to hand digitize three 10-foot interval contour lines at elevations 90.0 feet, 95.0 feet, and 100.0 feet. The 3D Analyst "topo to Raster" tool was then utilized to combine the full pond contour, hand digitized contours, and the MDIFW bathymetry spot depth readings resulting in a 10X10 foot DEM surface output. Littoral zone areas were defined using the 3D Analyst "Surface Volume" tool which computes the square foot acreages at specified elevations between 90.0 feet and 104.2 feet.

GIS calculated elevation-surface area relationships were as follows:

Sounding Depth (feet)	Graham Lake Elevation[1] (feet)	Surface Area (acres)
14.2	90	4,798
12.8	91.4	5,345
12.2	92	5,606
10.2	94	6,559
8.2	96	7,358
6.2	98	7,967
4.2	100	8,699
2.2	102	9,409
1.2	103	9,772
0.3	103.9	10,167
0.0	104.2	10,349

[1] Assumes sounding depths on 1980 MDIFW map were taken from normal full pond elevation 104.2 ft.

Minor differences between values reported in the USR and this calculation are contributed to how contours were defined from the limited depth soundings digitized. The USR Figure 3-3 had a note reporting the shoreline elevation 103.9 feet provided a surface area of 9,922 acres which provides a relatively good agreement to the GIS calculated surface area of 10,167 acres reported in the table above for the same elevation.

Results

Sounding Depth (feet)	Graham Lake elevation (feet)	Surface Area (acres)	Key Notes
11.6	91.4	5,345	littoral zone depth, 11.6 feet from 103.0 feet
0	103	9,772	FERC-recommended maximum impoundment elevation
NA	NA	4,428	difference full pond – littoral depth
NA	100.1	8,665	lake level and area wetting ~75% littoral area

Following the same MDEP-approved methodology used in the USR, the Graham Lake elevation of 100.1 feet is the approximate lake level that would provide 8,665 acres of wetted area, which would wet approximately 75% of the littoral zone of the full impoundment (based on a full impoundment elevation of 103.0 feet).

Image showing GIS calculated elevation-surface area contours (blue lines) and the 1980 MDIFW depth sounding locations (white dots):