UNITED STATES
DEPARTMENT OF
AGRICULTURE

SOIL
CONSERVATION
SERVICE

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Subject: GPR Survey, Ripple Lake
Grafton, MA. March 1992.

Date: 04-10-1992

To: Ronald Thompson
District Conservationist
USDA-SCS
Holden, MA.

Purpose:

On March 2, 1992, a Ground-penetrating radar (GPR) survey was conducted on a portion of Lake Ripple, in the town of Grafton, MA (see appendix A). The purpose of the radar investigation was to survey the thickness of soft bottom sediments(1) in the lake. Data collected with the radar will be used by the town to compute the volume of organic sediments to be removed for restoration of the lake.

Safety Precautions:

The following safety measures were taken prior to the survey on the frozen pond: (1)The ice thickness was measured and continually monitored, (ice thickness ranged from 6 to 10 inches); (2)direct communication was maintained with the town offices using a portable phone; (3)The fire department provided a rescue vehicle and operator to be at the site in case of an emergency.

Principal Participants:

George Carroll, Lake Ripple Dredging Committee
James Cote, Registered Land Surveyor
Peter Fletcher, Project Leader, USDA-SCS, Middleboro MA.
Phil Johnson, Grafton Highway Department
George Petterson, Grafton Town Selectman
Mark Santora, Grafton Town Engineer
Dave Therrien, Lake Ripple Dredging Committee
Jim Turenne, Soil Scientist/GPR, USDA-SCS, Middleboro MA.

1Soft-bottom sediments are organic or a mix of organic and mineral sediments which have been deposited over the mineral (hard-bottom) of the lake.

GPR Equipment:

The Ground-penetrating Radar Unit used by the Massachusetts SCS is an SIR (Subsurface Interface Radar) System-3(2). The System-3 consists of a model 8300 profiling recorder and a model 3110 antenna (120 MHz). The system is powered by a 12 volt battery.

The GPR is a broad bandwidth, pulse modulated radar system that has been specifically designed to penetrate earthen materials. Relatively high frequency, short duration pulses of energy are transmitted into the ground from a coupled antenna. When a pulse strikes an interface separating layers of differing electromagnetic properties, a portion of the pulse's energy is reflected back to the receiving antenna. The reflected pulse is received, amplified, sampled and converted into a similarly shaped waveform in the audio frequency range. The processed reflected signal is displayed on graphic paper for further analysis. The graphic profile obtained consists of a horizontal scale which represents distance traveled along the transect line and a vertical scale which is a time scale which can be converted to a depth scale if velocity of signal propagation is known (see appendix B - radar profile from transect D). Ground-truthing by probing selected areas provided depth scales for interpreting the GPR data.

Procedure:

A grid was layed out on the ice surface for the area of the lake to be surveyed with the radar unit. Transects spaced 200 feet apart were run in an east-west direction. Along the individual transect lines, observations were recorded at 100 foot intervals. The base map used for locating transect lines was a 1986 aerial photograph, scale 1:200. Ground measurements were made to verify the accuracy of the aerial photograph.

Once the transect line was established, the radar unit was pulled across the ice and a continuous reading of the thickness of the bottom sediments was recorded. Probing was conducted using metal rods at various locations (see figure 1), to assure accuracy and to develop depth scales. Probing was done by first measuring the depth to soft-sediment and then the depth to underlying mineral sediments. A metallic reflector was placed at the water/soft-sediment interface to assure the radar was recording the interface. A total of eight transects were made with the radar and seventeen points were ground-truthed. After the lake was profiled by the radar, soil samples were collected at selected sites (see figure 1) for laboratory analyses.

Results:

The radar recorded the water/soft-sediment interface and the soft-sediment/mineral or hard bottom interface. The radar also recorded other features within the reservoir including coarse fragments, possible boulders and stumps and stratified sediments in the underlying geologic deposits (see appendix B). The radar recorded the hard-bottom topography to a depth of 16 feet, below

2The use of trade names in this report is for identifications purposes only and does not constitute endorsement by the USDA-Soil Conservation Service.

16 feet the radar was unable to record the hard-bottom topography. Probing was done to determine the depth to hard-bottom in areas where the soft bottom sediments extended below 16 feet. With the available soil probing equipment, depths could only be verified to 30 feet. In some areas, the soft-bottom extended deeper than 30 feet.

Data from the radar profiles was entered into a computer program to produce bottom contour maps and calculate the volume of soft-bottom sediments.

Soil probe data and sample locations are located on figure 1 (Note: all transect lines are not shown on Figure 1). Soft-bottom sediments were collected using an organic sampling probe and samples were taken from two different depths at each site.

Figure 2 is a contour map of the pond bottom showing the depths from ice surface to the soft sediment. Figure 3 is a subsurface contour map showing the depth to geologic (hard-bottom) sediments. The maximum depth of probing was 30 feet and the depth to hard bottom may be greater than 30 feet in some areas. Figure 4 are profiles interpreted from each transect line (vertical exaggeration is 10x). Figure 5 is an isopach map showing the thickness of organic material.

Conclusion/Interpretations:

A computer program was used to calculate the volume of soft-bottom sediment material for the survey area.

For the 38 acres of lake surveyed:

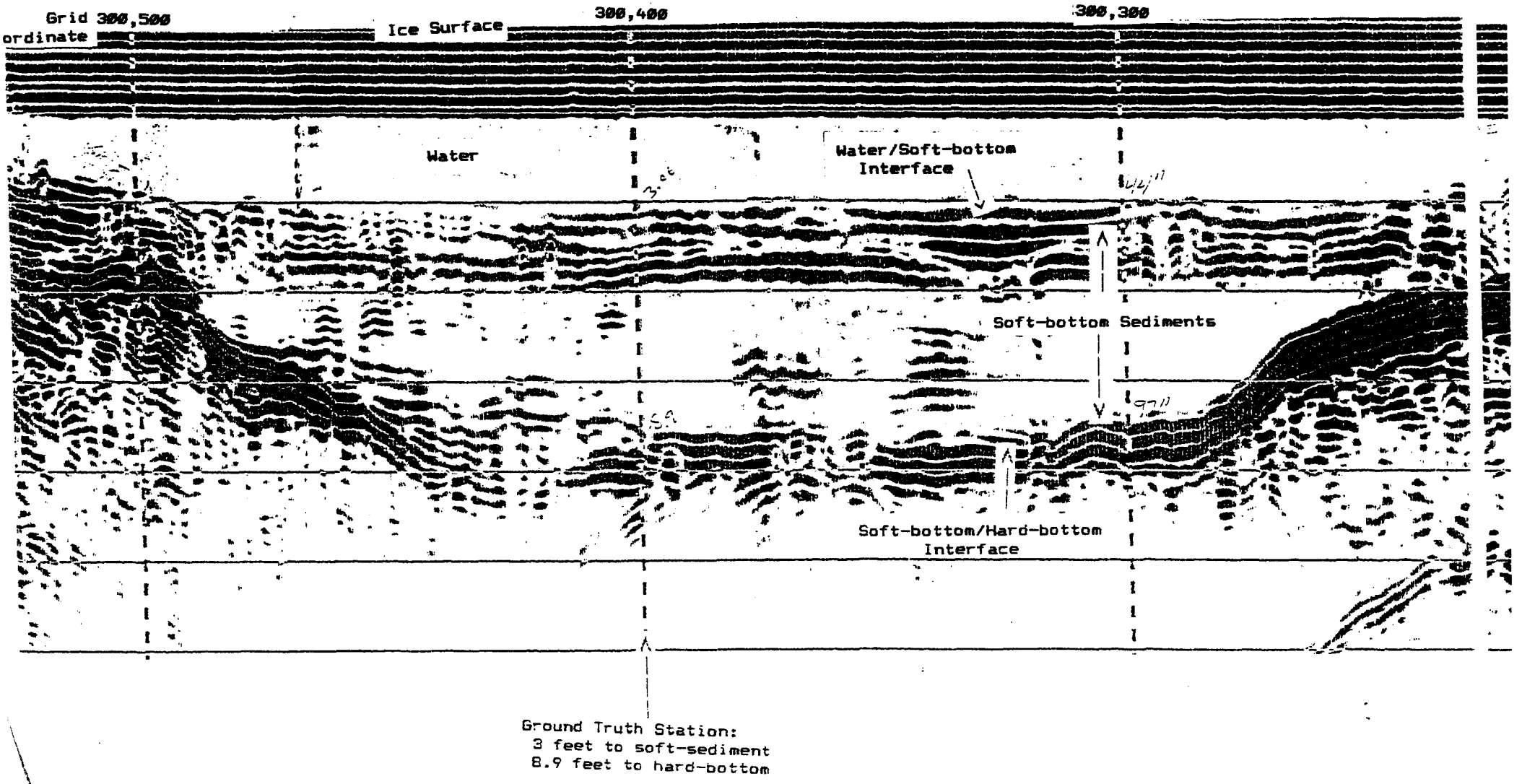
* to remove all of the soft-bottom sediment down to mineral hard-bottom, with a maximum water depth in some areas of 30 feet, would require excavation of approximately 503,000 cubic yards of soft-bottom sediments.

* to remove all of the soft-bottom sediments to a depth of 10 feet below the lake surface would require excavation of approximately 200,000 cubic yards.

James Turenne
Soil Scientist (GPR)
USDA-Soil Conservation Service

cc:
Carl Gustafson, State Conservation Engineer, USDA-SCS, Amherst, Massachusetts
Peter Fletcher, Project Leader, USDA-SCS, Middleboro MA.

Figure Five: GPR Profile from Transect line D



Ground Truth Station:
3 feet to soft-sediment
8.9 feet to hard-bottom