DEEP CREEK LAKE SHORELINE EROSION
Prepared by SPORE, 14 May 2012

SUMMARY:

The sediment accumulated in the lake since the land was flooded to create the lake, comes from surface runoff, the tributary streams, and shoreline erosion. We believe that the majority of the sediment in Deep Creek Lake is from erosion caused by wave action on the shoreline. The sources of these waves are wind action and boat traffic. The dynamics of the wave interactions with the shoreline are well understood in the literature[1]. Because the waves do not generally strike the shore perpendicularly there is some along shore and cross-shore transport of sediment.

WAVE DYNAMICS:

The dynamics of waves depends on water depth, lake bottom characteristics, the source of the waves, and wave energy. The wave energy is dependent on the height and the time between crests[2]. The energy is proportional to the product of the squares of the height and the period. The energy transferred to the shore is a function of the strike angle of the waves and the reflected wave energy.

On Deep Creek Lake the waves hitting the shore are either wind generated, or they are boat wakes, or a combination of the two.

Wind generated wave energy is dependent on the length of the lake the wind blows over and the wind speed. Our winds at Deep Creek Lake change direction and strength rather quickly, often before the waves can fully develop. When we see steady winds over 20 miles per hour white capped waves develop on the water. The energy from these waves is delivered to the shoreline. These waves can strike the shoreline at any angle but the greatest energy is transferred where it is perpendicular.

Boat traffic waves are a function of hull form, speed and speed-to-length ratio. The waves radiate out from the line of passage of the passing boat. Those waves are fully developed in two to three boat lengths. The energy of boat generated waves decrease with distance from the source. Boat waves have the greatest impact in narrow coves and where boats are turning.

Wave direction and height change as the wave moves into shallow water and feels the bottom. The waves lose their energy first by partial spilling of the wave crests followed by breaking and finally wave run-up onto the shore.

Rising lake levels allow more wave energy to attack the shoreline. Falling lake levels allows the energy to be dissipated in the shoreline. Property can be protected by a gently sloping shore that causes more of the wave power to be dissipated in the size graded stones termed shingle. See Figure 1 below.

[1] See “More to Explore” at the end.

[2] “Managing and assessing Boat Wake Waves”, William Glamore, PhD, University of New South Wales, PIANC AGA 2008.

WAVES FEELING THE BOTTOM

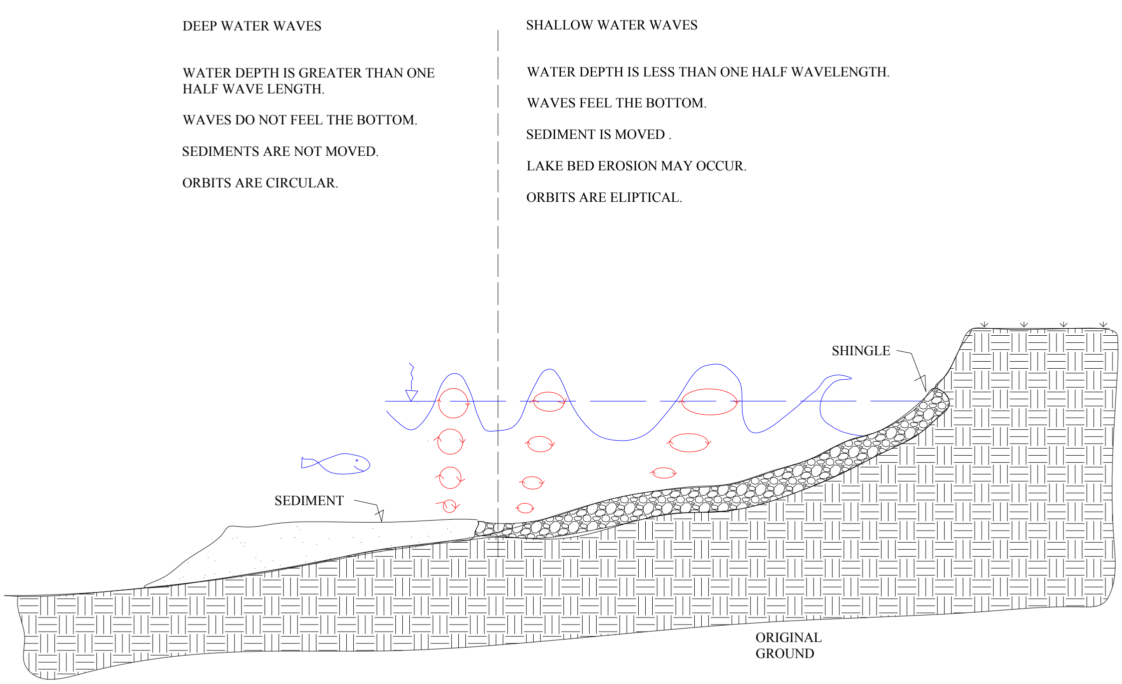

Figure 1 Typical Lake Shoreline Cross Section[3]

The wave energy is dissipated in the movement of the objects in the bottom where the waves feel the bottom. The weight of the objects the waves can move is a function of the wave energy. Over time the waves sort the objects by weight. The fine ones are transported out as sediment and the larger ones form a pavement of stones termed shingle.

SEDIMENT TRANSPORT:

Zoom into the lake shoreline in Google Earth. In most areas the shingle is visible. It is a band extending from the high water mark to the low water mark where the shore is in the fall and in the winter[4]. Sediment can be transported along the shore line where they settle in the deep water zone beyond the influence of the waves[5].

An understanding of the sediment transport mechanism is important for predicting and evaluating trends and the possible effects of engineered structures.

Ice is not a major factor in shoreline erosion at Deep Creek Lake, but will have a great impact on manmade structures it can get in its grasp.

[3] Adapted from “Living on the Coast”, Sea Grant, University of Wisconsin & US Army Corps of Engineers, Detroit District.

[4] “Notes on Shoreline Erosion Due to Boat Wakes and Wind Waves” Tim Gourlay, Centre for Marine Science and Technology, CMST Research Report 2011-16, November 2011

[5] Ibid.

From 1985 to 2012 there are places around the lake where the shoreline has moved back between five and 15 feet. This reduces the width of the strip between the water and the adjoining private property. The minimum width of that strip was set at 25 horizontal feet when the state sold the excess property to lakeshore property owners in a process called the 'buy-down.'

The wave interaction with the lake bottom at the shoreline acts like a conveyor belt out to deeper water. The circular motion of the wave churns up the bottom, and the bank, suspending the particles it can lift. When the wave recedes the suspended particles go as well. Once out in quiet water they settle out producing an off shore mud bar.

SHORELINE EROSION:

Pictures on the deepcreekanswers.com website[6] show the effects of bank undercut, bluff slumping, sliding, and toe erosion. Picture A012 shows typical bank undercut. Picture A124 shows an example of bluff slumping. Picture A055 shows sliding. Picture A106 shows toe erosion, as do most of the other pictures.

Shoreline stability is a function of the kind of material in the shallow area, the slope of the bottom and the wave exposure. The shoreline is most stable where all of the wave energy is expended moving the stones in the shingle. It is least stable where the wave action has direct contact with the soil. Some soils are more erodible than others. The higher the sand content the less resistant to erosion the soil is. The higher the clay content the more resistant to erosion the soil is.

SHORELINE PROTECTION:

The best shoreline protection systems incorporate protective vegetation, proper bank slope, filter fabric, and enough structure to hold the elements in place and to protect the vegetation roots and stems.

Materials of construction and methods employed need to be tailored to the situation. Consideration must be given to protection end treatments. The waves will go behind protection at the ends and carry it away.

The best practices will dissipate the wave energy by converting it to mechanical energy that can be absorbed by the structure. Massive impervious structures like poured concrete walls will reflect the wave energy to be dissipated somewhere else.

[6] deepcreekanswers.com

MORE TO EXPLORE:

"Maryland Department of Natural Resources Shore Erosion Control Guidelines for Waterfront Property", Second Edition, Tawes Office Building D-3, Annapolis, Maryland 21041.

"Role of Boat Wakes in Shore Erosion in Anne Arundel County, Maryland" Chris Zabawa and Chris Ostrom, Editors, Maryland Department of Natural Resources, 1 December 1980

US Army Corps of Engineers, "Coastal Engineering Manual, Revised 1 June 2006.