Glaciolacustrine sediments in the Clark Fork River valley at Garden Gulch, near Drummond, Montana, USA record highstand positions of the ice-dammed glacial Lake Missoula and repeated subaerial exposure. During these highstands the lake was at greater than 65% of its recognized maximum capacity. The initial lake transgression deposited a basal sand unit. Subsequent cycles of lake-level fluctuations are recorded by sequences of laminated and cross laminated silt, sand, and clay deformed by periglacial processes during intervening periods of lower lake levels. Optically stimulated luminescence (OSL) dating of quartz sand grains, using single-aliquot regenerative-dose procedures, was carried out on 17 samples. Comparison of infrared stimulated luminescence (IRSL) from K-rich feldspar to OSL from quartz for all the samples suggests that they were well bleached prior to deposition and burial. Ages for the basal sand and overlying glaciolacustrine exposure surfaces are indistinguishable within one standard deviation, and give a weighted mean age of 20.9 ± 1.3 ka (n = 11). Based on sedimentological and stratigraphic analysis we infer that the initial transgression, and at least six cycles of lake-level fluctuation, occurred over time scales of decades to ~2 ka. Bioturbated sandy slopewash dated at 10.6 ± 0.9 ka and 11.9 ± 1.2 ka unconformably overlies the upper glaciolacustrine deposits. The uppermost sediments, above the glaciolacustrine section, are younger than the Glacier Peak tephra (13.7-13.4 cal ka B.P.), which was deposited across parts of the drained lake basin, but has not been found at Garden Gulch. Our study indicates that glacial Lake Missoula reached >65 percent of maximum capacity by about 20.9 ±1.3 ka and either partially or completely drained twelve times from this position. Rapid lowering from the lake's highstand position due to ice-dam failure likely led to scour in the downstream portions of the glacial Lake Missoula basin and megafloods in the Channeled Scabland.

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