This **Supplemental Material** accompanies Wiedmer, R.M., Gillespie, A.R., Montgomery, D.R., and Greenberg, H.M., 2021, Further evidence for the Matanuska megaflood hypothesis, Alaska, *in* Waitt, R.B., Thackray, G.D., and Gillespie, A.R., eds., Untangling the Quaternary Period—A Legacy of Stephen C. Porter: Geological Society of America Special Paper 548, https://doi.org/10.1130/2021.2548(19).

Figure S1. Elmendorf moraine Knik lobe outwash deposited over Little Susitna River trough through the Matanuska lobe. (A) Color elevation contour map of junction between Knik (lower right) and Matanuska (upper) lobe Elmendorf moraines. (B) Elevation profile of outwash originating from Knik lobe. Outwash thickness reaches up to 30 m above sandy fan-delta plain to west.

Ground-penetrating radar data: Figures S2–S6.

GeoTek Alaska, Inc. acquired the radar data under contract using a Sensors & Software "pulseEKKO Pro" system. They used a 50-MHz antenna, with a nominal signal penetration of ≤19 m, or a 100-MHz antenna, with half the signal penetration, but with higher resolution. The antennae were towed and operated by walking crews. To improve interpretability, the vendor applied several digital signal processing routines (T-zero editing, dewow filtering, normal moveout for the near-surface, spreading and exponential calibrated compensation gain, and a migration routine) to the raw data. At a few locations, vertical temporal and median filters were used to reduce noise generated by ambient high-frequency radio signals. Topographic corrections, provided either by ground global positioning system (GPS) surveys or by elevations derived from the light detection and ranging (LiDAR) digital elevation model (DEM), were applied to raw radar profiles at all sites. The vendor provided us with processed ground-penetrating radar plots, not raw data.

We measured 19 ground-penetrating radar transects on six categories of landforms: recessional moraines, drumlins, an esker, very large dunes, large dunes, and a filled Pleistocene crevasse. For some of these transects, we used both the 100- and 50-MHz antennae, for a total of 29 profiles (Table S1). The reported depths in meters above sea level (m asl) were modeled from the delay time assuming a velocity of 0.1 m/ns and offset according to the independent GPS or LiDAR elevation data. All profiles are shown in Supplement Figures S2–S6, including those shown in the manuscript Figure 17. The ground-penetrating radar transects are identified by the letter codes in Table S1.

Each profile is presented in a panel that displays the radar data on the left and a 1-m-resolution LiDAR shaded-relief map showing the location of the transects (lines) on the right. Triangles indicate the start of the transect (usually at $x = 0$ m). North is up.

Figure S2. Moraines. 50- and 100-MHz profiles are shown for sites on two moraines that the Knik Glacier deposited during the episodic recession of the glacier and one site on a right-lateral moraine of the Matanuska Glacier. The Knik moraines occupy a lateral position on the northern flank of the glacier. Although the general flow of the Knik Glacier here was westward, the flow on its right-lateral margin was to the north out of the trough. The top two panels are from S. Alder Lane (AL); the second two are from S. Cotten Drive (SC_a and SC). S. Alder Lane cuts through individual moraine crests at $x = 100$, 140, and 180 m. S. Cotton Drive cuts through individual moraine crests at $x = 108$, 159, 192, 224, and 239 m. The last two profiles, for the Matanuska lateral moraine (LM and LM_a), are of different lengths (50 MHz: long; 100 MHz:

short). The 50-MHz profile (LM) takes a right-angle bend in the middle, so that for the first half, the direction of flow is into the page, and for the second half, it is from left to right. The same is true for the 100-MHz profile (LM_a), except that the final 130 m of LM were not measured.

Figure S3. Drumlins. Three drumlins from the bed of the Knik Glacier were probed with the 50-MHz antenna. The top panel shows a profile along W. Hollywood Road (HR), parallel to the long axis of the drumlin. The top few meters are Knik till; lower strata contain Matanuska-sourced granitics and appear to be Matanuska outwash. The drumlin was therefore erosional. The second panel, S. Andrea Drive (AD), was perpendicular to W. Hollywood Road. The S. Andrea Drive profile shows the flank of the drumlin. The third panel, W. Carmel Road (CR), shows a profile that crosses two drumlins and the trough between them. In this profile, radar reflectors are largely surface-conformable. The bottom panel shows a profile on Knik Knack Mud Shack Road (KK) that is orthogonal to the W. Carmel Road profile and oblique to the eastern of the two drumlins. In contrast to the W. Carmel Road profile, reflectors are truncated by the surface.

Figure S4. Very large dunes. Four very large dunes were probed by nine profiles of ground-penetrating radar. A long transect along W. King Arthur Road (KA) (50, 100 MHz) spans two dunes. W. King Arthur Road cuts through large dunes at $x \approx 124$, 279, 329, 424, 469, 540, 632, 719, 809, 894, 932, 1059, 1109, 1219, 1425, and 1480 m. Two short transects on N. Castle Drive (50, 100 MHz) parallel the long axis of one of the very large dunes and intersect the W. King Arthur Road transect. This transect crosses a culvert at $x = 5$ m. A second long transect across two dunes along W. Delroy Road (DR, 50 MHz) was accompanied by two 100-MHz segments, DR_a and DR_b. Two short transects on N. Dodge Drive (DD, 50, 100 MHz) intersect W. Delroy

Road. W. Delroy Road (DR) cuts through large dunes at $x = 20, 100, 150, 220, 665, 690, 760, 810, 855, 935$, and 1025 m. On the DR_a transect, large dunes are cut through at $x = 20, 100, 150$, and 220 m; and on the DR_b transect, large dunes are cut through at $x = 42, 110, 162, 212, 290$, and 382 m.

Figure S5. Large dunes. Parasitic dunes an order of magnitude smaller than the very large dune on which they are perched were measured on W. Hawk Lane (HL, 50 MHz). This transect crosses large dunes at $x = 30, 60, 115, 180, 210, 260, 290, 340, 400, 430$, and 485 m. Two parallel shorter segments parallel to W. Hawk Lane were measured at 100 MHz. HL_a was collected along the first 131 m of the W. Hawk Lane transect, and FP extended across undisturbed terrain under the W. Francis Clar powerline. Profile HL_a provides a detailed look at prominent large dunes at $x = 34, 68$, and 114 m. The profile of this large dune in HL and HL_a shows that it interfingers with sediment of the very large dune and was created synchronously instead of being deposited on top of it later. Profile FP crosses large dunes at $x = 21$ and 88 m and features an unconformity ~3 m below the surface. Another transect was established on the Zero Lake logging road (ZL, 50 MHz). This transect crosses below the southern ends of three large dunes at $x = 22, 85$, and 130. However, for this large dune, no interfingering relationship is clear, but sediment composition appears to abruptly change below ~4 m from the surface.

Figure S6. Crevasse fill and esker. The two top panels present ground-penetrating radar profiles for the Johnson Lake trail (JL, 50 and 100 MHz) (“crevasse fill”). The third panel presents two short 50-MHz profiles across the trough between filled crevasses (T_n) and along the bottom of the trough (T_l). The trough was created when the glacier ice between the filled crevasses melted.

It is now partly filled with a meter or two of material slumped from the adjacent steep ridge slopes.

The bottom panel ("esker") shows two 50-MHz profiles taken on the S. Horseshoe Lake Road (HS) and W. Lakes Boulevard (WL). The HS profile is normal to the long axis of the esker. At x = 25 m, it crosses a pipeline. The WL profile is on the crest of the esker. As displayed, flow direction within the esker was from right to left on WL and toward the reader on HL. The strong reflector ~6.5 m down appears to be over 1 m deeper than the flat ground surface adjacent to the esker.

Table S1. Ground-penetrating radar transects. Locations are those used in Figures 2, 3, 17, S2–S6, and in the main text.