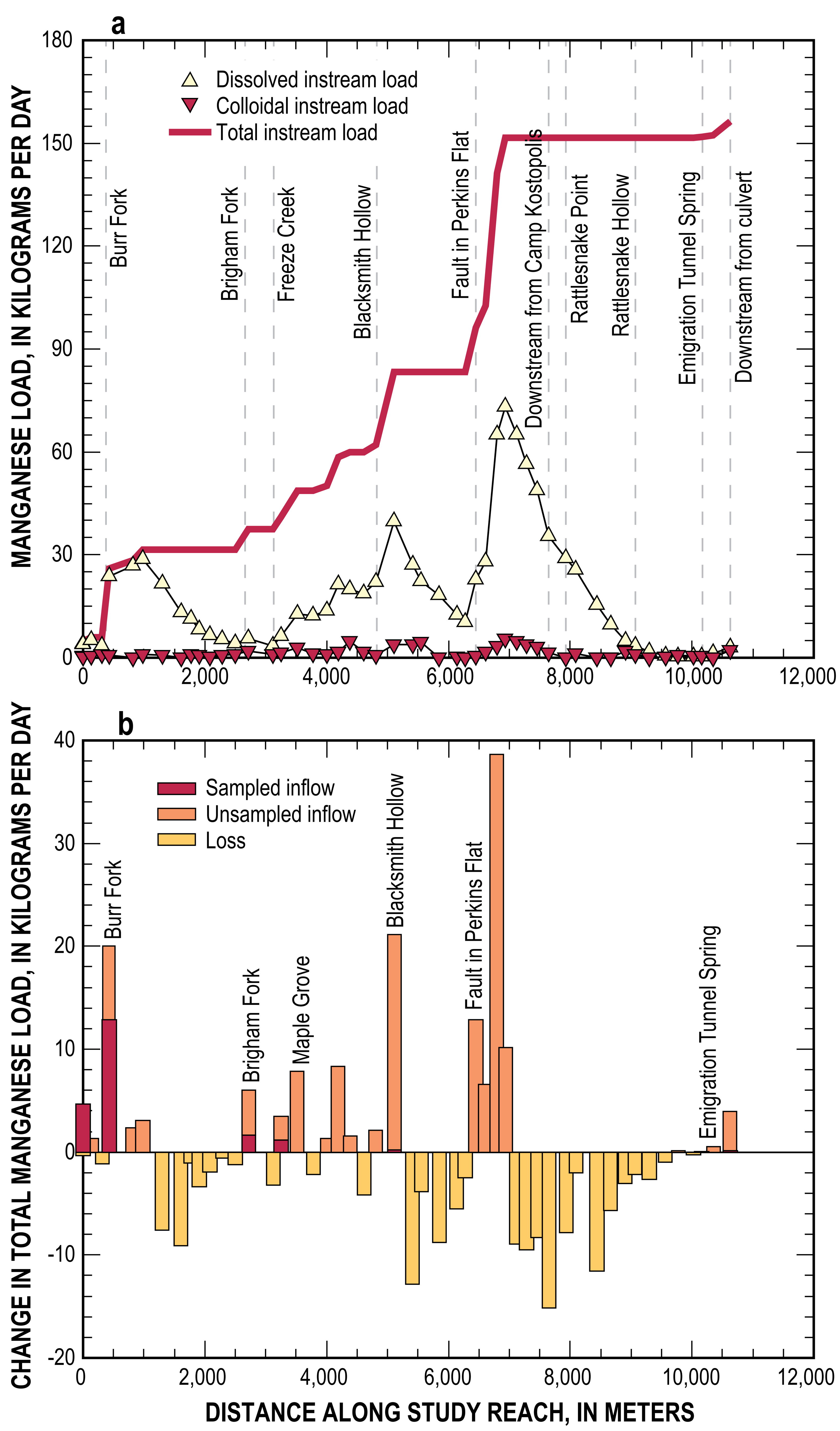

Figure 12. Variation of (a) dissolved and colloidal manganese load and (b) change in manganese load for individual stream segments with distance along the study reach, Emigration Creek, Utah, October 12, 2005.

Loading Pattern of Sulfate

The majority of trace elements had loading profiles that were similar to that of calcium (fig. 10), but patterns of sulfate, chromium, copper, lithium, and strontium were distinguished from the main pattern because the greatest loading for these constituents occurred at the end of the study reach, downstream from 10,160 m (fig. 9b). If the increase in loads for these downstream segments were a result of water re-emerging after being lost upstream (fig. 4), then one would expect the concentrations of most constituents to be similar to stream-water concentrations between 8,092 and 10,024 m (fig. 5). On the time scale of this experiment, no bromide would have occurred in any of those downstream inflow samples. But concentrations of sulfate and the trace elements were much higher in samples from inflows at 10,175, 10,541, and 10,633 m than in samples of stream water from 8,092 to 10,024 m (tables 2 and 3), suggesting that discharge from the downstream inflows was not from re-emergent stream water. The stream segment from 10,160 to 10,352 m contained loading from the Emigration Tunnel Spring. The segment from 10,352 to 10,626 m flowed in the culvert, and discharge from Wagner Spring (10,541 m), which is located on the north side of the road across from the culvert, is piped into the culvert (Jeff Nermeier, Salt Lake City Public Utilities, oral commun., 2006). The sulfate concentration in the sample from Wagner Spring, however, accounts for less than half of the sulfate loading in the stream segment (fig. 13b), suggesting that there could be additional sources of loading that discharge into the culvert. Downstream from 10,626 m, stream samples were affected by construction and no loading was calculated.

The loading of sulfate has characteristics of the major ions but also illustrates the pattern for this second group of constituents (fig. 13). Although sulfate concentration was nearly constant along most of the study reach, the loading profile indicated distinct locations where sulfate loading occurred. Sulfate concentration in samples from Burr Fork, Brigham Fork, and Freeze Creek was comparable (fig. 5d) because all three tributaries drain the same sequence of geologic formations along the north flank of the syncline (Bryant, 1990). Because those inflows account for the great majority of loading along the study reach down to the Emigration Tunnel Spring, the sulfate concentration remained nearly constant (fig. 5d). Sulfate load decreased between 7,931 and 10,024 m as a result of the decrease in discharge through that reach (fig. 4), and not as a result of a chemical or biological process because sulfate concentration did not decrease (fig. 5b).

Loading Patterns of Nitrate and *E. coli*

Loading patterns for nitrate and *E. coli* had little in common with the loading patterns of the major ions or trace elements. Nitrate load increased and decreased at many locations along the study reach, suggesting a dynamic system for nitrate, with uptake of nitrate keeping pace with nitrate loading (fig. 14). Nitrate load increased substantially between 4,007 and 4,189 m, but no particular source was observed there. Between 6,136 and 6,274 m nitrate load also increased, and this nitrate loading could be associated with the fault in Perkins Flat, similar to loading of other elements already noted (fig. 1). If so, this source would not be associated with septic or animal influences. A second location with substantial loading that has no apparent connection to septic systems is in the segment from 10,352 to 10,626 m, within the culvert. All the inflows that were sampled downstream from 10,160 m had $\delta^{15}N$ values that are in the range reported for septic systems, but occur in a part of the study reach with no homes (fig. 7b).