*Science* editors,

Please find the enclosed manuscript ‘Ephemeral stream water contributions to United States drainage networks’, in which we present the first continental-scale assessment of ephemeral stream hydrology and biogeochemistry for every river, lake, reservoir, canal, and ditch in the United States (U.S.). We find that ephemeral streams (those that only flow following rain events) contribute the majority of water to U.S. river networks and have potentially major implications for downstream water quality and quantity across the global river network. By incorporating state-of-the-art models in a novel routing framework for over 20,000,000 surface water features, this study represents a major advancement in 1) our understanding of the role that ephemeral streams play in global freshwater resources and 2) defining the scientific basis for ephemeral streams within U.S. water quality regulation.

Streams transport pollutants and other solutes from the land surface to larger rivers downstream and ultimately export into the ocean. The most upland streams are often ‘ephemeral’ channels, which flow only in direct response to precipitation and are disconnected from groundwater year-round. Temporary streams (which include both ephemeral channels and those that have intermittent groundwater connections) make up over half of the global river network. It is also regionally established that headwater streams contribute meaningfully to downstream water quality. However, these two ideas have never been reconciled at scale, nor are there any existing assessments capable of distinguishing between ephemeral and intermittent streams at the global scale.

To address that gap in knowledge, we use geomorphic theory, existing models, and a novel continental-scale routing framework to map the fraction of water (by volume) that is ‘ephemerally sourced’ for every river, lake, reservoir, canal, and ditch that drains the contiguous U.S. We also use existing data and models to estimate the average annual number of days that ephemeral streams flow. We find that, on average across basins, 60% of water exported from United States drainage networks comes from ephemeral streams that only flow, on average across basins, 104 (+/- 28) days per year. This significant contribution is facilitated by small headwater streams, where on average 82% of headwater streamflow is ephemeral.

Thus, the ephemeral terrestrial-aquatic connection is a substantial pathway through which pollution (and other solutes) may enter the downstream perennial drainage network and influence water quality. This should have significant implications for global hydrology and biogeochemistry, which to date do not explicitly account for ephemeral streams in their models.

More broadly, our results may help to establish U.S. federal jurisdiction for water quality regulation under the 'significant nexus' standard. The U.S. Clean Water Act grants U.S. federal agencies the authority to regulate the 'Waters of the United States' (WOTUS) and while there is general agreement that WOTUS includes large navigable waterways, differing and conflicting interpretations apply to smaller (tributary) waterways, especially including ephemeral streams. Due to the timeliness of our results in the context of a case presently pending before the U.S. Supreme Court on this topic, if our manuscript is sent to review we request it receive an expedited review process to rapidly assess for publication.

The authors of this study all approve of this submission, and there are no conflicts of interest. None of the material in this manuscript is under review or published elsewhere. We provide the data and code underlying our analysis in a private repository () and, if accepted, will make this repository public. Thank you for your consideration of this article (and of an expedited review process). If there are any questions regarding our methods, findings, or the broader implications of this work, please do not hesitate to contact corresponding author Craig Brinkerhoff.

On behalf of all authors,

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