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FROM: Paula Mabee, Chief Scientist and Observatory Director, NEON

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SUBJECT: Use of SF6 for NEON Reaeration (DP1.20190)

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Measuring reaeration in aquatic systems provides critical data on the gas movement between water and the air. https://data.neonscience.org/data-products/DP1.20190.001

Why use Sulfur Hexafluoride (SF6)?

- SF6 has been used for decades as a great tracer and used extensively by the EPA in the 1970s and 1980s in atmospheric dispersion experiments.
- The properties of this non-toxic gas are ideal for the types of experiments where NEON is using it, specifically the unique data it produces which is provided to environmental researchers working to monitor and improve the climate and environment.
- The reason SF6 is used by researchers, including those at NEON, is because it is inert biologically and abiotically and has low background concentrations, so no corrections are required. It is easy to analyze using a gas chromatograph, which is a widely available instrument at laboratories.
- NEON's mission involves using existing best practices in the scientific community to collect comparable data. When began collecting gas exchange experiments in 2014, SF6 was the most established method supported by the research community.
- NEON staff created the *Reaeration Technical Working Group (TWG)* in 2021 to advise NEON regarding available alternatives to SF6 and whether they should be incorporated into the NEON design.The Reaeration TWG is made up of six community technical experts in stream chemistry: https://www.neonscience.org/re-aearation-twg. TWG members have been supportive of NEON use of this gas in the experiments and highlight the novelty and value of the dataset being produced, as it covers a wide geographic range and different types of stream environments.

Alternatives to SF6

- The primary alternative to SF6 discussed with the TWG is argon, which has the advantage of not being a greenhouse gas. The drawback is that the collection process is more difficult (a different gas cannot simply be substituted in the workflow), and the downstream analysis

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requires a much more specialized piece of equipment that only a few labs have. Thus, a completely new field SOP, training, data ingest, external lab contracts, etc. would need to be established.

- Switching to a different gas at this point in time would require more SF6 releases due to the need to run side-by-side injections of both the new gas and the SF6 gas, so that researchers could connect old and new measurements.
- Based on the TWG assessment that NEON has sufficient data to stop experiments in most NEON sites, and that NEON only needed to target specific stream flow ranges in remaining sites, the TWG's opinion was that it did not make sense to make the switch for these last remaining measurements.

Proposed Changes to NEON Gas Exchange Measurements

- The TWG has recommended only continuing the use of SF6 at 10 of the 22 NEON aquatic locations where we were doing SF6 releases. They have been extremely helpful for identifying which sites to continue collecting data and the flow ranges that NEON needs to target. They have also provided invaluable advice about the analyses NEON has done to help with these determinations.
- NEON is reducing the use of this gas because we have enough data to provide to the community for some sites and additional gas exchange data is not needed to support metabolism and gas flux estimates by the community.
- NEON will continue to use this process up to three times per year at up to 10 sites for flow-targeted ranges, likely for 1-3 years depending on site conditions.
- Eventually we will stop using SF6 when all sites have enough data to draw conclusions about gas exchange rates across a wide range of flows at a site.

How much SF6 has been released?

- In 2021 NEON used ~18 lbs of SF6. We plan to release ~4 lbs in 2022/23 as we continue to find ways to limit SF6 releases while maintaining data quality and value.
- So far, NEON has released approximately 108 lbs or about 0.16 lbs per experiment and needed 30-40 experiments for most sites to cover the full practical range of flows for a stream.