Evaluation of an Automated Micro-Volume *in situ* Spectrometry-based Lab for High Spatial and Temporal Resolution Water Quality Measurements

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**Introduction**
- Data acquisition in environmental sciences is *always* partial in time and in space.
- We often make the hypothesis of spatial and temporal continuity between measurements.
- Decisions made from sparse and infrequent data may be risky.
- We hypothesize much better decisions could be made from higher spatial and temporal resolution data.
- New UV-Vis spectrometer probes make high temporal resolution water quality measurements possible.
- But they are expensive, so spatial resolution might suffer unless... 

**Research Questions**
- Can we build a high-frequency WQ automated sampler using UV-vis spectrometry to measure multiple sources of water?
- Can the sampled volume be minimized to expand use for porous media systems?
- What would be the performance of such a system: accuracy, precision, carry over, etc?

**System Design Components**
- **High sample frequency**: integrated control board provides automated sampling at intervals as low as four minutes.
- **Multi-port intake**: allows system to select which source to sample from by advancing valve with 12 different intakes.
- **Arduino Control Board**: gives high user control to adjust sampling intervals, collection routine, and purge sequences.
- **Triple 3-way valve setup**: provides greater versatility and function; allows water sample to be sent to multiple locations once collected.
- **UV-vis spectrometer**: gives immediate feedback on sample quality and provides accurate results at high sampling frequency.
- **Fraction volume collector**: once samples are tested using UV-vis they can be collected for later lab analysis to validate spectrometer results.
- **Reliable results**: Preliminary lab testing shows efficient purging routine gives low cross contamination between samples (< 1%).

**System Performance: Method**
- **1 - Define best sampling configuration to minimize cross contamination**
- Alternating low and high concentrations from separate water sources (Fig. 1)
- Low: tap water
- Highs: 3, 7, and 12 mg N/L nitrate solution.

**System Performance: Results**
- **2 - Evaluate performance for best configuration**
- Alternating low and high concentrations from single water source (Fig. 2)
- Cross-contamination evaluated in µL residual volume

- Residuals can be minimized to low, consistent vol. (< 40 µL equiv.) using effective purging with DI water and air between samples.
- Testing of source contamination shows low, predictable volumes of residual discharged to the source (< 20 µL equiv.).
- Detectable cross contamination after 1000 purges when alternating 10L solutions of <0.5 mg N/L and 10 mg N/L of nitrate

**Potential Applications**
- Application to mesocosm studies to provide high resolution data to more accurately determine reaction kinetics.
- High frequency data could provide better picture of nutrient loading to SW following storm events.
- Small sample volume and spatial resolution can provide insight on flow and biogeochemical processes in hyporheic and riparian zones.
- Can be used for source testing in hydroponics applications.