

# Samuel A. Flewelling, Ph.D.

## Principal

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Dr. Flewelling is a principal scientist at Gradient who specializes in evaluating water resources and the behavior of chemicals in the environment, including chemical transport through groundwater and surface water, fluid-rock interactions, and underground migration of multiple fluid phases (*i.e.*, DNAPL and LNAPL). He has published peer reviewed papers on a variety of topics ranging from the natural controls on agricultural chemical migration through the landscape, to the potential for hydraulic fracturing fluid to migrate through fractures and faults to shallow drinking water resources. As a consultant during the past 15+ years, he has applied in-depth knowledge of fluid-mediated processes to solve a range of complex challenges associated with the oil and gas, electric power, chemical manufacturing, pharmaceutical, mining, agricultural, and waste disposal sectors. This work has included site-specific evaluations (*e.g.*, CERCLA sites) as well as large-scale assessments of the potential transport and effects of chemicals across entire states or countries.

## Representative Projects

**Significant Nexus Evaluation:** For a Clean Water Act (CWA) case, evaluated the hydrology of drainage features at a site in relation to Significant Nexus allegations.

**Water Rights Dispute:** Provided technical evaluation and expert testimony for an equitable water allocation request before the U.S. Supreme Court (Original Action 142). Evaluations included assessments of watershed hydrology, groundwater flow, human water consumption, and reservoir operations.

**Hydraulic Fracturing Risk Evaluation:** Evaluated the potential effects of hydraulic fracturing (HF) of deep shale formations on potable aquifers, including the migration of HF additives through fractures and intact bedrock. The combination of a literature review and modeling analyses allowed for the estimation of the likelihood for HF additive migration beyond the target shale zone.

**Hydraulic Fracturing Impacts to Groundwater:** Evaluated a US EPA study of potential hydraulic fracturing (HF) impacts to potable aquifers in Pavillion, WY. Analysis included the assessment of potential migration of HF additives in groundwater, well construction and sampling methods, and inorganic geochemistry of groundwater.

**Pesticide Fate and Transport:** Modeled the biodegradation of a wide range of pesticides in soils to determine pesticide residue levels expected from historical applications. The analysis was used in negotiations over the need for additional sampling and site investigation.

**Radionuclides in Drinking Water:** For a toxic tort case, analyzed natural and anthropogenic sources of radionuclides to a coastal aquifer and the dominant transport mechanisms downgradient of an industrial facility.

**DNAPL Source and Release Timing:** At a complex multi-PRP site in the northeast, analyzed the fate and transport of PCB and chlorinated solvent DNAPLs as part of an evaluation regarding the sources, release timing, and impacts to streams bordering the site. The analysis considered DNAPL migration through underground pipes, fractures, and sand seams.

## Areas of Expertise

- Hydraulic Fracturing Risk Analysis
- Contaminant Fate & Transport
- Hydrological Modeling
- Groundwater-Surface Water Hydrology
- Chlorinated Solvents
- NAPL
- Petroleum Hydrocarbons
- Trace Metals

## Education

Ph.D., Environmental Sciences, University of Virginia

B.A., Environmental Sciences, University of Virginia

## Selected Presentations and Publications

**Flewelling, S.** 2017 (Spring) "Increasing water use will escalate disputes." *Gradient Trends - Risk Science & Application* 69: 1-2,6.

Fitzsimmons, M; **Flewelling, SA**; Tymchak, MP. 2014. "Will Earthquakes Shake Up The Shale Wastewater Debate?" Accessed at <http://www.law360.com/articles/539206/will-earthquakes-shake-up-the-shale-wastewater-debate> 6p.

**Flewelling, SA**; Sharma, M. 2014. "Constraints on upward migration of hydraulic fracturing fluid and brine." *Groundwater*, 52(1):9-19.

**Flewelling, SA**; Tymchak, MP; Warpinski, N. 2013. "Hydraulic fracture height limits and fault interactions in tight oil and gas formations." *Geophysical Res. Lett.*, 40:3602-3606.

**Flewelling, SA**; Sharma, M. 2011. "The Timing of DNAPL Releases in a Fractured-Clay Setting." Presented at Society of Environmental Toxicology and Chemistry North America 32nd National Meeting, Boston, MA, November 13-17.

Gu, C; Hornberger, G; Mills, A; Herman, J; **Flewelling SA**. 2007. "Nitrate reduction in streambed sediments: Effects of flow and biogeochemical kinetics." *Water Resour. Res.* 43(12):43-52.



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