

## There's Too Much in the Water: VOCs, APIs, Polar Solvents and Many Unknowns

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**Background/Objectives.** During investigation of a pharmaceutical site an increasing amount of compounds were detected in soil and groundwater. The initial intention was to delineate several VOC plumes migrating downgradient from historical and recent chemical sewer leaks. It became quickly clear that the sum of benzene, toluene, chlorobenzene, dichloromethane and 1,2-DCA between 100 and 500 mg/L was nowhere near enough to match a DOC of up to 2 g/L. Further plumes of MTBE (70 mg/L) and 1,4-dioxane (5 mg/L) were detected. Additionally, many active pharmaceutical ingredients (APIs) were analyzed with up to 10 mg/L, which is about four magnitudes higher compared to generally detected levels of <1 µg/L.

**Approach/Activities.** In the meantime, a pilot pump and treat (P&T) system with a stripping unit and vapor/liquid phase GAC filters has been installed as an emergency measure close to a recently discovered chemical sewer leak. An existing nearby monitoring well was used for groundwater extraction to provide immediate hydraulic capture. While investigating the reasons for constantly decreasing P&T efficiency with increasing carbon consumption additional polar solvents were analyzed. The sum of polar solvents (mainly acetone, isopropanol, tetrahydrofuran and dimethylformamide) added up to another 400 mg/L. Whereas most VOCs and APIs could be effectively treated with the GAC filters, the MTBE and 1,4-dioxane was only treatable with a high air / water ration of > 300:1. Less than 10% of the polar solvents were stripped, but only minimally adsorbed to the vapor/liquid phase GAC. Unfortunately, the filter screen of the extraction well, made of PVC in 2011, collapsed after less than 1 year of operation, likely due to the extreme solvent concentrations in combination with added soil pressure due to the water level decrease. As a result, the treatment system was flooded with sediment and needs to be replaced. Due to on-going findings of more substances, the regulator requested a non-target screening to detect all relevant compounds in groundwater, which revealed more than 200 previously unknown compounds. Three were above 1 mg/L (NMP, benzoic acid and lidocaine). Another 23 were above 100 µg/L. Also 88 unknown substances of which four were above 100 µg/L could not be verified at all.

**Results/Lessons Learned.** The difficulties with this suite of substances are not only the analytical detection methods and limits, but also the few data regarding threshold limits in groundwater, soil and air, the limited possibilities to calculate thresholds (e.g., via US-EPA regional screening level), many inconsistencies with toxicological data in risk assessments (e.g., according to the threshold of toxicological concern [TTC] concept or tolerable daily intakes [TDI]) or simply the negotiation with regulators about remediation and discharge limits or goals. Once a strategy about how to deal with all different compounds is agreed with the regulators, a combined approach of complete hydraulic capture and in situ treatment can be developed.