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EXAMINING SOURCES OF ARSENIC TO A CONTAMINATED STREAM.

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The Vineland Chemical Company manufactured arsenical herbicides at their factory in Vineland, NJ for more than 30 years, during which time nearby soils and groundwaters became heavily contaminated with arsenic. The Blackwater Branch, a small freshwater stream that flows near the perimeter of the former factory, also became contaminated with As. This contamination extends downstream into the Maurice River and Union Lake, both of which present significant opportunities for human contact. In 1984 the Vineland site was added to the National Priorities List; one of the primary remediation goals was to eliminate off-site migration of As occurring via groundwater discharge to the Blackwater Branch. Groundwater extraction and treatment is now occurring at a rate of about 66 liters/second, theoretically sufficient to accomplish hydraulic capture of all contaminated groundwaters. However, As concentrations in the Blackwater Branch still increase as it passes the site; for example in July 2003 dissolved As levels rose from 2.5±0.2 to 24.2±0.2 μg/L as the stream traversed ~1.4 km near the site. Investigations are being performed to evaluate potential sources of As to the stream, including a) continued groundwater discharge to the stream and b) remobilization of As previously accumulated by stream sediments. Samples collected for these investigations include sediment cores for pore water and solid phase analyses, surface water transects, and limited stream flow data. Particle accumulation rates of stream sediments were derived from ^{137}Cs dating, which suggested average sedimentation rates ranged in different cores from >0.6 cm/year to about 0.4 cm/year. Measurements on the pore waters included arsenic speciation using cathodic stripping voltammetry and analysis of a large suite of elements using ICP-MS. The pore water profiles showed a strong subsurface maximum of ~1100 μg/L As(V) at 3 cm, while As(III) was more constant with depth. Concentrations of total dissolved arsenic in the pore waters were 300 – 1800 μg/L, and total solid phase As concentrations at this site were up to 2 g/kg. Strong correlations were observed between dissolved iron and arsenic porewater concentration depth profiles, consistent with arsenic remobilization from the sediments. Diffusive fluxes of As into the stream from the sediment pore waters were calculated to be up to 3.8 mg/m^2/day. Stream flow increased from ~570 to ~900 L/s over 300 meters. If these stream flow measurements are extrapolated to the 1.4 km stream length where arsenic concentrations increased from 2.5 to 24.2 μg/L, the total flux is estimated at ~300 mg/m^2/day, approximately eighty times larger than the diffusive flux. These estimates are consistent with most of the dissolved arsenic in the Blackwater Branch coming from groundwater discharge to the stream, implying incomplete hydraulic capture by the network of extraction wells and treatment facilities. Whatever the primary processes involved, continued arsenic influx to the stream poses significant challenges to site clean-up goals.