Converting a Stormwater Pond into a Multi-Stage Treatment Reactor for Arsenic, Ammonia, and Benzene Including Dredging and Maintenance of Chemocline at the Groundwater/Surface Water Transition Zone

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Background/Objectives. The Industri-plex Superfund Site in Woburn, Massachusetts was placed on the National Priorities List in 1983. A chemical plant operated at the site from 1853 to 1931 and manufactured lead-arsenic insecticides; acetic, sulfuric, and picric acids; and phenol, benzene, toluene, and trinitrotoluene. Glue was manufactured from 1934 to 1969 using animal hides and chrome-tanned hide wastes. Manufacturing byproducts and residues contaminated soils and groundwater. The ~$130 million Operable Unit 1 (OU1) remedy, completed in 2000, consolidated wastes and capped 110 acres. The OU2 remedy focusses on down gradient areas with the key component being Halls Brook Holding Area (HBHA) Pond, which receives contaminated groundwater migrating from OU1 and surface water from the surrounding area. Groundwater discharges to the northern end of the Pond. A chemocline in the Pond treats or sequesters contaminants in the deeper zone of the northern end of the Pond. Some ammonia and arsenic diffuses upward across the chemocline, migrating south to the Pond outlet. Baseflow from the Pond varies from 2 to 9 cubic feet per second (cfs), whereas storm flow can reach 150 cfs (experienced) to ~570 cfs (modelled 100-year event). Outflow from the Pond must meet ambient water quality criteria (AWCQ) for arsenic, ammonia and benzene.

Approach/Activities. A sheetpile wall with a weir was installed to bisect the Pond, optimizing natural sequestration in the northern cell and directing water flow through an array of “Webitat” bioreactors. Webitats provide media and robust aeration for additional ammonia treatment through oxidizing bacteria. Fine bubble diffusers (at the cofferdam), coarse bubble diffusers (within the Webitats) and surface aspirating mixers provide aeration . In addition to ammonia treatment, aeration facilitates arsenic precipitation; these solids settle as sediment. A storm water bypass structure was constructed to divert storm flows around the northern treatment cell to maintain the chemocline because mixing would interfere with natural treatment processes. A diversion structure provides a steady flow of aerated surface water to maintain the chemocline. The area south of the cofferdam was dredged, removing significant ammonia and arsenic mass within sediments, increasing retention time, and creating a flat Pond bottom for webitat placement.

Results/Lessons Learned. Webitat design was extrapolated from pilot studies that demonstrated ammonia removal of ~3.9 x 10-3 kg/day/m^2 of media, resulting in a maximum removal rate of ~30.2 kg/day for the 18 Webitats. Monitoring to date has shown ammonia removal by the system and achievement of AWQC for ammonia, arsenic and benzene. No major storms have occurred to test the 100-year basis of design for the storm water bypass, but several significant rainfalls have shown it to work as designed. About 27,750 tons of sediment was mechanically dredged and stabilized with Portland cement prior to off-site disposal, removing an estimated 70,000 pounds of arsenic and 12,000 pounds of ammonia from the system.