Keeping the Balance: Understanding and Protecting Baseflow in a Brook Adjacent to a Pump-and-Treat Remedy

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Background/Objectives. We summarize our approach used to evaluate and protect baseflow conditions in a small brook adjacent to a Superfund site where phased implementation of individual remedial components is ongoing. A pump and treat remedy was selected for design and construction as the first of four major components to provide advanced containment of groundwater impacted by volatile organic compounds (VOCs) and support water treatment and supply during thermal remediation and soil excavation activities. The pump and treat system includes a network of seven pumping wells, two of which are in close proximity to the brook, to extract groundwater at a combined rate of 130 gpm. The nature and extent of past releases required installation of the two extraction wells near the brook at pumping rates with the potential for baseflow losses. Treated groundwater is returned to the subsurface using a combination of rapid infiltration basins and injection wells strategically placed so that a large fraction of extracted groundwater returns to the brook.

Approach/Activities. Groundwater modeling simulations developed during the design indicated neglible impacts to the brook. This prompted a baseline hydraulic study over the two years prior to startup to establish reference conditions for comparison after system startup. This study featured an innovative salt-dilution method to quantify stream flow in channels that were too shallow for conventional velocity-area methods by electromagnetic sensor. Paired groundwater and surface water elevations at staff gauges and wellpoints were used to quantify the potential for gaining conditions. Baseline rating curves and hydraulic gradient data were used predictively to establish baseflow performance criteria. This study determined the brook was vulnerable to baseflow losses when flows were below 3 cfs and the system was operating at 0.3 cfs (130 gpm equivalent) and recommended a multiple line of evidence approach to assess dewatering potential. These included evaluation of post-system startup measurements with baseline conditions using (i) groundwater-surface water elevation differentials across select reaches of the brook, (ii) flow deviation from baseline at a sensitivitiy of 20% at designated locations, and (iii) comparison of flow rates from the upgdradient-most station with tolerances established during the two-year baseline study.

Results/Lessons Learned. Twenty gauging events were conducted during an approximate four-month period of low flow conditions in the first year of system operation. As anticipated, pumping of the extraction well closest to the brook during low flow induced a reversed groundwater-surface water exchange gradient. This effect was observed at the piezometer-staff gauge pairing and prompted decreased pumping rates. In the four-year period following startup, the robustness of the baseline monitoring and post-startup monitoring programs were used to develop a schedule for modifying pumping rates to minimize baseflow loss in the brook. For this application, groundwater monitoring alone was incapable of evaluating the potential for baseflow loss based on model resolution and required an innovative field-based approach to develop flow rating curves and reference hydraulic conditions to ensure stream protection. As the final source area thermal remedy is implemented in close proximimty to the brook, conformance with flow critieria will be evaluated and also include temperature monitoring to confirm there are no adverse impacts to the brook.