# Wind-Driven Air Sparge System for Passive Remediation of Hydrocarbons in Groundwater

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**Background/Objectives**. Former refinery sites continue to present an ongoing challenge in terms of cost-effective treatment of subsurface hydrocarbons. A plausible solution to this problem involves the use of wind-driven air compressors to deliver atmospheric oxygen into the subsurface, where electron acceptor-limited environments may inhibit hydrocarbon degradation. The wind-driven air sparge (WDAS) system presents a means to passively inject atmospheric oxygen into the subsurface, through use of a wind turbine to generate pressure.

This presentation describes the methods, results, and lessons learned from a pilot scale application of the WDAS system, which was conducted at a former refinery in the western United States. The site has transitioned into long-term management status, and the WDAS is being evaluated to treat groundwater near a point-of-compliance (POC) monitoring well. The WDAS is designed to treat groundwater upgradient of the POC well, without the additional infrastructure, energy footprint, and power costs of a conventional air sparge system.

**Approach/Activities**. The pilot scale system comprises two 24-ft wind towers with wind-driven air compressors. Each of the towers is connected to an air accumulation tank, and each air accumulation tank is connected to two injection wells, with 15-foot spacing. A system of pneumatic valves controls the discharge pressure ($P_{discharge}$), i.e., the pressure at which air pulses were initiated. Through this system, air tanks automatically discharge into the subsurface when the internal tank pressure reaches the $P_{discharge}$ setpoint.

Data collection includes groundwater analytes and field parameters from monitoring wells near the air-sparge wells; transducers have been deployed to collect continuous groundwater elevation data. Continuous wind data and pulse counts have also been recorded. Groundwater analytes include benzene, toluene, ethylbenzene, and xylenes (BTEX) and select semi-volatile organic compounds (SVOCs). Measured indicator parameters include redox, dissolved oxygen, methane, sulfate, and dissolved iron. Transducer data is used to evaluate air pulsing impacts on wells and to calculate hydraulic gradient. Wind data and pulse counts are collected to correlate wind speed with pulsing frequency and to evaluate effects of these parameters on water quality.

**Results/Lessons Learned**. The data suggest advantages and limitation of the WDAS approach for subsurface remediation. The pilot-scale system has successfully delivered air into the subsurface, with high pulse frequencies (up to 12/hr) achieved under reasonably windy conditions. A limitation of the pilot scale involves a relatively flat hydraulic gradient near the pilot test area, which may have limited treatment of the POC well. The transducer data has confirmed that the pulsed air sparging has had an effect on nearby wells, and multiple lines of evidence suggest an effect in certain monitoring wells near the air-sparge system. The WDAS concept appears to provide a promising approach for the ability to passively deliver air into the subsurface, and is highly recommended for continued evaluation.