COMPARISON OF DIRECT-PUSH ANALYTICAL INSTRUMENTATION

Technology	Primary Uses	Advantages	Disadvantages	Media	Relative Cost
ORGANIC SYSTEMS					
Laser Induced Fluorescence (LIF) **TWO MAJOR SYSTEMS** Site Characterization and Analysis Penetrometer System (SCAPS) Rapid Optical Screening Tool (ROST™)	Real-time, in-situ, field screening of hydrocarbons (specifically gasoline, diesel fuel, jet fuels, fuel oil, motor oil, grease, and coal tar based upon PAH content of each)	ROST™–System is available commercially through the Fugro corporation. Provides real-time chemical and geological information while in the field Capable of achieving 200 to 300 feet of pushes in a 10-hour work day Allows for small zones of contamination to be delineated that might be missed by conventional sampling protocols No cuttings are produced Push holes are filled as the probe is withdrawn Rods and probes are steam cleaned as they are withdrawn and fluids are containerized.	SCAPS–System is not available to private citizens or corporations. System is very complex and therefore, requires highly trained technicians (three-person crew and a geologist) Does not provide quantitative data. Limited to unconsolidted sediments and sites accessable to 20-ton CPT Interference--UV source may cause other substances to fluoresce (i.e. calcite, deicing agents and antifreeze additives, detergents, organic matter; etc.) Detection Limits are soil and fuel dependent (i.e. clays and fuels with low PAH content reduce delectability)	Soil and groundwater	Systems are usually procurred as a service due to the system's complex nature. Purchase of a system incorporating the LIF is estimated at $200,000-400,000, rental cost is estimated at $4000/day. SCAPS–varies between $12 and $20 per foot ($2,400 to $6,000 per day) ROST™–under $20 per foot ($5,300 per day) LIF rental by itself costs range from $2,000 to $3,000 per day, which includes operators.

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Mercury (Hg) Fluorescence	Site-specific relative screening of contamination levels (specifically jet fuels, diesel, unleaded gasoline, home heating and motor oil, coal tars and creosote)	Cuts time needed to delineate the extent of hydrocarbon plumes from fuel spills or leaking storage tanks Can be adjusted for background fluorescence levels in soils with naturally occurring fluorescent substances Can provide real-time data and rapid three dimensional plume model without the time and expense of off-site data or post-processing of the data Analytical equipment is less costly than fiber optics	Environmental Conditions–output is decereased in cold temperatures, resulting in lower sensitivity Interference--the UV source may cause other substances to fluoresce (i.e. calcite, deicing agents and antifreeze additives, detergents, natural organic matter; etc.) Detection Limits–are soil and fuel dependent (i.e. clays and fuels with low PAH content reduce delectability)	Soil and groundwater	$28,000 for complete FFD system (probe, data aquisition system, etc.) Does not include direct-push system (rods and platform) Rental options are approximately $250.00/day or $1,500/week

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Membrane Interface Probe (MIP)	Identification of various VOCs, depending on detector used Characterize subsurface soils and sediments with chemical contamination, mapping contaminant distribution and migration pathways	Provides information on contaminant distribution and migration pathways (with a conductivity probe) Can qualitatively identify specific compounds with the DSITMS detector Provides quantitative estimates of subsurface contamination distribution with DSITMS detector DSITMS configuration capable of meeting the precision and accuracy quality control performance criteria (EPA Method 624)	Can not differentiate VOCs using PID or FID detectors PID and FID detectors provide relative response only Results are less precise for vadose soils	Soil, sediment, and groundwater	Unit costs for direct-push probes with multi-detector MIP and soil conductivity capabilities are estimated at $15/ft. or $3000/day Purchase cost for the MIP unit itself ranges from $19,000-$22,000, including conductivity sensor

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Thermal Desorption Sampler (TDS)	Characterization of shallow vadoze zone subsurface VOC contamination from fuel releases or chlorinated solvent releases	Not affected by moisture until sample is saturated Has been certified as achieving detection thresholds for TCE and DCE comparable to those of EPA Method 8260A Is certified by Cal/EPA as a near real-time, qualitative to semi-quantitative, in situ subsurface field screening method for VOCs in the vadose or capillary zone	Designed for on-site screening only Can only be used in the vadose zone When large lengths of line are used, water vapor from condensation in the transfer line can interfere with the analysis Exact soil sample weights anc volume may vary significantly based on the type of soil, reducing accuracy	Soil and soil gas	Approximately $4,500 to $5,500/day
Hydrosparge	Characterization sites with shallow groundwater VOC contamination	Able to analyze VOCs without retrieving the direct-push rods and handling or packaging samples No sample preparation required Provides quick analysis time (2 to 3 minutes to analyze sample)	Only able to sample one discrete interval as the probe must be retracted to expose the sample and cannot be re-advanced Must make separate pushes to determine sampling intervals Interference of non-target VOCs	Groundwater	Purchase cost is approximately $50,000 Rental cost $2,000 per month

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Technology	Primary Uses	Advantages	Disadvantages	Media	Relative Cost
INORGANIC SYSTEMS					
X-ray Fluorescence (XRF)	Detection, identification , and delineation of heavy metal contaminants in the subsurface	Capable of detecting multiple analytes Allows for high-resolution delineation of subsurface metals contamination No waste generation. Provides quantitative analysis of a variety of heavy metals X-ray tubes–more powerful and achieve lowere detection limits Radioisotope–generates a more consistent output and may deliver more precise and accurate results	Presence of radioactive source may require special licensing and shipping and handling procedures Matrix effect–physical and chemical properties of sample may effect analysis Susceptible to heterogeneity of contaminant distribution; no process for homogenizing soil before analysis Moisture above 20% may cause problems, but is manageable	Soil and sediment in unsaturated and saturated zones	Vary significantly

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Technology	Primary Uses	Advantages	Disadvantages	Media	Relative Cost
Laser-Induced Breakdown Spectroscopy (LIBS)	Detection, identification, and delineation of heavy metal contaminants in the subsurface	Capable of detecting multiple analytes Allows for high-resolution delineation of subsurface metals contamination No waste generation. Achieves a lower detection limit than XRF Little or no sample preparation is required to obtain useful results The technique is readily portable to the field	Matrix effect–susceptible to heterogeneity of contaminant distribution; no process for homogenizing soil before analysis Does not perform well in saturated soils and sediments	Soil and sediment in unsaturated and capillary zones	Approximately $4,500 to $5,500/day
EXPLOSIVES SENSOR					
Explosives Sensor	Assessment of sites contaminated with energetic materials such as TNT, RDX, HMX, their manufacturing intermediates and subsequent breakdown products	Very sensitive to low levels of TNT in dry soils (0.5 ppm) Offers cost relief and time savings for large-scale sites	Provides total explosives concentrations - cannot differentiate among multiple explosives compounds Matrix interference–samples collected from nearly identical site locations and depths can have significantly different contamination levels	Soil and sediment	No costs are currently available. The system is precommercial.