Appendix D. Field Screening Methods

Field Measurement Type	Method Name (• Example Products)	Media			Analyte	Overview	Advantages	Limitations	Quantification	Reference
		S [1]	W	V						
Immunoassay	SW-846 4030 • EnSys Petro Test System • SDI RaPID Assay	✓	✓		Bulk TPH (primarily low- to midrange)	Combination of immunoassay and colorimetry. Methanol extraction. Enzyme conjugate solution and antibody-coated test tube. Color developer solution and H_2O_2. Differential photometer and m-xylene reference standard.	• Samples can be analyzed quickly on-site • Not affected significantly by moisture content or pH	• Small mass of soil tested • Sensitivity depends on the binding of the target analyte to antibodies; kits are most sensitive to small aromatic compounds • Non-TPH compounds such as chlordane and toxaphene show cross-reactivity and can cause false positives • Sensitivity of test influenced by the nature of the hydrocarbon contamination and any degradation processes at the site • Organic and clay-rich soils may limit the effectiveness of soil extraction and may require longer extraction times than other soil types	25– >1,000 ppm	https://www.epa.gov/sites/production/files/2015-12/documents/4030.pdf
	Hach 10050 • Hach TPH in water and soil	✓	✓		Bulk TPH (low- to midrange)	Same as above, except reference standard not specified			20/50/100/200 ppm in soil as diesel 2/5/10/20 ppm in water as diesel	https://www.hach.com/asset-get.download.jsa?id=7639983907
	Modern Water SOP • Modern Water Total BTEX/ TPH RaPID Assay	✓	✓		Bulk TPH (low- to midrange)	Same as above, except reference standard is BTEX			• Soil: 0.9 –30 ppm as total BTEX standard • Water: 0.02–3.0 ppm as total BTEX standard • TPH: range varies based on fuel source (see supplier fact	https://www.modernwater.com/pdf/MW_Factsheet_Rapid-Assay_BTEX_TPH.pdf

[1] S – Soil; W – Water; V - Vapor

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								• Kits contain dangerous goods and/or hazardous materials (methanol, HCl, and N,N'-DMF); shipping and disposal are regulated • Generated extract may require hazardous waste disposal • Difficulty level of test is moderate to high; need trained personnel	sheet)	
Colorimetric	Friedel-Crafts method • Hanby TPH Soil Kit • Hanby TPH Water Kit • Chemetrics RemediAid™ TPH in Soil Test Kit	✓	✓		Bulk TPH (aromatic hydrocar-bons only)	Alkylhalide (e.g., AlCl3, CCl4) extracting agent and reagent react with aromatic hydrocarbon, producing a colored solution. Portable spectrophotometer may help at low concentrations.	• Inexpensive	• Chlorinated solvents can cause false positives • Organic-rich or clayey soils can cause color interferences • Extraction may be difficult with clayey soils	1–1,000 ppm (soil) 0.01–100 ppm (water)	https://www.epa.gov/ust/expedited-site-assessment-tools-underground-storage-tank-sites-guide-regulators https://envcoglobal.com/files/docs/total-petroleum-hydrocarbons-tph-soil.pdf https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=63294
	• Draeger Hydrocar-bon gas detector tubes			✓	Bulk TPH (aromatics)	Glass tubes filled with porous, solid carrier material coated with color reagents; hydrocarbons in the vapor phase react with the reagents.	• Samples can be analyzed quickly on-site • Low cost • Does not require power	• Detector tubes are compound-specific	2–1,400 ppm	https://www.sensidyne.com/assets/docs/detector-tubes/datasheets/187S_1.pdf http://www.gasdetectionwarehouse.com/content/Draeger%20Manuals/Draeger%20Tubes%20ManualDatasheet.pdf https://www.gastec.co.jp/files/user/asset/pdf/en/detector_tube/105.pdf

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	Oleophilic Dyes • Cheiron OilScreenSoil • KolorKut Oil-Finding Paste	✓			NAPL	Soil and oil-free water added to vial containing oleophilic dye and an expandable polystyrene bead; hydrocarbons released from the soil and associated dye attach to the bead to change the bead from white to red or blue; hydrocarbon may form a separate phase, colored layer.	• Quick analysis on-site • Low cost • Results can be assessed in terms of "saturated," "positive," "slightly positive" and "undetected"	• For small masses of soil, may not be practical for multi-increment samples • Not applicable for gasoline (only) contaminated sites, heavy crude oils (bunker C), or bituminous materials like asphalt or waxes • Mineral oil and motor oils may be detectable, but detergents in some synthetic oils can interfere with color development of kits	> 500 ppm	http://www.maine.gov/dep/spills/petroleum/documents/sop/ts004.pdf
Turbidimetric	SW-846 9074 • Dexsil PetroFLAG	✓			Bulk TPH (mid- to high- range); good complementary method to immune-assay or other test sensitive to aromatic hydrocarbons	Methanol extraction Aqueous emulsifier development solution Hydrocarbons precipitate out and become suspended in solution	• Samples can be analyzed quickly on-site • Low cost (after initial purchase of kit-specific turbidimeter that can only be used for this method) • Most do not require power	• Small mass of soil tested • Organic-rich soils can cause a positive interference as naturally occurring compounds become suspended in solution and/or cause a negative interference due to a reduced effectiveness of the extraction • Extraction may be difficult with clayey soils • Low bias at higher moisture content	10–2,000 ppm	https://www.epa.gov/sites/production/files/2015-12/documents/9074.pdf

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								• Temperature effect on the suspension; important to recalibrate if temperatures change more than 10 °C • Kit contains methanol • Generated extract may require hazardous waste disposal		
Ionization	Headspace analyses: SW-846 USEPA 3815 or Bag Headspace Test according to Maine DEP (MEDEP)2012 • PID (e.g., MiniRAE) • FID	✓	✓		Total organic vapor (includes TPH partitioned to the vapor phase; at room temperature according to Henry's law or using heated probe) Com-pounds detected depend on lamp and ionization energy; total (aromatic) volatile organic vapor (from TPH partitioned to the vapor phase)	A soil or groundwater sample is placed in an airtight container, typically a glass jar or polyethylene bag, leaving one-half to one-third empty (NOTE: Maine requires a double layer of strong metalized polyester and low-density polyethylene (3 mil)). The container is then shaken, heated, or left to sit for a period of time to allow the hydrocarbons to partition into the headspace (i.e., the air space above the sample). The headspace is then measured with an FID or PID. Ultraviolet lamp (PID) or hydrogen	• Samples can be analyzed quickly on-site (2–10 minutes) • Very low cost (excluding cost of instrumentation) • Can be used with field GC in connection with a membrane interface probe	• Relies on VOCs partitioning from NAPL and water phases, which is sensitive to soil type, moisture, temperature, and time to analysis. A standard method (such as headspace) should be used to manage variables. • PID not very sensitive to aliphatic hydrocarbons (ca. an order of magnitude lower than halogenated or aromatic hydrocarbons); includes all volatiles detectable with PID, not just TPH-related compounds. • FID more responsive to aliphatic hydrocarbons • FID requires special shipping and handling, as well as ultrapure hydrogen for calibration	1–1,000 ppm	https://www.epa.gov/sites/production/files/2014-03/documents/esa-ch6.pdf https://www.epa.gov/ust/expedited-site-assessment-tools-underground-storage-tank-sites-guide-regulators https://www.epa.gov/sites/production/files/2015-12/documents/3815.pdf http://www.maine.gov/dep/spills/petroleum/documents/sop/ts004.pdf

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						flame (FID) ionizes organic vapors. The detector reads the electrical current generated by the ionized compounds.		• Small mass of soil tested (e.g., 5 grams) • The type of volatile organics at the site must be known in advance and must be detectable by the PID. • False positives may occur if the PID is exposed to motor vehicle exhaust, solvents used for decontamination, or other sources of volatiles.		
Infrared Spectrophotometry	Ex-situ • HORIBA OCMA-350	✓			Mid- to high-range hydrocarbons (C10–C36, depends on calibration standard) with greater response to aliphatics	Hydrocarbons are extracted using S316 (proprietary). IR radiation will be absorbed by the hydrocarbons in the extract.	• Solvent extract does not generate hazardous waste	• Soil analysis subject to extraction • Requires field lab—not a rugged portable instrument • Requires specialized training and wet chemistry skills	1–1,000 ppm	http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10048Z6.TXT http://www.horiba.com/uploads/media/HRE1886E.pdf
	In situ/Ex situ • Ziltek REMScan	✓				Direct soil measurement, no extraction. Uses flat, compacted, dry surface. Measures soil surface only.	• Rapid, high-quality data (15 seconds for in situ reading) • No consumables (chemicals) required except for batteries	• Non-TPH compounds such as terpenes and eucalyptus (and all organics containing aliphatic C-H bonds) can cause false positives • Sensitive to soil porosity and soil moisture; may require drying samples prior to analysis	100–100,000 ppm	https://www.epa.gov/sites/production/files/2014-03/documents/esa-ch6.pdf

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								• Requires specialized training and/or hiring professionals to employ • Must create a site-specific calibration standard • High cost for purchase (rental may be a more affordable option for limited use); rough order of magnitude purchase/maintenance costs are comparable to lab instrumentation (GC, MS, HPLC, etc.)		
Ultraviolet Fluorescence Spectrophotometry	Ex situ • Sitelab UVF 3100 (254 nm) or TD-500D (365 nm)	✓			Polyaromatic hydrocarbons (range depends on UV wavelength)	Methanol extraction, filter then dilute. UV light beamed through sample. Wavelength of detected light indicates aromatic concentration.	• Not sensitive to humidity	• Suggested specialized training and/or hiring professionals • Soil analysis subject to methanol extraction • High purchase and calibration price • Requires field lab—not a rugged portable instrument	0.1– >1,000 ppm	http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10048Z6.TXT
	In situ • Dakota UVOST (308 nm) • Geoprobe Optical Image Profiler	✓				Direct push probe. Laser-induced fluorescence detects NAPL. Which compounds fluoresce depends on wavelength of laser.	• Rapid, high-quality data with vertical profiles allow for 3D visual of impacts • Not sensitive to humidity	• Best used in situ with a drill rig • Requires specialized training and/or hiring professionals to employ • Only identifies NAPL; no dissolved phase	200–10,000 ppm	

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Fiber Optic Chemical Sensor	• PetroSense PHA-100		✓	✓	Bulk TPH (greater response to aromatics and BTEX)	Light travels along fiber and is refracted along the fiber cladding. The cladding coating adsorbs hydrocarbons, which changes the refraction angle, and changes transmitted light.	• Quick, easy analysis • No waste generated from the analysis • Not sensitive to turbidity or humidity • Sensors can be calibrated to site-specific compounds	• Response depends on compound calibration • Probe must be kept clean for accurate readings • Trichloroethylene (TCE) and perchloroethylene (PCE) can cause false positives	1– >1,000 ppm (water) 5–10,000 ppm (air)	http://petrosense.com/pdf/PetroSense_Produced_Water_Monitoring.pdf