TECHNICAL BULLETIN TB-PETRO-001

AISCT® Petro™ System

AI-integrated Site Characterization Technology for solvent-extraction PHC screening, real-time analytics, and laboratory correlation.

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1. Introduction and Background

The AISCT® Petro™ System — part of TRIUM's Artificial Intelligence Site Characterization Technology platform — is a field screening system for extractable petroleum hydrocarbons in soil. Aligned with the CCME *Guidance Manual for Environmental Site Characterization* (Volume 1, 2016), Petro provides an integrated platform for real-time PHC screening, data analytics, quality assurance, and laboratory data correlation across all phases of a soil investigation.

Traditional field PHC screening methods — photoionization detectors and bag-based vapour testing — are widely employed as rapid characterization tools, but they measure what volatilizes rather than what the laboratory extracts. Reported correlations to laboratory extractable PHC data are typically below 25%, and often below 10%, owing to temperature sensitivity, moisture effects, compound-specific volatility differences, and operator technique. Petro was engineered to overcome those limitations by using a solvent-extraction approach that mirrors laboratory methodology.

Petro is designed to be deployed from the first day of a site investigation programme. As the site data set grows, the system's analytical power increases, enabling progressively more accurate threshold setting, delineation, and remediation performance tracking.

> **PERFORMANCE BENCHMARK**
> Petro consistently achieves solvent-extraction-to-laboratory correlation coefficients exceeding 90%, against <25% — and often <10% — for PID and bag-based vapour screening of extractable hydrocarbons. The advantage comes from using the laboratory's own extraction approach in the field, under a standardized protocol enforced by the kit and the application.

2. Regulatory and Technical Framework

Petro is developed in direct alignment with CCME guidance principles for environmental site characterization. Key regulatory touchstones include:

- **CCME Volume 1, Section 5.5.1 — field analytical methods.** CCME recognizes solvent-extraction PHC testing as a field analytical method for screening soil. Petro advances beyond vapour-phase proxies by employing a standardized solvent extraction that directly captures the extractable PHC fraction, providing significantly higher correlation to laboratory data.
- **CCME petroleum hydrocarbon fraction criteria.** Petro data aligns with CCME Canada-Wide Standard PHC fraction criteria (F2, F3) for soil, supporting direct comparison against fraction-specific guidelines.

- **CCME Volume 1, Section 2.2 — Phased Investigation Approach.** Petro supports phased site characterization from Phase II through delineation and remediation monitoring.
- **CCME Volume 1, Section 3 — Quality Assurance / Quality Control.** Petro incorporates automated QA/QC reporting including instrument reference checks, calibration records, blanks, duplicates, and triplicates.
- **CSA Z769 and applicable provincial PHC guidelines.** Petro supports field screening programmes aligned with CSA and provincial regulatory standards for petroleum hydrocarbon assessment.

Practitioners using Petro can document their methodology in site investigation reports with direct reference to the CCME framework, demonstrating that screening data has been collected under a standardized, reproducible, and quality-assured protocol.

3. System Overview

The system consists of three integrated components: the field hardware kit, the mobile and cloud application for data entry and analytics, and the AI reporting engine for automated summary report generation. All three function as an integrated, inseparable system. The sampling procedure must be followed identically for every sample so that results remain defensible, comparable, and statistically meaningful.

3.1 Hardware: the kit

The Petro hardware kit is a precision, AI-integrated solvent-extraction analysis system designed specifically for field screening of soil samples. It incorporates a solvent extraction station, centrifuge, vortex shaker, and optical measurement cuvette to generate a standardized, reproducible hydrocarbon response value for every sample tested. Key hardware characteristics include:

- Standardized extraction protocol using pre-filled extraction tubes with ball bearings, ensuring consistent soil-to-solvent ratios and extraction conditions for every sample
- Temperature monitoring and reference compensation to normalize optical readings across varying field conditions
- AI-assisted optical signal processing to reduce operator-induced variability and normalize for environmental interference
- Integrated reference check and calibration verification logging
- Encrypted data logging with remote access for TRIUM diagnostics and QA oversight

3.2 Application: data entry, logging, and QA/QC

The application serves as the central data hub for all field and laboratory information. Users enter site details, sample metadata, field observations — soil type, depth interval, temperature, moisture — and every screening result in real time. The application enforces the standardized sampling procedure on every entry, ensuring that all data in the system was collected under the same conditions and is therefore statistically comparable across samples, locations, depths, and dates.

3.3 Analytics engine: real-time data interpretation

As the data set builds, the analytics engine provides continuous, real-time interpretation of screening results. Because the instrument reports a concentration in the same units as the criterion, no population-derived threshold is developed: the user selects and enters the applicable screening criteria for the parameter at each sample location, and every result is classified against those criteria as it is recorded — with a probability of exceedance attached, so borderline samples are visible as borderline while the crew is still on site.

Spatial summary	Real-time breakdown of hydrocarbon screening results by depth interval and sample location, enabling rapid identification of spatial trends and anomalies.
Criteria entry	The user selects and enters the applicable fraction criteria for the parameter at each sample location. Results are classified against those criteria directly, in the same units, at the moment of reading.
Fraction-specific outputs	F1, F2 and F3 estimates reported separately, supporting direct comparison against fraction-specific regulatory criteria.
Probability of exceedance	Field duplicate readings capture the natural heterogeneity of the soil and are expressed as a probability that the sample sits above criteria — turning scatter into usable triage information.
Depth profiling	Vertical concentration profiles by location, supporting conceptual site model development and delineation decisions.
Laboratory confirmation	Petro reports fraction concentrations directly against their criteria, so no correlation model is required to interpret a result. Confirmation samples serve the regulatory record and provide ongoing verification of decision performance — sensitivity, specificity and overall accuracy per fraction, computed from the laboratory-paired subset.

3.4 Laboratory confirmation and decision-performance verification

This system reports a concentration directly, in the same units as the applicable criterion, so no site-specific correlation model is required before a field result can be used. The comparison against the criterion is available at the instrument, on the first sample of the programme. Laboratory confirmation therefore serves a different purpose than it does for a response-based screen:

- **The regulatory record** — accredited analysis of the samples the field data identified as the highest-consequence decision points, documenting decisions already made rather than unlocking them.
- **Decision-performance verification** — every laboratory-paired sample is classified against the criterion to build a confusion matrix for the programme, from which sensitivity, specificity and overall accuracy are computed and reported with the data.
- **Heterogeneity quantification** — duplicate splits and re-reads measure how variable the soil actually is at each location, and that measured spread is what the probability-of-exceedance output is built from.

Parameters compared against laboratory results are:

- F1 / Volatile Petroleum Hydrocarbons (VPH)
- F2 / Light Extractable Petroleum Hydrocarbons (LEPH)
- F3 / Heavy Extractable Petroleum Hydrocarbons (HEPH) — reported and correlated against the F3 criterion

Petro does not measure BTEX and makes no relationship to it. Although F1 is reported, the method is an extraction rather than a volatilization, and its strongest agreement with laboratory data is on C10 and heavier compounds — the fractions that drive extractable hydrocarbon decisions.

Because the field result is already expressed against the criterion, changing the criterion does not require a model to be re-derived. The threshold is set in the application and every probability of exceedance is recalculated against it. This allows practitioners to reduce laboratory submissions substantially without deferring the field decision, and to document decision performance for the programme rather than asserting it.

4. Field Performance

Petro's distinguishing application is the extractable hydrocarbon scenario — any programme where F2/LEPH and F3/HEPH criteria, rather than volatiles, drive the decision. Diesel, lubricating oil and other heavy-fraction impacts are the clearest case: because a vapour-phase method measures what partitions into headspace air rather than what a laboratory recovers by solvent extraction, it over-represents light volatiles and systematically underestimates the heavy fractions, and the bias shifts with temperature, moisture and compound volatility rather than sitting at a correctable offset. Petro removes the proxy entirely by running the laboratory's own extraction chemistry in the field, resolving F1, F2 and F3 separately so each can be compared directly against its own fraction-specific criterion. Typical deployments are larger remediation programmes, delineation and volume estimation, stockpile characterization and segregation, and remediation endpoint confirmation against extractable PHC guidelines.

5. AI-Assisted Report Generation

The system includes an integrated AI reporting function that automates the generation of professional site screening summary reports. Users define reporting parameters — date ranges, sample subsets, locations of interest, regulatory criteria — and the engine produces:

- Executive summary of screening programme scope and objectives
- Summary table of all samples collected within the defined parameters
- Identification and narrative description of elevated locations and depth intervals
- Classification of every result against the entered criteria, with probability of exceedance
- QA/QC summary including calibration records and field quality control performance
- Laboratory confirmation summary and programme decision-performance statistics
- Recommendations for further investigation, delineation sampling, or remediation

The AI report function reduces post-processing time from days or weeks to minutes, while producing a technically defensible, consistently formatted output that can be incorporated directly into site investigation reports or provided to clients and regulatory bodies. Users retain responsibility for review, professional sign-off, and any final regulatory submissions.

6. Application Throughout the Investigation Lifecycle

The system is most effective when deployed at the earliest possible stage of a site investigation and maintained consistently throughout the project lifecycle, providing progressively increasing analytical value as the data set grows.

Phase II ESA — initial PHC screening	Deploy from the first soil investigation. Establish baseline extraction response data, identify areas of elevated PHC concern, and submit targeted samples to initiate correlation.
Phase III ESA — PHC delineation	Classify every screened sample against the entered F2/F3 criteria as it is read, and use the probability of exceedance to direct targeted delineation and confirmation sampling.
Remediation monitoring	Track remediation performance in real time through continuous solvent-extraction screening against the applicable PHC criteria, with automated progress reporting.
Site closure support	Provide a comprehensive, QA/QC-documented record of all PHC screening performed across the project lifecycle in support of final regulatory submissions.

The value of the data set compounds over time. Sites where the system has been used from the beginning of investigation have the richest and most defensible data records, the most accurately calibrated thresholds, and the greatest ability to leverage predictive analytics.

7. Technical Specifications Summary

Target contaminants	Extractable petroleum hydrocarbons — TPH, F1/VPH, F2/LEPH and F3/HEPH
Measurement principle	Standardized solvent extraction mirroring laboratory PHC methodology, optical measurement
Key differentiator	Fraction-specific extraction — captures what the laboratory measures, not what volatilizes
Laboratory agreement	>90% (r^2) extraction-to-laboratory agreement under standard operating conditions
Laboratory parameters compared	F1 / VPH; F2 / LEPH; F3 / HEPH, each against its own fraction criterion; strongest agreement on C10 and heavier compounds. BTEX is not measured or inferred
Scenario fit	Heavy-fraction impacts, delineation and endpoint confirmation
Data output	Fraction concentrations vs. criteria, with probability of exceedance per sample
Criteria entry	User-entered fraction criteria per parameter and location
QA/QC outputs	Reference checks, calibration records, blanks, duplicates, triplicates
Reporting parameters	User-defined: date range, location, sample subset, regulatory criteria
Operating temperature	Above 0 °C — units must not be exposed to freezing conditions
Deployment	Day 1 of site investigation; best suited to larger programmes driven by extractable hydrocarbon criteria
Regulatory alignment	CCME Vol. 1 (2016) s. 5.5.1 and PHC fraction criteria (F2, F3); CSA Z769; provincial PHC guidelines; Alberta Tier 1
Required protocol	AISCT® Petro Standard Operating Procedure (Petro-SOP-001) — mandatory for every sample
Consumables	Pre-filled extraction tubes and reference materials must be sourced through TRIUM
Data ownership	All system logs, diagnostics and firmware data owned by TRIUM

8. Limitations and Important Requirements

8.1 PROTOCOL COMPLIANCE

Petro-SOP-001 must be followed exactly for every sample. Any deviation — non-approved extraction vials, non-standard soil quantities, alternative extraction durations — invalidates the comparability of results and the reliability of analytics outputs.

8.2 MATRIX EFFECTS

In some soil matrices, naturally occurring constituents respond in the heavy hydrocarbon range — a known interaction between soil chemistry and hydrocarbon detection, not a system error. Where present, use F2/LEPH as the primary petrogenic marker and apply the ratio-based interpretation framework in the AISCT® guidance rather than treating an F3 flag as a determination.

8.3 EXCLUSIVITY OF THE KIT

The analytics platform, criteria evaluation, probability modelling and laboratory confirmation functions are calibrated to the measurement characteristics of the Petro hardware and the proprietary extraction consumables. The reported correlation performance is achievable only with the Petro kit under the Petro SOP.

8.4 PROFESSIONAL RESPONSIBILITY

Petro is a decision-support tool. All professional judgments regarding site characterization, risk assessment, remediation design and regulatory submissions remain the responsibility of the qualified environmental professional.

IMPORTANT NOTICE

AISCT® Petro™ provides field screening information only. Results are not accredited laboratory data and must not be used as a substitute for accredited laboratory analysis for regulatory compliance purposes. Results should be interpreted by qualified environmental professionals.

The system can only be used with the AISCT® Petro™ hardware kit. Data from any other instrument or alternative screening method is not compatible with the AISCT® analytics platform, and the standardized sampling procedure must be followed identically for every sample.

TRIUM is not responsible for any decisions, interpretations, actions, or project outcomes arising from the use of AISCT® data. The user bears full responsibility for professional judgment, regulatory compliance, and all field and reporting decisions.

9. References

- Canadian Council of Ministers of the Environment (CCME). 2016. *Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment, Volume 1.* PN 1551.
- Canadian Council of Ministers of the Environment (CCME). 2008. *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil,* v1.1.
- CSA Group. *CSA Z769 — Phase II Environmental Site Assessment.*
- TRIUM. 2026. *AISCT® Petro Standard Operating Procedure (Petro-SOP-001).* Internal document.
- TRIUM. 2026. *AISCT® Petro — Fraction Interpretation and Matrix Guidance.* Internal guidance document.

DOCUMENT CONTROL

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