TECHNICAL BULLETIN TB-AURORA-001

AISCT® Aurora™ System

AI-integrated Site Characterization Technology for headspace vapour screening, real-time analytics, and laboratory correlation.

Developed by TRIUM EcoSystems **Bulletin** TB-AURORA-001 **Revision** 2.0 **Date** August 2026

1. Introduction and Background

The AISCT® Aurora™ System — part of TRIUM's Artificial Intelligence Site Characterization Technology platform — is a field screening system for volatile organic compounds, chlorinated solvents and petroleum hydrocarbons in soil. Aligned with the Canadian Council of Ministers of the Environment (CCME) *Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment* (Volume 1, 2016), Aurora provides an integrated platform for real-time vapour screening, data analytics, quality assurance, and laboratory data correlation across all phases of a soil investigation.

Traditional headspace vapour screening, referenced in CCME Section 5.5.1, has been widely employed as a field analytical method for detecting volatile organic compounds in soil. Conventional bag-based headspace testing, however, is documented to produce highly variable results — with reported correlations to laboratory data typically below 25%, and often below 10% — owing to inconsistent headspace volumes, variable equilibration times, bag integrity, and operator technique. Aurora was engineered to remove those variables.

Aurora 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, contamination delineation, and remediation performance tracking.

PERFORMANCE BENCHMARK

Aurora consistently achieves vapour-to-laboratory correlation coefficients exceeding 90%, against <25% — and often <10% — for conventional bag-based headspace screening. The advantage comes from the standardized, reproducible protocol enforced by the kit and the application, which removes the primary sources of error in traditional headspace methods.

2. Regulatory and Technical Framework

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

- **CCME Volume 1, Section 5.5.1 — Headspace Vapour Tests.** CCME recognizes headspace vapour testing as a field analytical method for screening soil for volatile organic contaminants. Aurora operationalizes and significantly advances that method through standardized, AI-driven analysis.
- **CCME Volume 1, Section 2.2 — Phased Investigation Approach.** Aurora supports phased site characterization from Phase II through delineation and remediation monitoring, building a continuously improving data set at each phase.

- **CCME Volume 1, Section 3 — Quality Assurance / Quality Control.** Aurora incorporates automated QA/QC reporting aligned with CCME data quality objectives, including calibration records, bump tests, blanks, duplicates, and triplicates.
- **CCME Volume 1, Section 2.8 — Validate and Interpret Data.** Aurora's analytics engine supports data validation and interpretation in real time, including population-based distribution analysis and spatial concentration summaries.
- **U.S. EPA field analytical guidance and the Triad approach.** Aurora is consistent with EPA recommendations for structured, reproducible field screening supported by an appropriate level of laboratory confirmation.

Practitioners using Aurora 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 Aurora hardware kit is a precision, AI-integrated vapour analysis instrument designed specifically for headspace screening of soil samples. It incorporates proprietary optical, electrical, and mechanical systems to generate a standardized, reproducible vapour response value for every sample tested. Key hardware characteristics include:

- Standardized sampling chamber ensuring consistent headspace volume and equilibration conditions for every sample
- Temperature monitoring and compensation, holding equilibration at 30–35 °C to normalize vapour release across field conditions
- AI-assisted signal processing to reduce operator-induced variability
- Integrated calibration verification and bump test 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. Prior to receipt of laboratory data, the percentile-based threshold — or a manually selected value — provides the most defensible available method for early screening classification, consistent with the principle that site characterization is an iterative, phased process in which decisions are made on the best available data at each stage.

Spatial summary	Real-time breakdown of vapour screening results by depth interval and sample location, for rapid identification of spatial trends and anomalies.
Population analysis	Automatic breakdown of the data population into percentile groups, providing statistical context for threshold setting.
Threshold selection	User-selectable screening threshold — percentile-based or manually defined — classifying samples as Impacted or Satisfies Criteria before laboratory data arrives.
Sample flagging	Automatic flagging of samples exceeding the selected threshold, updating live as the threshold is adjusted.
Depth profiling	Vertical concentration profiles by location, supporting conceptual site model development and delineation decisions.
Laboratory correlation	Automatic regression of field vapour response against laboratory Total BTEX, F1/VPH, F2/LEPH, TPH and chlorinated solvents — or any user-defined custom parameter. Where a strong relationship is established (typically $r^2 > 0.80$), the system enables laboratory-grounded threshold selection, reclassification of all screened samples, and predictive concentration estimation for samples never submitted to the laboratory.
Correlation reporting	Each parameter is reported against seven measures — sensitivity, specificity, accuracy, Youden's J, Pearson r, R^2 and Spearman ρ — each rated against an effectiveness threshold, so the strength of the relationship is stated rather than assumed.

3.4 Laboratory correlation module

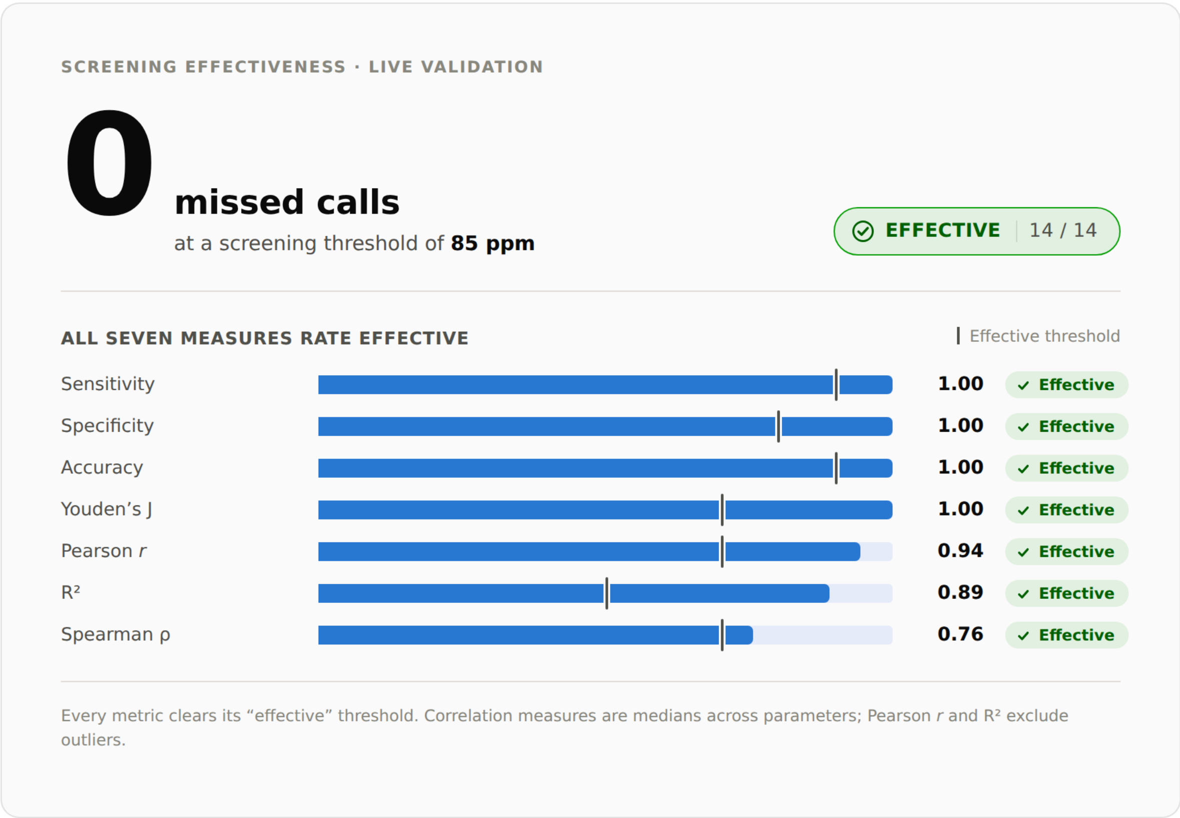
Once laboratory analytical results are entered into the application, the system performs automatic correlation analysis between field response values and laboratory concentrations of:

- Total BTEX (benzene, toluene, ethylbenzene, xylenes)
- F1 / Volatile Petroleum Hydrocarbons (VPH)
- F2 / Light Extractable Petroleum Hydrocarbons (LEPH)
- Total Petroleum Hydrocarbons (TPH)
- Chlorinated solvents — tetrachloroethylene (PCE), trichloroethylene (TCE), dichloroethylene (DCE), vinyl chloride (VC) and related compounds
- **Custom parameters** — user-defined contaminant comparisons created in the application and correlated alongside the standard parameter set

The correlation analysis reveals the statistical relationship between field response and laboratory-confirmed concentrations, and the strength of that relationship is presented to the user. Where a strong relationship is established, the system enables:

- **Laboratory-grounded threshold selection** — a 'maximum value not exceeding' threshold based on the established correlation, giving the field screening threshold laboratory-grounded context.
- **Sample reclassification** — reclassification of all screened samples, both submitted and non-submitted, against the laboratory-correlated threshold, enabling conservative or risk-based outcome determination.
- **Predictive concentration estimation** — estimation of concentrations for samples not submitted to the laboratory, based on their field response and the established correlation model.

The strength of each correlation is not left to the reader to judge. Every parameter is reported against seven measures — sensitivity, specificity, accuracy, Youden's J, Pearson r, R^2 and Spearman ρ — and each is rated against an effectiveness threshold, so a correlation that is not fit to carry a decision is visible as such before it is used. The application presents this as a live validation of the working screening threshold, alongside the count of missed calls that threshold would produce against the laboratory-confirmed set.



Live validation of a working screening threshold: all seven measures rate effective, and the threshold produces no missed calls against the laboratory-confirmed set.

This predictive capability allows practitioners to substantially reduce laboratory submission costs while maintaining a defensible, data-supported basis for site characterization decisions. It also allows remediation performance to be tracked in real time, without the cost and delay of submitting every sample to a laboratory.

4. Field Performance

A head-to-head comparative field study of 62 samples — 31 with laboratory confirmation, comprising 9 hydrocarbon-impacted and 22 non-impacted soils — evaluated Aurora against the conventional headspace vapour bag (HSVL) method using the same detector on the same soils. Aurora returned $R^2 = 0.94$ against laboratory Total BTEX and 0.82 against Total PHC (F1/F2); the bag method returned 0.002 and approximately zero on the same samples, with regression slopes that were not statistically significant ($p = 0.91$ and $p = 0.995$). Regression on the Aurora data set indicates that every 100 ppmv of vapour response corresponds to approximately +1.11 mg/kg Total BTEX and +41.4 mg/kg Total PHC. Aurora also held equilibration between 30 °C and 35 °C throughout, against an uncontrolled range of roughly 10–27 °C for the bag method.

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
- Data population analysis and threshold justification
- QA/QC summary including calibration records and field quality control performance
- Laboratory correlation summary, where applicable, and predictive model description
- 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 screening	Deploy from the first soil investigation. Establish baseline vapour response data, identify areas of elevated concern, generate QA/QC-compliant field records, and submit targeted samples to initiate correlation.
Phase III ESA — delineation	Apply laboratory-correlated thresholds to classify all screened samples. Use population analysis and spatial summaries to direct targeted delineation sampling and reduce laboratory cost through predictive estimation.
Remediation monitoring	Track remediation performance in real time. Apply established thresholds to monitor progress against site criteria and generate automated progress reports for clients and regulators.
Site closure support	Provide a comprehensive, QA/QC-documented record of all 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	VOCs and chlorinated solvents (PCE, TCE, DCE, vinyl chloride and related); BTEX; gasoline- and diesel-range hydrocarbons (F1 and volatile F2); TPH
Measurement principle	Temperature-controlled headspace vapour extraction with AI predictive modelling
Equilibration temperature	30–35 °C, controlled and logged for every sample
Correlation performance	>90% (r^2) vapour-to-laboratory correlation under standard operating conditions
Correlation measures reported	Sensitivity, specificity, accuracy, Youden's J, Pearson r, R^2 and Spearman ρ — each rated against an effectiveness threshold
Custom parameters	User-defined contaminant comparisons, correlated alongside the standard set
Laboratory parameters correlated	Total BTEX; F1 / VPH; F2 / LEPH; Total Petroleum Hydrocarbons (TPH); chlorinated solvents (PCE, TCE, DCE, VC); plus user-defined custom parameters
Population analysis	Percentile distribution — 1–10, 11–20, 21–30, 31–40, 41–50, >50th percentile
QA/QC outputs	Calibration records, bump tests, blanks, duplicates, triplicates
Data output	Real-time results, exceedance flags, confidence metrics, DSS-integrated dataset
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 investigation; all phases through delineation and endpoint confirmation
Regulatory alignment	CCME Vol. 1 (2016) ss. 2.2, 2.8, 3 and 5.5.1; U.S. EPA field analytical guidance
Required protocol	AISCT® Aurora Standard Operating Procedure (Aurora-SOP-001) — mandatory for every sample
Data ownership	All system logs, diagnostics and firmware data owned by TRIUM

8. Limitations and Important Requirements

8.1 PROTOCOL COMPLIANCE

Aurora-SOP-001 must be followed exactly for every sample. Any deviation — non-approved consumables, non-standard headspace volumes, alternative equilibration times — invalidates the comparability of results and the reliability of analytics outputs.

8.2 EXCLUSIVITY OF THE KIT

The analytics platform, population analysis, threshold calibration and laboratory correlation functions are calibrated to the measurement characteristics of the Aurora hardware. They cannot be replicated with data from other instruments. The reported correlation performance is achievable only with the Aurora kit under the Aurora SOP.

8.3 PROFESSIONAL RESPONSIBILITY

Aurora 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 overseeing the investigation.

IMPORTANT NOTICE

AISCT® Aurora™ 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® Aurora™ 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: Guidance Manual.* PN 1551. ISBN 978-1-77202-026-7.
- U.S. Environmental Protection Agency. *Triad Approach to Streamlined Site Characterization and Cleanup;* guidance on field analytical methods and data quality objectives.
- TRIUM. 2026. *AISCT® Aurora Standard Operating Procedure (Aurora-SOP-001).* Internal document.
- TRIUM. 2026. *AISCT® Aurora System — Comparative Field Study and Performance Validation.* Internal document.

DOCUMENT CONTROL

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