

OSAC RESEARCH NEEDS ASSESSMENT FORM



Title of research need: Assessing Heterogeneity of Soils at a Site

Describe the need: The variability of soils at a crime scene or suspect location affects the collection of known reference soils and evaluation of the evidence.

Keyword(s): Soil, Heterogeneity, Interpretation, Comparison, Variability, Urban, Rural, Land Use

Submitting subcommittee(s): Trace Materials **Date Approved:** 6/12/2025

Background Information:

1. Does this research need address a gap(s) in a current or planned standard? (ex.: Field identification system for on scene opioid detection and confirmation)

This research need is a fundamental study that would impact reference soil collection and the interpretation of soil as forensic evidence. ASTM E3272 – 23 “Standard Guide for Collection of Soils and Other Geological Evidence for Criminal Forensic Applications” provides some guidance on collection of known soil exemplars. The spatial heterogeneity of soils with respect to commonly characterized properties in forensic examinations should inform how many soil exemplars are sufficient to represent the properties within the area of interest and demonstrate differences outside of that area of interest.

2. Are you aware of any ongoing research that may address this research need that has not yet been published (e.g., research presented in conference proceedings, studies that you or a colleague have participated in but have yet to be published)?

There are small-scale limited studies of the spatial variability of surface soil properties relevant for forensic examination. There are no large-scale, systematic studies that address soil heterogeneity, both across the landscape and with depth, in a forensic context, using the methods commonly employed in forensic soil examinations. Ideally, this assessment should use methods that are analogous to those commonly used in forensic soils analysis (not bulk chemical methods i.e. de Caritat et al 2021).

3. Key bibliographic references relating to this research need: (ex.: Toll, L., Standifer, K. M., Massotte, D., eds. (2019). Current Topics in Opioid Research. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-88963-180-3)

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8. McKinley, J. 2013. How useful are databases in environmental and criminal forensics? Geological Society, London, Special Publication, 384, 109-119.
9. Morrison, A.R. et al. (2009) Characterization and Discrimination of Urban Soils: Preliminary Results from the Soil Forensics University Network. In Ritz, K. et al. (Eds) *Criminal and Environmental Soil Forensics*, Springer.
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13. Melo, Vander Freitas, Samara Alves Testoni, Lorna Anne Dawson, and Fábio Augusto da Silva Salvador. "Sand fraction is not suitable for forensic investigations in subtropical soils." *Revista Brasileira de Ciência do Solo* 44 (2020): e0190174.
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4. Review the annual operational/research needs published by the National Institute of Justice (NIJ) at <https://nij.ojp.gov/topics/articles/forensic-science-research-and-development-technology-working-group-operational#latest>? Is your research need identified by NIJ?

This research addresses:

"Scientific foundations for expert conclusions of forensic evidence"; "Practical statistical approaches for the interpretation of forensic evidence"

5. In what ways would the research results improve current laboratory capabilities?

This research would provide guidance to crime scene professionals on the number of reference (known) soil samples to collect to sufficiently represent the heterogeneity of soils in and around a crime scene. Collection of sufficient known soils from the vicinity of a crime scene that includes both exemplars lacking exclusionary differences and those with exclusionary differences soils, will enable the examiner to demonstrate both that soil evidence could have come from the crime scene but the methods used are capable of demonstrating exclusionary differences. The sufficient number and density of known soils to capture these differences will likely vary based on human (land use) and pedological (parent material, geomorphic position, landscape age, vegetation, and climate) factors. In addition, better collection of known soils and a better understanding of spatial heterogeneity will provide context for soil examination conclusions (associations, exclusions, inconclusive findings) for cases involving soil from different land use types, geomorphic position, landscape age, and bedrock/parent material characteristics. Appropriate limiting statements could be inserted into reports and findings could be qualified in court testimony in more rigorous ways than simply based on examiner experience. For example, if research demonstrates that soil tends to be more homogeneous across certain types of settings (i.e., prairie underlain by granitic bedrock), this would be important for a soil examiner to know as they evaluate the significance of a soil association in a case involving this type of setting.

6. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

This research would provide those performing forensic soil examinations with a better understanding of the significance of soil examination results to enable better conclusions (associations, exclusions, inconclusive findings) for cases involving soil from different land use, geomorphic position/age, and bedrock characteristics. It would also assist the subcommittee in developing a statistical approach to estimating population size for comparisons. This would enable the subcommittee to make informed interpretation and report writing recommendations to forensic practitioners in future standards and/or guidelines.

7. In what ways would the research results improve services to the criminal justice system?

It would improve the assessment of the probative value of any particular soil comparison result. It would aid in appropriate testimony and reporting. This research is needed to address the strength of a comparison, assessment of inconclusive, or exclusion.

8. Status assessment (I, II, III, or IV):

I

	Major gap in current knowledge	Minor gap in current knowledge
No or limited current research is being conducted	I	III
Existing current research is being conducted	II	IV

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.