



Designation: E3344 – 24

Standard Guide for Developing Representative Background Concentrations at Sediment Sites—Selection of Background Reference Areas¹

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1. Scope

1.1 This guide focuses on the selection of sediment background reference areas from aquatic environments for the purpose of developing representative background concentrations for sediment at sediment sites. These concentrations are typically used in contaminated sediment corrective actions performed under various regulatory programs, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Although many of the references cited in this guide are CERCLA-oriented, the guide is applicable to remedial actions performed under local, state, tribal, federal, and international cleanup programs. However, this guide does not provide a detailed description of the existing background requirements or guidance for each jurisdiction. The requirements for the regulatory entity under which the corrective action is being performed should be reviewed to confirm compliance.

1.1.1 The sediment background reference areas chosen using this guide will need to be approved by the regulatory agency having jurisdiction (or they should take no exception to the areas chosen), especially if the representative background concentrations for sediment developed will potentially be used to set sediment remedial criteria.

1.2 This guide provides a framework to select appropriate sediment background reference areas for the collection of sediment data in the development of representative background concentrations for sediment at sediment sites. It is intended to inform, complement, and support (but not supersede) the requirements or guidelines established by local, state, tribal, federal, or international agencies.

1.2.1 This guide is designed to apply to contaminated sediment sites where sediment data have been collected and are readily available. Additionally, it assumes that risk assessments have been performed, so that the potential contaminants of concern (PCOCs) that exceed risk-based thresholds for sedi-

ment have been identified. This guide can be applied at multiple points within the project life cycle (such as site assessment and remedial design).

1.2.2 Furthermore, this guide presumes that the identified risk-based thresholds for sediment are low enough to pose corrective action implementation challenges or that the sediment site is subject to recontamination from ongoing anthropogenic or naturally occurring sources (or both) that are not controlled. In either case, representative background concentrations for sediment are useful for determining the extent of corrective remedial actions (when used as remedial goals), evaluating risks posed by these representative background concentrations, and establishing appropriate post-remedial monitoring plans.

1.2.3 A case study for selecting a background reference area using a tiered decision analysis approach is presented in [Appendix X1](#). It compares various characteristics of a hypothetical sediment site associated with a former upland manufactured gas plant (MGP) facility to three candidate background reference areas and identifies the background reference area that best satisfies the decision analysis objectives in the choice of a single background reference area.

1.3 *Related ASTM Standards*—This guide is related several other guides. Guide [E3382](#) provides the overarching framework for the development of representative background concentrations for sediment at contaminated sediment sites, including Conceptual Site Model (CSM) considerations. Guide [E3242](#) describes how to evaluate candidate background data sets (including the use of statistical, geochemical, and chemical forensic methodologies) to obtain representative background data sets and then how to use these data sets to develop representative background concentrations for sediment. Guide [E3164](#) covers the sampling methodologies used in the field to obtain sediment samples (whether from the sediment site or background reference areas), and Guide [E3163](#) discusses appropriate laboratory methodologies to use for the chemical analysis of PCOCs in sediment samples. Guide [D4823](#), which concerns sediment core sampling, is also related to this guide.

1.3.1 Specifically, this guide is intended to be used under the overarching framework of Guide [E3382](#), in conjunction with the detailed framework to evaluate data and develop representative background concentrations for sediment outlined in

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Guide [E3242](#), to help ensure appropriate background reference areas are chosen for use in representative background concentration development.

1.4 *Units*—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this guide.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

[D4823](#) Guide for Core Sampling Submerged, Unconsolidated Sediments

[E178](#) Practice for Dealing With Outlying Observations

[E1689](#) Guide for Developing Conceptual Site Models for Contaminated Sites

[E3163](#) Guide for Contaminated Sediment Site Risk-Based Corrective Action—Selection and Application of Analytical Methods and Test Procedures

[E3164](#) Guide for Contaminated Sediment Site Risk-Based Corrective Action – Baseline, Remedy Implementation and Post-Remedy Monitoring Programs

[E3240](#) Guide for Risk-Based Corrective Action for Contaminated Sediment Sites

[E3242](#) Guide for Developing Representative Background Concentrations at Sediment Sites—Data Evaluation and Development Methodologies

[E3248](#) Guide for NAPL Mobility and Migration in Sediment – Conceptual Models for Emplacement and Advection

[E3382](#) Guide for Developing Representative Background Concentrations at Sediment Sites—Framework Overview, Including Conceptual Site Model Considerations

3. Terminology

3.1 Definitions:

3.1.1 *anthropogenic background*, *n*—human-made substances present in the environment due to human activities, not specifically related to site-related releases or activities (current or historical). [E3382](#)

3.1.1.1 *Discussion*—The definition of “anthropogenic background” varies by jurisdiction. In some jurisdictions, the regulator defines anthropogenic background as having both human-made and naturally occurring components. In this

guide, the definition of anthropogenic background includes only the human-made component.

3.1.2 *background (aka “reference”)*, *n*—substances, conditions, or locations that are not influenced by the sediment site; these are usually a combination of naturally occurring (consistently present in the environment but not influenced by human activity) and anthropogenic (influenced by human activity but not related to specific releases or activities [current or historical] at the sediment site) components. [E3382](#)

3.1.3 *background reference areas*, *n*—sediment areas that have similar physical, chemical, geological, biological, and land use characteristics as the sediment site being investigated but are not affected by site-related releases or activities (current or historical). [E3382](#)

3.1.4 *background threshold value (BTV)*, *n*—a measure of the upper limit of the representative background concentration that is developed from a representative background data set. [E3382](#)

3.1.5 *candidate background data set*, *n*—a raw (that is, unprocessed) data set obtained either by the collection of data from background reference areas or by the extraction of background data from the sediment site data set, or a combination of both. [E3382](#)

3.1.5.1 *Discussion*—The candidate background data set must first be evaluated using the framework described in Guide [E3242](#) and Section 5 to obtain a representative background data set, which can then be used to develop a representative background concentration for sediment at the sediment site.

3.1.6 *cleanup level*, *n*—the prescribed average or point sediment concentration of a chemical (that is, a molecular or elemental contaminant) that shall not be exceeded at the remediated site. [E3382](#)

3.1.7 *conceptual site model (CSM)*, *n*—the integrated representation of the physical and environmental context, the complete and potentially complete exposure pathways, and the potential fate and transport of PCOCs at a site. [E3382](#)

3.1.7.1 *Discussion*—The CSM should include both the current understanding of the site and an understanding of the potential future conditions and uses for the site. It provides a method to conduct the exposure pathway evaluation; inventory the exposure pathways evaluated; and determine the status of the exposure pathways as incomplete, potentially complete, or complete.

3.1.8 *contaminant of concern (COC)*, *n*—a substance identified as posing a risk based on a tiered risk assessment and that may warrant corrective action. [E3382](#)

3.1.8.1 *Discussion*—Typically, all PCOCs identified for a sediment site are evaluated in the risk assessment process. PCOCs that have sediment concentrations greater than risk-based thresholds identified in the risk assessment process are defined as COCs. Thus, the COCs identified for a sediment site are a subset of the PCOCs identified for that site.

3.1.9 *natural background*, *n*—naturally occurring substances present in the environment in forms (and at concentrations) that have not been influenced by human activity. [E3382](#)

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

3.1.10 *population, n*—in statistics, a comprehensive set of values consisting of all possible observations or measurements of a certain phenomenon from which a sample is to be drawn.

E3382

3.1.11 *potential contaminant of concern (PCOC), n*—a contaminant whose sediment concentrations at the site may exceed applicable screening levels.

E3382

3.1.11.1 *Discussion*—In risk assessments, PCOCs are often referred to as “chemicals of potential environmental concern” (COPECs) and “chemicals of potential concern” (COPCs).

3.1.12 *reference element, n*—a major element that represents the mineral to which a trace element may be adsorbed.

E3382

3.1.13 *representative background concentrations, n*—chemical concentrations that are inclusive of naturally occurring sources and anthropogenic sources similar to those present at a sediment site but are not from site-related releases or activities (current or historical).

E3382

3.1.14 *representative background data set, n*—a background data set obtained by evaluating a candidate background data set using a defined framework to remove data points that are not representative of background conditions for the sediment.

E3382

3.1.14.1 *Discussion*—The evaluation determines if there are any data points in the candidate background data set that are not representative of sediment site background conditions. These data points are then removed from the candidate background data set (using technically justifiable rationale) to obtain a representative background data set. Typically, the representative background data set can be used to develop a BTV, which is a measure of the upper limit of this data set; it is the BTV that is often used as the representative background concentration for the sediment at the sediment site. In this guide, the defined framework involves using the data evaluation and development methodologies described in detail in Guide **E3242**.

3.1.15 *sediment, n*—a matrix of porewater and particles including gravel, sand, silt, clay, and other natural and anthropogenic substances that have settled at the bottom of a tidal or non-tidal body of water.

E3163

3.1.16 *sediment site, n*—the area defined by the likely physical distribution of COCs from a source area and the adjacent areas required to implement the corrective action; a site could be an entire water body or a defined portion of a water body.

E3163

3.1.17 *trace element, n*—an element defined as generally being present at less than 0.1 weight percent in the sediment sample.

E3382

3.1.17.1 *Discussion*—Natural trace element concentrations are typically one or more orders of magnitude less than those of the reference elements that are indicative of the mineral to which trace elements adsorb. Trace elements that are typically evaluated geochemically include metals (such as copper) and metalloids (such as arsenic).

3.1.18 *urban runoff, n*—a non-point source of contaminants to the water body.

E3382

3.1.18.1 *Discussion*—Typically, this is stormwater from city streets and adjacent properties that carries contaminants into receiving waters directly by overland flow or indirectly via sewer systems.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *biological reference areas, n*—a location that is representative of background conditions resulting from localized and regional contaminant inputs but is not affected by site-related releases or activities, which is used to collect biological samples (such as fish and shellfish tissue, benthic community organisms) or sediment, or both, for laboratory bioassay testing (such as toxicity or bioaccumulation testing).

3.2.1.1 *Discussion*—A biological reference area can also serve as a background reference area, if sediment samples are also submitted for chemical analysis of PCOCs.

4. Significance and Use

4.1 *Intended Use:*

4.1.1 This guide may be used by various parties involved in sediment corrective action programs, including regulatory agencies, project sponsors, environmental consultants, toxicologists, risk assessors, site remediation professionals, environmental contractors, and other stakeholders.

4.2 *Importance of the CSM:*

4.2.1 The CSM should be updated as needed and refined to describe the physical properties, chemical composition and occurrence, biologic features, and environmental conditions of the sediment corrective action project (Guide **E1689**).

4.3 *Reference Material:*

4.3.1 This guide should be used in conjunction with other ASTM guides listed in **2.1** (especially Guides **E3242** and **E3382**); this guide should also be used in conjunction with the material in the References at the end of this guide (including **1**).³ Using these reference materials will direct the user in developing representative background concentrations for sediment at a sediment site.

4.4 *Flexible Site-Specific Implementation:*

4.4.1 This guide provides a systematic but flexible framework to accommodate variations in approaches by regulatory agencies and by the user based on project objectives, site complexity, unique site features, regulatory requirements, newly developed guidance, newly published scientific research, changes in regulatory criteria, advances in scientific knowledge and technical capability, and unforeseen circumstances.

4.5 *Regulatory Frameworks:*

4.5.1 This guide is intended to be applicable at a broad range of local, state, tribal, federal (such as CERCLA), or international jurisdictions, each with its own unique regulatory framework. As such, this guide does not provide a detailed discussion of the requirements or guidance associated with any of these regulatory frameworks, nor is it intended to supplant applicable regulations and guidance. The user of this guide will

³ The boldface numbers in parentheses refer to the list of references at the end of this standard.

need to be aware of the regulatory requirements and guidance in the jurisdiction where the work is being performed.

4.5.2 Depending on the regulatory requirements in a jurisdiction, the choice of background reference areas may need to consider critical habitats and ecological receptors.

4.6 *Systematic Project Planning and Scoping Process:*

4.6.1 When applying this guide, the user should undertake a systematic project planning and scoping process to collect information to assist in making site-specific, user-defined decisions for a particular project, including assembling an experienced team of project professionals. These practitioners should have the appropriate expertise to scope, plan, and execute a sediment data acquisition and analysis program. This team may include, but is not limited to, project sponsors, environmental consultants, toxicologists, site remediation professionals, analytical chemists, geochemists, and statisticians.

4.7 *Other Considerations:*

4.7.1 This guide does not cover all components of a program to develop representative background concentrations for sediment. It is meant to be used in conjunction with other guides (such as Guides [E3163](#), [E3164](#), [E3240](#), [E3242](#), and [E3382](#)) to do so.

4.7.2 Sediment sampling and laboratory analyses are not covered in this guide. Guides [E3163](#) and [E3164](#) contain extensive information concerning sediment sampling and laboratory analyses.

4.7.3 Data quality objectives are not covered in this guide. Data quality objectives are described in [\(2\)](#).

4.7.4 Background study design considerations are not covered in this guide but are described in other references, including Guide [E3163](#) and [\(3\)](#).

4.7.5 The use of data evaluation methodologies to obtain representative background data sets from candidate background data sets is not covered in detail in this guide but is discussed in more depth in Guide [E3242](#).

4.7.5.1 Identification and removal of high nondetect values from candidate background data sets are discussed in detail in Guide [E3242](#).

4.7.5.2 Identification and removal of outliers from candidate background data sets are discussed in detail in Practice [E178](#), as well as Guide [E3242](#).

4.7.5.3 Geochemical and chemical forensics methodologies used in evaluating candidate background data sets to obtain representative background data sets are discussed in detail in Guide [E3242](#); their applications during background reference area selection are discussed in this guide.

4.7.6 The use of statistical methods to develop BTVs from representative background data sets are discussed in detail in Guide [E3242](#).

4.7.7 The use of statistical methods to compare representative background data sets to sediment site data sets are discussed in detail in Guide [E3242](#).

4.7.8 Geospatial analysis considerations are not thoroughly discussed in this guidance but are discussed in more depth relative to environmental evaluations in [\(4\)](#), which focuses on quality assurance concerns relative to geospatial analyses.

4.7.9 In this guide, sediment ([3.1.15](#)) is defined as material being found at the bottom of a water body. Upland soils of sedimentary origin are excluded from consideration as sediment in this guide.

4.7.10 In this guide, only PCOC concentrations are considered to be in scope. Residual background radioactivity is out of scope.

4.8 *Structure and Components of this Guide:*

4.8.1 The user of this guide should review the overall structure and components of this guide before proceeding with use, including:

Section 1	Scope
Section 2	Referenced Documents
Section 3	Terminology
Section 4	Significance and Use
Section 5	Overview of Representative Background Concentrations for Sediment at Sediment Sites and Development Framework
Section 6	Background Reference Area Selection Criteria
Section 7	Keywords
Appendix X1	Case Study
References	

5. Overview of Representative Background Concentrations for Sediment at Sediment Sites and Development Framework

5.1 *Importance of Representative Background Concentrations for Sediment:*

5.1.1 This guide has been prepared to provide guidance for the selection of background reference areas, which is a key component in the overarching framework for the development of representative background concentrations for sediment at sediment sites that is outlined in Guide [E3382](#). Technically defensible representative background concentrations for sediment are critical in establishing an appropriate remedial response and providing realistic cleanup levels.

5.1.2 Multiple sources may contribute to the nature and extent of contamination at many sediment sites. The largest contribution of contamination at sediment sites is typically attributed to current or historical site-related releases or activities. However, contamination can also result from naturally occurring sources and ongoing anthropogenic sources not related to site-related releases or activities. Discharges from combined sewer overflows (CSOs), industrial outfalls, and storm sewer systems (municipal and private), as well as surface runoff, are examples of ongoing anthropogenic sources that may be unrelated to site-related releases or activities.

5.1.3 Off-site contamination not associated with current or historical site-related releases or activities is considered a component of representative background concentrations for sediment and will continue to be a source of contamination to the sediment site, unless all transport pathways onto the sediment site are eliminated. A primary objective of determining representative background concentrations for sediment is to account for any background chemical input (both naturally occurring and anthropogenic) that is expected to continue migrating onto the sediment site after the completion of corrective actions.

5.1.3.1 An important principle for management of contaminated sediment sites is the control of background sources of contamination, to the greatest extent possible, prior to the

initiation of corrective actions at the sediment site. However, it is rarely practicable to control all background sources.

5.1.4 Technically defensible representative background concentrations for sediment are those that reflect chemical inputs to a sediment site from ongoing naturally occurring sources and anthropogenic sources unrelated to current or historical site-related releases or activities. In addition to informing or establishing technically defensible cleanup levels, representative background concentrations for sediment can assist in determining sediment site boundaries, understanding risks at a sediment site due to background concentrations, establishing and optimizing realistic post-remedy monitoring plans, and assessing the effectiveness of corrective actions (Guides E3164 and E3242).

5.1.5 In the absence of technically defensible representative background concentrations for sediment, risk-based cleanup levels may be used inappropriately at sediment sites where the representative background concentrations are actually greater than the risk-based cleanup levels. Similarly, if the representative background concentrations for sediment have been erroneously calculated, inappropriately low cleanup goals could be used in the corrective action evaluation process. Under both circumstances, surface sediments may initially meet all chemical concentration-based remedial objectives (such as cleanup levels) upon corrective action completion, but they will eventually return to representative background concentrations for sediment at some time after completion, and the cleanup levels will again be exceeded. Due to exceedances of the inappropriately low cleanup goals, the sediment corrective actions would be perceived as a failure.

5.1.6 Attempting to implement corrective actions to achieve concentrations for sediment less than representative background is not sustainable over the long-term and can require considerable expenditures that serve no environmental or public health purpose (Guide E3382). The process described in Guide E3382 is intended to help promote a scientifically sound approach for establishing representative background concentrations for sediment, leading to corrective action decisions that avoid costly perceived corrective action failures at contaminated sediment sites. The subject of this guide, the selection of suitable background reference areas, is a critical component of the process outlined in Guide E3382.

5.2 Overview of Framework to Develop Representative Background Concentrations for Sediment:

5.2.1 Application of background guidance for soil and groundwater at upland sites may not be appropriate at sediment sites. Sediment sites have many different characteristics that are not present at upland sites (Guides E3242 and E3248), including physical characteristics, geochemical characteristics, biological characteristics, and different contaminant emplacement and transport mechanisms.

5.2.1.1 Practitioners should be aware of existing background requirements and guidance that are applicable to the jurisdiction in which the sediment site is located. Even if the background guidance is not specifically tailored for sediments, but is intended for use with soil or groundwater at upland sites,

regulators may attempt to utilize concepts and methodologies from their upland guidance at sediment sites under their jurisdiction.

5.2.2 This guide and its associated guides (Guides E3163, E3164, E3240, E3242, and E3382) have been developed (in part) to fill a gap due to the absence of existing guidance from various regulatory agencies for the development of representative background concentrations for sediment at contaminated sediment sites.

5.2.3 Fig. 1 presents the overall framework to develop representative background concentrations for sediment at a sediment site; this framework is described in detail in Guide E3382. As a first step, a thorough understanding of the sediment site is necessary before developing representative background concentrations for sediment. This can be accomplished by developing a CSM (refer to Guides E3240 and E3382). As part of this CSM, the sediment site PCOCs must be identified.

5.2.3.1 The framework depicted in Fig. 1 is not the only possible framework to develop representative background concentrations for sediment for use in comparison to sediment site data sets. However, many of the principles presented in this guide and associated Guides E3242, and E3382 (such as, the selection of appropriate background reference areas for the sediment site and the handling of outliers in candidate background data sets) are also applicable to these other frameworks.

5.2.4 Once the preliminary sediment site CSM (as defined in Guide E3240) has been developed, a suitable background reference area (or areas) can be identified for sampling (that is, the second step in Fig. 1); this second step is the focus of this guide.

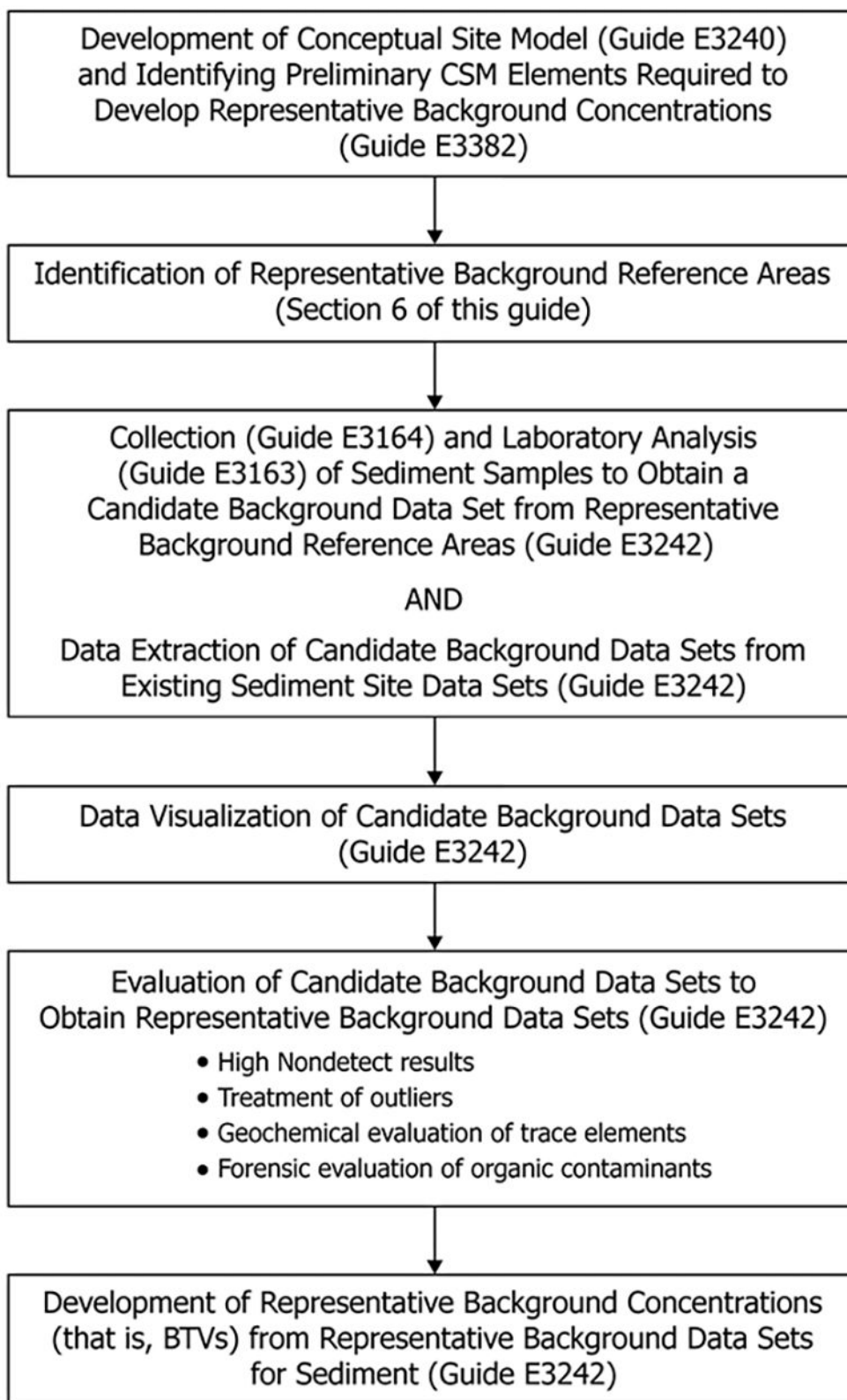
5.2.5 Once analytical data are available for the background reference area sediment samples, the methodologies described in detail in Guide E3242 can be utilized to develop representative background concentrations for sediment.

6. Background Reference Area Selection Criteria

6.1 Selection Rationale:

6.1.1 Sediment sites are dynamic in nature; they are constantly receiving suspended sediment from off-site sources. The background reference area (or areas) used to calculate representative background concentrations for sediment should have physical, geological, anthropogenic (land use), chemical, and biological characteristics that are as similar as possible to the sediment site. Importantly, the background reference areas should not be influenced by current or historical site-related releases or activities, but they should include ongoing sources that contribute to regional contamination, including ongoing sources at the sediment site. Typically, any selected background reference area should not have been designated as a contaminated sediment site (that is, contaminated from its own current or historical site-related releases or activities) by a regulatory agency.

6.1.2 When there are multiple characteristics to consider, categorizing and ranking important characteristics can aid in background reference area selection decisions. Examples of the characteristics where the similarity between sediment site and the candidate background reference area...



Geochemical and forensic evaluations may be useful in various steps of the process.

FIG. 1 Framework to Develop Representative Background Concentrations for Sediment (Modified from Guide E3382)