Designation: D7045 – 17

Standard Guide for Optimization of Groundwater Monitoring Constituents for Detection Monitoring Programs for Waste Disposal Facilities[1]

This standard is issued under the fixed designation D7045; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This standard provides a general method of selecting effective constituents for detection monitoring programs at Waste Disposal Facilities. The process described in this standard presents a methodology that takes into consideration physical and chemical characteristics of the source material(s), the surrounding hydrogeologic regime, and site-specific geochemistry to identify and select those parameters that provide most effective detection of a potential release from a waste management unit (WMU).

1.2 In the following sections, details of an evaluation of effective monitoring constituents for a groundwater detection-monitoring program were based on site-specific waste characterization.

1.3 The statistical methodology described in the following sections should be used as guidance. Other methods may also be appropriate based on site-specific conditions or for monitoring situations or media that are not presented in this standard.

1.4 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education, experience and professional judgements. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged without consideration of a project's many unique aspects. The word standard in the title of this document only means that the document has been approved through the ASTM consensus process.

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 and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D5792 Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives

D6312 Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs at Waste Disposal Facilities

3. Terminology

3.1 *Definitions*—For common definitions of technical terms used in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *leachate*—a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

3.2.2 *outlier*—a measurement that is statistically inconsistent with the distribution of other measurements from which it was drawn.

3.2.3 *practical quantitation limit (PQL)*—the lowest level that can reliably achieved with specified limits of precision and accuracy during routine laboratory operating conditions.

3.2.4 *qualified groundwater scientist (QGWS)*—a scientist or engineer who has received a baccalaureate or postgraduate degree in the natural sciences or engineering and has sufficient training in groundwater hydrology and related fields as may be demonstrated by state registration, professional certifications, or completion of accredited university programs that enable the individual to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and corrective action.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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

*A Summary of Changes section appears at the end of this standard

3.2.5 *upper confidence limit (UCL)*—an upper limit that has a specified probability (for example, 95 %) of including the true concentration (or other parameter). Taken together with lower confidence limit, forms a confidence interval that will include the true concentration with confidence level that accounts for both tail areas.

3.2.6 *upper limit (UL)*—an upper limit of a data set of population (*n*) that may be statistically or non-statistically based.

3.2.7 *waste management unit (WMU)*—a permitted waste disposal unit or temporary containment structure that is designed and constructed to inhibit the migration of wastes to the adjacent environment.

4. Summary of Guide

4.1 The guide is summarized as figures shown in Figs. 1-3. These figures provide a flow-chart illustrating the steps used in characterizing the source material, collecting background data, establishing an upper limit for each analyte included in the program, and/or establishing effective monitoring constituents that will provide an indication of whether the WMU is potentially impacting surface and groundwater in the vicinity of the unit.

5. Significance and Use

5.1 The principal use of this standard is in the identification of effective groundwater monitoring constituents for a detection-monitoring program. The significance of the guide is to minimize the false positive rate for the facility by only monitoring those constituents that are intrinsic to the waste mass and eliminate those constituents that are present in background in concentrations that confound evaluation from downgradient wells.

5.2 Governing regulations require large generic lists of constituents to be monitored in an effort to detect a release from a WMU. However, identification and selection of parameters based on site-specific physical and chemical conditions are in many cases also acceptable to regulatory agencies and result in a more effective and environmentally protective groundwater monitoring system.

5.2.1 Naturally occurring soil and groundwater constituents within and near a WMU area should be determined prior to the development of a monitoring program. This is important in the selection of site-specific constituents lists and avoiding difficulties with a regulatory authority regarding sources of monitored constituents.

5.2.2 Site-specific lists of constituents relative to the WMU will provide for the regulator those constituents which will effectively measure the performance of a WMU rather than the use of a generic list that could include naturally occurring constituents as well as those not present in the WMU.

5.3 Site-specific constituent lists often result in fewer monitored constituents (that is, monitoring programs are optimized). This process is critical to the overall success of the monitoring program for the following reasons:

5.3.1 The reduction of the monitoring constituents to only those found or expected to be found or derived from site-specific source material will reduce the number of false-positive results since only those parameters that could indicate a release are monitored.

5.3.2 The use of constituents that contrast significantly to background groundwater eliminates those that could lead to erroneous results merely due to temporal and spatial variability of components found in the natural geochemistry of the upper-most water-bearing zone.

5.3.3 Where statistics are required, fewer statistical comparisons through well and constituent optimization enhances the statistical power (or effectiveness) of the monitoring program (Gibbons, 1994; USEPA, April 1998).

5.3.4 Eliminating the cost of unnecessary laboratory analyses produces a more efficient and cost-effective monitoring program and minimizes the effort needed by both the local enforcement agency and the owner/operator to respond (either with correspondence or additional field/laboratory efforts) to erroneous detection decisions.

5.4 This type of approach is acceptable to regulatory agencies arid applicable under most groundwater monitoring programs.

NOTE 1—For example, in the United States, determining the alternate constituent list at Solid Waste Facilities, 40 CFR 258.54(a)(l) allows for deletion of 40 CFR 258 Appendix I constituents if it can be shown that the removed constituents are not reasonably expected to be in or derived from the waste contained in the unit. 40 CFR 258(a)(2) allows approved States to establish an alternate list of inorganic parameters in lieu of all or some of the heavy metals (constituents 1-14 in Appendix I to Part 258), if the alternative constituents provide a reliable indication of inorganic releases from the unit to groundwater.

5.5 The framework for this standard is generally based on the guidelines established under 40 CFR 258.54(a)(l) to optimize a groundwater-monitoring network in such a manner as to still provide an early warning system of a release from the WMU. This guidance document is, however, applicable for most WMU, not just those associated with solid waste disposal facilities. In determining the alternative constituents, consideration must be made for: *(1)* the types, quantities, and concentrations of constituents in wastes managed at the waste management unit (or WMU); *(2)* the mobility, stability, and persistence of waste constituents in the unsaturated zone beneath the WMU; *(3)* the detectability of indicator parameters, waste constituents, and reaction products in groundwater; and *(4)* the concentration or contrast between monitoring constituents in leachate and in background groundwater.

5.6 An essential factor in this guide is the knowledge of the quality of the potential source material [for example, the types and concentrations of liquid or other leachable wastes (that is, leachate) within the WMU]. The characterization of the source material is critical in determining an optimum set of indicator parameters that provide an early warning system of a release from the unit. Details for the appropriate levels of effort to characterize the waste stream or source(s) in the WMU are not included within this guidance document. Waste stream and/or source data collected by the owner/operator as well as liquid data from key collection points (that is, sumps or natural gravity drain collection points) are an integral part of any waste characterization process.

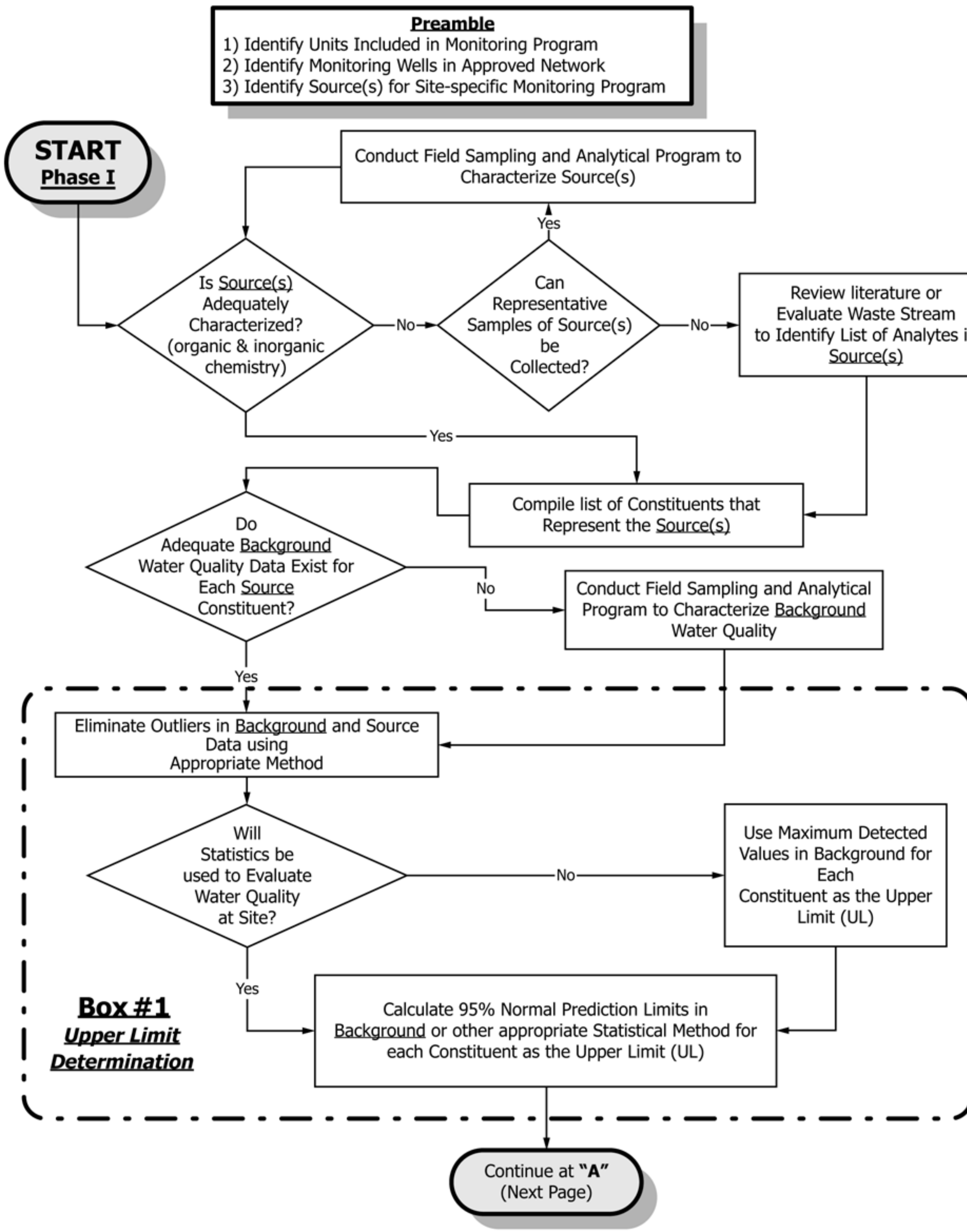

FIG. 1 Phase I—Indicator Parameter Identification

5.7 Another key factor to be used in this guide is knowledge of background quality of groundwater unaffected by the WMU and knowledge of local sources other than the WMU that may presently be impacting groundwater quality. The main objective then is to choose those constituents that are derived from the WMU (for example, are present in the leachate or residual liquids) at much higher concentrations than groundwater and/or that are only present in the waste or waste residuum (for

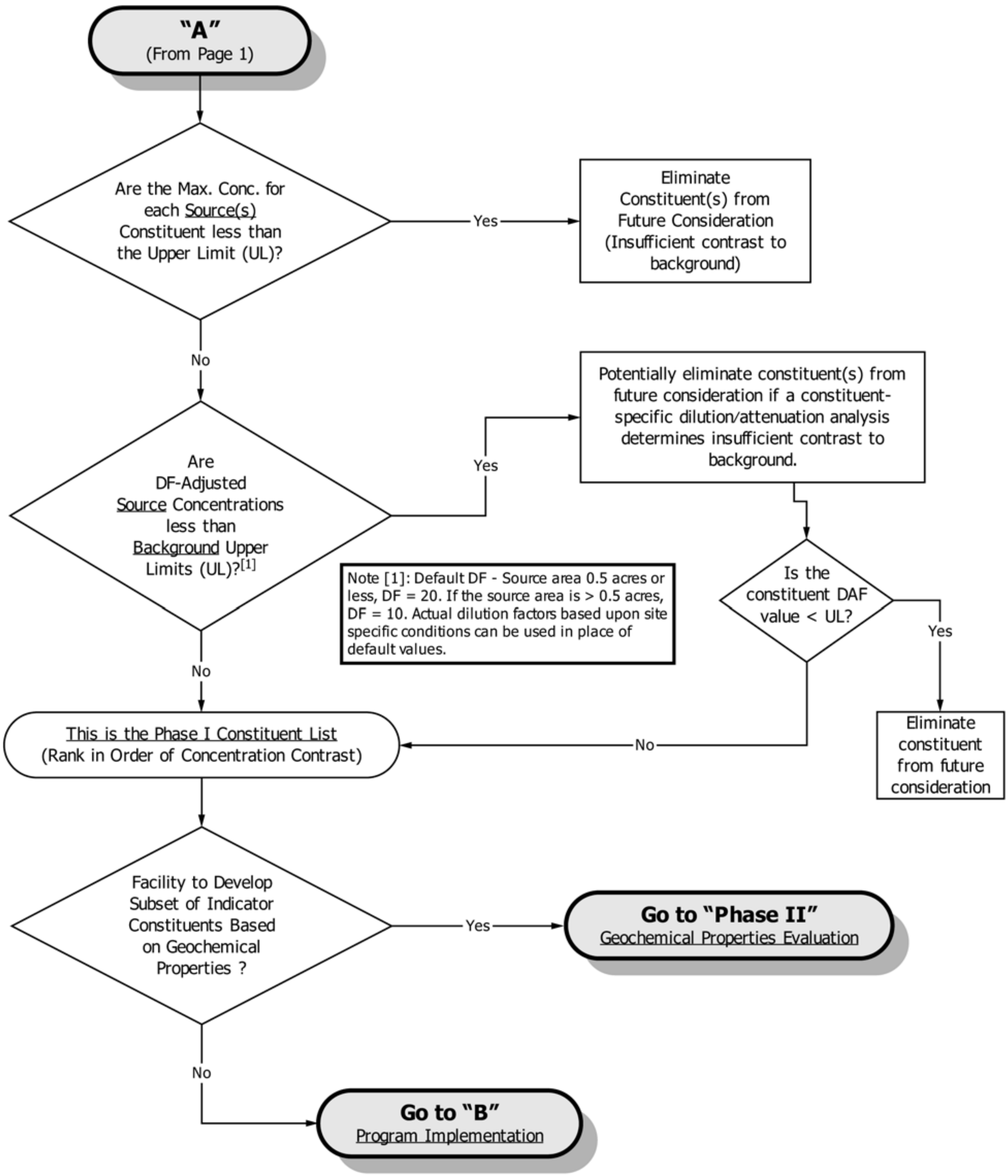

FIG. 1 Phase I—Indicator Parameter Identification *(continued)*

example, leachate) and absent in groundwater. The analytes chosen must also be mobile, persistent, and easily quantifiable in the specific hydrogeologic and groundwater regime.

6. Procedure

6.1 This guide is used to identify and select site-specific monitoring constituents. The practice requires site-specific characterization of the liquids derived from the source (that is, leachate) and background groundwater geochemistry (that is, the types, quantities, and concentrations of constituents present in the WMU). First, comparison of maximum detected leachate constituents to background prediction limits are used as a "first-order" process to identify indicator parameters in leachate that contrast significantly to background groundwater quality. Next, a mixing model is used as a "second-order" process, if necessary, to further identify analytes that are best

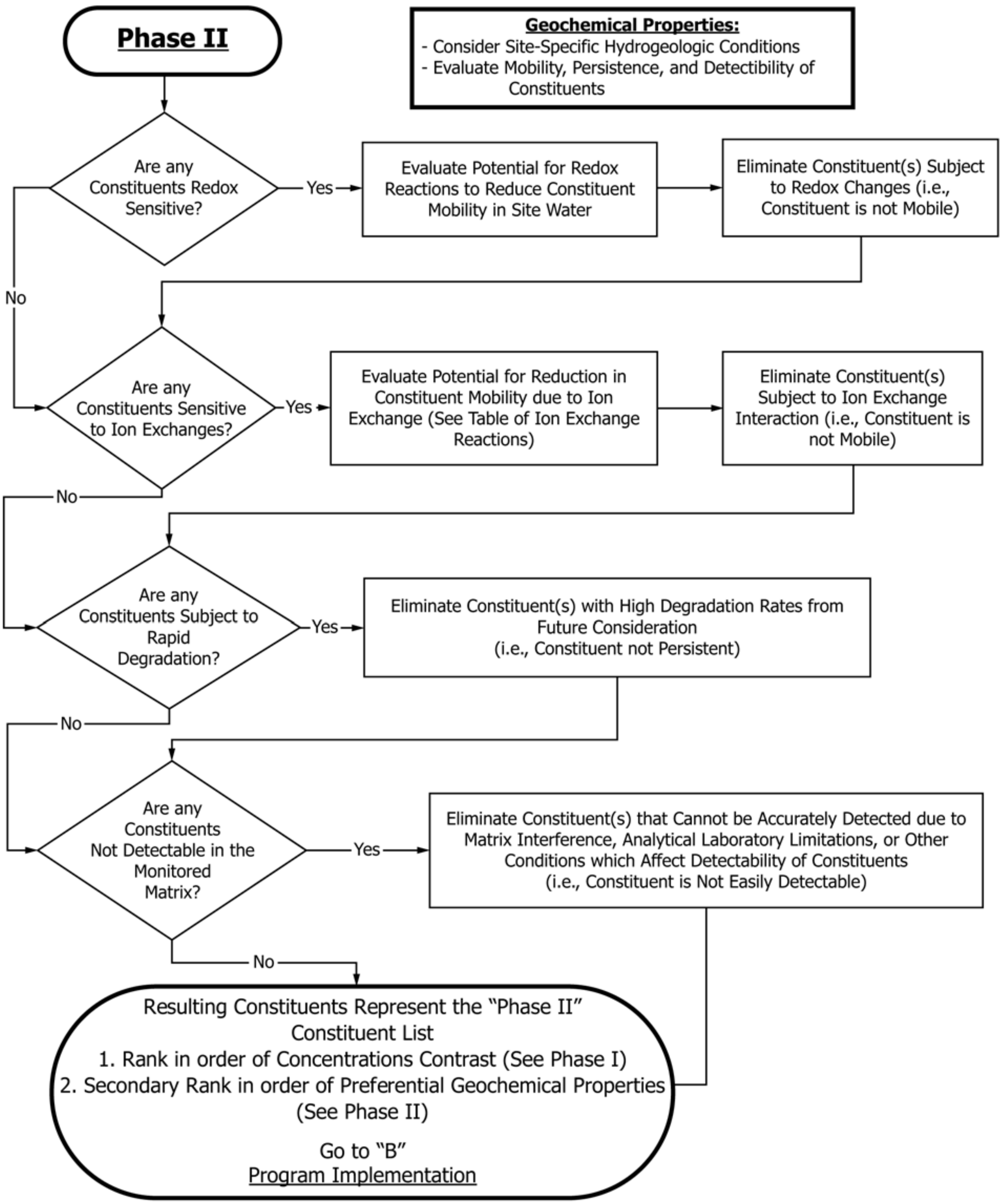

FIG. 2 Phase II—Geochemical Properties Evaluation

suited for the detection-monitoring program based on site hydrogeology (that is, groundwater flow rates). Finally, other processes, primarily geochemical chemical interactions, can be addressed as a "third order screening process" for those sites that have adequately completed the first two processes and desire a more representative subset of the source material. Once a suitable list of site specific constituents is identified, a QGWS can select and propose an analyte list for the detection-monitoring program at the WMU. A sequential flow chart has been included as Attachment 1 to provide a means to follow the constituent optimization program outlined in this standard.

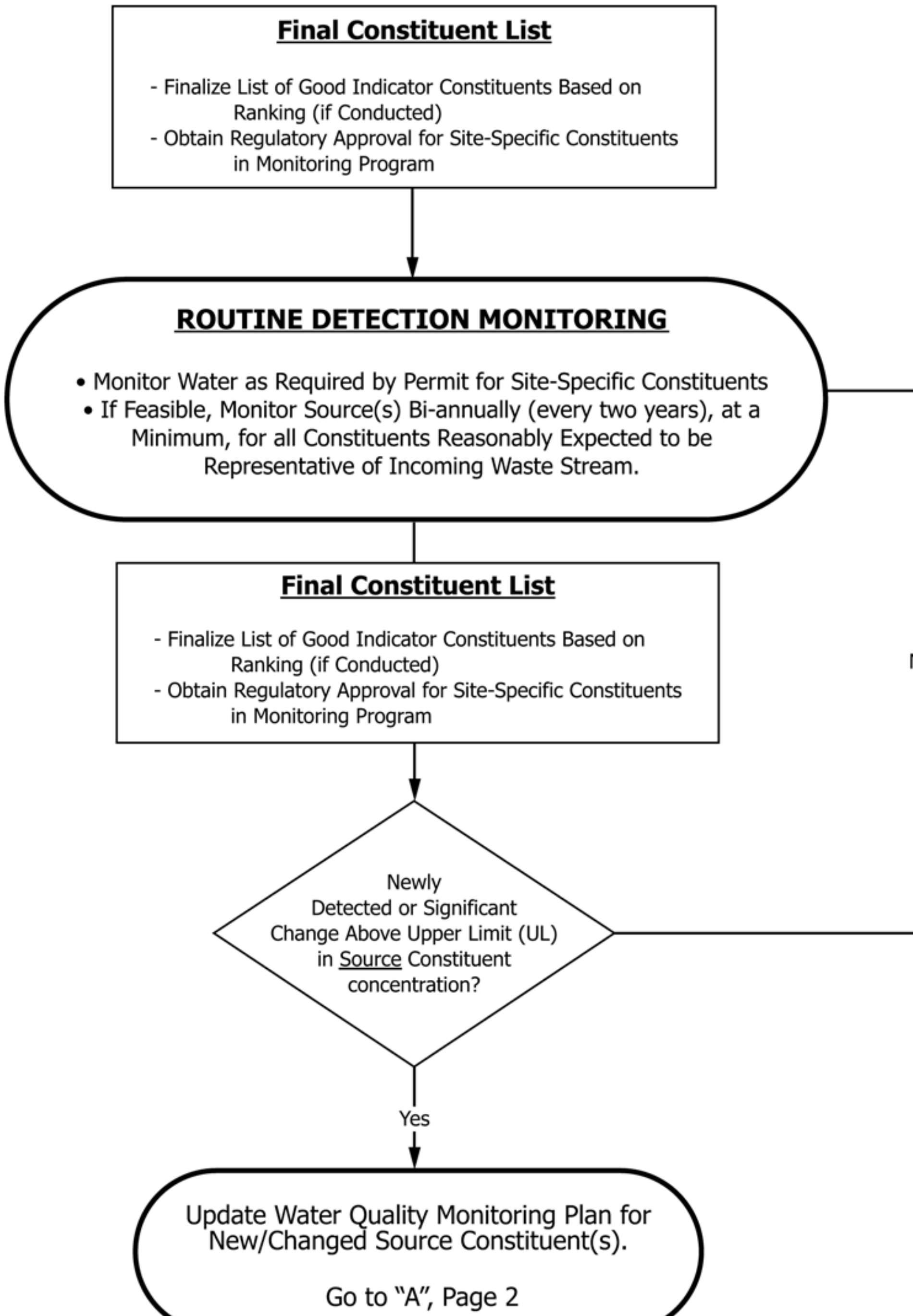

FIG. 3 Monitoring Program Implementation

6.2 *Source Characterization:*

6.2.1 As a first-order screening process, the owner/operator needs to determine if sufficient source characterization data exists to be able to define (that is, fingerprint) the liquid, or the more mobile, waste stream contained within the WMU. For the purposes of this standard, we refer to liquids derived from the WMU as leachate. Leachate is a complex matrix containing a variety of soluble, insoluble, organic, inorganic, ionic, nonionic, and bacteriological constituents in an aqueous medium. Leachate usually is more than 99 % water.

6.2.2 Leachate characterization should include an assessment and demonstration of the quantity and composition of leachate contained within the WMU. Estimates of volumetric production rates of leachate are important in evaluating the fate and transport of the constituents. Leachate production rates depend on rainfall, run-on, run-off, evapo-transpiration, water table elevation relative to the bottom of the WMU, in-place moisture or water content of the waste, and the volumetric in-flow of free liquids into the WMU (if allowed by local permit). An often overlooked source of water is that derived from the compression (settlement) of the waste and/or natural soils.

6.2.3 If leachate composition data that are representative of the WMU (or historical waste contained within the unit) are not available, then leachate data with a similar expected composition should be compiled.

NOTE 2—EPA530-R-93-017 provides one means of how to compile the data.

6.2.4 A review of existing literature for similar waste management units, as well as a compilation of waste profiles on file with the owner/operator that characterizes waste inflow, should be conducted. References for the chemical composition of leachate at solid and/or hazardous waste sites include Cravy (1990), Plumb et al. (1991), Gibbons et al. (1992), Gintautas (1993), and Christensen et al. (1994).

6.2.5 Determine if existing, analytical chemical data is available for site leachate. Analytical data might include actual data collected from WMU leachate or an analytical characterization of the waste stream placed into the WMU (recommended for mono-fills). For solid waste disposal facilities, analytical data might include, but are not limited to, anthropogenic (man-made) compounds such as VOCs, inorganic macrocomponents, and (at a minimum) heavy metals included in 40 CFR §258.54 or other applicable regulation.

6.2.6 If analytical data are not available, then a determination should be made if leachate is present and can be sampled. Representative samples of site leachate, as determined by a QGWS, should be collected and analyzed for a suite of analytical parameters capable of detecting a constituent in the waste based on a reasonable assumption by the owner/operator or available data. Examples of representative data include single or composite samples from multiple sumps or samples from a main leachate header line. Samples should be collected prior to treatment or to discharge into a storage tank or other storage device. Leachate samples should be collected at least annually, throughout the monitoring program, to evaluate geochemical changes over time and to allow the facility to periodically review and, if necessary, update the groundwater-monitoring program based on geochemical changes.

6.2.7 If a sample of leachate is not attainable by way of standard sampling techniques (for example, there is no collection system), then a generic list of typical leachate constituent concentrations should be used. If the facility is new, wait until leachate appears in the collection sump [that is, it is advisable to wait for 6 months to a year to make sure that the sample is more representative of the liquids derived from the WMU and is not from rainwater infiltration or construction water].

6.3 *Background Groundwater Quality:*

6.3.1 Background groundwater quality should be determined as the first step toward the establishment of detection monitoring programs. Background groundwater quality should be characterized from the upper-most water-bearing unit beneath the WMU from properly constructed monitoring wells installed at locations not impacted from a WMU release. This requires an understanding of the upper-most groundwater flow regime in the vicinity of the WMU including, but not limited to, horizontal and vertical flow components of the water-bearing strata, locations of sumps or areas with higher probabilities of leakage (that is, have the greatest potential for buildup of head), and locations of local recharge or discharge points.

6.3.2 In very simple hydrogeologic situations conceptual geologic models may not be necessary to define the target monitoring zone or to define gradients adjacent to a facility. However, using a hydrogeological flow model developed for the site can support the well placement and rationalize the locations selected for groundwater samples. Groundwater samples collected from hydraulically up gradient (or cross-gradient) locations, are often representative of natural groundwater quality in the area of the WMU. Hydraulically down-gradient wells should be utilized if the owner/operator can show that these wells have not been previously impacted by the WMU. Background groundwater quality parameters analyzed from these samples should include a list of regulatory required parameters (for example, in the United States for permitted Subtitle D solid waste disposal facilities, 40 CFR 258 Appendix I trace metals and organics and/or state required constituents), inorganic macrocomponents of groundwater (anions and cations), as well as an appropriate list of site-specific indicator parameters and groundwater quality constituents that are likely to represent the variety of wastes placed into the WMU. A sufficient number of samples should be collected over time to account for temporal variability. The number of samples that are needed to support a defensible background population database will vary depending on the spatial variability evident in the local hydrologic unit(s) but is typically characterized by two or more sampling locations per geologic unit monitored at the site. Quantification of temporal variability is an important aspect of the characterization as natural geochemistry of groundwater can fluctuate over time based on conditions such as flood or drought. Therefore, a minimum sampling period is one year with samples collected with a frequency to account for seasonal fluctuations, usually quarterly. Background samples usually have to be collected for a period longer than one year to account for climatic changes and can be updated after the initial baseline period to adjust the values for flood or drought conditions.

6.4 *Evaluate Source Data and Background Data for Outliers:*

6.4.1 A thorough review of source and background data for analytical method compliance as well as accuracy and precision is necessary so that the baseline values included in future comparisons accurately represent the actual range of concentrations for these media. A detailed review by a qualified professional using standard industry practices is advised.

NOTE 3—In the United States, recommendations for data review procedures are included in EPA guidance as well as laboratory data review protocols.

6.5 *Initial Determination of Contrast of Site Leachate to Background Groundwater Quality:*

6.5.1 A site-specific groundwater monitoring parameter list should include only those parameters that are characteristic of WMU leachate (or typical source leachate if site-specific leachate data is not available) and provide a sufficient contrast to background groundwater quality such that an increasing trend or statistical exceedance of a statistically-derived limit would provide an early indication of a potential leachate release. If parameters are included in the detection monitoring program that are not characteristic of the source waste stream (leachate) and/or do not provide suitable contrast with background groundwater quality, then they would not be expected to be an indicator of a release. Evaluation of such data with an increasing trend or statistically-significant increase over background may just be indicative of temporal or spatial variability in a data set that was not adequately characterized through a limited background set period.

6.5.2 Background groundwater quality should be calculated using up gradient (or potentially cross-gradient) data, samples should be obtained from a sufficient number of wells to account for spatial variability (usually more than three) and over a sufficient period of time (for example, two years of quarterly sampling) to consider temporal, or seasonal, variability. Down-gradient well data should be used whenever practical (that is, whenever it can be shown that prior impacts have not occurred) since using down-gradient sample locations completely eliminates the special component of background variability (which constitutes up to ⅔ of total variability). This method allows one to evaluate ranges of concentrations that represent a level of confidence that the next sample, if measured within that range, would be representative of background groundwater quality. This guidance document recommends the calculation of a background Upper Limit (UL) that can be either statistically or non-statistically based. The "first order screening practice" includes a comparison of source constituent concentrations (either the maximum detected concentration or the mean of a source concentration data set depending on your method of comparison) to the calculated UL to determine if sufficient contrast exists to include that parameter in the detection-monitoring program.

6.5.3 A statistically-derived option discussed by Gibbons (1994) is the use of the 95 % confidence normal, lognormal, or non-parametric prediction limit (depending on the distribution of the data) for the mean of the background data set collected from the site. Comparison of the maximum site leachate constituent concentrations to the upper prediction limits of background groundwater quality provides a preliminary, "first order" indication if potential source concentrations significantly exceed background groundwater quality. If the mean concentration calculated from more than one leachate sample is used for comparison purposes, the 95 % upper confidence limit (UCL) should be used to calculate the background UL (Gibbons, 2000 personal communication).

6.5.4 For sites that do not intend on utilizing statistics as a part of their data evaluation process, the use of the maximum detected concentration from the background data set can be used as the UL for that parameter. This method provides a non-statistical substitute for the prediction limit in that it provides an upper bound of the natural background data set based on a limited number of background samples. It should be noted that with the collection of routine background data from wells over time, this UL may have to be updated to account for temporal variability in the data set that may not have been characterized in the initial calculation.

6.5.5 A constituent that is detected in leachate at a concentration less than the reporting limit or practical quantitation limit (PQL) for the constituent or less than the UL for the background data set should not be included as a part of the Detection Monitoring program for the site. By definition, these data would not contrast to groundwater, no matter what the mixing conditions. This is consistent with multiple guidance documents on parameter optimization including the California EPA (1997). This guidance for determining chemicals of potential concern (COPC) for WMUs states "The simplest method for identifying analytes as COPC involves comparison of the highest concentration detected at the site (Cmax) with a concentration representing the upper range of ambient conditions. If Cmax does not exceed this value, then the metal is excluded as a COPC."

6.6 *Assessment of the Effect of In-Situ Conditions to Leachate Migration:*

6.6.1 The migration of leachate in the subsurface depends on factors such as the volume of the liquid component of the waste, the chemical and physical properties of the leachate constituents, the loading rate, climate, and the chemical and physical properties of the subsurface (saturated and unsaturated). A number of physical, chemical, and biological processes also may influence migration. Complex interactions between these processes may result in specific constituents being transported through the subsurface at different rates. Certain processes result in the attenuation and/or degradation of some monitored constituents. The degree of attenuation is dependent on the time the monitored constituent is in contact with the subsurface material, the physical and chemical characteristics of the subsurface material, the distance that the contaminant has traveled, and the volume and characteristics of the constituent.

6.6.2 The comparison of site-specific indicator concentrations to a UL of background groundwater quality data provides a very conservative screening methodology to eliminate constituents that clearly do not provide an indication of a release of leachate from the facility. However, this methodology does not consider the effects of dilution, attenuation, or complexation of metal ions in the shallow subsurface flow regime. For the purposes of screening analytes and the development of a primary constituent list, if a leachate analyte is detected at a concentration of at least 20 times greater (for a source area less than 0.5 acres in size) or 10 times (for a source area greater than 0.5 acres in size) than the background prediction limit, the analyte is to be included on the Phase I constituent list for screening by a QGWS. If a leachate analyte is detected at a concentration between the UL and the 10× or 20× limit, a parameter-specific dilution/attenuation calculation should be completed in order to evaluate if the constituent should be retained in the detection-monitoring program. [Note: For the purposes of this calculation, the source area is considered the area of the facility that is leaking, not the entire area of disposal (unless the conservative default is that the entire area is subject to leakage, for example, unlined, equal head).] Use of this guidance means that a leachate constituent must have a detected concentration at least 10× or 20× (depending on the size of the source) that of the calculated UL in order to consider that constituent as effective in providing an early indication of release of leachate from the landfill. The use of this standard is a conservative guidance standard to consider the effects of dilution and attenuation without consideration to parameter-specific attenuation or complexation factors or the dilution effects of varying hydrogeologic flow regimes.

6.6.3 This approach is modified from the USEPA Office of Solid Waste and Emergency Response study published in 1996 (EPA/540/R-95/128) to determine methods for calculating Dilution/Attenuation Factors (DAFs) for use on sites with a variety of source contaminants. The conclusion of USEPA was that a simple Dilution Factor (DF) would be more conservative and would be more applicable to a wider variety of sites since the determination of the effects of chemical processes on the contaminant concentration is much more complex and site-specific in nature. In some cases, the DF data cannot be collected or calculated to provide a reasonable baseline model, a default value can be used with the caution that it may not be as conservative or accurate as a site-specific DF calculation. In determining a default value that could be considered applicable across a variety of site conditions, USEPA conducted a sensitivity analyses of other variables that would have an effect on the calculation of a DAF for a site. The results of the sensitivity analyses indicate that the climate (net precipitation), soil types and size of the contaminated area have the greatest effect on the calculation of a DAF. The USEPA concluded that the size of the source area lends itself to the generation of general DF's that have cross-media application. The USEPA developed a default DAF value to provide a simple means to consider the effects of dilution (and limited attenuation) without the need to collect detailed site-specific data (EPA/540/R-95/128, May 1996). The USEPA selected a default DAF of 20 to account for contamination dilution and attenuation during transport through the saturated zone to a compliance point (that is, receptor well). The default DAF of 20 represents an adjustment from the DAF of 10 presented in the December 1994 draft Soil Screening Guidance (USEPA, 1994h) to reflect a change in default source size from 30 acres to 0.5 acres. A DAF of 20 is considered protective for sources up to 0.5 acres in size (USEPA, 1996). For sources larger than 0.5 acres, a DAF of 10 is an acceptable default value that provides a conservative estimate of the effects of dilution and attenuation on source migration.

6.6.4 Subsurface soil or rock units with relatively low hydraulic conductivities (that is, clayey soils or unfractured bedrock) will have a less pronounced dilution effect while more porous subsurface units (such as sands or dissolution cavities in limestone) may have a more pronounced impact relative to dilution. However, at most sites, use of a default DAF will more accurately reflect a contaminant's threat to groundwater resources than assuming a DAF of 1 (that is, no dilution or attenuation). USEPA selected a DAF of 20 (for sources smaller than 0.5 acres) using a "weight of evidence" approach. This approach considered results from OSW's EPACMTP model as well as results from applying the Soil Screening Level (SSL) dilution model described in EPA/540/R-95/128 (May 1996) to 300 groundwater sites across the country. The use of these default values based on source size should be evaluated on a case-by-case basis to determine if these values conservatively represent in-situ conditions.

6.7 *Completion of Phase I Constituent List:*

6.7.1 Following completion of the comparison of maximum leachate concentrations to the calculated UL and completion of the calculated or default dilution factor (if applicable based on State and permit limitations) for the leachate concentrations, the remaining constituents comprise the Phase I constituent list for the facility. These constituents are to be ranked in order of concentration contrast to provide a hierarchy of optimum constituents for inclusion in the groundwater detection-monitoring program.

6.7.2 To consider the constituent-specific and flow regime-specific effects of dilution and attenuation, a more detailed geochemical evaluation should be conducted to optimize the detection monitoring parameter list. The processes to be followed for such an evaluation are outlined in Fig. 3.

7. Monitoring Program Implementation

7.1 *Selection of the Final Constituent List:*

7.1.1 This standard has provided a mechanism to develop a Phase I constituent list based on a reasonable characterization of site-specific leachate data and comparison of actual leachate values to background UL. However, the selection of the Phase I constituent list should be subject to review by a qualified groundwater scientist (QGWS) to eliminate constituent that should not be included due to site-specific geologic or hydrogeologic conditions, or known up gradient source constituents that do not allow that parameter to effectively provide an indication of a release from the solid waste disposal facility. Examples may be mineral deposits that are not uniformly distributed throughout the site, geologic boundaries that are separated between up gradient and downgradient locations at the site, or a known up gradient waste disposal area that was otherwise not accounted for during the data evaluation process.

7.1.2 A Phase II constituent list is composed of only a subset of indicator parameters that provide the most reliable indication of a release from WMU while taking into consideration the effects of site-specific attenuation effects on the contaminant release. During routine detection monitoring, if Phase II constituents are detected at concentrations determined to be significant in nature, an expanded list, including at a minimum each parameter included in the Phase I constituent list, should be added to the detection monitoring program for the well which detected the constituent(s).

7.2 *Updating the Final Constituent List:*

7.2.1 The liquids contained within the WMU should be further characterized on at least an annual basis for the constituents reasonably expected to be representative of the incoming waste stream. A newly detected constituent, or constituent detected at concentrations greater than the adjusted DF source concentration, should be evaluated using the methods described in section 6.6.3 to determine if the constituent should be added to the Detection Monitoring Program. As a part of this evaluation, background should also be modified to reflect natural changes in groundwater chemistry due to temporal variability in the data set.

8. Keywords

8.1 groundwater; groundwater quality; monitoring; monitoring program; optimization; RCRA; waste disposal facilities

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(10) *USEPA Soil Screening Guidance: Technical Background Document*, EPA/540/R-95/128, Office of Solid Waste and Emergency Response, May 1996.

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (D7045–04 (2010)) that may impact the use of this standard. (February 1, 2017)

(1) Revised terminology section to comply with D18 requirements and removed terms not used in the text, or included in D653.
(2) Removed or moved references to RCRA to notes to make standard less US centric. Removed RCRA from Title and moved RCRA information into notes.
(3) Removed symbols not used in the standard.
(4) Removed or edited jargon and superlatives from the text to improve clarity.
(5) Updated References.