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Standard Guide for Characterization of Coal Combustion Products (CCPs) in Storage Area(s) for Beneficial Use¹

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1. Scope

1.1 This guide provides a framework to characterize coal combustion products (CCPs) situated in active or inactive storage units for potential harvesting and beneficial use and may be considered a companion standard to Guide E3183.

1.2 A framework is provided in this guide to address critical aspects related to the characterization of CCPs placed in active (operational) and inactive storage of (closed or no longer receiving CCPs) storage area(s). These storage area(s) may be used for wet or dry CCPs.

1.3 This guide does not include information on how to determine what storage area(s) or facilities should be selected for potential characterization of CCPs as each entity may approach a characterization program in accordance with their own intent and regulatory requirements. In addition, it does not include information on how the user should evaluate inventories to determine the order of their storage area(s) for potential characterization including consideration of risk, performance, and cost. This guide for potential harvesting for beneficial use is intended to be used to evaluate the storage area(s) once the storage area(s) are selected for evaluation.

1.4 This guide does not include information on the permitting that may be required to implement CCP characterization activities or may be associated with the processing or end use(s). Therefore, additional approvals not discussed within this guide may be needed.

1.5 This guide is intended to help characterize CCPs that may be harvested while gaining understanding of their homogeneity within a given wet or dry storage area.

1.6 The CCPs that may be characterized include fly ash, bottom ash, and economizer ash; boiler slag; flue gas desulfurization material; fluidized bed combustion products as defined in Terminology E2201; cenospheres; or other materials suitable for beneficial use.

1.7 Laws and approval requirements governing the use of CCPs vary by locality, state, province, and country and generally do not yet include provisions for CCP characterization as described herein. The user of this guide is responsible for determining and complying with the applicable approval requirements, which may extend beyond characterization to include approval requirements or guidance on issues such as disturbance, storage, transportation, end use, and other concepts. This guide may complement approval programs in which guidance on characterization is unavailable or insufficient, thereby improving the chance that such storage area(s) may be repurposed for public or private benefit or both. It may be important to engage and educate the approval authority early and often throughout the planning, design, and implementation of the characterization activities. The project team may also consider affording an opportunity to solicit input from other stakeholders.

1.8 This guide should not be used to characterize (that is, environmentally assess) wet or dry CCP storage area(s) for ownership transfer, although portions of such information resulting from characterizing CCPs using this guide may supplement other environmental assessments that are used in such a transfer.

1.9 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.10 *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.*

1.11 *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.*

¹ This guide is under the jurisdiction of ASTM Committee E50 on Environmental Assessment, Risk Management and Corrective Action and is the direct responsibility of Subcommittee E50.03 on Beneficial Use.

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2. Referenced Documents

2.1 *ASTM Standards:*²

- C22/C22M** Specification for Gypsum
C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C311/C311M Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
C330 Specification for Lightweight Aggregates for Structural Concrete
C471M Test Methods for Chemical Analysis of Gypsum and Gypsum Products (Metric)
C472 Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete
C476 Specification for Grout for Masonry
C566 Test Method for Total Evaporable Moisture Content of Aggregate by Drying
C593 Specification for Fly Ash and Other Pozzolans for Use With Lime for Soil Stabilization
C595 Specification for Blended Hydraulic Cements
C618 Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C1325 Specification for Fiber-Mat Reinforced Cementitious Backer Units
C1761 Specification for Lightweight Aggregate for Internal Curing of Concrete
C1797 Specification for Ground Calcium Carbonate and Aggregate Mineral Fillers for use in Hydraulic Cement Concrete
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D2940 Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
D3018 Specification for Class A Asphalt Shingles Surfaced with Mineral Granules
D3462 Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules
D4417 Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
D4832 Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Cylindrical Test Specimens
D4940 Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
D5971 Practice for Sampling Freshly Mixed Controlled Low-Strength Material
D6023 Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM)
D6024 Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application

- D6044** Guide for Representative Sampling for Management of Waste and Contaminated Media
D6103 Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)
D6155 Specification for Nontraditional Coarse Aggregates for Asphalt Paving Mixtures
D7393 Practice for Indicating Oil in Abrasives
E105 Guide for Probability Sampling of Materials
E1527 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process
E2060 Guide for Use of Coal Combustion Products for Solidification/Stabilization of Inorganic Wastes
E2201 Terminology for Coal Combustion Products
E2278 Guide for Use of Coal Combustion Products (CCPs) for Surface Mine Reclamation: Revegetation and Mitigation of Acid Mine Drainage
E3183 Guide for Harvesting Coal Combustion Products Stored in Active and Inactive Storage Areas for Beneficial Use

2.2 *ACI Standards:*³

- ACI 214-14** Guide for Structural Lightweight-Aggregate Concrete
ACI 325.9R-15 Guide for Construction of Concrete Pavements
ACI PRC-211.7-15 Guide for Proportioning Concrete Mixtures with Ground Limestone and Other Mineral Fillers
ACI PRC 213-14 Guide for Structural Lightweight-Aggregate Concrete
ACI PRC-229-13 Report on Controlled Low-Strength Materials
ACI PRC 230.1-09 Report on Soil Cement
ACI PRC 232.2-18 Report on the Use of Fly Ash in Concrete
ACI PRC-232.3-14 Report on High-Volume Fly Ash Concrete for Structural Applications

2.3 *Other Standards:*

- 40 CFR 260.10** Definitions⁴
40 CFR 312.10 Definitions⁴
AASHTO M295 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete⁵
EPA 530-R-16-011 Methodology for Evaluating Beneficial Uses of Industrial Non-Hazardous Secondary Materials⁶
NIOSH Method 7500 Crystalline Silica Content⁷
PennDoT MS-0450-0001 Anti-Skid for Municipal Use⁸

³ Available from American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331-3439, <http://www.concrete.org>.

⁴ Available from www.ecfr.gov.

⁵ Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, <http://www.transportation.org>.

⁶ Available from the U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery 1200 Pennsylvania Ave., NW (5306T), Washington DC 20460, www.epa.gov.

⁷ Available from the National Institute for Occupational Safety and Health, <https://www.cdc.gov/niosh/docs/2003-154/pdfs/7500.pdf>.

⁸ Available from the Pennsylvania Department of Transportation, Department of Transportation Bureau of Planning & Research, 400 North St., 6th Fl., Harrisburg, PA 17120, <https://www.dot.state.pa.us/public/PubsForms/Publications/Pub%20447.pdf>.

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.

3. Terminology

3.1 Definitions:

3.1.1 For additional definitions related to coal combustion products (CCPs), see Terminology **E2201**. For definitions related to geotechnical properties, see Terminology **D653**.

3.1.2 *active storage area(s)*, *n*—storage area(s) containing CCPs that has not completed closure in accordance with the approval authority requirements.

3.1.3 *approval authority*, *n*—entity that is authorized to establish and enforce compliance with environmental protection and public/worker safety laws and directives concerning the management of CCP storage area(s) and this includes governments of cities, counties, states, countries, provinces, and tribal organizations.

3.1.4 *beneficial use of CCPs*, *n*—recycling CCPs in lieu of disposal.

3.1.4.1 *Discussion*—The beneficial use of CCPs, when appropriate, may result in the conservation of natural resources and energy and the reduction of greenhouse gas emissions while protecting human health and the environment. For the purpose of this guide, examples of beneficial uses include, but are not limited to, raw feed for cement clinker, concrete, grout, flowable fill, and controlled low-strength material; controlled or structural fill; road base/sub-base; soil modification; mineral filler; snow and ice traction control; blasting grit and abrasives; roofing granules; mining applications; gypsum panel; waste stabilization/solidification; soil amendment; and agriculture.

3.1.5 *beneficiation*, *n*—improvement of the chemical or physical properties of a raw material or intermediate product by the removal or modification of undesirable components or impurities.

3.1.6 *blasting/abrasive grit*, *n*—material used to clean or texture a material such as metal or masonry.

3.1.7 *boiler slag*, *n*—molten ash collected at the base of slag tap and cyclone boilers that is quenched with water and shattered into black, angular particles having a smooth, glassy appearance.

3.1.8 *bottom ash*, *n*—ash that results from the process of combustion of ground or powdered coal that is not transported by flue gases.

3.1.8.1 *Discussion*—See Terminology **E2201** for more information.

3.1.9 *cement, hydraulic*, *n*—cement that sets and hardens by chemical reaction with water and is capable of doing so under water.

3.1.10 *cenosphere*, *n*—type of fly ash particle consisting of lightweight, hollow sphere.

3.1.11 *clinker*, *n*—partially fused product of a kiln that is ground to make cement.

3.1.12 *concrete*, *n*—composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate; in hydraulic-cement concrete, the binder is formed from a mixture of hydraulic cement and water.

3.1.13 *coal ash*, *n*—fly ash and bottom ash resulting from the process of combustion of ground or powdered coal (for example, fly ash, bottom ash, or boiler slag).

3.1.14 *coal combustion products, CCPs*, *n*—solid materials that result from the process of combustion of ground or powdered coal.

3.1.14.1 *Discussion*—Examples of coal combustion products include fly ash, bottom ash, flue gas desulfurization residue, and boiler slag. This definition of coal combustion products does not include, among other things, the residue resulting from: (1) fluidized bed combustion, (2) the burning of municipal solid waste or any other refuse with coal, or (3) the burning of industrial or municipal solid waste in incinerators.

3.1.15 *coal refuse and mine fire abatement*, *n*—application of CCP slurry to abate smoldering coal refuse piles and deep-mine fires.

3.1.16 *controlled low-strength material, CLSM*, *n*—mixture of soil or aggregates (sand or gravel or both), cementitious materials, water, and sometimes, admixtures, that hardens into a material with a higher strength than the soil but less than 8400 kPa [1200 psi].

3.1.16.1 *Discussion*—Used as a replacement for compacted backfill, CLSM can be placed as a slurry, a mortar, or a compacted material and typically has strengths of 350-700 kPa [50-100 psi] for most applications.

3.1.17 *dry CCP storage area(s)*, *n*—area of land or excavation used to manage and store coal combustion products that is not a wet CCP storage area.

3.1.18 *economizer ash*, *n*—coal ash that exits the combustion chamber carried in the flue gases used by the economizer, which is typically captured by hoppers.

3.1.18.1 *Discussion*—Economizer ash is heavier and coarser than fly ash but lighter and less coarse than bottom ash.

3.1.19 *end use(s)*, *n*—material or product in which raw or harvested CCP will be used, for example, an end use of fly ash can be concrete.

3.1.20 *engineering controls*, *n*—constructed containment barriers or systems that control the downward migration, infiltration, or seepage of surface runoff and rain; control the natural leaching/migration of contaminants through the subsurface over time; control fugitive emissions; and measures that minimize the flow of liquids and fugitive emissions into or out of a regulated storage area(s).

3.1.20.1 *Discussion*—Examples of engineering controls are engineered soil liners or caps, leachate collection and removal systems, dewatering systems, surface water management systems, and dust control systems.

3.1.21 *environmental professional*, *n*—person trained and experienced in the management of materials and storage area(s).

3.1.21.1 *Discussion*—An environmental professional has the credentials to make professional judgments about the acceptability of how land is used; potential impacts to safety, human health, and the environment; and the effectiveness of engineering, institutional, and regulatory controls. The definition of environmental professional in this guide is different and

mutually exclusive of the definition of environmental professional as defined in the Environmental Protection Agency's (EPA's) All Appropriate Inquiries rule (40 CFR 312.10) and Practice **E1527**.

3.1.22 *facility, n—as used in this guide*, a coal-fired power plant including all contiguous land, structures, other appurtenances, and improvements on the land used for treating, storing, disposing, or otherwise conducting solid waste management of CCPs.

3.1.22.1 *Discussion*—A facility may consist of several treatment, storage, or disposal operational units [for example, one or more active or inactive storage area(s)]. A facility as defined in this guide is not necessarily a permitted Resource Conservation and Recovery Act (RCRA) treatment, storage, or disposal facility as defined in 40 CFR 260.10.

3.1.23 *flowable fill, n*—material that flows as a liquid, is self-leveling, requires no compaction or vibration to achieve maximum density, hardens to a predetermined strength, and is sometimes a CLSM.

3.1.24 *flue gas desulfurization, FGD, n*—removal of gaseous sulfur dioxide from boiler exhaust gas.

3.1.24.1 *Discussion*—See Terminology **E2201** for more information.

3.1.25 *flue gas desulfurization (FGD) material, n*—product of an FGD process typically using a high-calcium sorbent such as lime or limestone.

3.1.25.1 *Discussion*—See Terminology **E2201** for more information.

3.1.26 *fluidized-bed combustion (FBC) ash, n*—fly ash and bed ash produced by an FBC boiler.

3.1.27 *fly ash, n*—finely divided residue that results from the process of combustion of ground or powdered coal and is transported by flue gases.

3.1.27.1 *Discussion*—This definition of fly ash does not include, among other things, the residue resulting from: (1) fluidized bed combustion, (2) the burning of municipal solid waste or any other refuse with coal, or (3) the burning of industrial or municipal solid waste in incinerators.

3.1.28 *grout, n*—cementitious mixture, with or without aggregate or admixtures, that is used primarily to fill voids.

3.1.29 *gypsum panel, n*—sheet product that has a noncombustible core made primarily of gypsum.

3.1.30 *harvesting, v*—removal, or reclamation, of CCPs from an active or inactive storage area(s) for the purpose of beneficial use.

3.1.31 *historic CCP fill material, n*—CCPs typically that were placed before effective regulatory requirement governed material placement, and therefore, they were stored without a permit or an approval obtained by an approval authority.

3.1.32 *historic (or unpermitted) storage area(s), n*—location where historic CCPs were placed before effective environmental regulatory requirements governed material placement.

3.1.33 *inactive storage area(s), n*—storage area(s) containing CCPs that has completed closure in accordance with the

approval authority requirements or has not placed CCPs within a period specified by the approval authority (as applicable).

3.1.34 *institutional controls, n*—measures established and enforced by an approval authority that directs users of CCP storage area(s) on appropriate or prohibited activities and deliverable documents concerning the control of leachate, stormwater runoff, and water infiltration.

3.1.34.1 *Discussion*—These measures may include what activities are allowed or permitted, what is to be measured during inspections, and required responses or corrective action are to be implemented if conditions exceed what is considered acceptable.

3.1.35 *level of confidence for beneficial use, n*—acceptable, self-selected level of confidence the user of this guide is comfortable with regarding characterization of CCP storage area(s) to support their understanding of site conditions related to a harvesting project.

3.1.35.1 *Discussion*—Level of confidences range across three tiers with Tier I representing the lowest level of confidence and Tier III representing the highest.

3.1.36 *lightweight aggregate, n*—aggregate with bulk density less than 1120 kg/m³ [70 lb/ft³] such as, pumice, scoria, volcanic cinders, tuff, and diatomite; expanded or sintered clay, shale, slate, diatomaceous shale, perlite, vermiculite, or slag; and end products of coal or coke combustion.

3.1.37 *mine subsidence and acid mine drainage mitigation, n*—application of CCP to stop or prevent surface subsidence above mined areas and the use of alkaline CCP to control acid mine drainage from deep mines.

3.1.38 *mineral filler, n*—finely divided mineral product at least 65 % of which passes the 75 mm (No. 200) sieve.

3.1.39 *mining applications, n*—applications that include: (1) coal refuse and mine fire abatement, (2) mine subsidence and acid mine drainage mitigation, and (3) surface mine reclamation.

3.1.40 *permitted storage area(s), n*—storage area(s) where the placement of CCPs was governed by approval from an approval authority [that is, governing documents regulate the construction, operations, and closure of the storage area(s)].

3.1.41 *processing, v*—activities that the CCP undergoes, such as dewatering, dredging, drying, and/or milling of CCPs before storage or transportation or both of the materials to end use.

3.1.42 *project team, n*—two or more professionals (including the environmental professional) who collaborate on the evaluation and selection of a CCP storage area(s) to be harvested.

3.1.42.1 *Discussion*—The team may include the user; environmental professionals; the local, state, and country approval authority; ash management/marketing partner; and the storage area(s) owner or his or her representatives or both. For some storage area(s), the project team may also include community stakeholders.

3.1.43 *runoff, n*—any rainwater, leachate, or other liquid that drains over land from any part of a CCP storage area(s).

3.1.44 *reserve deposition model, RDM, n*—written or pictorial depiction of a CCP storage area(s) that is developed based upon site-specific review of the available or new technical information from various sources for the operational history, CCP storage area(s) design and applicable status, CCP characteristics (physical/chemical), and other attributes that may be used when planning a CCP characterization for harvesting activities.

3.1.45 *roofing granules, n*—graded, mineral material used as surfacing in asphalt shingles.

3.1.46 *run-on, n*—any rainwater, leachate, or other liquid that drains over land onto any part of the CCP storage area(s).

3.1.47 *sample, n*—representative part or a single item from a larger whole or group especially when presented for inspection or shown as evidence of quality.

3.1.47.1 *Discussion*—See Guides **D6044** and **E105** for more information.

3.1.48 *site characterization, n*—process to evaluate site-specific attributes to be considered for developing and implementing the CCP characterization plan that will be used to evaluate the suitability of CCP harvested from wet or dry CCP storage area(s) CCP for potential end use(s).

3.1.49 *soil amendment, n*—material applied to the land primarily to enhance soil characteristics (rather than as plant food).

3.1.50 *storage area(s), n*—area where wet CCPs [see wet storage area(s)] or dry CCPs [see dry storage area(s)] are stored within a facility.

3.1.51 *structural fill, n*—engineered fill with a projected beneficial end use that is typically constructed in layers of uniform thickness and compacted to a desired unit weight in a manner to control the compressibility, strength, and hydraulic conductivity.

3.1.52 *subbase, n*—layer in a pavement system between the subgrade and the base course or between the subgrade and the pavement.

3.1.53 *subgrade, n*—soil prepared and compacted to support a structure or a pavement system.

3.1.54 *surface mine reclamation, n*—application of CCP to surface mines to improve the physical characteristics of the soil, create better-graded soil texture, improve the water-holding capacity of the soil, and serve as a medium for supporting vegetation, especially in the case of alkaline CCP.

3.1.55 *Tier I (initial) level of confidence, n*—designation is the lower end of confidence selected along a spectrum regarding an understanding of CCP storage area(s) conditions when planning characterization activities to support harvesting activities.

3.1.55.1 *Discussion*—This usually is associated with reliance upon available, site-specific CCP storage area(s) information and may consider a collection of a very limited amount of additional site information following a CCP characterization plan.

3.1.56 *Tier II (moderate) level of confidence, n*—designation is the moderate level of confidence selected along a spectrum

regarding an understanding of CCP storage area(s) conditions when planning characterization activities to support harvesting activities.

3.1.56.1 *Discussion*—This usually is associated with reliance upon available site-specific CCP storage area(s) information and may consider a collection of a limited amount of additional site information following a CCP characterization plan.

3.1.57 *Tier III (comprehensive) level of confidence, n*—designation is the higher end of confidence selected along a spectrum regarding an understanding of CCP storage area(s) conditions when planning characterization activities to support harvesting activities.

3.1.57.1 *Discussion*—This usually is associated with reliance upon available site-specific CCP storage area(s) information and requires the collection of a limited or extensive amount of additional site information following a CCP characterization plan.

3.1.58 *unpermitted storage area(s), n*—storage area(s) where the placement of CCPs was not governed by approval from an approval authority.

3.1.58.1 *Discussion*—Current governing requirements that regulate construction, operations, and closure of the storage area(s) are not applicable to unpermitted storage area(s).

3.1.59 *waste stabilization/solidification, n*—treatment process designed to accomplish one or more of the following results: (1) improve the handling and physical characteristics of the waste, as in the sorption of free liquids; (2) decrease the surface area of the waste mass across which transfer of loss of contaminants can occur; and/or (3) limit the solubility of any hazardous constituents of the waste such as by pH adjustment or sorption phenomena.

3.1.60 *wet CCPs, n*—CCPs that were hydraulically placed in a storage area(s).

3.1.61 *wet storage area(s), n*—topographic depression, man-made excavation, impoundment, or diked area, which is designed to hold an accumulation of CCPs and liquids.

3.1.61.1 *Discussion*—Wet storage area(s) contain wet CCPs.

4. Significance and Use

4.1 *Purpose*—This guide provides a process for characterization of existing CCPs placed in active and inactive storage area(s) to assist in potential harvesting strategies. In this guide, information on the following activities required for the safe and effective characterization of CCPs from storage area(s) is included: (1) available site characterization information inventory/review, (2) available end use(s) information inventory/review, (3) end use(s) and level of confidence (Tiers I, II, and III) related to the CCP characterization selected and RDM; (4) CCP characterization plan development; and (5) CCP storage area(s) characterization report. More detailed descriptions of these activities are in Sections 6 – 10.

4.2 *Potential Beneficial Use(s) of CCPs*—There are many CCP storage area(s) that are potentially harvestable and can provide a functional benefit. The beneficial use of CCPs contained in these storage area(s) can have significant environmental and economic benefits for the user and can significantly

reduce disposal operations (1-4).⁹ Beneficial use of CCPs can provide industry with a safe and responsible way to manage the CCPs economically, while promoting conservation and recycling, meeting sustainability goals, and addressing the shortage of CCPs in some building product market areas (1, 2, 5). CCPs consist of fly ash, bottom ash, boiler slag, FBC ash, economizer ash, and FGD material. End use(s) may include cement/concrete, light aggregate, flowable fill, controlled or structural fill, road base/subbase, soil amendment, waste stabilization/solidification, agriculture, grout, mineral filler, snow/ice traction control, blasting grit/abrasives, roofing granules, mining application, gypsum panel, and others (see Terminology E2201 for definitions of CCPs) (Sections 6 and 7).

4.2.1 Fly ash is the most abundant CCP in existing storage area(s). Its beneficial uses include, but are not limited to, partial replacement for cement in concrete and concrete products—once in concrete, fly ash reacts with Portland cement to create additional reaction products that improve the strength and durability of concrete; raw feed for the production of clinker—fly ash can be calcined along with other minerals to produce clinker; blended cements—fly ash can be an important component in the production of blended cement, especially when pozzolanic properties are desired; filler in plastics—fly ash typically increases the stiffness and compressive strength when used as a filler in plastics; CLSM—CLSM that include fly ash typically have improved flowability and strength as well as reduced bleeding and shrinkage; as a soil stabilization material; as an aggregate/soil replacement construction material in structural fill and mine reclamation projects; fillers in carpet backing—fly ash is a high-performance mineral filler; and as a solidification agent within landfills and remediation projects (Sections 6 – 9).

4.2.2 Bottom ash can be beneficially used as raw feed to produce clinker, as a component of structural fills, and as aggregate in the manufacturing of masonry products (Sections 6, 7, and 9).

4.2.3 Boiler slag can be used as blasting grits and roofing granules. Other applications include, but are not limited to, as a component of structural fills and mineral filler in asphalt (Sections 7 and 9).

4.2.4 FBC ash can be used in various mixtures as a low-strength concrete material and soil stabilization agent (Section 7).

4.2.5 FGD gypsum, in its majority, is typically beneficially used in gypsum panel products. Other uses include in agricultural applications to improve soil, as a component in structural fills, and as an important component in the production of cement (Sections 6, 7, and 9).

4.3 *Approval Context*—This guide does not supersede local, state, or country requirements, if applicable. This guide is intended to be used for storage area(s) that are both within an approval authority program and historic (or unpermitted) storage area(s).

⁹ The boldface numbers in parentheses refer to the list of references at the end of this standard.

4.3.1 For characterizing CCPs from storage area(s) for potential harvesting within an approval authority program, governing documents should be carefully reviewed and followed to establish that all requirements relative to harvesting design, operations, monitoring, closure, and post closure are followed or that agreements are established for compliance and allow for characterization activities.

4.3.2 For characterizing CCPs from historic (or unpermitted) storage area(s) for potential harvesting, the project team may engage with the appropriate local, state, province, country approval, or combination thereof, authorities to determine the appropriate requirements and should establish that the appropriate engineering controls and institutional controls are incorporated into the characterization project.

4.3.3 In addition to approvals related to the CCP storage area and harvesting activities, some jurisdictions may have a separate approval process for beneficial uses of materials. This approval process, often referred to as a beneficial use determination, may require characterization of the material and the beneficial use. Jurisdictions that require approval of beneficial use may also maintain exemptions or predeterminations for certain materials or beneficial uses.

4.4 *Use of Guide*—Approval authorities may incorporate this guide, in whole or part, into general guidance documents or site-specific approval documents.

4.5 *Professional Judgment*—This guide presumes the active involvement of an environmental professional who is knowledgeable in how to characterize CCP, design and construct storage area(s), and identify acceptable site conditions or, when appropriate, satisfy applicable statutory or approval authority limitations on the use of an operating, closed, or historic (unpermitted) storage area(s).

4.6 *Inherent Uncertainty*—Professional judgment, interpretation, and some uncertainties are inherent in the processes described herein even when decisions are based on objective scientific principles and accepted industry practices.

5. Project Planning and Scoping

5.1 Before applying this guide, the user should perform the following project planning and scoping activities: (1) select an environmental professional, (2) select a project team, (3) identify CCP storage area(s) of interest and approval authority, (4) complete preliminary review of storage area(s), and (5) review of potential CCP end use(s).

5.1.1 The user should identify an environmental professional, who for the purposes of this guide, is a person who possesses sufficient education, training, experience, and certifications (as applicable) and exercises sound professional judgment regarding the components of this guide.

5.1.2 The user should assemble a project team that considers attributes such as historical site knowledge; technical expertise relevant to the components of this guide, including the investigation, assessment, design, approval process (as applicable), harvesting, construction, operation, monitoring, and maintenance of active/inactive storage area(s) that are protective to human health, public safety, and welfare; approval authority requirements; and stakeholder interests and concerns, if known.

5.1.3 Before using this guide, the user should determine which storage area(s) could provide useful CCPs for beneficial use and should be evaluated for potential harvesting. This guide is to be used to evaluate the potential harvesting of active/inactive storage area(s) once the storage area(s) are selected for evaluation. When an approval authority program governs characterization of CCPs, the user should evaluate whether the applicable approval authority program and the goals and requirements of this guide complement each other and are protective to human health, public safety, and welfare.

5.1.4 The user should complete preliminary review of storage area(s) including: site history, active/inactive status, ownership, general property attributes, CCP storage area(s) information, permits associated with CCP storage area(s) and surrounding environs, and regulatory status.

5.1.5 The user should review and identify potential end use(s) of interest and relevant information including identifying potential end use(s), desired CCP characteristics for beneficial use and beneficiation, geography/proximity to market, approval/regulatory authority, and end-use(s) performance standards.

5.2 *Process*—The six phases of the characterizing CCPs stored in active and inactive storage area(s) for harvesting guide are presented in **Table 1**. Detailed information on the six phases is presented on **Figs. 1-5** and **Sections 5 – 10**.

6. Available Site Characterization Information Inventory/Review: Phase II

6.1 A site characterization information inventory/review should be initiated after the project planning and scoping activities are completed (see **Section 5**), including selection of an environmental professional and project team, determination of which storage area(s) should be evaluated for potential harvesting, initial determination of potential beneficial uses of CCPs, and compilation of relevant storage area(s) information.

6.2 *Available Site Characterization Information Inventory/Review*—The available site characterization information inventory/review process follows four steps. The four steps are summarized in **6.2.1 – 6.2.4** and shown in **Fig. 2a**.

6.2.1 *Step 1: Determine the Operational History of the CCP Storage Area(s)*—An understanding of the operational history of wet or dry CCP storage area(s) is useful when developing an RDM. An RDM is a written or pictorial depiction of a CCP storage area(s) that is developed based on a site-specific review of the available or new technical information from various sources for the operational history, CCP storage area(s) design and applicable status, CCP characteristics (physical/chemical),

and other attributes that may be used when planning a CCP characterization for harvesting activities. The level of detail in an RDM can vary based on the user(s) needs and range from an initial RDM using readily available information versus a more detailed RDM. Either can be used to establish an understanding of information and a decision tool for determining if additional characterization data may be required to assist in evaluating CCP storage area(s) potential for harvesting. An understanding of operational history is also useful in developing a CCP characterization plan for potential harvesting activities. A CCP characterization plan outlines the approach to develop and implement a characterization study to attain additional data required to establish an understanding of CCP characteristics with a level of confidence for the selected end use(s) if adequate data are not available. These data may provide information on the types of CCP and placement of materials in the CCP storage area(s). Historical photographs may provide evidence of the progression of CCP deposits. During interviews conducted by the environmental professional, operational staff may recall details of CCP storage area operations that are not included in paper documentation.

6.2.1.1 *Ownership*—Documentation regarding a coal fire energy plant or facility ownership and/or operators may include the deed or property transfer history available from the local or regional authority or site-specific records.

6.2.1.2 *Age*—The age of the CCP storage area(s) may be determined using site-specific permits, operational records, and/or site mapping or aerial photography.

6.2.1.3 *Plant processes*—Site-specific permits and operational records provide information on plant processes and resulting types of CCP and production volumes over the life of the facility.

6.2.1.4 *CCP management plan*—A plan outlining how the types and volumes of CCP were managed and tracked over time, including placement in wet or dry CCP storage area(s).

6.2.1.5 *CCP storage area(s)*—Permits and operational records may contain information on the location, active/inactive status, design, and operational history for CCP storage area(s). The user(s) should attempt to identify the placement of any non-CCP materials in the unit.

6.2.1.6 *Permits and correspondence*—Site-specific permits, operational records, and correspondence typically are available that include information on CCP storage area(s).

6.2.1.7 *Regulatory status*—Documentation may be available regarding the regulatory status of permitted and unpermitted CCP storage area(s) that may yield information on the location, design, and operational history for CCP storage area(s).

TABLE 1 Characterization Phase Information

NOTE 1—Process assumes the storage area(s) have already been chosen. Site selection is not included in this guide.

Phases	Description	Location Within This Guide
I	Project Planning and Scoping	Fig. 1 and Section 5
II	Available Site Characterization Inventory/Review	Fig. 2a and Section 6
III	Available End Use(s) Information Inventory/Review	Fig. 2b and Section 7
IV	End Use(s) and Level of Confidence Related to the CCP Characterization Selected and RDM	Fig. 3 and Section 8
V	CCP Characterization Plan Development	Fig. 4 and Section 9
VI	CCP Storage area(s) Characterization Report	Fig. 5 and Section 10