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Standard Guide for Beneficial Use of Landfills and Chemically Impacted Sites[1]

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INTRODUCTION

Over the last half-century, environmental protection programs have withdrawn from use properties posing significant adverse human health impacts, yet some with lesser potential impact continue to be heavily used [for example, pedestrian; recreational; or outdoor entertainment-related, concert audience seating] without evaluation. Assessment of environmental conditions for properties undergoing ownership transfer is now common (and often required), yet those of historic ownership are not similarly evaluated. This guide serves the need for a forward-looking program that allows a knowledgeable environmental professional to complete an evaluation of a proposed beneficial use, utilizing readily available information and her/his professional judgment whether property usage restrictions are necessary to be protective of human health. Two outcomes of such an evaluation include finding that the proposed beneficial use is acceptable, or a finding that the proposed beneficial use request is not acceptable. The environmental professional may condition her/his finding of acceptability of beneficial use with institutional and engineering controls based on actual or potential soil chemical concentrations, known background chemical concentrations, and other approaches that provide a barrier between a chemical and a site user or limit times of use.

1. Scope

1.1 This guide provides a beneficial, *acceptable use* framework for the *development* of: (1) Inactive and *pre-RCRA* (or *pre-regulatory*) *solid waste landfills* that are considered *orphan* or *latchkey* to be repurposed, despite having offsite migration impacts of *landfill gases* and/or *leachate*, albeit at *de minimis* levels; (2) other types of unregulated *waste* landfills; (3) sites impacted by chemical releases; (4) *legacy* or ongoing, intentional, or unintentional fill placement; (5) *closed*, open, or operating *post-RCRA landfills* or *landfills* in the planning stages such that materials may be placed in ways that optimize a *landfill's* use in future years; and (6) underutilized or heavily used (for example, pedestrian; recreational; or repetitive, entertainment, single event) *chemically impacted sites*. Also, this guide identifies land usage and conditions of adjacent/non-waste portions of a *landfill* (that is, *buffer* areas not within the footprint of an actual *landfill* or *chemically impacted site* itself) that should be evaluated before a *site use* is considered *acceptable*.

1.2 Provided herein is instruction on evaluating and judging the *acceptability* of: (1) Chemical exposure barrier(s) (and other *engineering and institutional control* measures) in place between actual or potential chemically impacted soil; and/or (2) time of use restriction(s) established at a *waste / chemically impacted site*.

1.3 Additionally provided is instruction on assessing the *terminal conditions* at a *municipal solid waste (MSW) landfill*; that is, flows of methane below which passive rather than active venting is recommended, and flows of *leachate* of a long-term, consistent quality that is clean enough to allow direct discharge of the liquid to surface waters. See Appendix X3 for additional information.

1.4 This guide complements *solid waste* regulatory programs where guidance on beneficial usage is unavailable or insufficient, thereby improving the chance that such sites may be repurposed for public and/or private benefit.

1.5 This guide may be implemented in conjunction with ASTM's Standard Guide for Integrating Sustainable Objectives in Cleanups (Guide E2876-13) with respect to *community engagement* activities. See Guide E2876 for more information.

1.6 This guide should not be used as a justification to avoid, minimize, or delay implementation of specific cleanup activities as required by law or regulation.

1.7 This guide should not be used to characterize (that is, environmentally assess) a site for the purpose of ownership transfer, although it could supplement other environmental assessments that are used in such a transfer.

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1.8 Users of this guide make professional judgments that only apply to a particular site, at a particular date and time, and do not warrant safe conditions existing beyond that date. It is not impossible that a significant environmental exposure condition exists at a site but was missed by the user of this guide or the *Environmental Professional* who led the evaluation, or that the condition was introduced subsequent to the evaluation. The evaluation of a site by an *Environmental Professional* is not intended to be exhaustive; there may be significant unknown conditions that may not be apparent through reasonable site characterization efforts. Further, the user of the guide should advise the site owner to maintain any *Environmental Professional*-recommended *engineering* and *institutional controls* and any *established* signage into the future for the planned, identified beneficial use. Those who use the final reports generated through the use of this guide are cautioned to understand the limits of what the *Environmental Professional's Completed Site Evaluation* describes. Compared to a *waste / chemically impacted site* NOT evaluated (in the manner described herein) before a use activity is implemented is clearly subject to greater *potential adverse impacts to human health, public safety, or welfare* than a *waste / chemically impacted site* that is. See 3.1.24 for a discussion of the *Due Diligence Threshold of the Environmental Professional* and 4.4 for additional information.

1.9 Users of this guide should comply with all applicable federal, State, and local statutes and regulations requiring and/or relating to protection of human health. This includes, and is not limited to, laws and regulations relating to health and safety of the people using a *developed waste / chemically impacted site*, the surrounding community, and/or public sector and private sector personnel who are involved in the management or oversight of *waste / chemically impacted sites*. See **(1)**[2] for useful information on land revitalization and **(2)** for information on chemical safety.

1.10 Use of this guide is considered a *sustainable urban governance* practice as identified by Rowland (2008) **(3)**.

1.11 This guide is composed of the following sections: Referenced Documents; Terminology; Significance and Use; Planning and Scoping; Site Use Activity Evaluation and Selection Process; and Site Use Activity Evaluation, Reporting, and Documentation.

1.12 *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 limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E1527 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process
E2201 Terminology for Coal Combustion Products
E2247 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property
E2876 Guide for Integrating Sustainable Objectives into Cleanup
E2893 Guide for Greener Cleanups

3. Terminology

3.1 *Definitions:*

3.1.1 *active use, n*—typically expressed as "active recreational use," this term could be used to describe a use that has similar potential for exposure to chemicals in bare soil. See 4.1.1 for a discussion on this type of activity.

3.1.2 *acceptable use, n*—an *Environmental Professional's* description of a proposed beneficial use, characterized by the nature and duration of activities involved, for a property that is evaluated and determined to be protective of human health, public safety, and welfare with, if necessary, specified *engineering and institutional controls* and *established* signage.

3.1.3 *acceptable site conditions, n*—a descriptive condition for a site proposed for beneficial use (either *active use* or *passive use*) using Guide E3033 when concentrations of chemicals [listed in Appendix X5 as Soil Cleanup Objectives (SCOs)] are less than those listed but may otherwise be known to exist in surface soils, and no *imminent threats to human health, public safety or welfare* exist.

3.1.4 *applicable local, state, or tribal (regulatory agency) organization, n*—the political or official authority concerning the use of land for public or private purposes where there art *potential adverse impacts to human health, public safety, or welfare* or other objectionable conditions, such as odors, smells, or poor visual qualities.

3.1.5 *beneficial use of a coal combustion product, n*—the use of or substitution of the coal combustion product (CCP) for another product based on performance criteria. For purposes of this definition, beneficial use includes but is not restricted to raw feed for cement clinker, concrete, grout, flowable fill, controlled low strength material; structural fill; road base/subbase; soil modification; mineral filler; snow and ice traction control; blasting grit and abrasives; roofing granules; mining applications; wallboard; waste stabilization/solidification; soil amendment; and agriculture. See Terminology E2201 and US EPA, 2015 **(4)** for more information.

3.1.6 *buffer area, n*—a geographically linear land parcel that blocks the adverse visual, auditory, or odiferous effects of *waste* management.

3.1.7 *caps and liners, n*—natural (for example, compacted clay liners) or synthetic (for example, HDPE) materials placed on the top, bottom, and sidewalls of a *landfill* to totally contain *leachate*, prevent rainwater and groundwater infiltration, and direct the flow of gases to a venting system on top (and the flow of leachate to the base, for extraction) of a *municipal solid waste landfill*.

[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] 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.

3.1.8 *caretaker mode, n*—long-term management scheme of a non-operating *landfill* in which *terminal conditions* for migrating methane, *leachate*, and low-density buried solids have been attained. See 3.1.42 and Appendix X3 for additional information.

3.1.9 *charrette, n*—an intensive planning session where *stakeholders* (including property owners and neighboring landowners) collaborate on a vision for a use at a *chemically impacted site*. It provides a forum for ideas and offers the unique advantage of giving immediate feedback to the users of this guide. See Guide E2876 for more information.

3.1.10 *chemically impacted site, n*—an area where chemicals have been placed intentionally or by nature, upon the ground surface or at depth, not containing putrescible, organic *wastes* of a *municipal solid waste landfill*; includes sites with *historic, urban fill* and urban land areas impacted by lead emissions from automobiles and lead paint chips from building surfaces. It is common to label such sites as brownfields, as opposed to land that is not *chemically impacted* that are known as a greenfields.

3.1.11 *closed site, n*—see 3.1.39, *landfill closure*.

3.1.12 *coal ash, n*—collective term referring to any solid materials produced primarily from the combustion of coal (a type of *industrial waste*). Examples include fly ash, bottom ash, and boiler slag.

3.1.13 *coal ash dry management unit, n—coal ash landfill*, a material management unit that is characteristically more stable (that is, has a higher load bearing capacity) and therefore is potentially available for the eight types of beneficial *site uses* identified herein.

3.1.14 *coal ash wet management unit, n—coal ash* surface impoundment; a material management unit less stable than a *dry management unit*, associated with sidewall failures and spills into the environment. These types of units are not to be considered for any of the eight types of beneficial *site uses* identified herein. See Katz (2015)(**5**) and US EPA (2015) (**6**), for more information.

3.1.15 *community engagement, n*—pro-active reaching out to neighbors of a *waste / chemically impacted site*, adjacent property owners, *stakeholders*, and civic leaders by the owner of the *waste / chemically impacted site*, the guide user, *Environmental Professional*, and the *Project Team* for the purpose of selecting an *acceptable site use* activity. See Guide E2876 for more information.

3.1.16 *completed site evaluation, n*—the end of this guide's process; a report (prepared by an *Environmental Professional*) that *accepts* or rejects a proposed beneficial use of a *waste / chemically impacted site*. If *accepted*, one or more of the Appendix X4 forms are completed as described therein. See 7.2 for additional information.

3.1.17 *concurrence, n*—agreement among two or more individuals or organizations that a course of action provides *acceptable* protection of human health, public safety, and welfare.

3.1.18 *conditional expedited use, n*—a timely approval (that is, between 2 weeks and 90 days) for a proposed beneficial use. See Appendix X2 for a discussion of the conditional expedited use process and guidance on filling out Form 2 – Conditional Expedited Use, and Appendix X4 for Form 2 that an *Environmental Professional* uses to identify an *acceptable* conditional expedited use. See 7.2.2 for additional information.

3.1.19 *construction & demolition debris, n*—a *waste* that includes wood, metal, glass, concrete, asphalt, and other materials associated with constructing buildings or tearing them down. This is a type of *industrial waste*.

3.1.20 *cover, n*—see 3.1.32, *generic cover*.

3.1.21 *de minimis, adj*—that which has an effect or quality that is *acceptable* and measurable; for example, human chemical exposure below an OSHA threshold limit value or US EPA concentration limit for water discharge to a river. See Appendix X5 for a listing of chemical concentrations in bare, surface soil considered *acceptable* for two types of recreational activities; generally, concentrations lower than those listed are considered de minimis. Also de minimis are concentrations of *pollutants* beneath a *generic cover* or *cap* that provide a barrier to exposure. Note that a concentration limit for water discharge to a river may not be *acceptable* with respect to direct human contact; the user or *Environmental Professional* using this guide does not identify as *acceptable*, activities for anything other than land-based uses.

3.1.22 *development, n*—act of taking a greenfield or restoring a *waste / chemically impacted site* and providing living space, recreational space, nature preserves, commercial / employment opportunities, agricultural products, and/or opportunities for recovering value from a site.

3.1.23 *due diligence, n*—the reasonable, environmental professional approach to research of *readily available information* and documents and interviews with available current or past owners or operators of property for the purpose of creating knowledge regarding the known or likely presence of *pollutants* in assessing *potential adverse impacts to human health, public safety, or welfare* at a specific site that includes consideration of: (1) past land usage; (2) *releases* of chemicals on the site or upon adjacent properties that might be expected to migrate onto the site; and (3) past placement of fill soils or *waste* and, if known, the origin of those materials. The performance of a Phase I environmental site assessment (in accordance with Practice E1527 or Practice E2247) is not required by this guide, but information resources referenced in those Practices should be considered. See 5.6.3 for a description of the *due diligence* process.

3.1.24 *due diligence threshold of the environmental professional, n*—the criteria used by an *Environmental Professional* for rendering judgment that sufficient knowledge has been reached whereupon the *Environmental Professional* may offer recommendations concerning what is an *acceptable use* at a selected *landfill* or *chemically impacted site*. The *Environmental Professional* should only offer beneficial use recommendations until she/he has reviewed *readily available information* and the eighteen considerations listed in Appendix X6.

3.1.25 *easements, buffers, and rights-of-way, n*—typically, narrow but long corridors of land that are used by municipal service or public or private utility vehicles for maintenance,

repair, or service; could contain buried or overhead utility systems or could be green spaces used innovatively for recreational space, stormwater management, *nature-based land usage*, or *nature preserve land usage*.

3.1.26 *engineering control, n*—a constructed measure that minimizes the flow of liquids into or out of a *post-RCRA landfill* (for example, compacted clay bottom, sidewalls, and *cap*; *leachate* and methane collection and removal systems) that may include below ground slurry walls (to block groundwater infiltration or outward migration) and *lined* drainage swales. For *chemically impacted sites*, an engineering control may include a dense grass cover or vegetation that limits exposure to chemically impacted soil. *Generic covers* are types of an engineering control.

3.1.27 *environmental justice, n*—the public administrative effort to question and/or prevent the siting of *waste sites* in poor neighborhoods, and those of people of color. Also includes such efforts to make currently used of abandoned sites *acceptable* for use or continued use.

3.1.28 *environmental professional, n*—a person trained and experienced in the management of *waste* materials and *chemically impacted* soils or materials, meeting the requirements of 40 CFR 312.10(b) **(7)**; some U.S. State agencies identify this person as a Qualified Environmental Professional (QEP). In this document, this person is identified as an Environmental Professional, as she/he has the credentials to make professional judgments about the *acceptability* of how land is used in spite of *potential adverse impacts to human health, public safety, or welfare* should protective barriers (that is, *engineering controls*) or schedules for use (that is, *institutional controls*) to *waste* and *chemically impacted* soils be compromised or exceeded. See **(7)** for additional information.

3.1.29 *established, adj*—description of municipal code, law, regulation, or best management practice that is currently in effect regarding conditions of *acceptable* use of property and the prominent display (that is, signage, posting) of such conditions at the entrance(s) of the site (being or to be beneficially used), or in brochures, pamphlets, or programs available to site users.

3.1.30 *expedited use, n*—approval of a proposed beneficial use within two weeks of a request. See Appendix X2 for a discussion of the expedited use process and guidance on filling out Form 1 – Expedited Use, and Appendix X4 for Form 1 that the Environmental Professional uses to identify an acceptable expedited use. See 7.2.2 for additional information.

3.1.31 *freedom of information request, n*—a written or electronically composed and delivered message to a *regulatory agency* with jurisdiction over land being considered for beneficial use that asks for all correspondence and reports regarding the site, that are not already in the public domain.

3.1.32 *generic cover, n*—concrete, asphalt, or soil used to provide a physical barrier against contact with a soil *pollutant*; considered an *engineering control*. These materials impede but do not prevent the flow of liquids or gases into or out of a *landfill / chemically impacted site*.

3.1.33 *historic fill material, n*—primarily soil and soil-like *waste* generated near 19th and 20th century industrial urban centers (that is, Northeast, Midwest, and Southeast U.S.), with constituents of lead, mercury, chromium, semivolatile organics, and PCBs; typically disposed without a 40 CFR Part 264 or Part 265 (RCRA) (or equivalent) permit. This is a type of *industrial waste*. See **(8)** for additional information.

3.1.34 *historic fill site, n*—the location where *historic fill material* was placed before effective environmental regulations (typically, in the U.S., before 1970 to as late as the 1990s, known as a *pre-regulatory* site) for the purpose of leveling property, filling in wetlands to increase acreage, and to discard *waste* materials at low cost.

3.1.35 *imminent threat to human health, public safety, or welfare, n*—the conclusion of an *Environmental Professional* (after a site evaluation), expressed at the instant she/he realizes that the current or proposed use of a site may have immediate adverse impacts on human health, public safety, or welfare, including death or injury from: a) Exposure to *pollutants*; b) conditions that might pose a likelihood of fire or explosion; or c) conditions that present tripping or falling hazards due to variable surface features of a *waste / chemically impacted site*. See Ref. **(2)** and 3.1.51 for additional information.

3.1.36 *industrial waste, n*—materials that are not putrescible, as is household *waste* (that contains a high percentage of food waste), but rather includes non-hazardous chemicals and by products of manufacturing, processing, and refining.

3.1.37 *institutional control, n*—administrative measures (of a *regulatory agency*) that guide property owners of *waste / chemically impacted sites* on required or prohibited activities, and deliverable documents concerning the control of *leachate*, methane, storm drainage, and water infiltration. These conditions may include what is allowed (when, how long, where, and by whom), what is to be measured during inspections, and what is to be done if conditions exceed what is considered *acceptable*. The *Environmental Professional* may recommend such controls in her/his evaluation of a site using this guide, in addition to what a regulatory agency requires.

3.1.38 *landfill, v*—the act of placing discarded materials into a land surface depression (for example, wetlands) and/or upon uplands; (n) the accumulated mass of discarded materials, typically of a mounded shape that often contains environmental pollutant media in the form of solids, liquids (*leachate*) and gases (for example, methane).

3.1.39 *landfill closure, n*—the transition period (of a duration of relative certainty) of a *landfill*, between the active receipt of discarded material and the start of the period of *post-closure care*; often involves the installation of a *landfill cap* (that is, low permeability soils, synthetic liner, gas collection wells, and piping systems) that isolates (that is, prevents the upward migration of) low density, discarded materials (that include automobile tires and glass) while accommodating the ability of gases and liquids to be removed during *waste* decomposition. *Pre-regulatory landfills* cannot achieve "closure;" all that they may attain is a periodically reviewable status of *acceptable use*.

3.1.40 *landfill gas, n*—typically, the gaseous byproduct of anaerobic decomposition of organic discarded material; includes methane, hydrogen sulfide, carbon monoxide, and carbon dioxide. However, this gas could also be that of the discarded material itself, such as gasoline or other volatile liquids.

3.1.41 *landfill post-closure care period, n*—an indefinite span of time that ends when *landfill* decomposition gases and liquid no longer pose *potentially adverse impacts to human health, public safety, or welfare* to the satisfaction of *applicable local, State, or tribal (regulatory agency) organization(s)*; may include a period of time of infrequent monitoring to assess when *terminal conditions* for monitoring or maintenance have been reached. See 3.1.52 and Appendix X3 for additional information.

3.1.42 *latchkey landfill, n*—an unwanted *landfill* that has a *caretaker* party / agency that provides minimal legal care of the property; such properties have potential values that are not currently recognized. See 3.1.8 for additional information.

3.1.43 *leachate, n*—the liquid byproduct of *landfilling* discarded materials whose origin may be of four sources: (1) The discarded material itself; (2) the result of anaerobic decomposition of organic *waste*; (3) *waste* dissolved in rainwater that infiltrates the *landfill*; or (4) *waste* dissolved in groundwater that has infiltrated the *landfill* (typically at the base of a *pre-regulatory landfill*) that began as a filled-in wetland, sandpit, natural surface depression, or man-made ditch or canal.

3.1.44 *legacy landfill, n*—a *landfill* containing *municipal solid waste*, typically disposed in the U.S. during the 1940s to the 1990s, without *regulatory agency* oversight (also called a *pre-regulatory landfill*).

3.1.45 *monofill landfill, n*—the accumulation of a homogeneous *waste* material (a type of *industrial waste*) configured and protected in ways to limit erosion, airborne dispersion, or the generation of *leachate*. See 3.1.13 for an example.

3.1.46 *municipal solid waste, n*—putrescible, organic waste that includes food waste and household garbage. Another name for *solid waste*, known by the acronym MSW. See 3.1.66 and 3.1.73 for additional information.

3.1.47 *nature preserve land use, n*—a landscape large enough for the maintenance of an ecosystem and/or isolated (that is, from human presence) enough to provide a corridor for wildlife movement.

3.1.48 *nature-based land use, n*—a landscape or constructed recreational park feature with barriers to human entry (for example, fencing, thick brush or bushes) such that the feature exists for visual pleasure and/or the sake of a non-human habitat; chemical concentrations in soil may exceed that which are *acceptable* for *passive* recreational *use*, as these barriers limit human exposures.

3.1.49 *orphan landfill, n*—an unwanted and abandoned, *pre-regulatory waste site* that has no active *caretaker* party / agency. Such properties may have potential values but are not currently recognized.

3.1.50 *passive use, n*—typically expressed as "passive recreational use," this term is used to describe a use that has a similar potential for exposure to chemicals in soil. See 4.1.2 for a discussion of this type of activity.

3.1.51 *pollutant, n*—any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring; this may include the above-mentioned materials or agents as well as volatile chemicals, including petroleum, natural gas and synthetic gas flowing as a free product material or a constituent of gas, liquid, or solid, whether above the ground surface, upon the ground surface, or within (that is, dissolved) groundwater. This definition is similar to that found in **(6)**.

3.1.52 *post-closure care measures, n*—activities that a *waste site* owner must take in order to maintain the effectiveness of *engineering and institutional controls* that protect against *potential adverse impacts to human health, public safety, or welfare*; applies to a site under the authority of a *regulatory agency*.

3.1.53 *post-RCRA landfill, n*—a *landfill* built to the specifications of 40 CFR Part 264 or Part 265 **(1)**, or the regulations of a State authorized to administer the similar requirements. RCRA is the acronym for Resource Conservation and Recovery Act of 1976. This type of *landfill* accepts(ed) *waste* according to a permit, usually issued by a U.S. State that specifies(ed) what *waste* could and could not be buried; the *landfill* is constructed with protective measures to limit releases of *leachate*, the infiltration of surface water and groundwater, and to control the release of gases that include methane. *Landfills* of this type include sites that began *pre-RCRA* (that is, *pre-regulatory*) but were closed *post-RCRA*, meaning that no *landfill* bottom or sidewall protective measures (that is, *liners*) were installed, although a *cap* was installed.

3.1.54 *potential adverse impacts to human health, public safety or welfare, n*—the condition exhibited when chemicals in surface soils at a site under consideration for a beneficial use exceed the concentrations listed in Appendix X5 for either *active* or *passive use*, depending on the proposed use. The *Environmental Professional* may use professional judgment to advise (on a case-by-case basis) that such an impact has not been reached although one or more *Soil Cleanup Objective* of Appendix X5 has been exceeded. See 1.8, 3.1.21, 3.1.24, 3.1.28, 3.1.35, 3.1.65, and 4.4 for additional information.

3.1.55 *pre-RCRA landfill, n*—this type of *waste* disposal site (in the U.S.) was operated out of the necessity to discard unwanted materials, including *MSW* and/or *industrial waste*. Some federal, State, and local *landfill* regulations specified minimal standards for operation (including the federal Solid Waste Disposal Act of 1965). See **(9)** for additional information.

3.1.56 *pre-regulatory landfill, n*—a type of *waste* disposal site that is/was operated outside of the legal sanction of RCRA-type laws and regulations (designed to protect human health and the environment from chemical and waste exposures). This guide may be used to evaluate the *acceptability* of a beneficial use at a specific *waste / chemically impacted site*, but should not be used to designate a *waste* or *chemically impacted site* as closed, unless a *regulatory agency* with jurisdiction over the site adopts this guide for that purpose. Beneficial use requires the attainment of a periodically reviewable status of *acceptable use*. See 3.1.2, 3.1.3, and 3.1.39 for additional information.

3.1.57 *project team, n*—two or more professionals (including the *Environmental Professional*) who collaborate on the evaluation and selection of a particular use at a *landfill* or *chemically impacted site* in conformance with this guide. The team may include additional *Environmental Professionals*, the user (for example, the environmental consultant), the State and/or federal regulator, site owner and/or her/his representative, and additional experts, as needed. For some sites, the project team may include community *stakeholders*. In addition, the *Environmental Professional* and user can be the same person or work for the same entity.

3.1.58 *readily available information, n*—that which increases the knowledge of the *Environmental Professional* concerning the physical conditions at a *landfill* or *chemically impacted site* through: a) Real-time observations; b) electronic recordings; c) physical investigation and subsequent reports (including laboratory results of various environmental media analysis); and d) review of documents regarding prior ownership, use, and ownership/use of nearby and adjacent properties. See Appendix X6 for additional information.

3.1.59 *regulatory agency, n*—a governmental authority that is tasked to assure compliance with environmental protection and public / worker safety laws and regulations concerning the management of *waste* and *chemically impacted sites*; this includes cities, counties, States, federal governments, and tribal organizations. See **(2, 10, and 11)** for the identification of such an organization.

3.1.60 *release of a hazardous substance, n*—chemicals, chemical compounds, pure substances, or pollutants that are observed by the *Environmental Professional* or reasonably assumed by the *Environmental Professional* to be emitted to the air, surface water, soils, or groundwater upon her/his *Completed Site Evaluation* using Form 2 – Conditional Expedited Use and/or Form 5 – Site-Specific Use. Such a release may be a reason the Environmental Professional chooses to end her/his evaluation without recommending that the site be beneficially used. See Appendix X2 for a discussion of filling out those forms and Appendix X4 for the forms. See 3.1.21, 3.1.26, 3.1.35, 3.1.37, and 3.1.51 for additional information.

3.1.61 *restoring land, v*—bringing a land surface to its original condition, or modifying it to a desired condition.

3.1.62 *secured monitoring infrastructure, n*—constructed wells and vents that are used to periodically measure concentrations of chemicals in air, surface water, groundwater, *landfill* or soil pore gas, and/or *leachate* that are enclosed by fences and other structures that keep trespassers out and keep wells and vents available for use by authorized environmental *technicians*. Property owners of sites being beneficially used should exclude access to these areas by *establishing* appropriate measures.

3.1.63 *site use, n*—the alternative to abandonment of property that includes the active preparation of land for productive utilization, also known as *development*.

3.1.64 *slope stability, n*—a physical condition of an engineered or natural mound, slope, hill, berm, or wall that is at a low risk of failure (that is, it is constructed or is naturally configured to safely support surface loads with a reasonable factor of safety, typically several times what is required to just preclude failure). See Appendix X3 for additional information.

3.1.65 *soil cleanup objective (SCO), n*—the concentration of a chemical or chemical compound in exposed soil that suggests an unacceptable condition exists for *active* recreational or *passive* recreational *uses*. Soils under pavement, a *nature-based land use*, or other use feature that blocks the exposure pathway of subsurface chemicals or *wastes* has no SCO. See Appendix X5 for a listing of these chemicals and chemical compounds. The *Environmental Professional* may identify SCOs at a particular site for *pollutants* not listed in Appendix X5. Note that the SCO table in Appendix X5 is based on regulations identified in **(10)**. These SCOs identify bare soil concentrations of chemicals that pose a risk of cancer at the rate of one cancer per one million people exposed. The user of the guide may use similar tables of other *regulatory agencies* in place of one in Appendix X5. See **(11)** for additional information on the creation of the SCO table in Appendix X5.

3.1.66 *solid waste, n*—discarded materials contained in a *landfill* that include *municipal solid waste* (garbage), *construction & demolition debris*, *coal ash*, urban *historic fill*, and other unwanted materials. As with US EPA definition, solid waste may be physically a solid, liquid, or gas.

3.1.67 *spill, n*—the accidental release of *waste* or chemicals into the air, land, surface water, or groundwater.

3.1.68 *stakeholder, n*—a person with an interest in the outcome of a decision to create a *site use* at a *waste / chemically impacted site*; includes the property owner, neighboring property owners, neighbors of the site, and community representatives.

3.1.69 *sustainability, n*—the achievement of institutional arrangements of human actions today that are guided by a vision of desired future arrangements which allow present societal needs to be met without compromising the ability of future generations to meet theirs.

3.1.70 *sustainable urban governance, n*—an integrated system of: city planning, capital projects, operations, and maintenance; security (police and fire protection); critical utility assurance (water supply, sanitary sewerage systems, power supply, and communication systems); sanitation and food security (health protection); natural environment systems (*waste* management and *pollutant* exposure protection); transit systems (roads, bridges, tunnels, and tracks); cultural, entertainment, and recreational venues; education provision;

and safe housing and public buildings (through building codes) that provides continually improving, higher quality of services at lesser per capita costs through focusing on key objectives that vary year to year, using outcome measurement and metrics to identify objectives to be met and results to be achieved. See Rowland (2008)(**3**) for additional information.

3.1.71 *technician, n*—a person with technical training in the monitoring and maintenance at a *waste / chemically impacted site* who periodically visits the site to perform tasks identified by the *Environmental Professional* that include: (1) Assuring that all technical settings of gauges and flow meters have nominal readings (that is, there is no threat of a chemical release or condition that would put the technician, the public, or other people at risk of harm); (2) assessing the site for trespass activity and correcting any infrastructure system that is deficient; (3) collecting air, gas, soil, or water samples; and (4) responding to complaints by the public or needs of the property owner.

3.1.72 *terminal conditions of a landfill that is beneficially used, n*—the measured concentration(s) of *marker chemicals and leachate markers* that meet (an) agreed upon target(s) for use activities [for example, the measured concentration, pressure, and flow (both onsite and *de minimis* offsite migration) of methane; and the absence of upwardly migrating, low-density buried solids (for example, glass) through a landfill *cap*] that is(are) evidence that a *landfill* no longer needs: (1) Frequent monitoring (that is, monthly or quarterly), but rather annual or less frequent monitoring; and/or (2) its *leachate* to be discharged to a municipal wastewater treatment plant, but rather allowed to flow to a receiving water body; and/or (3) its methane to be collected and flared, but rather allowed to passively vent or beneficially used. See Appendix X3, and Appendix X7, sections X7.3 and X7.5 for additional information.

3.1.73 *waste, n*—discarded household, agricultural, construction, or industrial materials that no longer serve their intended purposes, including soil and debris from a construction site that are in excess of need; contains a high percentage of food *waste*.

3.1.74 *waste / chemically impacted site, n*—property that contains *waste* or chemicals. See Table 1 for examples of six categories and eleven types of such sites.

3.1.75 *waste site, n*—there are three categories of a MSW (waste) *landfill* site: *pre-regulatory landfill*; *pre-RCRA landfill*; and open or closed *post-RCRA landfill*. See 3.1.56, 3.1.55, and 3.1.53, respectively, for additional information.

4. Significance and Use

4.1 *Purpose*—This guide provides a process (complementary to various *regulatory agency waste site* use programs) for evaluating and *restoring* among eight *site use* activities at eleven types of *waste / chemically impacted sites*. The *site use* activities include: (1) Active Recreation; (2) Passive Recreation; (3) Alternate Energy / Deep Anchoring Need; (4) Materials Recovery; (5) Stormwater Management; (6) Composting Imported Debris; (7) Agricultural Cultivation (non- or lightly mechanized) or Marketing; and, (8) Nature Preserve / Nature-based / Buffer Area Use. The *waste / chemically impacted sites* include: (1) MSW / Pre-RCRA; (2) MSW / Post-RCRA Closure – Operated pre-RCRA; (3) MSW / Operating(ed) or Closed Post-RCRA; (4) MSW / In-design; (5) C&D Landfill / Closed; (6) C&D Landfill / Operating or In-design; (7) Historic Fill; (8) Airborne Deposition; (9) Monofill / Coal Ash; (10) Monofill / Foundry Sand; (11) Non-impacted Buffer Area. More detailed descriptions of these use activities follow.

4.1.1 *Active Recreation*—Utilization of a *waste / chemically impacted site* where the likelihood of physical contact with and accidental ingestion of soil is high, due to the nature of the sport (for example, football, baseball, soccer). Note that active sports played on synthetic turf are not *active* recreational *uses* in this definition, as the focus is on potential human exposure to chemicals in soil and not on the activity, per se. See Appendix X5 for a listing of chemical compounds and their concentrations considered appropriate for this *site use*. Also, see 3.1.65 for additional discussion of *SCOs*.

4.1.2 *Passive Recreation*—Utilization of a *waste / chemically impacted site* where physical contact with and ingestion of soil is possible but unlikely (for example, biking, walking, bird watching). See Appendix X5 for a listing of chemical compounds and their concentrations considered appropriate for this *site use*. Also, see 3.1.65 for additional discussion of *SCOs*.

4.1.3 *Alternate Energy / Deep Anchoring Need*—Penetration of the *cover* soil or *capping* layer of a *waste / chemically impacted site* to establish a foundation for a structure subject to weight or wind loading, or seismic forces (for example, photovoltaic arrays, wind turbines, solar water heating systems).

4.1.4 *Materials Recovery*—Capture and utilization of *landfill gas*, or excavation of materials once considered *waste* but found to have high value (for example, beneficial capture and recovery of *MSW* methane, or excavation of *coal ash* for use as a beneficial cement or grout additive or fill material in soil stabilization projects such as those involving road beds). See Appendix X2, item 6 for additional information.

4.1.5 *Stormwater Management*—Installation of a stormwater management practice that retains, detains, or slows down the flow of rainwater into an urban combined sewer (that is, combination sanitary and storm sewer) (for example, raingarden, bioswale, constructed wetland) and/or allows eroded sediments to settle out before entering a natural surface water body.

4.1.6 *Composting Imported Debris*—Placement of non-site organic *waste* and non-site soil upon a *waste / chemically impacted site*, and allowing the organic waste to decompose while the mixture is blended and turned; site *cover* material risks becoming part of the composting product unless a barrier is placed between the compost and cover.

4.1.7 *Agricultural Cultivation (non- or lightly mechanized) or Marketing*—The placement of soil (assured quality appropriate for the intended use) upon a *waste / chemically impacted site* in raised beds for the growing of vegetables (that is, leaf, root, or fruit types) (for example, community gardens and cooperative farms); the raising of animals for human consumption at a waste site; and, the marketing of produce from the

TABLE 1 Types of Waste / Chemically Impacted Sites

	Site Types		Description
1 -	Municipal Solid Waste Landfill	Pre-RCRA	This type of site was not planned for environmental protection assurance. Prior to the 1980s (and even several years after), *MSW landfills* in the U.S. began as a desire to reclaim land through the filling in of wetlands. This is why many early such *landfills* have no bottom *liner* and are in hydraulic connection with open waters. Also, if the site ended operations before the 1980s, there may not be a surface cap to prevent the infiltration of rainwater, and thus there is an elevated risk of *leachate* generation and *leachate* discharges to surface water and groundwater.
2 -	Municipal Solid Waste Landfill	Closed Post-RCRA/ Operated pre-RCRA	*Landfills* of this type began as *pre-RCRA* but were *closed* with *post-RCRA* controls, such as an impermeable surface *cap*, a methane collection and flaring system, a leachate collection /treatment /discharge system, and a stormwater management system. An important monitoring feature is an array of methane migration observation wells on every border between the *landfill* and adjacent properties. If a methane capture and withdrawal system malfunctions, the impact may be the migration of methane to neighboring properties, and if the migration is strong enough, the methane could enter dwellings and be ignited (for example) by the pilot light of a water heater.
3 -	Municipal Solid Waste Landfill	Operating(ed) / Closed Post-RCRA	Operating *MSW landfills* or ones that operated and closed *post-RCRA* have all the required RCRA *landfill* features, including those mentioned immediately above, plus a bottom liner and bottom leachate collection system. This type of landfill is protective of the environment and provides for safe operations regarding waste and chemical exposure to the community within the vicinity of the site. Methane migration observation wells are a key protective feature of this *waste / chemically impacted site*.
4 -	Municipal Solid Waste Landfill	In design	*MSW landfills* in design have the opportunity to pre-design *post-closure* land uses; for example, deep anchoring systems for wind turbines and photovoltaic arrays. Also, special care can be taken to assure minimal upward movement of low density materials (for example, glass) in areas designated for *active recreational uses* such as ballfields and soccer fields.
5 -	Construction and Demolition Landfill	Closed	*C&D landfills* contain concrete, asphalt, soil, debris from the demolition of buildings, and other construction waste. Potentially, their internal volumes may have more void space than a *MSW landfill*, so that settlement of a surface *cap* may be greater than the latter type of *waste / chemically impacted site*. On the positive side, *C&D landfills* have much less *waste* that decomposes into methane. Although possible, it may be difficult to place an anchoring system for a wind turbine (for example) because of the often haphazard nature of *waste* placed in this type of *landfill*. Care must be taken for the possibility of asbestos being present in the surface soils or in the subsurface of a *C&D landfill* (if excavations are made).
6 -	Construction and Demolition Landfill	Operating / or In design	Operating and in-design *C&D landfills* could be engineered to support many of the eight *site uses* described in this guide.
7 -	Historic Fill		Urban areas with 19th and 20th century histories of U.S, industrial development (for example, East Coast, Midwest, and Southesast) used industrial and demolition wastes to fill in wetlands and other land surface depressions. In New York City, it is estimated that 20% of the land area rests upon *historic fill* (Walsh, 1991 **(12)**). The composition varies, but includes metals (for example, lead, chromium, zinc, and mercury), PCBs, and semivolatile organics. The challenge for a successful *site use* on this type of site is keeping low pH rainwater or stormwater from infiltrating these sites, as that may solubilize subsurface metals and cause once relatively stable buried *waste* to migrate offsite or into groundwater aquifers with unknown effects. Recreational uses and agricultural cultivation require clean cover soils to prevent chemical exposures. However, natural areas may be an appropriate *site use* as long as entry barriers are erected to control trespass.
8 -	Airborne Deposition		In addition to historic fill, older industrial cities have experienced a special type of polluting episode; one that accumulates over long periods of time from airborne chemicals that fall to the ground with rain water or as dust or soot. Metal smelting operations (for example, lead), the combustion of coal (for example, mercury), and the operation of automobiles fueled by leaded gasoline released metals into the air and then polluted the ground surface. Often these contaminants co-mingle with historic fill and other waste / chemically impacted sites so that the origin of chemicals is uncertain. In current, common usage of automobiles, semivolatile organics are known to be emitted from exhaust and settle on adjacent land. The effect is most pronounced within 100 feet of a stop sign (or example) where an automobile comes to a stop and is allowed to pollute a specific space greater than a more distant space. This phenomenon is an important consideration in the placement of agricultural cultivation and produce marketing sites, as well as recreational use sites, because as clean as a person may make a site, external factors may alter conditions incrementally over time.
9 -	Monofill	Coal ash	*Coal ash* is a high volume *waste* material that is typically placed in a single-purpose *landfill* called a *monofill*. It is conceivable that in the future, a society may find high value in this *waste* (beneficial use of *coal combustion products*) as an additive to cement in the manufacture of concrete or grout, for soil stabilization, and for road beds, although now the material is much more easily obtained from an operating coal-fired power plant. Recent episodes of sidewall failures (see Katz, 2015 **(5)**) at *coal ash wet management units* (surface impoundments) suggests that it is appropriate to limit use activities for only *coal ash dry management units*.
10 -	Monofill	Foundry sand	Foundry sand is an industrial byproduct of metal manufacturing; that is, the manufacture of automobiles. Sand is used to form a casting/ mold into which molten metal is poured in the creation of an engine block. The sand is used once and is discarded. The material has the same physical properties as natural sand, so very stable *site uses* are possible upon this type of *waste/chemically impacted site*. However, just as with *historic fill* and airborne deposited chemicals, caution has to be taken to assure chemicals are not transferred to compost / topsoil or allowed to be ingested during an *active recreational use*. Note that some foundries process different raw materials involving different contaminants, including heavy metals. Also, several types of *waste* may be generated within the same casting plant.
11 -	Non-impacted Buffer Area		The reason that a *buffer area* is included in this list of *waste /chemically impacted sites* is that many *MSW landfills* incorporate them in their designs to block public views of operations that are not attractive and may generate controversy. Often, these areas have no *waste* buried beneath them, so they could have *site uses* that complement activities of adjacent properties and/or provide amenities desired by a neighboring community. For example, *waste/ chemically impacted sites* are known to provide stop overs for migratory birds; and *landfills* converted to parkland provide linkages for wildlife corridors for terrestrial animals.

above identified cultivation activities (for example, neighborhood green markets) according to *established* code and regulation.

4.1.8 *Nature Preserve / Nature-based / Buffer Area Use*—Natural or intentionally engineered surface vegetation and/or water features with limited access to human intrusion of the space. Some *waste / chemically impacted sites* utilize *buffer areas* (beneath which no waste or only *de minimis* concentrations of chemicals exist) to create distance between the public and *waste site* operations. Although, such areas could be "nature" areas, it may be appropriate and desirable (for example, by adjacent property owners) for *buffer areas* to host limited, *active* or *passive* recreational *uses*, or low impact *site use* activities. These uses may occur in locations identified as *easements, buffers, and rights-of-way*. See Appendix X3, item 8 for additional information.

4.2 *Regulatory Context*—This guide does not supersede federal, State, or local regulations.

4.2.1 The user is responsible for determining the regulatory context, and associated constraints and obligations at a designated *waste / chemically impacted site* and should comply with all *established* applicable laws and regulations, including CERCLA, RCRA, TSCA, and other environmental laws and municipal codes in the *development* of the site for a new use activity. The typical *waste / chemically impacted site* where this guide is intended to be used are ones that are not currently (and not anticipated to be in the future) within a *regulatory agency* program.

4.2.2 The user should comply with health and safety requirements under the Occupational Safety and Health Act (OSHA) (**2**), worker right-to-know laws, and parallel requirements of *applicable local, State, or tribal (regulatory agency) organizations*. See (**2**) for more information.

4.3 *Use of Guide—Regulatory agencies* may incorporate this guide, in whole or in part, into general guidance documents or site-specific regulatory documents. This guide may also be integrated into complementary standards, guidelines, or contractual agreements, relating to the post-construction / end use phase of *sustainable* or greener cleanups; see Guide E2876 and Guide E2893, respectively.

4.4 *Professional Judgment*—This guide presumes the active involvement of an *Environmental Professional* who is knowledgeable in how to design and construct use activity features at a *waste / chemically impacted site* and how to identify *acceptable* site conditions or (when required) satisfy applicable statutory or *regulatory agency* limitations on the use of an operating, closed, abandoned, or *legacy waste / chemically impacted site*, including those with *community engagement* and *Environmental Justice* concerns. The *Environmental Professional* must be current (that is, is a qualified and registered professional in her/his field of expertise and have satisfied requirements for continuing education) in her/his knowledge of *developments* in the use of *waste / chemically impacted sites*, as well as case studies where some use activities succeed and others express *potential adverse impacts to human health, public safety, or welfare*.

4.5 *Elimination of Uncertainty*—Professional judgment, interpretation, and some uncertainty are inherent in the processes described herein even when decisions are based upon objective scientific principles and accepted industry practices. In addition, new methods are continually being developed for this evolving field.

4.6 *Process Entry*—This guide may be initiated at any stage of *waste / chemically impacted site development* from planning, construction, closure, and post-closure, or upon discovery of an unplanned or unsafe site, and/or a site with an emergency chemical *spill* or *release of a hazardous substance*.

4.7 *Process Reporting and Documentation*—The user should decide (in coordination with relevant *stakeholders*) when site evaluations, reporting, and documentation will occur during Planning and Scoping, Section 5.

4.8 *Process Overview*—At initiation, the user should review: Section 3, Terminology; and then proceed to Section 4, Significance and Use; Section 5, Planning and Scoping; Section 6, Site Use Activity Evaluation and Selection Process; and Section 7, Site Use Evaluation, Reporting, and Documentation.

4.8.1 Section 5, Planning and Scoping, describes the *Project Team* approach (see 3.1.56) for implementing this guide, including, but not limited to: a) Selecting the *waste / chemically impacted site*; b) selecting a desired *site use* and making a *due diligent* assessment of environmental conditions; c) evaluating possible *engineering controls*, site safety, and opportunities for material recovery; d) submitting the project to a *regulatory agency* and receiving approval (if required); e) selecting a site evaluation process (that is, choosing Site Evaluation Forms 1, 2, 3, 4, or 5); f) soliciting *concurrence* for the *Environmental Professional's* proposed approach at a *stakeholder* and *community engagement charrette* (meeting) (if a *regulatory agency's* approval is required but approval is not granted, go back a step, if approval is given or not needed, proceed); and g) arriving at two possible outcomes. These outcomes are: (1) The *Environmental Professional* prepares a final report that contains one or more *Completed Site Evaluation* forms for the use activity, delivers the report to the user of the guide, and completes all documentation – this includes having the *Project Team* and *stakeholders* making applicable planning and scoping documents available to the public; and (2) the *Environmental Professional* terminates the evaluation because the *Due Diligence Threshold* (of knowledge) of the *Environmental Professional* of the site had not been reached.

4.8.2 Section 6, Site Use Activity Evaluation and Selection Process describes steps for identifying, selecting, and implementing (a) use activity(ies) at (a) specific *waste / chemically impacted site(s)*.

4.8.2.1 Section 6 provides the four-step process for Site Use Activity Evaluation and Selection, including: Site Use Opportunity Assessment; Site Use Priority Listing; Site Use Selection and Reporting; and Site Use Implementation and Documenting.

4.8.3 Section 7 describes use activity evaluation, reporting, and documentation. Section 7 does not instruct the user on how to perform the use activity analysis; it presumes that at least one member of the *Project Team* is knowledgeable about each

type of proposed use activity at the *waste /chemically impacted site*, and sufficient, *readily available information* is available to them/her/him to complete one or more of the Site Use Evaluation Forms 1, 2, 3, 4, and 5. See Appendix X2 and Appendix X4 for more information on the use of those Forms. See Appendix X1 for supporting documents cited in the body of this guide.

4.8.3.1 Section 7 identifies when the five Site Use Evaluation forms are to be used for which *site uses* and for which *waste / chemically impacted sites*. Appendix X2 supports Section 7 by providing additional considerations on which Site Use Evaluation forms should be completed for the selected use activity.

4.8.3.2 Appendix X3 provides the user with ten additional considerations in the beneficial use process / framework for site evaluation for eight possible uses. Appendix X3 includes discussions of: a) Establishing when and how a *MSW landfill* could achieve conditions where active controls are limited or terminated (that is, removed or abandoned); b) need for special care regarding the venting of carcinogenic gases versus methane and other less harmful (to human health, public safety, or welfare) gases; c) physical safety requirements related to firm foundations for a proposed *site use*; d) special considerations for *pre-regulatory waste sites*; e) alternative methods for testing the solubility of *waste* materials; f) opportunities to enhance the flow of methane where it is being commercially recovered; g) the use of phytoremediation for beneficial *site use*; h) use of the guide by municipalities in the designation of easements, buffers, and rights-of-way; i) how this guide complements regulations, laws, and policies of *regulatory agencies*; and j) how the guide contributes to the *sustainable* use of urban resources.

4.8.3.3 Appendix X4 includes five forms that the *Environmental Professional* selects for her/his evaluation that (a) use activity(ies) is(are) *acceptable* and thereby considered protective of human health, public safety, and welfare: Form 1 is for *expedited use* involving no *cover* or *cap* disturbance and a low chance of exposure to chemicals in soil (for example, see exposure assumptions of *passive* recreational *use*, Section 4.1.2); Form 2 is for *conditional expedited use* that may involve cover or *cap* disturbance and repair (note that a Form 3 evaluation is needed if a required *capping* system is disturbed or if a new *cap* is installed), with a sufficient number of control measures to protect human health, public safety, and welfare (for example, see exposure assumptions of *active* recreational *use*, Section 4.1.1); Form 3 is for *cap* disturbance (that is, that which may compromise the effectiveness of this *engineering control*), such as full intrusion of a protective *cap*, and a more extensive number of *engineering* and *institutional controls* to limit chemical exposures; Form 4 is for evaluating agricultural operations or marketing; and Form 5 is for site-specific use activities for sites that may require *regulatory agency* permit modifications to allow the *development* of a use activity at sites with irregular circumstances (for example, *regulatory agency* orders that limit what can be placed at a site, or operation and maintenance activities that may increase chemical exposures). An important feature of Form 5 is that it provides information about what needs to be controlled, and what *engineering* and *institutional controls* are needed to protect human health, public safety, and welfare, what settings are needed for the *engineering controls*, the names and contact numbers for the person(s) responsible achieving an *acceptably* safe condition, and the conditions upon which the various controls and monitoring frequencies can be relaxed or *terminated* (as discussed in Appendix X2 and Appendix X3). In each case the *Environmental Professional* completes the evaluation forms after a *due diligent* assessment of *potential adverse impacts to human health, public safety, or welfare* at the site by her/him and other professionals (as needed) with expertise to perform such assessments.

4.8.4 The *Environmental Professional* identifies an *acceptable* quality of soil in the conduct of her/his *waste / chemically impacted site* evaluation (that is, the *soil cleanup objective*, or *SCO*) as described below. See Appendix X5 for more information.

4.8.4.1 Appendix X5 includes a table of chemicals and chemical compounds with two columns of information. The first column is a set of maximum concentrations for those chemicals and chemical compounds that may be present in the upper six inches of uncovered, bare soil if the use activity involves *active* recreational use (where contact and ingestion of soil is likely because of the intended activity). The second column is a set of maximum concentrations for those chemicals and chemical compounds that may be present in the upper six inches of uncovered, bare soil if the use activity involves *passive* recreational *use* (where contact and ingestion of soil is possible but unlikely because of the intended activity). No single concentration should be considered a “bright line” limit, but rather an order-of-magnitude consideration when the *Environmental Professional* evaluates a use activity. For example, if a few concentrations are slightly above respective limits, the soil may still be *acceptable*. However, if ten or more are considerably above their limits or one is significantly above its limit, then the *Environmental Professional* may recommend against a use activity on those grounds. See **(10)** and **(11)** for more information.

4.8.5 The *Environmental Professional* determines whether or not a threshold of knowledge exists upon which she/he may offer recommendations on a *site use*. See 5.6 and Appendix X6 for more information.

4.8.6 Appendix X7 provides definitions for terminology used in the Appendices.

5. Planning and Scoping

5.1 When applying this guide, the user should perform the following planning and scoping activities: Select an *Environmental Professional* to lead the effort; assemble a *Project Team*; identify applicable *regulatory agency* goals; reference applicable documents listed in Section 2, Appendix X1, and Appendix X7; compile site data; determine the proposed use activity(ies) at each portion of a *waste / chemically impacted site*; and establish how, how long, when, and where the planning and scoping documents created from the use of this guide are to be made publicly available.

5.2 The user should select an *Environmental Professional* who for the purpose of this guide, is a person possessing

sufficient education, training, and experience who meets the requirements set forth in 40 CFR 312.10(b) (**8**), and exercises professional judgment regarding the Site Use Activity Evaluation and Selection Process (see Section 6) of this guide. The person may be an independent contractor or an employee of the user, or the user her/himself.

5.3 The user should assemble the appropriate *Project Team*, considering factors such as: Technical expertise related to the design, construction, monitoring, and maintenance of *waste / chemically impacted sites* that are protective of human health, public safety, and welfare, including the establishment of appropriate barriers against chemical exposure by the public and people visiting the *waste site*; *regulatory agency* requirements; *stakeholder* interests and concerns, if known; and project budget.

5.4 When a *regulatory agency* program governs a use activity, the user should evaluate whether the applicable program and the goals and requirements of this guide are each effective, complementary, and protective of human health, public safety, and welfare. All elements of *landfill post-closure care* (when applicable) must be cited in all *Completed Site Evaluations*. The user should discuss expectations for the use of this guide with the *regulatory agency* prior to implementation.

5.5 The user should: Compile environmental, demographic, and land use characteristics; estimate project costs; identify a project schedule (that includes reasonable contingencies); and identify other factors that may influence the decision to establish one or more use activity(ies) at the specific *waste / chemically impacted site*.

5.5.1 These characteristics include: Site size; actual or *potential adverse impacts to human health, public safety, or welfare*; presence and operability of all *engineering and institutional controls* that prevent such impacts (see Appendix X2 and Appendix X3 for additional information); distribution of existing use activities in the vicinity of the targeted *waste / chemically impacted site* so as to address community *acceptability* of the proposed use activity; presence and desirability of wildlife corridors (for the *nature preserve / nature-based / buffer use* activity); capacity impacts of potentially modified stormwater flows; and impacts of increased traffic of those wishing to use the site.

5.5.2 The user should identify the current and reasonably anticipated future use of the site, and of properties located proximate to the site.

5.5.3 The user should establish a budget and schedule for meeting the goals and requirements of this guide, and discuss how the Site Use Activity Evaluation and Selection Process (see Section 6) could maximize social benefits and/or private benefits.

5.6 *Process*—The Beneficial Use of Landfills and Waste / Chemically Impacted Sites Process is presented in Fig. 1 and the Due Diligence Process is presented in Fig. 2. Each process is described below. The more technical aspect of the guide is presented in Section 6, where the illustrated Site Use Activity Evaluation and Selection Process describes how the match between a *waste / chemically impacted site* and a use activity is achieved.

5.6.1 Fig. 1 presents a process that involves the *Environmental Professional*, and the *Project Team* who: a) Evaluate the possible use activities (that is, opportunity assessment) at a selected site; b) conduct a *due diligent* assessment of *potential adverse impacts to human health, public safety, or welfare* (that is, follow Appendix X6); c) identify *engineering* and *institutional controls*; d) submit the proposal to develop the site to *regulatory agencies* for approval to proceed (as required); e) identify evaluation form(s) to be used, and report the *site use* selection to the public and *stakeholders* (and seek *concurrence* with the proposed *site use*) at a *charrette*; and f) implement the selected use and provide documentation of the selection process.

5.6.2 Fig. 2 presents the Due Diligence Process. This process involves the *Environmental Professional* and the *Project Team* in the determination of which Forms (as presented in Appendix X4) should be completed for a proposed *site use*. The six steps of this process are: a) Utilize *readily available information* about the site and review the eighteen considerations listed in Appendix X6 to determine whether it is prudent to continue the evaluation of a site for a proposed beneficial use; b) if the *Environmental Professional's* review reveals data gaps and/or unacceptable conditions, the *Environmental Professional* proceeds to step "c)" below, but if no gaps or unacceptable conditions exist, the Environmental Professional prepares a Form 1 – Expedited Use – Completed Site Evaluation report; c) if the *Environmental Professional* determines that a *generic cover* (that is, concrete, asphalt, or soil) can make a proposed use *acceptable*, the *Environmental Professional* prepares a Form 2 – Conditional Expedited Use – Completed Site Evaluation report, or if *generic covering* is not *acceptable*, the *Environmental Professional* proceeds to step "d)" below; d) if the *Environmental Professional* determines that *capping* the site or restoring a disturbed, existing *cap* (alone) will *acceptably* control *potential adverse impacts to human health, public safety, or welfare* for the proposed beneficial use, the *Environmental Professional* prepares a Form 3 – Cap Disturbance – Completed Site Evaluation report with sufficient details (for example, engineering drawings) for implementation contained in that report, otherwise the *Environmental Professional* proceeds to step "e)" below; e) if it is determined that site-specific measures (perhaps including a supplemental *cap*) will *acceptably* control *potential adverse impacts to human health, public safety, or welfare* for the proposed beneficial use, the *Environmental Professional* prepares a Form 5 – Site-Specific Use – Completed Site Evaluation report, or if *potential adverse impacts to human health, public safety, or welfare* cannot be *acceptably* controlled, the *Environmental Professional* terminates the evaluation; and f) if, upon completion of Forms 1, 2, and 3, the *Environmental Professional* determines that the guide user desires to allow agricultural operations or the marketing of agricultural goods at the site, the *Environmental Professional* prepares a Form 4 – Agricultural Use – Completed Site Evaluation report, but if the guide user does not desire those uses, the *Environmental*

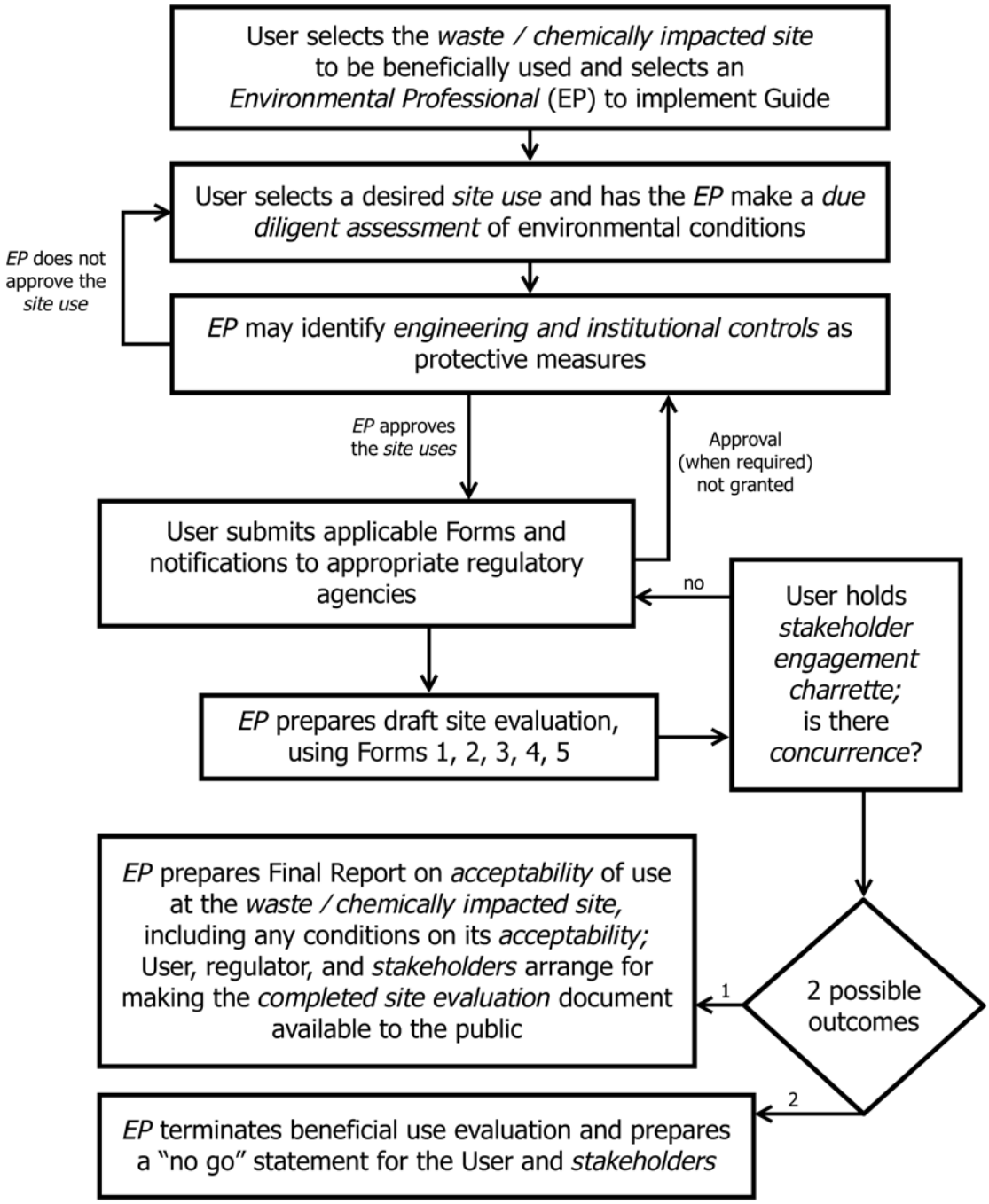

FIG. 1 Beneficial Use of Landfills and Waste / Chemically Impacted Sites Process

Professional terminates the evaluation. See 5.6.3 for obligations of the *Environmental Professional*, guide user, and site owner when the evaluation is terminated because *potential adverse impacts to human health, public safety, or welfare* cannot be *acceptably* controlled.

5.6.3 Fig. 2 has a *due diligent* process step of "Environmental Professional terminates the evaluation," that identifies two situations when an *site use* evaluation may end. One situation is when one or more of the Appendix X4 evaluation forms are completed and the identified proposed beneficial use(s) is(are) implemented. In the other situation, the *Environmental Professional* cannot identify a *cover*, *cap*, or other site-specific measure that could *acceptably* control *potential adverse impacts to human health, public safety, or welfare*. As Appendix X6 describes the latter situation, the *Environmental Professional* is obligated to refuse offering professional advice on *acceptable uses* of a site, and to fully explain why in a final evaluation report. However, the guide user and/or site owner is obligated to fairly compensate the *Environmental Professional* for the arrival of the *Environmental Professional* to that conclusion. The guide user and/or site owner must then provide that information to any subsequent *Environmental Professional* who evaluates the same site for a beneficial use. Any subsequent *Environmental Professional* who accepts the task of

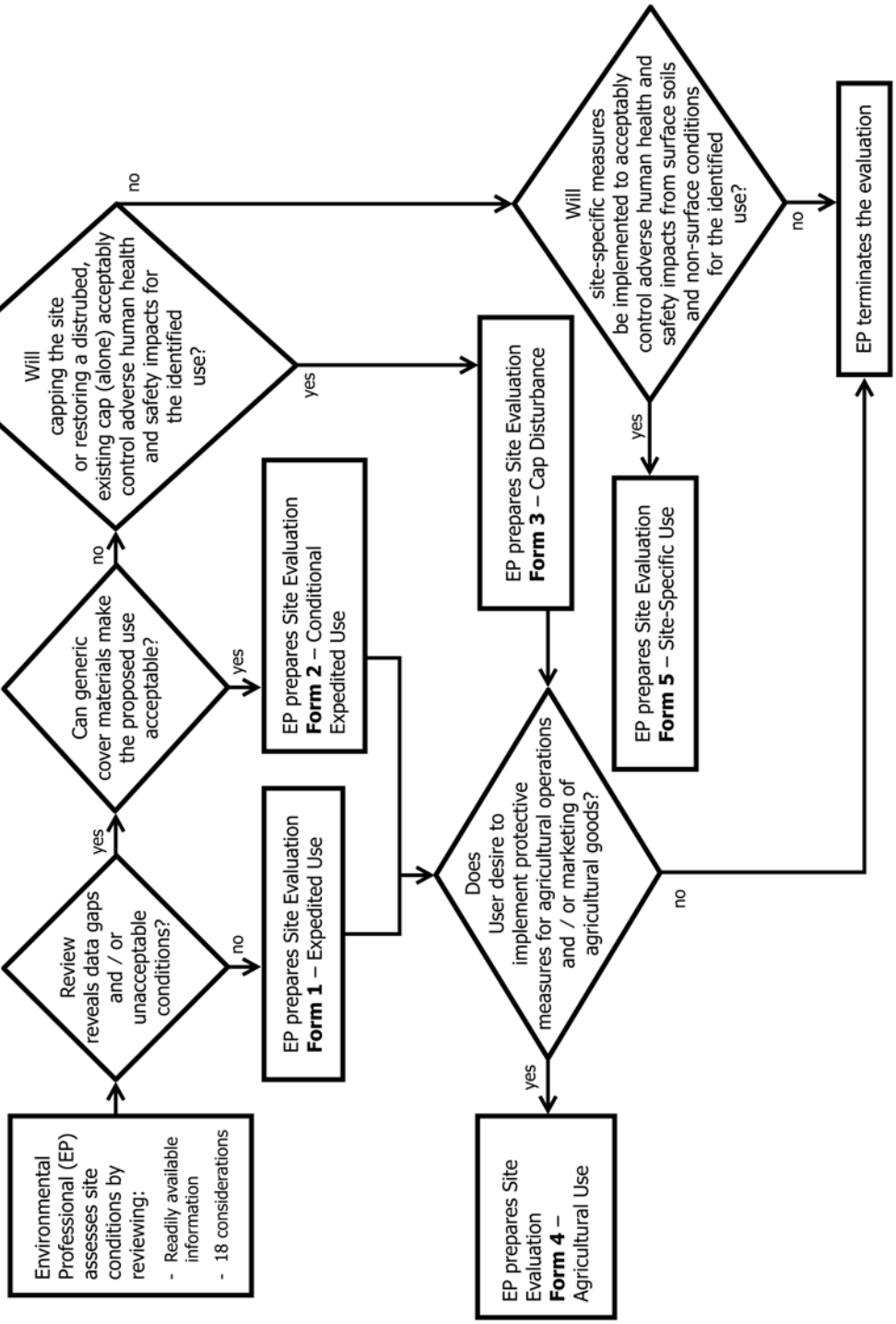

FIG. 2 Due Diligence Process

re-evaluating a beneficial use at the same, specific location must describe (for example, quantify) the new knowledge that is believed sufficient for the *Environmental Professional* to then claim that the *due diligence threshold* has been reached, and thereby allows her/him to provide a Completed Sites Evaluation report for that use.

5.6.4 Table 1 describes the eleven types of *waste / chemically impacted sites*. Table 2 suggests which *waste / chemically impacted sites* are applicable for each of the eight *site uses*. Table 3 identifies the various *engineering and institutional controls* (including *secured monitoring infrastructure*), site safety issues, and opportunities for material recovery at the

TABLE 2 Applicable[A] Waste / Chemically Impacted Sites for Selected Site Uses

Site Uses	Applicable Waste / Chemically Impacted Site	Discussion / Considerations
Active Recreation	Municipal Solid Waste Landfills: 2-Closed post-RCRA/Operated pre-RCRA 4-In design C&D Landfill: 5-Closed; Historic Fill Site (7) Airborne Deposition Site (8) Monofill: 9-Coal ash; 10-Foundry Sand Non-impacted Buffer Area (11)	Except for the Non-impacted *Buffer Area*, the *waste / chemically impacted sites* listed here require pavement, synthetic turf, a thick vegetative cover, and/or clean *cover* soils or *cappping* material as barriers to subsurface *waste* and chemicals if they are to be used for active *recreational* purposes. Only the Non-impacted *Buffer Area* qualifies for an Expedited Use evaluation (Form 1). Also, if, in the *Environmental Professional's* judgment, there are doubts about the stability of subsurface materials, a Site Specific Use (Form 5) evaluation is needed. A Conditional Expedited Use evaluation (Form 2) is otherwise appropriate.
Passive Recreation	Municipal Solid Waste Landfills: 1- Pre-RCRA; 2-Closed post-RCRA/Operated pre-RCRA; 3-Operatlng(ed)/Closed post-RCRA; 4-In design C&D Landfill: 5-Closed; 6-Operating/In deslan Historic Fill Site (7); Airborne Deposition Site (8) Monofill: 9-Coal Ash; 10-Foundry Sand Non-Impacted Buffer Area (11)	All *waste / chemically impacted sites* are candidates for *passive recreational uses*, as *potential adverse impacts to human health, public safety, or welfare* are less than for *active recreational uses*. All of these sites qualify for Expedited Use (Form 1) evaluation. If, in the *Environmental Professional's* judgment, there are doubts about the stability of subsurface materials, a Site Specific Use (Form 5) evaluation is needed. A Conditional Expedited Use evaluation (Form 2) is otherwise appropriate.
Alternate Energy/ Deep Anchoring Need	Municipal Solid Waste Landfills: 4-In design C&D Landfill: 5-Closed; 6-Operating/In deslqn Historic Fill Site (7); Airborne Deposition Site (8) Monofill: 9-Coal ash; 10-Foundry Sand Non-impacted Buffer Area (11)	This *site use* requires careful considerations for weight and wind forces unlike all others. Except for *MSW sites* in design, *MSW sites* should not accommodate this use type. An Expedited Use (Form 1) Evaluation Is appropriate only if the anchoring infrastructure were pre-planned and installed. In all other cases, a Cap Disturbance (Form 3) and/or Site Specific Use (Form 5) evaluation is required.
Materials Recovery	Municipal Solid Waste Landfills: 2-Closed post-RCRA/Operated pre-RCRA 3-Operating(ed)/Closed post-RCRA; 4-In design Monofill: 9-Coal Ash; 10-Foundry Sand	This *site use* involves the capture, transmission, and processing of methane (from *MSW sites*) for sale to municipal energy utility organizations; *pre-RCRA MSW landfills* are not good candidates for methane recovery for sale, as the *MSW* has typically decomposed significantly over the 30 year period. *Monofills* such as for *coal ash* and foundry sand could be mined for the value of buried material, provided releases of chemicals and eroded soils to the air, water, and groundwater are controlled. Recent (Burger, 2012 **(13)**) reports of *MSW landfill* mining for recovery of rare earth metals from electronic *waste* suggests that this *site use* is gaining in popularity. Cap Disturbance (Form 3) and Site Specific Use (Form 5) evaluations are required in all cases.
Stormwater Management	Municipal Solid Waste Landfills: 4-In design Historic Fill Site (7): Airborne Deposition Site (8) Monofill: 9-Coal ash; 10-Foundry Sand Non-impacted Buffer Area (11)	Impermeable, lined stormwater retention ponds can pose restrictive weight challenges at a *MSW site*. Provided water is not allowed to percolate into soils containing soluble chemicals, this *site use* can be implemented at many *waste/ chemically impacted sites*. *Buffer areas* (that do not have subsurface wastes) are acceptable for bioswales, rain gardens, and other features that involve infiltration of rainwater. Use of evaluation Forms 1, 2, 3, and 5 are appropriate.
Composting Imported Debris	Municipal Solid Waste Landfills: 2-Closed post-RCRA/Operated pre-RCRA; 3-Operating(ed)/Closed post-RCRA 4-In design C&D Landfill: 5-Closed	This type of *site use* runs the risk that chemicals from the *waste / chemically impacted site* make their way into the compost and topsoil product. Only those impacted sites that have engineered *covers* (preferably concrete or asphalt pavement) providing a sufficient barrier to subsurface *wastes* and chemicals are *acceptable* for this *site use*. Use of a Conditional Expedited Use evaluation (Form 2) is appropriate.
Agricultural Cultivation (non- or lightly mechanized) or Marketing	Municipal Solid Waste Landfills: 1-Pre-RCRA; 2-Closed post-RCRA/Operated pre-RCRA; 3-Operating(ed)/Closed Post RCRA; 4-In design; C&D Landfill: 5-Closed; 6-Operating / In design Historic Fill Site (7) Airborne Deposition Site (8) Non-impacted Buffer Area (11)	In all cases, it is appropriate for community gardens to be raised at least to the depth that covers the length of roots anticipated for one growing season (usually two feet). Soil of a quality and fertility acceptable for the agricultural need should be supplied to this raised bed. Gardens and green markets should be at least 200 feet from a traffic intersection to avoid the deposition of semivolatile organic chemicals from automobile exhaust. Use of evaluation Forms 1, 2, 3, and 4 is appropriate.
Nature Preserve / Nature-based / Buffer Area	Municipal Solid Waste Landfills: 1-Pre-RCRA C&D Landfill: 5-Closed Historic Fill Site (7) Airborne Deposition Site (8) Monofill: 9-Coal ash; 10-Foundry Sand Non-impacted Buffer Area (11)	This type of *site use* is *acceptable* for the *waste / chemically impacted sites* listed. *Buffer areas* may have clean soils, but if they do not, they could still be *established* (for example, restrictive fencing and signage) for public use and use by wildlife. Larger impacted sites may be naturally selected by wildlife as a migratory bird stop over location; urban impacted sites may be linked with adjacent, non-impacted sites to provide a land-based wildlife corridor. Use of evaluation Forms 1 and 2 is appropriate.

[A] Applicability is used in a general sense here, as actual use is site specific; the user should evaluate all features of a site before recommending a specific use.

TABLE 3 Engineering and Institutional Controls and Site Safety Considerations and Material Recovery Opportunities

			SITE SAFETY							VALUE CAPTURE
			CONTROLS							
Type of Site			Erosion	Infiltration	Secured Monitoring Infrastructure	Leachate	Landfill Gas	Soil / Waste Stability	Trespass	Material Recovery
1 -	Municipal Solid Waste Landfill	Pre-RCRA (orphan, latchkey)	X	X	–	X	–	X	–	X
2 -	Municipal Solid Waste Landfill	Closed post-RCRA/ Operated pre-RCRA	X	X	X	X	X	X	–	–
3 -	Municipal Solid Waste Landfill	Operating(ed)/ Closed post-RCRA	X	X	X	X	X	X	X	X
4 -	Municipal Solid Waste Landfill	In design	X	X	X	X	X	X	X	X
5 -	Construction and Demolition Landfill	Closed	X	X	–	–	–	X	–	–
6 -	Construction and Demolition Landfill	Operating / In design	X	X	–	–	–	X	–	–
7 -	Historic Fill Site		X	–	–	–	–	–	–	–
8 -	Airborne Deposition Site		X	–	–	–	–	–	–	–
9 -	Monofill	Coal ash	X	X	X	X	–	X	X	X
10 -	Monofill	Foundry sand	X	–	–	–	–	–	–	X
11 -	Non-impacted Buffer Area		–	–	–	–	–	–	X	–

eleven *waste / chemically impacted sites*. It is important to note that this guide gives general directions for typical sites that the user applies to her/his specific site. Each site has its own features and challenges that cannot be fully anticipated. Appendix X2 identifies considerations on which Forms should be completed for a selected *site use*. Appendix X3 provides guidance for use activity development at *MSW landfills* and *chemically impacted sites* concerning the release of methane and *leachate*, the venting of carcinogenic gases, *waste site* stability, considerations for *landfills* in *caretaker mode*, alternate material solubility tests, use of phytoremediation techniques, and the *acceptability* of proposed *site uses*.

5.6.5 It is through use of Section 7 and Appendix X2, Appendix X3, Appendix X5, and Appendix X6 where the *Environmental Professional* uses her/his professional judgment in completing Site Evaluations [that is, selecting the appropriate Appendix X4 Site Evaluation Form(s) and identifying the necessary conditions for that(those) form(s)] for a use activity at the specific *waste / chemically impacted site*. Appendix X5 lists the soil chemical concentrations considered *acceptable* for either *active* or *passive use*. Appendix X6 identifies a *Due Diligence Threshold of the Environmental Professional* where after the *Environmental Professional* is obligated to render a judgment about a proposed land use. Short of this threshold, the *Environmental Professional* should terminate the evaluation as described above in 5.6.3.

5.6.6 The purpose of the Site Use Activity Evaluation and Selection Process and the Due Diligence Process is to identify appropriate and desired use activities that maximize social benefits and/or private benefits at underutilized or heavily-used *waste / chemically impacted sites* that may be in operation, in *closure*, in *post-closure*, in *caretaker mode*, or ones that are located at unplanned or unsafe sites. This guide could be used, for example, by a *regulatory agency* to direct a responsible party of a chemical *spill* or *release of a hazardous substance* on *acceptable* cleanup end points based on the use activity that had been established or to establish a new use activity.

5.7 The user should review the provisions for public availability of the Site Use Activity Evaluation and Selection Process Evaluation Report as described in Table 4 and 7.1.1 and establish a plan to meet them.

5.8 The contractual relationship and/or legal obligations existing between and among the parties associated with a *waste / chemically impacted site* and the selected use activity(ies) are beyond the scope of this guide.

6. Site Use Activity Evaluation and Selection Process

6.1 The Site Use Evaluation and Selection Process may be initiated at a *waste / chemically impacted site* as early as the design phase, during operation, during *closure*, during *post-closure*, or after years of use or non-use. Use during the design phase may improve the *acceptability* of and *engineering control* for a use activity (for example, a use that requires deep anchoring of an alternate energy structure).

TABLE 4 Site Use Activity Evaluation and Selection Process

Step 1	*Site Use Opportunity Assessment* User identifies the waste / chemically impacted site where he/she intends to implement a desired site use activity upon (see Table 1) User identifies the constraints and limitations that the identified use activity poses for a selected waste / chemically impacted site (see Table 2) User identifies the various engineering and institutional controls (for example, time of use limitations), site safety provisions, and opportunities for materials recovery for each waste / chemically impacted site (see Table 3) User reviews the eight types of site uses and retains those that warrant further consideration, based on anticipated evaluation burden (see Table 5)
Step 2	*Site Use Priority Listing* User identifies all site uses with the greatest potential for timely and acceptable cost of implementation.
Step 3	*Site Use Selection and Reporting* User reviews the short list of site uses and selects the one(s) that achieve the User's need(s) and objective(s); User also prepares a report for the property owner, regulatory agency (as required), and stakeholders on the short list of preferred site uses.
Step 4	*Site Use Implementation and Documenting* User takes direction (as appropriate) from the property owner, stakeholders, and (if necessary) regulatory agency (with full consideration of neighboring community input) and implements the originally selected Site Uses (Step 3), their modification or their alternate. Documentation of the selection and implementation process follows the provisions of Section 7 and Appendix X2 and Appendix X3, using the applicable forms in Appendix X4, the soil cleanup objective concentrations listed in Appendix X5, and the due diligence threshold-defining process described in Appendix X6. Documentation is kept by the property owner and made publicly available.

6.2 *Site Use Evaluation and Selection Process Steps*—The Site Use Evaluation and Selection Process follows four steps: Step 1 – Site Use Opportunity Assessment; Step 2 – Site Use Priority Listing; Step 3 – Site Use Selection and Reporting; and Step 4 – Site Use Implementation and Documenting. The user should follow all four steps to select a use activity when using this guide. The four steps are described below and summarized in Table 4.

6.2.1 *Step 1: Site Use Opportunity Assessment*—This is a screening level assessment where constraints and limitations of a *waste / chemically impacted site* may decrease the potential for a use activity that would otherwise be attractive. During this step, the user retains all *site use* activities considered potentially *acceptable*, based on the anticipated evaluation burden outline in Table 5.

6.2.1.1 The user reviews Table 1 and selects the *waste / chemically impacted site* that best matches the site she/he is evaluating. This information should be included in the *Completed Site Evaluation* report (discussed in 7.2).

6.2.1.2 The user then reviews Table 2 and selects among the eight *site uses* for the waste / chemically impacted site she/he has selected. Documentation of the reasons for alternate recommendations of a use activity (not included in Table 2) should be provided in the Completed Site Evaluation report (discussed in 7.2).

6.2.1.3 The user then reviews Table 3 and selects the *engineering and institutional controls*, site safety measures, and opportunities for materials recovery for the selected *site use*. It is the *Environmental Professional's* obligations to identify additional applicable and *acceptable* controls or safety measures not included in Table 3. The *Environmental Professional* notes these controls, measures, and opportunities and includes them in the *Completed Site Evaluation* report (discussed in 7.2).

6.2.2 *Step 2: Site Use Priority List*—The user reviews the use activities retained in Step 1 and prioritizes them based on the relative ability of each to maximize social benefits and/or private benefits, to the satisfaction of the *Project Team*.

6.2.2.1 The user identifies those use activities with the greatest potential to meet the expressed desires of the stakeholders, including the owner(s) of the *waste / chemically impacted site* property and neighboring property owners. The purpose of the prioritization is to facilitate the selection process of Step 3 so that during that step, the use activities with higher priority (that is, those meeting the greatest number of diverse needs cited above) are given greater consideration for selection and implementation. Should the owner of the *waste / chemically impacted site* identify a use activity option of lesser priority than that desired by the *stakeholders*, the user should have the owner clearly explain the reason(s) (for example, the private economic benefits of extraction of coal ash) and identify all appropriate measures needed to be taken to limit me *potential adverse impacts to human health, public safety, or welfare* of that option. This information should be included in the *Completed Site Evaluation* report (discussed in 7.2).

6.2.2.2 Prioritization is based on the professional judgment of the *Environmental Professional* and does not require a detailed analysis. See 1.8 for additional information.

6.2.2.3 The user may group use activities that are mutually compatible (for example, stormwater management structures that are improved to control increased pollutant flows from composting operations).

6.2.2.4 As part of this step, the user prepares a prioritized list of use activities and includes this list in the *Completed Site Evaluation* report (discussed in 7.2).

6.2.3 *Step 3: Site Use Selection and Reporting*—The user reviews each use activity in the prioritized list (Step 2) and selects as many of them for implementation to achieve the user's needs and objectives. The user then prepares a report for the property owner, regulatory agency (as required), and *stakeholders* that identifies the short-listed *site uses*.

6.2.3.1 Unless there is a compelling reason to do otherwise (for example, conforming to *Environmental Justice* concerns of a neighboring community), the user selects each use activity from the prioritized list in Step 2 for implementation. Compelling reasons for eliminating a use activity from consideration could include substantive issues associated with *acceptability*, ability to implement, impracticality, and cost. Those reasons should be included in the *Completed Site Evaluation* report (discussed in 7.2).

TABLE 5 Applicable Forms for Site Use Type and Waste / Chemically Impacted Site Characteristics

Site Use Type	Waste / Chemically Impacted Site Characteristics	FORM 1 Expedited Use	FORM 2 Conditional Expedited Use	FORM 3 Cap Disturbance	FORM 4 Agricultural Use	FORM 5 Site Specific Use
Active Recreation	Compacted, stable soil, with no glass or sharps floating to surface; no evidence of chemical exposure or unsafe conditions; active recreational quality soils	X	X			X
Passive Recreation	Less stable soils than for active recreational uses; chemically impacted soils at passive recreational quality concentrations	X	X			X
Alternate Energy / Deep Anchoring Need	Soil and/or waste with high soil strength to support the weight and wind loads characteristically needed for wind turbines and photovoltaic arrays	X (if preplanned)		X		X
Materials Recovery	*MSW* up to 7 years old, but less than 20 years (for optimum methane generation); value of buried materials; ease of recovery; available and cost effective controls to avoid *potential adverse impacts to human health, public safety, or welfare* during recovery			X		X
Stormwater Management	Impermeable *liner* below base to prevent water infiltration into *waste*; stable soils; large acreage; also for rain gardens and increased infiltration	X	X	X		X
Composting Imported Debris	Impermeable barrier between compost materials and *cover* or *cap* materials; enhanced stormwater management need		X			
Agricultural Cultivation (non- or lightly mechanized) or Marketing	Sunlight exposure; wind blockage; low slope (unless terraced); green market use	X	X	X	X	
Nature Preserve / Nature-based / Buffer Area Use	Within a known wildlife corridor or supporting a special habitat	X	X			

6.2.3.2 If during implementation, new information or changed circumstances relevant to the use activity or *waste / chemically impacted site* render a use activity selected in Step 3 unacceptable to *stakeholders*, impracticable to implement, or cost-prohibitive, the user may elect not to implement that specific use activity. The user documents the rationale for not implementing any selected use activity and includes that information in the *Completed Site Evaluation* report (discussed in 7.2).

6.2.4 *Step 4: Site Use Implementation and Documentating*—The user records the *site use* activity that is implemented and includes that information in the Completed Site Evaluation report (discussed in 7.2).

6.2.4.1 The user follows the reporting and documentation steps outlined in Section 7 of this guide.

7. Site Use Evaluation, Reporting, and Documentation

7.1 The Site Use Evaluation Report should contain: (1) An executive summary that details in one page the recommended action and why other options were not selected; (2) a narrative of the evaluation and selection process outlined in Section 6; (3) a narrative of the reporting process outlined in Section 7; (4) the applicable requirements for monitoring or maintaining a *waste / chemically impacted site* (as cited in 7.2.2.7, 7.2.3.2, and 7.2.5.3 – 7.2.5.8) such that the implemented use activity is protective of *potential adverse impacts to human health, public safety, or welfare*; (5) the applicable *Completed Site Evaluation* forms (found in Appendix X4) completely filled out, and signed (with professional stamp and seal, as appropriate); and,

(6) the identified needs and requirements of applicable *regulatory agency* programs, contractual agreement, or other *stakeholder* commitments relative to the proposed allowed beneficial uses. The user should refer to Table 5 – Applicable Forms for Site Use Type and Waste / Chemically Impacted Site Characteristics to identify the appropriate Forms for the selected site use(s).

7.1.1 The user should make the *Completed Site Evaluations* for use activities and all other documents generated when following this guide publicly available, such as a public library, federal or State government office, municipal administration building, or other secure public place.

7.1.2 With consent from a *regulatory agency*, the user may submit the documents to that agency, where the public can access them through a *Freedom of Information Request*.

7.2 Documentation supporting the *Completed Site Evaluation* of a *site use* activity should include completed evaluation forms, using those forms found in Appendix X4 and described in Appendix X2 – Considerations on Which Evaluation Form(s) Should be Completed for the Selected Site Use, evidence of the use of Appendix X3 – Additional Considerations in the Restoration of Waste / Chemically Impacted Sites for Beneficial Use, and other information used in the evaluation. The *Completed Site Evaluation* report may include: Form 1 only, Form 2 only, Form 3 only, or Form 5 only; or the combinations of Forms 2 and 3, Forms 3 and 5, Forms 1 and 4, Forms 2 and 4, or Forms 3 and 4.

7.2.1 *Form 1: Expedited Use Evaluation*—For *site use* activities that conform to the requirements of Form 1, the *Completed Site Evaluation* report should contain statements acknowledging:

7.2.1.1 The *Due Diligence Threshold of the Environmental Professional* is reached, as described in Appendix X6.

7.2.1.2 The site is characterized through investigation and does not need to be investigated further in order to characterize the degree and extent of *pollutant* concentrations.

7.2.1.3 No construction or placement of any buildings over a *MSW* disposal area.

7.2.1.4 No excavation of a required cover or *cap* or *waste* materials.

7.2.1.5 No evidence of a release of *hazardous substance* or *pollutant* or other unacceptable conditions.

7.2.1.6 *Site use* activities were fully considered and engineered in pre-design and/or pre-construction phases of the *waste / chemically impacted site* development (if applicable).

7.2.1.7 The Form is signed by the *Environmental Professional* [and sealed and stamped, as appropriate (for example, Professional Engineer license)], and by other professionals who assisted the *Environmental Professional* with the evaluation of the site, listing their area(s) of expertise.

7.2.2 *Form 2: Conditional Expedited Use Evaluation*—For site use activities that conform to the requirements of Form 2, the *Completed Site Evaluation* report should contain statements acknowledging:

7.2.2.1 The *Due Diligence Threshold of the Environmental Professional* is reached, as described in Appendix X6.

7.2.2.2 The site is characterized through investigation and does not need to be investigated further in order to characterize the degree and extent of *pollutant* concentrations.

7.2.2.3 Known chemical exposure pathways are effectively blocked with a *generic cover* (for example, concrete, asphalt, or soil).

7.2.2.4 Required *capping* systems (if they exist) are not disturbed.

7.2.2.5 The site has less than 10 acres of *municipal solid waste* (less than 5 feet thick) that was disposed at the *waste / chemically impacted site* (in the U.S.) before 1981. See Appendix X3 for additional information.

7.2.2.6 No evidence of hazardous substances being released (except *de minimis* amounts) from the buried materials.

7.2.2.7 The site may be *developed* in spite of the identified hazards that may be caused or enhanced by the proposed *site use* provided an *acceptable* explanation and information about those identified potential hazards are provided [for example, wastes are contained, any existing *engineering* and *institutional controls* (as well as *secured monitoring infrastructure*)] are effective and are in place, and there is (if necessary) a credible, visible presence of *technicians* (at a frequency appropriate for the control) to maintain the effectiveness of the control(s).

7.2.2.8 The Form is signed by the *Environmental Professional* [and sealed and stamped, as appropriate (for example, Professional Engineering license)], and by other professionals who assisted the *Environmental Professional* with the evaluation of the site, listing their areas of expertise. The names of the *waste / chemically impacted site* property owner and the Site Developer (as appropriate) are entered on the form.

7.2.3 *Form 3: Cap Disturbance Evaluation*—For *site use* activities that conform to the requirements of Form 3, the *Completed Site Evaluation* report should contain statements acknowledging:

7.2.3.1 The *Due Diligence Threshold of the Environmental Professional* is reached, as described in Appendix X6.

7.2.3.2 Construction or placement of buildings, structures, and infrastructure systems over a *waste* disposal area is *acceptable* and protective of human health, public safety, and welfare, provided that the integrity of the *cap* is maintained.

7.2.3.3 The Form is signed by the *Environmental Professional* [and sealed and stamped, as appropriate (for example, Professional Engineering License)] who is licensed in the State where the *waste / chemically impacted site* is located, and by other professionals who assisted the *Environmental Professional* with the evaluation of the site, listing their areas of expertise.

7.2.4 *Form 4: Agricultural Use Evaluation*—For *site use* activities that conform to the requirements of Form 4, the *Completed Site Evaluation* report should contain statements acknowledging:

7.2.4.1 The *Due Diligence Threshold of the Environmental Professional* is reached, as described in Appendix X6.

7.2.4.2 Agricultural cultivation or marketing upon the *waste / chemically impacted site* is acceptable and protective of human health, public safety, and welfare.

7.2.4.3 The Form is signed by the *Environmental Professional* [and sealed and stamped, as appropriate (for example, Professional Engineering License)] who is licensed in the State where the *waste / chemically impacted site* is located, and by other professionals who assisted the *Environmental Professional* with the evaluation of the site, listing their areas of expertise.

7.2.5 *Form 5: Site-Specific Use Evaluation*—For *site use* activities that conform to the requirements of Form 5, the *Completed Site Evaluation* report should contain statements acknowledging or identifying:

7.2.5.1 The *Due Diligence Threshold of the Environmental Professional* is reached, as described in Appendix X6.

7.2.5.2 The site is characterized through investigation and does not need to be investigated further in order to characterize the degree and extent of *pollutant* concentrations.

7.2.5.3 No evidence of hazardous substances being released (except *de minimis* amounts) from the buried materials.

7.2.5.4 The site may be *developed* in spite of the identified hazards that may be caused or enhanced by the proposed *site use* provided an *acceptable* explanation and information about those identified potential hazards are provided [for example, wastes are contained, any existing *engineering* and *institutional controls* (as well as *secured monitoring infrastructure*)] are effective and are in place, and there is (if necessary) a credible, visible presence of *technicians* (at a frequency appropriate for the control) to maintain the effectiveness of the control(s).

7.2.5.5 Why such measures and controls (as described immediately above) are necessary.

7.2.5.6 The sizes, thicknesses, flow rates, etc. that are appropriate for the above-identified measures and controls.

7.2.5.7 Required *capping* systems for any *landfill* or *chemically impacted site* may not be disturbed and no construction or placement of buildings over the *waste* disposal area may be done (that is, unless the *Environmental Professional* evaluates the site according to 7.2.3).

7.2.5.8 The *technician(s)* who is(are) (with 24-hour contact numbers) obligated to assure that the measures and controls are functioning and are effective is known and identified by name in the *Completed Site Evaluation* report.

7.2.5.9 The conditions or time at which some or all measures and controls may be *terminated* due to a finding of *acceptable* site conditions. See Appendix X3 for additional information about use activities developed on *MSW* sites.

7.2.5.10 The Form is signed by the *Environmental Professional* [and sealed and stamped, as appropriate (for example, Professional Engineering License)] who is licensed in the State where the *waste / chemically impacted site* is located and by other professionals who assisted the *Environmental Professional* with the evaluation of the site, listing their areas of expertise.

7.3 The user should report which selected *site use* activities were not implemented and provide rationale for their exclusion. The rationale for site use activity exclusion should include one or more of the following reasons: challenges in implementation, uncertain effectiveness, excessive cost, or other factors.

APPENDIXES

(Nonmandatory Information)

X1. SUPPORTING DOCUMENTS—GOVERNMENT AND NON-GOVERNMENT DOCUMENTS AND INFORMATION RESOURCES THAT MAY BE USEFUL TO USERS OF THIS GUIDE

ASTM Standard Guide for Risk-Based Corrective Action (E2081)

ASTM Standard Practice for Environmental Site Assessment: Phase II Environmental Site Assessment Process (E1903)

ASTM Standard Guide for the Development of Conceptual Site Models for Contaminated Sites (E1689)

ASTM Standard Guide for Use of Activity and Use Limitations, Including Institutional and Engineering Controls (E2091)

ASTM Standard Guide for Application of Engineering Controls to Facilitate Use or Redevelopment of Chemically Affected Properties (E2435)

New York State Department of Environmental Conservation, 2015. Upland Disposal / Management of Dredged Sediments. Found on 3/7/15 at http://www.dec.ny.gov/chemical/8734.html

New York State Department of Environmental Conservation, 2015. Composting and Organic Matter Management. Found on 3/7/15 at http://www.dec.ny.gov/chemical/8798.html

New York State Department of Environmental Conservation, 2015. Construction and Demolition Debris Processing Facilities. Found on 3/7/15 at http://www.dec.ny.gov/chemical/23686.html

North Carolina Department of Environment and Natural Resources. 2015. Online Access to Superfund Section Documents. Found on 8/1/15 at http://portal.ncdenr.org//web/wm/sf-file-records

North Carolina Department of Environment and Natural Resources. 2015. Inactive Hazardous Sites Program Website. Found on 8/1/15 at http://portal.ncdenr.org/web/wm/sf/ihshome

North Carolina Department of Environment and Natural Resources. 2015. Interactive Maps with DWM Sites and Permitted Facilities. Found on 8/1/15 at http://portal.ncdenr.org/web/wm/gis/maps

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X2. CONSIDERATIONS ON WHICH EVALUATION FORM(S) SHOULD BE COMPLETED FOR THE SELECTED SITE USE

INTRODUCTION

This Appendix provides considerations on which Site Evaluation Forms (see Appendix X4) the user should complete for the selected site use. Each site use is an example of development. Table 5 – Applicable Forms for Site Use Type and Waste / Chemically Impacted Site Characteristics provides a good introduction to this activity. Below are additional considerations.

X2.1 Form 1–Expedited Use

X2.1.1 This is the least restrictive evaluation, and the appropriate site uses for this Form's use include the following. This form is appropriate for the post-cleanup phase of restoring a site after a chemical spill or release of a hazardous substance upon land.

X2.1.2 *Active Recreation*—For this type of use, Form 1 is only appropriate for the Non-impacted Buffer Area site.

X2.1.3 *Passive Recreation*—In most cases the Environmental Professional can judge the acceptability of this low impact land use with the least amount of documentation, provided surface soils meet the passive use quality soil concentrations listed in Appendix X5.

X2.1.4 *Alternate Energy / Deep Anchoring Need*—Form 1 is only appropriate for this site use if adequate foundational support was incorporated in the original design of the waste / chemically impacted site; if so, the use of this simple Form and the associated evaluation is a reward for forward thinking.

X2.1.5 *Stormwater Management*—Waste / chemically impacted sites without subsurface wastes (for example, Non-impacted Buffer Areas) are ideal for bioswales, rain gardens, and other rainfall infiltration practices to limit stormwater runoff.

X2.1.6 *Agricultural Cultivation (non- or lightly mechanized) or Marketing*—Provided cultivation operations are conducted in raised beds, use horticultural quality soils that meet the active recreational use soil concentrations listed in Appendix X5, and are separated sufficiently from the soil at the chemically impacted site, this level of evaluation should be most easily completed with similar effort as for passive recreational use. When green markets are set up on waste / chemically impacted sites, the property owner or vendor/tenant should take care not to disturb site soils, such as installing stakes to set up a canopy.

X2.1.7 *Nature Preserve / Nature-based / Buffer Area Use*—Providing a habitat (or corridor for movement) for wildlife should be even more of a low impact than passive recreational use, provided that barriers to waste / chemically impacted soil (when necessary) are employed.

X2.2 Form 2–Conditional Expedited Use

X2.2.1 This evaluation acknowledges that limited control measures (that is, measures that may be considered an engineering control that are subject to engineered design, technical monitoring, and maintenance) may be required before a site use can be implemented under this guide. The appropriate site uses for this Form's use include:

X2.2.2 *Active Recreation*—The conditions appropriate for this site use involve the acceptability of surface soils meeting the SCOs listed in Appendix X5 for the various chemicals, as it is likely that people using the site would come into contact with soils during the period of use. These conditions include:

X2.2.2.1 A sufficient depth (at least 6 inches) of active recreational use quality soil over the play area;

X2.2.2.2 Acceptable clean, imported cover soil that is free of glass, brick, and other sharp objects that could migrate to the play surface over time;

X2.2.2.3 Stable soils that are not susceptible to erosion or settlement; and

X2.2.2.4 A periodic reassessment (for example, biennial) of these conditions to assure continued safe use.

X2.2.3 *Passive Recreation*—The conditions appropriate for this site use involve the acceptability of surface soils meeting the SCOs listed in Appendix X5 for the various chemicals, as it is possible (though unlikely) that people using the site would come into contact with soils during the period of use. These conditions include:

X2.2.3.1 A paved pathway or synthetic turf (for example, asphalt or concrete) over passive recreational use quality soil;

X2.2.3.2 Vegetated buffers along or bordering use areas;

X2.2.3.3 Stable soils that are not susceptible to erosion or settlement; and

X2.2.3.4 A periodic reassessment of these conditions.

X2.2.4 *Stormwater Management*—The potential for adverse impacts to human health, public safety, or welfare from stormwater management are more uncertain when the quality of subsurface wastes is unknown or of limited knowledge. For example, water infiltrating historic fill may be appropriate if the infiltrating water has a neutral to higher pH so as to avoid making potentially toxic metals (for example, lead) soluble, and thus able to migrate to groundwaters or into nearby storm sewers. The user should be cautious about implementing this site use.

X2.2.5 *Composting Imported Debris*—The areas where organic matter is received and/or mixed, and where the resultant compost is allowed to develop into a horticultural product should be provided with a sufficient, hardened ground surface barrier such that the landfill cover soil and/or chemically impacted soil is not disturbed (that is, is not inadvertently excavated to become part of the compost).

X2.2.6 *Agricultural Cultivation (non- or lightly mechanized) or Marketing*—See discussion above for Form 1.

X2.2.7 *Nature Preserve / Nature-based / Buffer Area Use*—See discussion above for Form 1.

X2.3 Form 3–Cap Disturbance

X2.3.1 This evaluation acknowledges that the cap at a waste / chemically impacted site may be disturbed for the sake of implementing a site use, provided that the disturbed cap is subsequently repaired. The appropriate site uses for this Form's use include:

X2.3.2 *Alternate Energy / Deep Anchoring Need*—Cap disturbance for this site use at a MSW site is typically not appropriate, as subsurface materials often do not provide sufficient strength for supporting significant weight and wind loads. However, for all other types of waste / chemically impacted sites (except unstabilized coal ash wet management unit sites), sufficient strength of subsurface materials may be available. If a MSW landfill had pre-designed an anchoring system, that would be an exceptional allowance. See discussion for Form 1 for additional information.

X2.3.3 *Materials Recovery*—Materials can be recovered from a MSW landfill and from a chemically impacted site. At the chemically impacted site, solid materials are excavated, processed, and the volume reduced to those that are valuable, leaving the remainder for reburial. At the MSW landfill, high Btu-content methane gas is captured as recovered fuel or is combusted near the site of capture. In each case, a safe and environmentally controlled method should be identified to limit releases to land, air, groundwater, or surface water, especially during storm events and windy conditions. Provisions should be made to prevent soil erosion or settlement. No landfill or chemically impacted site required capping system should be disturbed without a Form 3 evaluation approved by a Professional Engineer. If a landfill or chemically impacted site has no capping system, such can be designed and installed with a Form 3 evaluation.

X2.3.4 *Stormwater Management*—See discussion above for Forms 1 and 2; infiltration of rainwater is not acceptable where wastes are capped.

X2.3.5 *Agricultural Cultivation (non- or lightly mechanized) or Marketing*—This evaluation form is appropriate for those sites that had a cap installed or repaired, then the user chose to use the site for agricultural purposes.

X2.4 Form 4–Agricultural Use

X2.4.1 This evaluation identifies the acceptable protective measures taken for the growing of plants for the purpose of harvesting food for human consumption, producing products for ornamental display, naturally manufacturing cosmetics that are applied to the skin, and/or raising farm animals for human consumption or as commodities. The acceptable site use for this Form's use include:

X2.4.2 *Agricultural Cultivation (non- or lightly mechanized) or Marketing*—This evaluation form is for the growing of plants in soil or the raising of animals. In all cases, plants should be grown in raised beds (at least 2 feet deep, or as deep as a plant's root system) because of the concentrations of chemicals in surface soils at a waste / chemically impacted site. See additional information under Form 1.

X2.5 Form 5–Site-Specific Use

X2.5.1 This evaluation identifies whether existing engineering and institutional controls acceptably preclude adverse impacts to human health, public safety, and welfare, or where such controls do not exist, that identified controls should be implemented. The appropriate site uses for this Form's use include:

X2.5.2 *Active Recreation*—In addition to the limited control measures recommended in a Form 2 evaluation and a Form 3 cap disturbance and restoration evaluation, this form identifies additional measures that an Environmental Professional may recommend for this site use. Together, the forms identify acceptable site-specific operational and maintenance measures for the specific waste / chemically impacted site.

X2.5.3 *Passive Recreation*—See discussion above for active recreation. Measures taken for active recreational usage are acceptable for passive recreational usage.

X2.5.4 *Alternate Energy / Deep Anchoring Need*—In addition to a Form 3 cap disturbance and restoration evaluation, this form identifies additional measures that an Environmental Professional may recommend for this site use. Together, the forms identify acceptable site-specific operational and maintenance measures for the specific waste / chemically impacted site.

X2.5.5 *Materials Recovery*—In addition to the control measures recommended in a Form 2 evaluation and a Form 3 cap disturbance and restoration evaluation, this form identifies additional measures that an Environmental Professional may recommend for this site use. Together, the forms identify acceptable site-specific operational and maintenance measures for the specific waste / chemically impacted site.

X2.5.6 *Stormwater Management*—In addition to the limited control measures recommended in a Form 1 evaluation, a Form 2 evaluation, and a Form 3 cap disturbance and restoration evaluation, this form identifies additional measures that an Environmental Professional may recommend for this site use. Together, the forms identify acceptable site-specific operational and maintenance measures for the specific waste / chemically impacted site.

X3. ADDITIONAL CONSIDERATIONS IN THE RESTORATION OF WASTE / CHEMICALLY IMPACTED SITES FOR BENEFICIAL USE

INTRODUCTION

Below are ten categories of additional considerations that the user should include (as applicable) in his/her evaluations for selecting a site use at a waste / chemically impacted site.

X3.1 Establishing Terminal Conditions for a MSW Landfill Site

X3.1.1 The two aspects of a pre-regulatory MSW landfill that put limitations on it for potential site uses is the generation of flammable methane and leachate liquid. Methane (lighter than air) is generated during the decomposition of MSW; it migrates to the landfill surface, while leachate percolates with gravity to adjacent water bodies and/or local groundwater table. Below is a guide on setting conditions for minimizing active controls for either and both aspects, which is identified as "terminal conditions" for the closed MSW landfill, meaning that releases of their sort have only de minimis impact on human health, public safety, and welfare. Each aspect is discussed below. This activity requires a Form 5 evaluation.

X3.1.2 *Methane*—Two rules of thumb should be considered when assessing the acceptability of converting an active methane collection and flaring operation at a MSW landfill to a passive methane venting system.

X3.1.2.1 *#1*—If the current methane flow rate is at 10% of its maximum recorded flow (or what can reasonably be estimated to be the maximum flow.

X3.1.2.2 *#2*—If the operations contractor for the landfill has to burn commercial fuel at 10% of the Btu content of recovered methane from the landfill in order to maintain the flame at the flaring station.

X3.1.3 *Leachate*—The scenario below illustrates issues involved in the management of leachate at a pre-regulatory MSW landfill that has a post-RCRA capping system.

X3.1.3.1 If these conditions exist:

(1) Groundwater inflow to the landfill is blocked;

(2) Leachate outflow from the landfill is significantly contained;

(3) The landfill is capped with an impermeable cover and leachate flows have decreased over a period of 20 years;

(4) The chemical quality of leachate has stabilized, matching the quality of an adjacent surface water body to which there is a hydraulic connection;

(5) Collected leachate is now pumped to a treatment plant that receives a combined flow of stormwater and sanitary sewage (a CSO), and a rainfall event as small as ½ inch causes raw sewage to be discharged to surface waters due to a lack of capacity to treat the inflow.

X3.1.3.2 Then the response could be:

(1) Identify *leachate markers* and/or *marker chemicals* for sample analysis rather than a more costly full suite of tests for parameters that rarely or never appear, or have stable concentrations;

(2) Decrease the frequency of monitoring events to once per year or longer;

(3) Discontinue pumping leachate to the treatment plant;

(4) Keep all leachate pumping infrastructure on stand by until a one-year assessment of the effects of non-pumping are acceptable;

(5) Allow leachate to flow to the adjacent surface water body;

(6) Mothball or remove all leachate collection and pumping infrastructure.

X3.1.4 See Appendix X7, sections X7.2, X7.3, and X7.5 for additional information.

X3.2 Venting of Human Carcinogenic Soil Gas

X3.2.1 It is a common and acceptable practice to vent low concentrations of methane, radon, and alpha radiation from the subsurface at a chemically impacted site to the atmosphere at a height sufficient to not be released into the breathing zone of people or the air intake of a building or other structure. Venting methane at a MSW site requires control measures that require a Form 5 evaluation. However, when spills of gasoline, other hydrocarbon fuels, and dry cleaning chemicals (perchloroethyiene) have occurred beneath or in the vicinity of a waste / chemically impacted site being developed, venting soil gas to the atmosphere presents a different level of risk. A component of gasoline and other hydrocarbon fuels is the chemical benzene, a Class A human carcinogen. A soil microbial degradation product of perchloroethyiene is vinyl chloride, a Class A human carcinogen. If either of these chemicals is in low concentration, venting may be acceptable, but if concentrations are high or uncertain, it is not prudent to assume that venting either is acceptable. A Form 5 evaluation should be completed if dense non-aqueous phase liquid benzene or chlorinated solvents (that is, perchloroethyiene, trichloroethylene, or dichloroethylene) have been identified in subsurface groundwater or soils. If lesser amounts are identified, the Professional Engineer may recommend the completion of a Form 5 evaluation.

X3.3 Slope Stability

X3.3.1 It is not prudent to assume qualities of slope stability at a MSW site, characterized as a buried mix of heterogeneous materials that decompose over time. Although construction and demolition waste sites generally have more stable slopes than MSW sites, the former suffers from the potential for high void ratios within the waste, which could result in water infiltration and the creation of planes of weakness within the materials. Sites that consist of historic fill, dry coal ash, foundry sand, and air deposition-impacted materials have subsurface materials that are more soil like, and therefore are more predictable (that is, standard engineering analysis can be performed). If a site

use involves the placement of features on the slopes of a waste / chemically impacted site, a Form 5 evaluation is required.

X3.4 Special Considerations for Pre-Regulatory Orphan, Latchkey, or Landfills in Caretaker Mode

X3.4.1 The reason that the area and depth of waste at a MSW site (specified in Form 2) of ten acres and five feet deep were selected is that those criteria match the typical size and depth of legacy waste sites operated by small cities across the U.S. up until the 1980s. It is acknowledged that some of the pre-regulatory MSW sites are larger than ten acres and five feet deep, but that criteria sets the difference between that which could be approved with a Form 2 evaluation and a Form 5 evaluation. Five feet of MSW can decompose with easily correctable settlement effects. Also, after thirty or more years, any methane being generated can be considered of de minimis concentrations with low potential adverse impacts to human health, public safety, or welfare.

X3.5 Solubility Tests

X3.5.1 Alternative methods exist for testing a material's solubility, including:

Test Method 1311
Test Method 1313
Test Method 1316

X3.5.2 See Appendix X1 for links to EPA documents on each of these test methods. Also, see Appendix X7, sections X7.1 and X7.4 for additional information.

X3.6 Extended Methane Recovery at an Aging MSW Site

X3.6.1 A significant number of MSW sites currently generate revenue from the sale of extracted methane that is refined into a product ready for commerce (known as good *landfill economics*). As waste decomposes over long periods of time, the revenue from those operations decrease. MSW landfills in design and those being constructed could engineer systems that allow the periodic "feeding" of the waste site such so that the waste continues to decompose to a more complete state, and revenues continue to be generated. Although more challenging for the closed MSW site, the property owner may seek to implement measures to increase her/his revenues without adversely impacting the environment. In that instance, the owner may work with an Environmental Professional to complete a Form 5 evaluation. The property owner and Environmental Professional should work with the applicable regulatory agency to limit impacts to surface and ground water pollution, odor, noise, and air pollution.

X3.7 Ongoing or Enhanced Phytoremediation Techniques

X3.7.1 The Environmental Professional should evaluate potentially cost-effective measures to keep a waste site from posing a potential adverse impact on human health, public safety, and welfare by utilizing ongoing natural *phytoremediation* effects, where heavy metals such as lead, cadmium, and chromium are removed from soil and sediment. These effects are described as:

Phytosequestration
Phytoextraction
Phytostabilization

X3.7.2 See Appendix X1 link to a EPA article on phytoremediation and Appendix X7, Section X7.6 for additional information.

X3.8 Existing or Needed Municipal or Private Utility Easements, Buffers, or Rights-of-Way

X3.8.1 When a municipality needs to provide easements, buffers, or rights-of-way for utility systems or other purposes at a waste / chemically impacted site, it is useful to have an easy-to-implement process for protecting human health, public safety, and welfare. This guide offers Forms 2 and 3 for that purpose.

X3.9 Conformance with Regulatory Documentation, Government Policy, or Environmental Law

X3.9.1 This guide should not be used to avoid compliance with relevant environmental regulatory laws, regulations, or policies. It creates a forward-looking program that allows a knowledgeable Environmental Professional to complete an evaluation of a proposed beneficial use, utilizing readily available information and her/his professional judgment whether property usage restrictions are necessary to be protective of human health. The guide fills a niche that is now serviced by a patchwork of uncoordinated approaches whose practitioners have few opportunities to collaborate. Use of the guide may promote economic development of small cities whose last available developable lands are sites in a regulatory limbo. It is anticipated that cities and States will memorialize this guide into statutes and regulations for the reasons cited above.

X3.10 Neighbor Acceptance of the Site Use as an Example of Sustainable Urban Governance Desired by the Community

X3.10.1 As defined by Rowland (2008)**(3)** , the practice of sustainable urban governance is characterized by the effective and economically efficient provision of public services through a continually improving process. The use of this guide allows public revenues to increase (by placing more valuable land onto the tax roles) while providing an opportunity for neighbors of a waste / chemically impacted site to get involved with its beneficial use so that human health, public safety, and welfare are protected and/or Environmental Justice concerns are addressed. See Rowland (2008) **(3)** for additional information.

X4. THE FIVE SITE USE EVALUATION FORMS

FORM 1 – EXPEDITED USE EVALUATION

The Site Use described below (Section A) is acceptable and protective of human health, public safety, and welfare under the conditions prescribed below (Section B).

Section A – What exactly is proposed, where, when, how and how long, and by whom.

Section B – Conditions under which this recommendation is made.

- Due Diligence Threshold of the Environmental Professional is reached;
- Site is characterized through investigation and does not need to be investigated further in order to characterize the degree and extent of pollutant concentrations;
- No construction or placement of buildings over a MSW disposal area;
- No excavation of a required cover or cap, or waste materials;
- No evidence of a release of a hazardous substance or pollutant or other unacceptable conditions;
- Site Use activities were fully considered and engineered in pre-design and/or pre-construction phases of the waste / chemically impacted site development. (Circle one: NA or A)

Caveat – This Form is intended solely to document an Environmental Professional's professional judgment regarding the beneficial use of a waste / chemically impacted site.

Recommendation – The undersigned acknowledges that she/he is qualified [as in accordance with 40 CFR 312.10(b) **(7)**] to provide professional opinions regarding use of the identified waste / chemically impacted site (defined by Guide E3033 or applicable rules and regulations of the political jurisdiction with authority over the identified waste / chemically impacted site).

Below, list the names of other professionals or experts consulted prior to making this recommendation.

_____	_____
Name	Area of Knowledge
_____	_____
Name	Area of Knowledge
_____	_____
Signature of the Environmental Professional	Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

FORM 2 – CONDITIONAL EXPEDITED USE EVALUATION

The Site Use described below (Section A) is acceptable and protective of human health, public safety, and welfare under the conditions prescribed below (Section B).

Section A – What exactly is proposed, where, when, how and how long, and by whom.

Section B – Conditions under which this recommendation is made.

- Due Diligence Threshold of the Environmental Professional is reached;
- Site is characterized through investigation and does not need to be investigated further in order to characterize the degree and extent of pollutant concentrations;
- Known chemical exposure pathways are effectively blocked with a generic cover;
- Required cover or capping systems are not disturbed;
- Site has less than 10 acres of municipal solid waste (less than 5 feet thick) that was disposed before 1981 (see Appendix X3 for additional information);
- No evidence of hazardous substances being released (except de minimis amounts);
- Site may be developed in spite of identified hazards that may be caused or enhanced by the proposed site use provided an adequate explanation and information about those potential hazards are provided on page 2 of this Form. (Circle one: NA A)

Caveat – This Form is intended solely to document an Environmental Professional's professional judgment regarding the beneficial use of a waste / chemically impacted site.

Recommendation – The undersigned acknowledges that she/he is qualified [as in accordance with 40 CFR 312.10(b)**(7)**] to provide professional opinions regarding use of the identified waste / chemically impacted site (defined by Guide E3033 or applicable rules and regulations of the political jurisdiction with authority over the identified waste / chemically impacted site).

Below, list the names of other professionals or experts consulted prior to making this recommendation.

_____ _____

Name Area of Knowledge

_____ _____

Name Area of Knowledge

_____ _____

Signature of the Environmental Professional Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

_____

Name of Site Owner

_____

Name of Site Developer

FORM 2 – CONDITIONAL EXPEDITED USE EVALUATION (continued)
Page 2 of 2

This site may be developed in spite of hazards that may be caused or enhanced by the proposed development, provided: (1) An adequate explanation and information about those potential hazards; (2) the necessary controls measures (to limit those hazards) to be installed and kept effective; and (3) the disturbance of any required cover or capping system at a landfill or chemically impacted site (note: if a capping disturbance is planned, a Form 3 evaluation should be provided by a Professional Engineer) are described in the space below.

FORM 3 – CAP DISTURBANCE EVALUATION

The Site Use described below (Section A) is acceptable and protective of human health, public safety, and welfare under the conditions prescribed below (Section B).

Section A – What exactly is proposed, where, when, how and how long, and by whom.

Section B – Conditions under which this recommendation is made.

- Due Diligence Threshold of the Environmental Professional is reached; and
- Construction or placement of buildings over the waste disposal area is acceptable and protective of human health, public safety, and welfare as described on page 2 of this Form.

Caveat – This Form is intended solely to document an Environmental Professional's professional judgment regarding the beneficial use of a waste / chemically impacted site.

Recommendation – The undersigned acknowledges that she/he is qualified [as in accordance with 40 CFR 312.10(b)**(7)**] to provide professional opinions regarding use of the identified waste / chemically impacted site (defined by Guide E3033 or applicable rules and regulations of the political jurisdiction with authority over the identified waste / chemically impacted site).

Below, list the names of other professionals or experts consulted prior to making this recommendation.

_____ _____
Name Area of Knowledge

_____ _____
Name Area of Knowledge

_____ _____
Signature of Lead Environmental Professional Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

_____ _____
Signature of Professional Engineer Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

FORM 3 – CAP DISTURBANCE EVALUATION (continued)
Page 2 of 2

This site may be developed in spite of hazards that may be caused or enhanced by the proposed development, provided: (1) An adequate explanation and information about those potential hazards; and (2) the necessary engineering and institutional controls (to limit those hazards and protect the integrity of the cap) to be installed and kept effective are described in the space below.

FORM 4 – AGRICULTURAL USE EVALUATION

The Site Use described below (Section A) is acceptable and protective of human health, public safety, and welfare under the conditions prescribed below (Section B).

Section A – What exactly is proposed, where, when, how and how long, and by whom.

Section B – Conditions under which this recommendation is made.

- Due Diligence Threshold of the Environmental Professional is reached; and
- Agricultural cultivation and/or marketing is acceptable upon this waste / chemically impacted site and protective of human health, public safety, and welfare as described on page 2 of this Form.

Caveat – This Form is intended solely to document an Environmental Professional's professional judgment regarding the beneficial use of a waste / chemically impacted site.

Recommendation – The undersigned acknowledges that she/he is qualified [as in accordance with 40 CFR 312.10(b) **(7)**] to provide professional opinions regarding use of the identified waste / chemically impacted site (defined by Guide E3033 or applicable rules and regulations of the political jurisdiction with authority over the identified waste / chemically impacted site).

Below, list the names of other professionals or experts consulted prior to making this recommendation.

_____ _____
Name Area of Knowledge

_____ _____
Name Area of Knowledge

_____ _____
Signature of the Environmental Professional Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

_____ _____
Signature of Professional Engineer Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

FORM 4 – AGRICULTURAL USE EVALUATION (continued)
Page 2 of 2

This site may be developed in spite of hazards that may be caused or enhanced by the proposed development, provided: (1) A description of why and how agricultural cultivation or marketing over the waste / chemically impacted site is acceptable and protective of human health, public safety, and welfare; and (2) the necessary control measures (to limit any potential hazards) to be installed and kept effective are described in the space below.

FORM 5 – SITE-SPECIFIC USE EVALUATION

The Site Use described below (Section A) is acceptable and protective of human health, public safety, and welfare under the conditions prescribed below (Section B).

Section A – What exactly is proposed, where, when, how and how long, and by whom.

Section B – Conditions under which this recommendation is made.

- Due Diligence Threshold of the Environmental Professional is reached; and
- Site is characterized through investigation and does not need to be investigated further in order to characterize the degree and extent of chemical impact; and
- No evidence of hazardous substances being released (except de minimis amounts);
- Site may be developed in spite of identified hazards that may be caused or enhanced by the proposed development provided an adequate explanation and information about those potential hazards are provided on pages 2 through 6 of this Form.

Caveat – This Form is intended solely to document an Environmental Professional's professional judgment regarding the beneficial use of a waste / chemically impacted site.

Recommendation – The undersigned acknowledges that she/he is qualified [as in accordance with 40 CFR 312.10(b)**(7)**] to provide professional opinions regarding use of the identified waste / chemically impacted site (defined by Guide E3033 or applicable rules and regulations of the political jurisdiction with authority over the identified waste / chemically impacted site).

Below, list the names of other professionals or experts consulted prior to making this recommendation.

_____ _____

Name Area of Knowledge

_____ _____

Name Area of Knowledge

_____ _____

Signature of Lead Environmental Professional Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

_____ _____

Signature of Professional Engineer Seal / Stamp

License No: _____ Date Issued: _____ Date Expires: _____

Date of Signature: _____

FORM 5 – SITE-SPECIFIC USE EVALUATION (continued)
Page 2 of 6

Provide below a complete listing of the institutional and engineering controls to be installed, implemented, and maintained (until terminated), such that releases of hazardous substances from the buried waste or chemically impacted soils are prevented.

FORM 5 – SITE-SPECIFIC USE EVALUATION (continued)
Page 3 of 6

Provide below an explanation of why such engineering controls (that is, those listed on page 2 of 6 or this Form 5) and protective measures are necessary.

FORM 5 – SITE-SPECIFIC USE EVALUATION (continued)
Page 4 of 6

Identify below the size(s), thickness(es), flow rate(s), etc. that are appropriate for the engineering controls (listed on page 2 of 6 of this Form 5) and protective measures that are necessary to protect human health, public safety, and welfare.

FORM 5 – SITE-SPECIFIC USE EVALUATION (continued)
Page 5 of 6

Identify below the person(s) (and contact information) who is/are obligated to assure that the engineering controls (that is, those listed on page 2 of 6 of this Form 5) are functioning and effective.

FORM 5 – SITE-SPECIFIC USE EVALUATION (continued)
Page 6 of 6

Identify the conditions and time frame whereby some or all of the engineering controls (that is, those listed on page 2 of 6 of this Form 5) may be terminated because potential adverse impacts to human health, public safety, and welfare are of de minimis levels.

X5. SOIL CLEANUP OBJECTIVES (SCOs) FOR ACTIVE AND PASSIVE RECREATIONAL USES

TABLE X5.1 Soil Cleanup Objectives for Active and Passive Recreational Use Soils[A]

	Active Recreational Use Limits (mg/kg)	Passive Recreational Use Limits (mg/kg)
Metals		
Arsenic	16	16
Barium	400	400
Beryllium	72	590
Cadmium	4.3	9.3
Chromium, hexavalent	110	400
Chromium, trivalent	180	1,500
Copper	270	270
Total Cyanide	27	27
Lead	400	1,000
Manganese	2,000	10,000
Total Mercury	0.81	2.8
Nickel	310	310
Selenium	180	1,500
Silver	180	1,500
Zinc	10,000	10,000
PCBs/Pesticides		
2,4,5-TP Acid (Silvex)	100	500
4,4'-DDE	8.9	62
4,4'-DDT	7.9	47
4,4'-DDD	13	92
Aldrin	0.097	0.68
alpha-BHC	0.48	3.4
beta-BHC	0.36	3
Chlordane (alpha)	4.2	24
delta-BHC	100	500
Dibenzofuran	59	350
Dieldrin	0.2	1.4
Endosulfan I	24	200
Endosulfan II	24	200
Endosulfan sulfate	24	200
Endrin	1	89
Heptachlor	2.1	15
Lindane	1.3	9.2
Polychlorinated biphenyls	1	1
Semivolatiles		
Acenaphthene	100	500
Acenapthylene	100	500
Anthracene	100	500
Benz(a)anthracene	1	5.6
Benzo(a)pyrene	1	1
Benzo(b)fluoranthene	1	5.6
Benzo(g,h,i)perylene	100	500
Benzo(k)fluoranthene	3.9	56
Chrysene	3.9	56
Dibenz(a,h)anthracene	0.33	0.56
Fluoranthene	100	500
Fluorene	100	500
Indeno(l,2,3-cd)pyrene	0.5	5.6
m-Cresol	100	500
Naphthalene	100	500
(that is, those listed on page 2 of 6)	100	500
p-Cresol	100	500
Pentachlorophenol	6.7	6.7
Phenanthrene	100	500
Phenol	100	500
Pyrene	100	500
Volatiles		
1,1,1-Trichloroethane	100	500
1,1-Dichloroethane	26	240
1,1-Dichloroethene	100	500
1,2-Dichlorobenzene	100	500
1,2-Dichloroethane	3.1	30
cis-1,2-Dichloroethene	100	500
trans-l,2-Dichloroethene	100	500
1,3-Dichlorobenzene	49	280
1,4-Dichlorobenzene	13	130
1,4-Dioxane	13	130
Acetone	100	500

TABLE X5.1 *Continued*

	Active Recreational Use Limits (mg/kg)	Passive Recreational Use Limits (mg/kg)
Benzene	4.8	44
Butylbenzene	100	500
Carbon tetrachloride	2.4	22
Chlorobenzene	100	500
Chloroform	49	350
Ethylbenzene	41	390
Hexachlorobenzene	1.2	6
Methyl ethyl ketone	100	500
Methyl tert-butyl ether	100	500
Methylene chloride	100	500
n-Propylbenzene	100	500
sec-Butylbenzene	100	500
tert-Butylbenzene	100	500
Tetrachloroethene	19	150
Toluene	100	500
Trichloroethene	21	200
1,2,4-Trimethylbenzene	52	190
1,3,5- Trimethylbenzene	52	190
Vinyl chloride	0.9	13
Xylene (mixed)	100	500

[A] in accordance with http://www.dec.ny.gOv/regs/15507.html#15513 (NYS 6NYCRR Part 375)

X6. DUE DILIGENCE THRESHOLD OF THE ENVIRONMENTAL PROFESSIONAL

X6.1 This Appendix provides the criteria for rendering judgment that the threshold of knowledge has been reached whereupon an Environmental Professional may offer recommendations concerning acceptable beneficial use of a landfill or chemically impacted site, using the five evaluation forms in Appendix X4, after reviewing information presented in Appendix X2 and Appendix X3. This appendix and guide concern human health, public safety, and welfare impacts from such uses; impacts to the environment are not comprehensively considered.

X6.2 The due diligence threshold-defining criteria of the Environmental Professional consists of the review of readily available information and eighteen considerations listed below. It is important to note that there is no presumption for these considerations to be answered negatively or affirmatively in order for the due diligence threshold to be reached; all that is required is that the considerations are fully addressed when relevant. The Environmental Professional should address each consideration, and explain why and how each is applicable or not for the proposed use.

X6.3 *Readily Available Information*:

X6.3.1 Real-time observations;

X6.3.2 Electronic recordings;

X6.3.3 Physical investigation and subsequent reports; and

X6.3.4 Review of documents regarding prior ownership, use, and ownership/use of nearby and adjacent properties.

X6.4 *Eighteen Considerations*:

X6.4.1 Conduct interviews with past and present owners, operators, and occupants of the site concerning the use, storage, or management of chemicals;

X6.4.2 Conduct reviews of historical sources of information, such as chain of title documents, aerial photographs, building department records, and land use records to assess the possibility that chemicals were used, stored, or managed;

X6.4.3 Conduct reviews of federal, state, tribal, and local government records, waste disposal records, underground storage tank records, and hazardous waste handling, generation, treatment, disposal, and spill records concerning contamination at or near the site;

X6.4.4 Conduct visual inspections of the facility and adjoining property;

X6.4.5 Acquire commonly known or reasonably ascertainable and relevant information; and

X6.4.6 Judge the degree of obviousness of the presence or likely presence of contamination at the property and the ability to detect the contamination.

NOTE X6.1—*Ubiquitous Nature of Soil Contaminants in the Locality*—The Environmental Professional shall evaluate and identify as acceptable or unacceptable, the following additional considerations listed below. The Environmental Professional should provide a reasoned response based on personal professional experience, review of regulatory agency remedial or investigation project files, or professional environmental remediation literature.

X6.4.7 Urban concentrations of lead and semivolatile organics may be present in natural turf areas or bare soils near automobile traffic, especially (for lead) soil at intersections and roadsides that have not been replaced since the late 1970s when lead (that is, tetraethyl lead) was no longer added to gasoline;

X6.4.8 Other urban land or transportation-related land may have been impacted over the period of 19th and 20th centuries by uses that generated soil pollutants of (for example) lead, mercury, PCBs, cadmium, arsenic, semivolatile organics, chlorinated solvents (for example, industrial or commercial use of

chemicals in dry cleaning, auto repair, metal plating, electrical components, and paint);

X6.4.9 Pesticide, herbicide, and fertilizer-related chemicals may be present in agricultural, rural, or forestland areas;

X6.4.10 Naturally-occurring materials may pose potential adverse human health or environmental concerns that include asbestos (for example, serpentine rock outcrops, radon gas, and mining waste) (see Appendix X1 for the report from Shacklette and Boerngen on naturally occurring metals concentrations);

X6.4.11 Soil pollutants related to historic disposal of chemicals, wastes, and other discarded materials (for example, orphan or latchkey municipal solid waste landfills, and subsurface materials containing coal ash and incineration residue) may be present;

X6.4.12 Methane and other gases from the decomposition of municipal solid waste may be migrating upward to the atmosphere and/or laterally where the gas may accumulate in occupied buildings;

X6.4.13 Radioactivity near historic uses or releases of isotopes of transuranic elements (for example, Chernobyl, Fukushima, Oak Ridge, Brookhaven, and other Manhattan Project-era project sites, and medical waste dump sites) may be at levels harmful to human health;

X6.4.14 Petroleum or coal-related chemicals near historic manufacturing, use, or release of crude or refined fuel products (or corridors of transportation) [for example, Exxon Valdes spill, BP Deepwater Horizon spill, manufactured gas waste, naturally-occurring radioactive material (NORM) in oil drill pipe and oil drilling fluid, leaking underground fuel storage tanks, vehicle maintenance yards, railways, ports, highways, and subway tunnels] may be present;

X6.4.15 Chemicals, explosives, and other military agents in theaters of war or acts of terrorism may be present; and

X6.4.16 Illegal manufacture or chemical processing of drugs for human consumption (for example, methamphetamines and ecstasy) or the agricultural growth and harvesting of plants containing such drugs (for example, marijuana) may have occurred.

X6.4.17 The period of time (or schedule) for which the beneficial use is proposed (for example, one-time only, daylight hours, holiday season, or weekends) may be limited; and

X6.4.18 A sufficient thickness or protective quality of barrier is proposed to be placed between the source of potential chemical exposure (or object of physical harm) and the human or other receptor such that the proposed site use can be safely implemented.

X7. TERMINOLOGY OF THE APPENDICES

X7.1 *characteristic of hazardous waste, n*—one method used to identifying soil waste as hazardous, through US EPA Test Method 1311, in which the soil is mixed with water, agitated, then the leachate is analyzed for a specific set of chemicals, often the metal lead. Method 1311 is known as the Toxicity Characteristic Leaching Procedure (TCLP). See X7.4 (below) for other leaching procedures. See Appendix X1 for more information.

X7.2 *landfill gas economics, n*—The calculation of cost and benefit for collecting, processing, and distributing methane from a landfill where "good" economics means that it is profitable to collect / process / distribute the gas, and "bad" means that it is not.

X7.3 *leachate marker, n*—A chemical substance in leachate that is characteristic of the discarded material within a landfill (for example, ammonium nitrate from municipal solid waste).

X7.4 *leaching environmental assessment framework (LEAF), n*—alternative methods for determining the potential for materials to be made soluble and thereby be released into the environment, using EPA Methods 1313 and 1316. See Appendix X1 for additional information.

X7.5 *marker chemical, n*—A chemical, chemical compound, or pure substance that is characteristic of the quality of the environmental media being investigated; a marker is selected and used by an Environmental Professional to limit the number and frequency of tests at a solid waste landfill or chemically impacted site, which is acceptable because a marker chemical will always be detected, whereas the vast majority of other constituents that have been or could have been detected are only intermittently detected. When the number of chemicals being investigated is limited, monitoring expenses may be reduced.

X7.6 *phytoremediation, n*—A general category of techniques to clean up chemically impacted sites through the use of plants that requires a long-term commitment, as the process is dependent on a plant's ability to grow and thrive in an environment that is not ideal for normal plant growth. Within this category are three techniques important for properties identified in this guide: (1) Phytosequestration involves reducing the fraction of a chemical or compound that is bioavailable through transport protein inhibition on the root membrane, thus preventing chemicals from entering the plant; the chemical or compound is then sequestered into the vacuoles of root cells; (2) phytoextraction involves the uptake and concentration of chemical substances from the environment into a plant's biomass; and (3) phytostabilization involves reducing the mobility of chemical substances in the environment by limiting the leaching of substances from the soil.

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