Introduction:
Justification: Humans have become a major soil forming factor, and the extent of human modification of soil is growing. Significantly altered soils should be recognized in a new soil order because of their unique physical and chemical properties and singular dominant soil forming factor (human activity). Recognizing significantly thick HAHT soils in existing orders such as Inceptisols and Entisols is inadequate because they often contain fragments and remnants of much more highly developed soils, especially if the HAHT material at the surface is fairly thin. The HAHT soils contain major property, behavior, suitability, and risk differences from more naturally-formed soils that exist on older, more stable geomorphic surfaces. The advantage of recognizing HAHT soils in a new order (rather than solely as Subgroups to existing orders) is to provide more specific information about the very unique soil properties and interpretations at the Great Group and Subgroup levels. Also, adding a full suite of Suborders through Subgroups for all possible combinations of properties in each existing soil order would greatly over-expand the system. The HAHT materials with significant thickness of 50 cm or more that warrant separate identity include soils with high artifact content, archaeological soils, excavated and replaced soils, and human-transported parent materials.

There are several justifications for recognizing HAHT soils in a new soil order. Modified soils such as human-altered and human-transported (HAHT) soils behave differently and must be interpreted differently than undisturbed soils. Many soils in urban areas contain artifacts. The parent material is unique due to artifact content that translates to elevated heavy metal content and unique weathering products and processes which are largely unknown and understudied. New research has shown that elevated heavy metal content can be correlated with discrete, noxious artifact content. The impact of soil materials considered to be contaminated (metals or manufactured materials occur above published natural background concentrations and at concentrations reported to be harmful to humans in published sources (hereafter called hazic material) is an increased risk to human health and environmental quality. The risk is heightened because hazic materials are most likely to occur in close proximity to where the majority of the human populations live. Manufactured materials (e.g., plastics, hydrocarbons) weather much differently in the soil than primary and secondary earth minerals, but the nature of that is unknown until we identify the soils and study them. Some HAHT soils contain significant thickness of human-transported materials that have unique physical properties such as increased risk of subsidence, liquefaction, and mass movement. Other HAHT soils contain densic material contacts and preferential flowpaths to water movement in the subsoil, a major concern for engineers and environmentalists. Human-altered and human-transported soils have undocumented engineering properties such as Atterberg Limits needed for designing and planning. The physical properties of HAHT soils need more study, and unique classification in Soil Taxonomy allows them to be named and the data from studies shared and correlated. The NRCS has the mandate from Congress to interpret soils for
human uses and to make soil maps that identify potential risks, hazards, suitabilities, and limitations. Even though HAHT soils surround our houses and underlie our buildings and transportation corridors, few of the areas with HAHT soils have been mapped. Most urban areas have no soil mapping products or the taxa and soil series are limited to an extremely few very general choices such as Urban Land or Typic Udorthents. The absence of soils information does not serve our client’s needs, especially when there is potential for harm in the absence of cautionary information and interpretation.

Many HAHT soil properties are variable and understudied in proportion to their importance. In order to study HAHT soils more fully, we must be able to classify them so the study results can be communicated, shared, and extrapolated. The HAM- and HAT-based taxa added to the 2014 Keys to Soil Taxonomy have allowed us to gather additional information and recognize extent and variability. Those taxa are preserved for use as intergrades and extragrades. Now that we have more information, we can consolidate the lab data, transects, soil survey information, and soil series into meaningful higher taxa.

The major types of HAHT soils to be included in Artesols are soils with either significant artifact content, a continuous manufactured layer, 50 cm or more of excavation followed by replacement, or with 50 cm or more of human-transported material (may be covered by a recent deposit of other material up to 25 cm thick).

Some soils highly modified by humans are excluded from Artesols. Soils that are modified for agricultural purpose need more detailed interpretations that would be allowed through a new soil order, and so they are excluded from this proposal. This includes deeply plowed soils used primarily for agriculture, artificially drained soils, flood-irrigated soils with Anthraquic conditions, and those formed on conservation terraces and on hillslope terraces are intensively managed and require more detail than can be provided in Artesols. Soils with long duration artificial ponding are so variable that they must remain in existing taxa and modified by the Anthrolacic subgroup. Deeply-excavated soils such as road-cuts, quarries, and pit areas can be identified by the Anthrocavic subgroups in existing orders, and can be mapped easily using GIS, Lidar, and existing soil survey. The Anthrocavic subgroup can also be used to identify 50 cm or more of mined or intentionally burned organic soil materials. A unique set of subgroups such as Anthroportic, Anthraltic, or Anthropic can be used within other soil orders for soils with limited thickness of human-altered and human-transported material. Other soils with human influences can be recognized at the soil series level or through mapping phases.

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**Taxa:**

**A. Order:**

Name: Artesols (from Latin phrase *arte factum* made with skill). Formative element: art. Reason: Soils in the Artesols order form in human-altered soils or in human-transported material following intentional human activity. They are *made with skill* and many contain
artifacts that are also made with skill. The art formative element starts with a vowel and fits well linguistically with the suborder formative elements. The art formative element is different enough from existing formative elements to avoid confusion in pronunciation.

Table 1. Order through Great Groups of Artesols.

<table>
<thead>
<tr>
<th>Artesols</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wassarts</strong> – subaqueous soils with HTM</td>
</tr>
<tr>
<td><strong>Sulfiwassarts</strong> – have human-transported sulfidic materials</td>
</tr>
<tr>
<td><strong>Psammoiwassarts</strong> – sandy particle-size class</td>
</tr>
<tr>
<td><strong>Haplowassarts</strong> – Other Wassarts</td>
</tr>
<tr>
<td><strong>Endoaquarts</strong> – Other Aquarts <strong>Fishkill</strong></td>
</tr>
<tr>
<td><strong>Humifactarts</strong> – stable, long-term OC additions such as middens</td>
</tr>
</tbody>
</table>

| **Portifactarts** – Other Factarts **Laguardia** |

B. **Suborders**: Table 2. Suborder formative elements names.

<table>
<thead>
<tr>
<th>Formative Element</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wass (water)</td>
<td>subaqueous and peraquic conditions</td>
</tr>
<tr>
<td>Aqu (water)</td>
<td>aquic conditions</td>
</tr>
<tr>
<td>Fact (manufactured)</td>
<td>contains significant content of artifacts</td>
</tr>
<tr>
<td>Orth (straight, true)</td>
<td>other HAM and HTM soils</td>
</tr>
</tbody>
</table>
The sequence of Suborders is based on limitations, and they are ranked from most limiting (Wassarts) to least limiting (Ortharts). The soil temperature and moisture regimes are recognized at the family level except where they are considered severely limiting to land use and management.

a. Wassarts are subaqueous HTM soils forming in 50 cm or more of human-transported material. They exist in developed coastal zones, mainly as a result of dredging.
b. Aquic and peraquic HAHT soils with aquic conditions within 50 cm of the soil surface (or artificial drainage) are next separated from the better drained HAHT soils.
c. Factarts have human-transported material with common to many [10% or more (by volume or weight)] artifacts in a layer 15 cm or more thick.
d. All other HAHT soils with 50 cm or more of human-altered or human-transported material.

C. Great Groups: Table 3. New Great Group formative element names not previously defined in Soil Taxonomy. Arranged alphabetically.

<table>
<thead>
<tr>
<th>Formative Element</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garbi (garbage)</td>
<td>Contains garbage</td>
</tr>
<tr>
<td>Hum(i)</td>
<td>HTM with elevated levels of organic carbon</td>
</tr>
<tr>
<td>Manu (manufactured)</td>
<td>Contains garbage beneath a manufactured liner</td>
</tr>
<tr>
<td>Port(i) (transported)</td>
<td>Formed in human-transported material</td>
</tr>
<tr>
<td>Rest (restored)</td>
<td>Excavated and replaced soil material</td>
</tr>
<tr>
<td>Sulf(i)</td>
<td>Have a sulfuric horizon or sulfidic materials</td>
</tr>
<tr>
<td>Wasti (waste, tailings)</td>
<td>Manufacturing or mining waste, tailings, polluted or contaminated soil material</td>
</tr>
</tbody>
</table>

All Great Groups formed in HAM or HTM of significant thickness. The sequence of Great Groups within each Suborder is based on limitations, and they are ranked from most limiting to least limiting or most typical (common). Among the least limiting, they are arranged from atypical to typical or common.

a. Wassarts: are subaqueous. Sulfiwassarts contain human-transported sulfidic materials that may become oxidized into acid-sulfate soils if exposed to oxygen. These are usually dredged sediments redeposited underwater. Psammowassarts form in HTM with a sandy particle-size class, often in dredged sandy material redeposited underwater. Other less sulfidic or less sandy Haplowassarts are typical and are not limiting except by being underwater.
b. Aquarts: have aquic conditions near the surface. The Sulfaquarts with either a sulfuric horizon or sulfidic materials key out first. Sulfuric horizons and sulfidic materials that may form sulfuric horizons if exposed to oxygen can degrade infrastructure and inhibit plant growth. Sulfuric horizons formed in human-transported material are considered hazic materials. Psammaquarts are sandy dredged HTM deposited into wet but not
subaqueous conditions. Deep sandy wet soils are susceptible to liquefaction and low strength. Epiaquarts are HTM soils with episaturation that can perch water close to the soil surface. The least limiting and most common Endoaquarts have endosaturation.

c. Factarts: have an artifactic horizon. The Garbifactarts contain garbage and occur in unlined landfills, whereas Manufactarts contain garbage in landfills above manufactured liners. Landfills contain hazic material and those that are unlined may be sources of methane and contaminants to the groundwater. Lined landfills are less dangerous. The Wastifactarts have an artifactic horizon containing hazic material such as mine processing tailings, noxious manufacturing waste, noxious building debris (such as asphalt), or noxious combustion residue such as coal “bottom” ash. Psammifactarts are sandy throughout the particle-size control section and are droughty. Noxious artifacts may produce weathering products that leach easily in sandy textures. The Humifactarts are soils that form in middens, plaggen materials, ancient agricultural fields, and terra preta soils where humans apply organic-rich materials with artifacts to soils over a very long period of time. They have either an anthrohumic, pretic, or plaggen epipedon. The least limiting Portifactarts form in HTM that has innocuous artifacts like crushed rock or building debris. These are the most common soils formed in HTM with artifacts. Subsidence and compaction are possible limitations.

d. Ortharts: have low amounts of artifacts. The Sulfortharts with a sulfuric horizon or sulfidic materials key out first due to the danger to plants and animals and infrastructure from acid-sulfate soils. Sulfortharts with sulfidic materials may form sulfuric horizons if exposed to oxygen. Sulfuric horizons formed in human-transported material are considered hazic materials. Psammortharts are sandy dredged or bulldozed soils. Sandy materials are susceptible to wind erosion and have low water-holding capacity. Restortharts are soils that have been excavated and replaced, such as filled trenches and graves or reclaimed spoil such as mine soils. They may have subsidence issues and diverted or highly altered hydrology, or the graves may contain communicable disease or have cultural significance. Humortharts have either an anthrohumic, pretic, or plaggen epipedon. Humortharts are not limiting, but are distinctly different than Portortharts. Portortharts are not limiting and are the most common soils formed in HTM without artifacts. They include archaeological and cultural mounded deposits as well as modern fill material. They may have subsidence issues and diverted or highly altered hydrology.

D. Subgroups:
The sequence of Subgroups within each Great Group is based on limitations, and they are ranked from most limiting to least limiting (Typic). The following are Subgroups that will logically be used with the proposed Great Groups, but other Subgroups may be used as well. In addition, the “Anthro” Subgroups are proposed below. New proposed “Anthro” Subgroups are in italics. These can be used in any soil order, as extragrades, or intergrades between the new soil order and existing soil orders. These are listed in logical sequence from most limiting to least limiting. Among the least limiting, they are arranged from atypical to typical or common.
Subgroups (new Subgroups to be proposed are in italics). Edits shown in red text and strikethrough.

“HAHT” Subgroups for Artesols: The following subgroup adjectives ...

- **Anthraquic** (modified from Gr. *anthropos*, human, and L. *aqua*, water). Soils that have anthraquic conditions (i.e., anthric saturation). These soils are extensive in flooded rice paddies.

- **Ekranic** (from French *écran*, shield). Having a manufactured layer < 5 cm deep intended for use as a pavement (e.g., sidewalk, paved street) or to seal the soil surface (e.g., concrete-lined aqueduct). Vertical barriers are not included. Note to reviewers: These surfaces are removable, but the effect of sealing on the biology and gas content of the soil may be considerable in extent and duration. Used within Artesols.

- **Anthrodensic** (modified from Gr. *anthropos*, human + L. *dēnsus*, crowded). Root and water-restrictive layer with high bulk density due to compaction by human activity or auto-consolidation following deposition of human-transported material. Commonly found in most mined soils. Note to reviewers: Used within Artesols or as an extragrade in existing soil orders.

- **Anthronekric** (modified from Gr. *anthropos*, human + Gr. *Nekros*, corpse). Having 50 cm or more of human-transported material or excavated and replaced human-altered soil material containing human remains or evidence of a ceremonial burial (e.g., a casket, burial chamber, or ceremonial offerings). Note to reviewers: Anthronekric is associated with burial mound anthropogenic landforms and grave microfeatures. Used within Restortharts or Restifactarts Great Group of Artesols.

- **Plaggic** (from Low German *plaggen* sod). Soils that have a plaggen epipedon. Note to reviewers: Used within the Artesols in the Humifactarts or Humortharts Great Groups or as an extragrade within Spodosols and Inceptisols.

- **Haploplaggic** (Gr. *haplous*, simple, and Ger. *plaggen*, sod). Soils that have a surface horizon 25 cm to less than 50 cm thick that meets all of the requirements for a plaggen epipedon except thickness.

- **Pretic** (from Portuguese *preto*, black). Has a pretic epipedon. Used within Artesols and as an extragrade in Oxisols and Ultisols.

- **Anthrohumic** (modified from Gr. *anthropos*, human + L. *humus*, ground). A mineral soil material created by humans by transporting and placing excavated soil material during reclamation, landscaping, or landform construction. The anthrohumic epipedon has all the properties of either the mollic, umbric, or melanic epipedon and may overlap some properties of the plaggen and pretic epipedons. Note to reviewers: Within Restifactarts and Restortharts, the anthrohumic epipedon with properties of the umbric epipedon is used in the “Typic” Subgroup. Also used as an extragrade in Gelisols, Andisols, Vertisols, Ultisols, Mollisols, Alfisols, Inceptisols and Entisols.
Previously existing Haploplaggen (simple + sod) is no longer needed since WRB changed the minimum thickness of plaggen to 20 cm.

“HAHT” Subgroups for other soil orders: Edits shown in red text and strikethrough. The following Subgroups are used as extragrades in existing soil orders and possibly as intergrades to Aretesols. They are listed in order of interpretive significance as a guide, but the significance and order may change slightly depending on the great group in which they are recognized. These subgroups are not included for use within Atesols because the soils they describe need a higher amount of specificity than can be provided within Artesols. Therefore they should remain in existing soil orders.

- **Anthrolacic** (human + Latin *lacus* lake, pool). Soils under artificial impoundment of water caused by building dams to pond or store water persistently for recreation, flood control, or water supply. Note to reviewers: Not used for temporary ponds such as stormwater retention basins or for waters that dry up in most years. Used with subaqueous soils alone or in combination with other subgroups.
- **Anthrocavic** (human + Latin *excavātus* excavated). Have had 50 cm or more soil material excavated with less than 50 cm replaced or transported from an outside source. Anthrocavic is associated with (destructural) anthropogenic landforms and microfeatures. Note to reviewers: Used as an extragrade in existing soil orders.
- Anthraquic (modified from Gr. *anthropos*, human, and L. *aqua*, water). Soils that have anthraquic conditions (i.e., antric saturation). These soils are extensive in flooded rice paddies. Used as an extragrade in existing soil orders. Note to reviewers: Soils with anthraquic conditions are included in existing soil orders because we can provide more detailed information and interpretations for these otherwise unmodified agricultural soils.
- Anthroportic (modified from Gr. *anthropos*, human + carry, move). Soils that formed in 25 cm or more of human-transported material. This adjective is used primarily for soils that formed in human-transported material of dredged or mine spoil areas as well as for soils of urban areas and transportation corridors. Note to reviewers: Used as an Intergrade to Portifactarts or Portortharts.
- Anthraltic (from Gr *Anthropos*, human + L. *alterāre*, to change). Soils that formed in 25 cm or more of human-altered material. This adjective is used primarily for human-altered material where ripping or deep plowing has fractured and displaced diagnostic subsurface horizons that were root-limiting (e.g., duripans) and in excavated areas (e.g., borrow pits, pipeline corridors). Note to reviewers: Used as an extragrade within Inceptisols and Entisols or an intergrade to Restortharts.
- Anthropic (anthropic epipedon) (from Gr *Anthropos*, human). Soils that have an anthropic epipedon based on the presence of artifacts or midden material. Note to reviewers: Used as an intergrade to Artesols in existing soil orders.
**Suggested sequence for recognition within any Great Group:**

- *Anthrolacic*
- *Anthraquic*
- *Ekranic*
- *Anthrodensic*
- *Anthrocavic*
- *Anthronekric*
- *Anthrohumic*
- *Plaggic*
- *Pretic*
- *Anthroportic*
- *Anthrotalic*
- *Anthropic* (should come right before Typic subgroups)

An example of inclusion between existing subgroups may be found in Portifactarts and Portortharts.

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**E. Family classes:**

1. **Revision to requirements for using a HAHT Family class.** Edits shown in red text and strikethrough.

   **Use of Human-Altered and Human-Transported Material Classes**

   Human-altered and human-transported material classes are only used in taxa of mineral soils where one of the following occurs: (1) human-altered or human-transported material extends from the soil surface (or from the base of recent deposit of new material up to 25 cm thick) to a depth of 50 cm or to a root-limiting layer, whichever is shallower; or (2) the soil classifies in a “HAHT” subgroup (defined in Chapter 3); or (3) the soil contains an artifactual horizon 15 cm or more thick starting in the upper 30 cm of the soil. ...snip...

2. **New Classes:** Add to the beginning of the list of HAHT family classes.

   **Key to Human-Altered and Human-Transported Material Classes**

   The following key to human-altered and human-transported material classes is designed to make important distinctions in the order of most importance to human health and safety.

   A. Mineral soils that have, in some part of the human-altered and human-transported material control section, one of the following:
1. Radiohazic (from Latin radius, ray and Middle English hasard - danger, risk): having hazic material with contamination by radioactivity elements (occurring above published natural background concentrations and at concentrations reported to be harmful to humans in published sources). The effect is through regular direct contact (e.g., touching, ingestion, or inhalation) with the soil particles or indirect contact through proximal exposure to radioactive elements such as Plutonium, Iodine-131, or Cesium-137 released on the soil with short half-life or long term dangerous period. The effect may be by indirect exposure through a plant or animal food source.

2. Anthrohazic (from Greek anthropos, human being + Middle English hasard - danger, risk): having hazic material with concentrations of contaminants (occurring above published natural background concentrations and at concentrations reported to be harmful to humans in published sources) that markedly affect the health of humans who come in direct contact (e.g., touching, ingestion, or inhalation) with the soil particles or water that percolated through contaminated soil, or by indirect contact by ingesting plants or animals that have bioaccumulated the contaminants.

3. The detectible evolution (>1.6 ppb) of methanethiol...snip...

12. A horizon or layer in human-altered or human-transported material, 15 cm or more thick, with 1 percent or more (by volume) artifacts produced by pre-industrial processes (e.g. pottery, stone tools) and an absence of post-industrial artifacts; or

Archaic

...snip...

3. Revision of Existing Classes: Edits shown in red text and strikethrough.

...snip...

Justification: Artifactic and Pauciartifactic are realigned to agree with the definition of artifactic horizon and the base level for artifacts in many established soil series.

10. A horizon or layer 150 cm or more thick, with 35 percent or more (by volume) artifacts which are both cohesive and persistent and are 2 mm in diameter or larger.

Artifactic

Or

11. A horizon or layer 150 cm or more thick, with 150 percent or more (by volume) artifacts which are both cohesive and persistent and are 2 mm in diameter or larger.

Pauciartifactic

...snip...
4. **Other changes at the Family level:**
   Soil moisture regime and soil temperature regime are to be reported at the family level for all Artesols.

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F. **Series criteria:** Approximately 75 soil series have been proposed as of May, 2019.
   1. HTM 2-2.7 m thick. Justification: Depth of house basements. These soils should be recognized because the soil may be subject to settling or have irregular hydrologic flowpaths.
   2. HTM > 2.7 m thick. Justification: Depth of commercial building basements. These soils should be recognized because the soil may be subject to settling or have irregular hydrologic flowpaths.
   3. HTM with aquic or oxyaquic conditions 2-3.2 m deep. Justification: Critical depth for siting for stormwater infiltration pipe.
   4. Unusual parent materials or weathering products not recognized by a HAHT-family class. Justification: Important for interpretations. Already being done in many series.
   7. Depth class to anthropogenic materials, similar to root-limiting classes for bedrock: Justification: Major interpretive break because of root-limitation.
   8. Major type of artifacts (already being done).

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G. **Phase criteria:** The following differences can be used to establish mapping phases to improve detail in soil survey map units.
   1. Sealed phase: Have a manufactured layer ≤ 5 cm deep intended for use as a pavement (e.g., sidewalk, paved street) or to seal the soil surface (e.g., concrete-lined aqueduct). Vertical barriers are not included.
   2. Hillslope terrace phase: A hillslope landform terraced with multiple steps (treads) and risers to allow sustained agriculture (e.g., cultivation, vineyards, orchards). Terrace steps and risers are concurrently built anthropogenic microfeatures built largely by hand labor, animal labor, and simple tools to allow agriculture on steep slopes. Risers may be built partially or entirely of rock fragments. Does not include modern conservation terrace microfeatures built by heavy machinery to reduce runoff and erosion. Fifteen percent or more of the step part of the map unit has been excavated to 25 cm or more (human-altered material) on the uphill side or had 25 cm or more of the excavated material placed on top of a nearby slope segment (human-transported material) on the downhill side. Note to reviewers: Risk of slope failure mass movement of soil is a danger, especially where the base of the terrace system is undercut by infrastructure development or downcutting of rivers, in flood-irrigated conditions, or where water is concentrated on the hillslope system. Where terrace risers are 1 m or more in height (typically where the original contour was 12.5% slopes and the steps are 8 m or more in width), about 15% of the step on the upslope side has human-altered (anthrocavic)
material excavated to 50 cm or more; about 15% of the step tread on the downslope side has (anthropogenic) human-transported material 50 cm or more thick; about 30% of the step tread has either human-altered material or human-transported material 25-50 cm thick; and the remainder of the step tread is not altered more than 25 cm deep.

3. Conservation terrace phase: Conservation terrace anthropogenic microfeatures built long a hillslope contour by heavy machinery to allow or enhance agriculture on sloping ground, decrease or divert runoff, and reduce erosion. Fifteen percent or more of the map unit has been excavated to 25 cm or more (human-altered material) on the uphill side or had 25 cm or more of the excavated material placed on top of a nearby slope segment (human-transported material) on the downhill side.

4. Habitation terrace phase: A steeply sloping hillslope with multiple steps (treads) and risers (headwalls) to allow infrastructure development (e.g., housing development). Excavated soils and rock (human-altered material) on steps may be deposited in adjacent or remote areas. Approximately 15% or more of the step part of the map unit has either been excavated to 50 cm or more (human-altered material) or had 50 cm or more of the excavated material placed on top of a pre-existing soil (human-transported material).

5. Thin fill phase: Human-transported material extends to a depth of 25 to less than 50 cm across 85% or more of the map unit. Not used with soils in any “HAHT” subgroups.

6. Truncated phase: Soils excavated (truncated) 25 cm to less than 50 cm (without replacement) across 85% or more of the map unit.

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H. Keys: (arranged from highest to lowest levels). This be the first soil order to key out to avoid exclusion criteria in multiple places in the keys to soil order and below.

1. Order

A. Soils formed in human-altered or human-transported materials that have one or more of the following:
   1. An artifactual horizon; or
   2. An ekranic manufactured layer 3 m or more in width with one or more pedogenic horizons beneath; or
   3. A continuous (> 95% horizontal extent), very slowly permeable to impermeable, manufactured layer (e.g., geomembrane) starting ≤ 200 cm from the soil surface; or
   4. Human-altered material 50 cm or more thick produced by excavation and replacement; or
   5. Human-transported material that either:
      a) extends to a depth of 30 cm or more and contains a sulfuric horizon; or
      b) extends to a depth of 30 cm or more and contains 50% or more by volume sulfidic materials; or
      c) extends to a depth of 50 cm or more.
2. Suborder

AA. Artesols that have a positive water potential at the soil surface for more than 21 hours of each day in all years. Wassarts

AB. Other Artesols that have human-transported materials extending to 50 cm or more (may be covered by a recent deposit of other material up to 25 cm thick) and:
1. Aquic or peraquic conditions within 50 cm of the mineral soil surface for some time in normal years (or artificial drainage that prevents aquic saturation within 50 cm of the soil surface); or
2. At a time when the soil is not being irrigated, either:
   a. Enough active ferrous iron to give a positive reaction to alpha, alpha-dipyridyl, three consecutive times repeated at least seven days apart; or
   b. Removal of 25% or more paint from a 10-cm section of an IRIS tube or strip left in the soil for 6 weeks or less time; and
3. A layer within 50 cm of the mineral soil surface, that has 50 percent or more chroma of either:
   a. 2 or less if there are redox concentrations; or
   b. 1 or less; or
   c. Common, distinct redox concentrations in the lower part of an anthrohumic, mollic, umbric, melanic, plaggen, or pretic epipedon. Aquarts

AC. Other Artesols with an artifactual horizon. Factarts

AD. Other Artesols. Ortharts

3. Great Group

AAA. Wassarts that have a horizon or horizons with a combined thickness of at least 15 cm within 50 cm of the mineral soil surface that contains sulfidic materials. Sulfiwassarts

AAB. Other Wassarts that have a texture class of loamy fine sand or coarser in all layers within the particle-size control section. Psammowassarts

AAC. Other Wassarts. Haplowassarts
ABA. Aquarts with:
  1) A sulfuric horizon or sulfidic materials within 50 cm of the soil surface; and
  2) Human-transported materials extending to 50 cm or more.

ABB. Other Aquarts that have a texture class of loamy fine sand or coarser in all layers within the particle-size control section.

ABC. Other Aquarts with episaturation.

ABD. Other Aquarts with endosaturation.

ACA. Factarts that contain garbage, waste, trash, or refuse disposed of by humans in a collection area with no manufactured layer contact (e.g., unregulated landfills).

ACB. Other Factarts that contain garbage, waste, trash, or refuse disposed of by humans in a collection area and a manufactured layer contact (e.g., regulated landfills).

ACC. Other Factarts with hazic material (e.g., mine tailings, asphalt, manufactured waste, manufacturing by-products, or combustion residue).

ACD. Other Factarts that have a texture class of loamy fine sand or coarser in all layers within the particle-size control section.

ACE. Other Factarts with an anthrohumic, pretic, or plaggen epipedon.

ACF. Other Factarts.

ADA. Ortharts with a sulfuric horizon or sulfidic materials within 50 cm of the soil surface and evidence of hydrologic alteration by humans (e.g., excavation, water diversion, or ditching) or deposition of human-transported material.
ADB. Other Ortharts that have a texture class of loamy fine sand or coarser in all layers within the particle-size control section.

ADC. Other Ortharts with evidence of excavation of soil by humans to a depth of 50 cm or more below the soil surface followed by replacement of the excavated soil.

ADD. Other Ortharts with an anthrohumic, pretic, or plaggen epipedon.

ADE. Other Ortharts.

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4. Subgroup

AAAA. Sulfiwassarts that have an artifactic horizon.

AAAB. Other Sulfiwassarts with a texture class of loamy fine sand or coarser in all layers within the particle-size control section.

AAAC. Other Sulfiwassarts.

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AABA. Psammowassarts that have an artifactic horizon.

AABB. Other Psammowassarts that have a horizon or horizons with a combined thickness of at least 15 cm within 100 cm of the mineral soil surface that contain sulfidic materials.

AABC. Other Psammowassarts

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AACA. Haplowassarts that have an artifactic horizon.

AACB. Other Haplowassarts that have a horizon or horizons with a combined thickness of at least 15 cm within 100 cm of the mineral soil surface that contain sulfidic materials.

AACC. Other Haplowassarts.
ABAA. Sulfaquarts that have an artifactic horizon.  
Artifactic Sulfaquarts

ABAB. Other Sulfaquarts that have a texture class of loamy fine sand or coarser in all parts of the particle-size control section.  
Psammentic Sulfaquarts

ABAC. Other Sulfaquarts.  
Typic Sulfaquarts

ABBA. Psammaquarts that have an artifactic horizon.  
Artifactic Psammaquarts

ABBB. Other Psammaquarts that have a histic epipedon.  
Histic Psammaquarts

ABBC. Other Psammaquarts that have a sulfuric horizon or sulfidic materials within 100 cm of the mineral soil surface.  
Sulfic Psammaquarts

ABBD. Other Psammaquarts.  
Typic Psammaquarts

ABCA. Epiaquarts that have an artifactic horizon.  
Artifactic Epiaquarts

ABCB. Other Epiaquarts that have a sulfuric horizon or sulfidic materials within 100 cm of the mineral soil surface.  
Sulfic Epiaquarts

ABCC. Other Epiaquarts with a densic contact created by human activity within 100 cm of the mineral soil surface.  
Anthrodensic Epiaquarts

ABCD. Other Epiaquarts that have a root-limiting layer within 100 cm of the mineral soil surface.  
Antirhyzic Epiaquarts

ABCE. Other Epiaquarts that have a texture class of loamy fine sand or coarser in all parts of the particle-size control section.  
Psammentic Epiaquarts

ABCF. Other Epiaquarts that have a histic epipedon.  
Histic Epiaquarts

ABCG. Other Epiaquarts.  
Typic Epiaquarts
ABDA. Endoaquarts that have an artifactic horizon.  
Artifactic Endoaquarts

ABDB. Other Endoaquarts that have a sulfuric horizon or  
sulfidic materials within 100 cm of the mineral soil surface.  
Sulfic Endoaquarts

ABDC. Other Endoaquarts that have a texture class of loamy fine  
sand or coarser in all parts of the particle-size control section.  
Psammentic Endoaquarts

ABDD. Other Endoaquarts that have both:  
1. Texture class of loamy fine sand or coarser throughout a  
layer extending from the mineral soil surface to a depth of  
50 cm or more; and  
2. A buried layer of organic soil material 20 cm or more thick  
immediately below.  
Psammentic Thapto-histic Endoaquarts

ABDE. Other Endoaquarts that have a buried layer of  
organic soil material 20 cm or more thick.  
Thapto-histic Endoaquarts

ABDF. Other Endoaquarts that have a histic epipedon.  
Histic Endoaquarts

ABDG. Other Endoaquarts.  
Typic Endoaquarts

ACAA. Garbifactarts with a densic contact created by  
human activity within 100 cm of the mineral soil surface.  
Anthrodensic Garbifactarts

ACAB. Other Garbifactarts that have a texture class of loamy fine  
sand or coarser in all parts of the particle-size control section.  
Psammentic Garbifactarts

ACAC. Other Garbifactarts that have, in one or more horizons  
within 100 cm of the mineral soil surface, redox depletions with  
chroma of 2 or less and also aquic conditions for some time in  
normal years (or artificial drainage).  
Aquic Garbifactarts

ACAD. Other Garbifactarts with 50 cm or more of human-transported  
soil material or rock fragments containing less than 10% by volume  
or weight artifacts.  
Capic Garbifactarts

ACAE. Other Garbifactarts.
ACBA. Manufactarts with a densic contact created by human activity within 100 cm of the mineral soil surface.

ACBB. Other Manufactarts that have a texture class of loamy fine sand or coarser in all parts of the particle-size control section.

ACBC. Other Manufactarts.

ACCA. Wastifactarts that have an ekranic manufactured layer containing asphalt.

ACCB. Other Wastifactarts that have a sulfuric horizon or sulfidic materials within 100 cm of the mineral soil surface.

ACCC. Other Wastifactarts with a densic contact created by human activity within 100 cm of the mineral soil surface.

ACCD. Other Wastifactarts that have:
   1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years and slickensides or wedge shaped peds in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; or
   2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

ACCE. Other Wastifactarts that have a texture class of loamy fine sand or coarser in all layers between 25 and 100 cm below the soil surface.

ACCF. Other Wastifactarts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

ACCG. Other Wastifactarts.
ACDA. Psammifactarts with a densic contact created by human activity within 100 cm of the mineral soil surface.  

Anthrodensic Psammifactarts

ACDB. Other Psammifactarts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage to a depth of ≥ 100 cm).

Aquic Psammifactarts

ACDC. Other Psammifactarts.

Typic Psammifactarts

ACEA. Humifactarts with a petrocalcic horizon formed in human-transported material.

Petrocalcic Humifactarts

ACEB. Other Humifactarts that have:

1. An anthrohumic epipedon that meets all requirements of a mollic epipedon; and

2. Either:
   a. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) within 50 cm of the mineral soil surface; or
   b. Redox concentrations in the lower part of the mollic epipedon.

Aquollic Humifactarts

ACEC. Other Humifactarts that have aquic conditions for some time within 100 cm of the mineral soil surface in most years (or artificial drainage).

Aquic Humifactarts

ACED. Other Humifactarts with a plaggen epipedon.

Plaggic Humifactarts

ACEE. Other Humifactarts with a pretic epipedon.

Pretic Humifactarts

ACEF. Other Humifactarts with an anthrohumic epipedon that meets all of the requirements of the melanic epipedon.

Melanic Humifactarts

ACEG. Other Humifactarts with identifiable secondary carbonates or free carbonates throughout the upper 100 cm or to a root-limiting layer if shallower than 100 cm.

Calcaric Humifactarts

ACEH. Other Humifactarts with one or both of the following:
1. A calcic horizon; or
2. Identifiable secondary carbonates or free carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; or
   b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; or
   c. Any other class and within 110 cm of the mineral soil surface.

ACEI. Other Humifactarts with an anthrohumic epipedon that meets all of the requirements of the mollic epipedon.

Mollic Humifactarts

Umbric Humifactarts

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ACFA. Portifactarts that have an ekranic manufactured layer.

Ekranic Portifactarts

ACFB. Other Portifactarts that have a sulfuric horizon or sulfidic materials within 100 cm of the mineral soil surface

Sulfuric Portifactarts

ACFC. Other Portifactarts that have a gelic soil temperature regime.

Gelic Portifactarts

ACFD. Other Portifactarts that have a cryic soil temperature regime.

Cryic Portifactarts

ACFE. Other Portifactarts that have a salic horizon.

Salic Portifactarts

ACFF. Other Portifactarts that have a fragipan.

Fragic Portifactarts

ACFG. Other Portifactarts that have a densic contact created by human activity within 100 cm of the mineral soil surface.

Anthrodensic Portifactarts

ACFH. Other Portifactarts that have an oxic horizon.

Oxic Portifactarts

ACFI. Other Portifactarts that have a texture class of loamy fine sand or coarser in all layers between 25 and 100 cm below the soil surface.

Psammentic Portifactarts

ACFJ. Other Portifactarts that have a clayey or clayey-skeletal particle-size class by weighted average of the upper 100 cm of the soil or to a root-limiting layer if one occurs shallower than 100 cm.
Vertic Portifactarts

ACFK. Other Portifactarts that meet the base saturation requirements of an Ultisol and has an abrupt textural change at the top of an argillic or kandic horizon that occurs beneath human-altered or human-transported material.

Abruptic Ultic Portifactarts

ACFL. Other Portifactarts that meet the base saturation requirements of an Ultisol and has an argillic or kandic horizon beneath human-altered or human-transported material.

Ultic Portifactarts

ACFM. Other Portifactarts that meet the base saturation requirements of an Alfisol and has an abrupt textural change at the top of an argillic or glossic horizon that occurs beneath human-altered or human-transported material.

Abruptic Alfic Portifactarts

ACFN. Other Portifactarts that meet the base saturation requirements of an Alfisol and has an argillic or glossic horizon in or beneath human-altered or human-transported material.

Alfic Portifactarts

ACFO. Other Portifactarts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Portifactarts

ACFP. Other Portifactarts that have andic soil properties.

Andic Portifactarts

ACFQ. Other Portifactarts that have a spodic horizon.

Spodic Portifactarts

ACFR. Other Portifactarts that have a buried layer of organic soil material 20 cm or more thick.

Thapto-Histic Portifactarts

ACFS. Other Portifactarts with identifiable secondary carbonates or free carbonates throughout the upper 100 cm or to a root-limiting layer if shallower than 100 cm.

Calcaric Portifactarts

ACFT. Other Portifactarts with one or both of the following:
1. A calcic horizon; or
2. Identifiable secondary carbonates or free carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; or
   b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; or
c. Any other class and within 110 cm of the mineral soil surface.

ACFU. Other Portifactarts that are saturated with water within 100 cm of the mineral soil surface in normal years for either or both:
1. 20 or more consecutive days; or
2. 30 or more cumulative days.

ACFV. Other Portifactarts that have a cambic horizon.

ACFW. Other Portifactarts.

ADAA. Sulfortharts that have a texture class of loamy fine sand or coarser in all parts of the particle-size control section.

ADAB. Other Sulfortharts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

ADAC. Other Sulfortharts.

ADBA. Psammortharts with a densic contact created by human activity within 100 cm of the mineral soil surface.

ADBB. Other Psammortharts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage to a depth of ≥100 cm).

ADBC. Other Psammortharts.

ADCA. Restortharts with a sulfuric horizon or sulfidic materials within 100 cm of the mineral soil surface
ADCB. Other Restortharts with a densic contact created by human activity within 100 cm of the mineral soil surface.

ADCC. Other Restortharts with a clayey or clayey-skeletal particle-size class by weighted average of the upper 100 cm of the soil or to a root-limiting layer if one occurs shallower than 100 cm.

ADCD. Other Restortharts that have a texture class of loamy fine sand or coarser in all layers between 25 and 100 cm below the soil surface.

ADCE. Other Restortharts with evidence of burial of human remains or artifacts associated with ceremonial burial (e.g., caskets or vaults).

ADCF. Other Restortharts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

ADCG. Other Restortharts.

ADDA. Humortharts with a petrocalcic horizon formed in human-transported material.

ADDB. Other Humortharts that have:

1. An anthrohumic epipedon that meets all requirements of a mollic epipedon; and
2. Either:
   a. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) within 50 cm of the mineral soil surface; or
   b. Redox concentrations in the lower part of the mollic epipedon.

ADDC. Other Humortharts that have aquic conditions for some time within 100 cm of the mineral soil surface in most years (or artificial drainage).

ADDD. Other Humortharts with a plaggen epipedon.

ADDE. Other Humortharts with a pretic epipedon.
ADDF. Other Humortharts with an anthrohumic epipedon that meets all of the requirements of the melanic epipedon.

Melanic Humortharts

ADDG. Other Humortharts with identifiable secondary carbonates or free carbonates throughout the upper 100 cm or to a root-limiting layer if shallower than 100 cm.

Calcaric Humortharts

ADDH. Other Humortharts with one or both of the following:
1. A calcic horizon; or
2. Identifiable secondary carbonates or free carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; or
   b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; or
   c. Any other class and within 110 cm of the mineral soil surface.

Calcic Humortharts

ADDI. Other Humortharts with an anthrohumic epipedon that meets all of the requirements of the mollic epipedon.

Mollic Humortharts

ADDJ. Other Humortharts.

Umbric Humortharts

ADEA. Portortharts that have an ekranic manufactured layer.

Ekranic Portortharts

ADEB. Other Portortharts that have a sulfuric horizon or sulfidic materials within 100 cm of the mineral soil surface

Sulfuric Portortharts

ADEC. Other Portortharts that have a gelic soil temperature regime.

Gelic Portortharts

ADED. Other Portortharts that have a cryic soil temperature regime.

Cryic Portortharts

ADEE. Other Portortharts that have a salic horizon.

Salic Portortharts

ADEF. Other Portortharts that have a fragipan.

Fragic Portortharts

ADEG. Other Portortharts that have a densic contact created by human activity within 100 cm of the mineral soil surface.

Anthrodensic Portortharts

ADEH. Other Portortharts that have an oxic horizon.
ADEI. Other Portortharts that have a texture class of loamy fine sand or coarser in all layers between 25 and 100 cm below the soil surface.

Psammentic Portortharts

ADEJ. Other Portortharts that have a clayey or clayey-skeletal particle-size class by weighted average of the upper 100 cm of the soil or to a root-limiting layer if one occurs shallower than 100 cm.

Vertic Portortharts

ADEK. Other Portortharts that meet the base saturation requirements of an Ultisol and has an abrupt textural change at the top of an argillic or kandic horizon that occurs beneath human-altered or human-transported material.

Abruptic Ultic Portortharts

ADEL. Other Portortharts that meet the base saturation requirements of an Ultisol and has an argillic or kandic horizon beneath human-altered or human-transported material.

Ultic Portortharts

ADEM. Other Portortharts that meet the base saturation requirements of an Alfisol and has an abrupt textural change at the top of an argillic or glossic horizon that occurs beneath human-altered or human-transported material.

Abruptic Alfic Portortharts

ADEN. Other Portortharts that meet the base saturation requirements of an Alfisol and has an argillic or glossic horizon in or beneath human-altered or human-transported material.

Alfic Portortharts

Adeo. Other Portortharts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Portortharts

Adep. Other Portortharts that have andic soil properties.

Andic Portortharts

Adeq. Other Portortharts that have a spodic horizon.

Spodic Portortharts

Ader. Other Portortharts that have a buried layer of organic soil material 20 cm or more thick.

Thapto-Histic Portortharts

Ades. Other Portortharts with identifiable secondary carbonates or free carbonates throughout the upper 100 cm or to a root-limiting layer if shallower than 100 cm.

Calcaric Portortharts

Adet. Other Portortharts with one or both of the following:
1. A calcic horizon; or
2. Identifiable secondary carbonates or free carbonates within
   one of the following particle-size class (by weighted average
   in the particle-size control section) and depth combinations:
   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil
      surface; or
   b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the
      mineral soil surface; or
   c. Any other class and within 110 cm of the mineral soil surface.

Calcic Portortharts

ADEU. Other Portortharts that are saturated with water within
100 cm of the mineral soil surface in normal years for either or both:
1. 20 or more consecutive days; or
2. 30 or more cumulative days.

Oxyaquic Portortharts

ADEV. Other Portortharts that have a cambic horizon.

Inceptic Portortharts

ADEW. Other Portortharts.

Typic Portortharts

I. **New differentiae proposed:** (these are all new proposals).

1. **Artifactic horizon** (from Latin *arte*, by skill, and *factum*, to do or make). A mineral soil
   material horizon with abundant artifacts within human-altered or human-transported
   materials. Justification: This is used to simplify the definition of other differentiae, the
   key to Artesols, and other keys. These are the breakpoints of artifact levels that either
   support existing mapping and soil series or are supported by data from NYC, New Jersey,
   and Los Angeles soil surveys analyzed by Jacob Isleib. Also supported by mapping done
   in Detroit by Jeff Howard of Wayne State and Steve Dadio of Cedarville Engineering in
   Doylestown, PA.

Required Characteristics

The artifactic horizon:
1. Formed in human-altered or human-transported material and contains one of the
   following:
   a. 35% or more (by volume) artifacts in a layer 15 cm or more thick
      starting ≤ 200 cm of the soil surface; or
   b. 20% or more (by volume) artifacts in a layer 15 cm or more thick
      starting ≤ 100 cm of the soil surface; or
c. 10% or more (by weighted average volume) artifacts between 25 and 100 cm (or
to a manufactured, cemented, or indurated root-limiting layer if shallower than
100 cm); or
d. Contains 10% or more (by volume or weight) artifacts in a layer 15 cm or more
thick starting in the upper 30 cm of the soil.

2. **Hazic materials** (from Middle English *hasard* danger, risk, peril). Modified from Toxic secondary qualifier in WRB (IUSS Working Group WRB 2015). Hazic materials are contaminated (from Latin *contāminātus*, to defile, spoil) or polluted (from Latin *pollut*, soiled, defiled) human-altered or human-transported material containing metals (other than ions of Al, Fe, Na, K, Ca and Mg) such as lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni); radioactive elements such as Plutonium, Iodine-131, or Cesium-137 with short half-life; or dangerous manufactured materials (such as asbestos) or compounds (such as PCBs) occurring above published natural background concentrations and at concentrations reported to be harmful to humans in published sources. Hazic soil materials become contaminated through human activity and do not include naturally elevated levels such as soils naturally high in Ar or Selenium (Se). Contamination occurs through intentional (e.g., military, dumping, draining) or accidental (e.g., spills) human activity. Hazic materials include sulfuric materials that develop by human activity such as draining, dredging, or mining and transport that exposes sulfidic materials to oxidation. In such cases the pH may drop to very low levels, making some dangerous heavy metals soluble. The dangerous period for hazic materials is several decades or longer unless the contaminant is mitigated or the soil is remediated.

**Justification:** Hazic materials markedly adversely affect the health of humans through inhalation, ingestion, or direct skin contact. Ingestion and injury may also occur by drinking contaminated water, eating contaminated plants, or eating lower animals that have accumulated the contaminant. Interpretation of danger to humans is not expected. Instead, documentation of the contamination (occurring above published natural background concentrations and at concentrations reported to be harmful to humans in published sources) is necessary before soil classification.

**Required Characteristics**

Hazic material consists of one or more adjacent horizons or subhorizons that meets the following:

- 35% or more (by volume) artifacts in a layer 15 cm or more thick starting ≤ 200 cm of the soil surface containing garbage, refuse, or noxious artifacts (e.g., landfills); or
- The soil occurs within an area documented to be one of the 10 categories of US EPA defined contaminated lands (having a contaminant occurring above published natural background concentrations and at concentrations reported to be harmful to humans in published sources); or
- The soil is found to be contaminated following the US EPA procedure to conduct a Phase I and II Environmental Site Assessment ([https://www.epa.gov/sites/production/files/2017-11/documents/brownfieldsroadmapepa542-r-12-001.pdf](https://www.epa.gov/sites/production/files/2017-11/documents/brownfieldsroadmapepa542-r-12-001.pdf)); or
d. The soil has been sampled and analyzed by soil lab testing or proximal or remote sensing that documents greater than 50% probability that it meets or exceeds a published level of contamination documented to be hazardous to humans through any direct or indirect pathway of exposure. For example, typical mean Pb concentration for surface soils worldwide averages 32 mg kg\(^{-1}\) and ranges from 10 to 67 mg kg\(^{-1}\) (Kabata-Pendias, A. 2010. Trace Elements in Soils and Plants, 4th Ed. CRC Press [online]. ISBN 9781420093681. DOI: https://doi.org/10.1017/S0014479711000743). If the soil is sampled for heavy metals by lab analysis or by using portable x-ray fluorescence readings at georeferenced sampling sites, and the results exceed 67 mg kg\(^{-1}\), the data can be extrapolated from the points to an areal map using kriging or hyperspectral mapping. All soils where the extrapolated values exceed a 50% probability of exceeding 67 mg kg\(^{-1}\) could be classified as containing hazic material.

3. Anthrohumic epipedon (from Greek *anthropos*, human being + Latin *humus* ground, mould). A mineral soil material epipedon created by humans transporting and placing excavated soil material during long-term habitation, reclamation, landscaping or landform construction. They may occur in long-term cultivated soils, middens (Hester et al., 1975), archaeological sites, on anthropogenic landforms and microfeatures or above such features, and on constructed landforms in reclaimed mined or landscaped areas shaped to mimic the original contour. The anthrohumic epipedon meets all the requirements for a mollic epipedon except base saturation, and meets some of the properties of the umbric, pretic, plaggen, and melanic epipedon. It typically contains artifacts and discarded cooking and eating debris (e.g., oyster shells and bones) in middens or pottery in archaeological sites, but is typically artifact-free in reclaimed soils, landscaped soils, or excavated and replaced soils. The transported material often sits unconformably above a discontinuity with underlying soil, sediment, or continuous bedrock that does not meet the requirements of an anthrohumic epipedon. The anthrohumic epipedon does not form in andic soil materials like the melanic epipedon. The anthrohumic is required to occur on anthropogenic landforms or microfeatures or excavated and reclaimed surfaces which is not required by the mollic epipedon. It may also contain artifacts or have lower base saturation than the mollic epipedon. The anthrohumic is not required to form in materials containing significant additions of char and high P like the pretic epipedon. The anthrohumic does not require spade marks or occurrence on raised landforms like the plaggen. The anthrohumic has higher organic carbon and darker soil color than the anthropic epipedon.

Justification: Humans have created epipedons in many parts of the earth with properties that resemble mollic epipedons. Many of these are archaic and should be recognized as such using the new “archaic” HAHT family class. They were originally called anthropic epipedons. They can be created by adding kitchen waste, or organic carbon, plant residues and manure over long periods of farming. Many have elevated P levels but that is not a requirement, and a level that would consistently separate them from naturally high P level soils is not supported by data in the NRCS
Pedon database. Other types include epipedons created or replaced in the process of landscaping, mining, or construction of pipelines and other infrastructure. They do not have the same physical properties as natural mollic epipedons and should be recognized separately.

Required Characteristics

1. Components\(^1\) of the anthrohumic epipedon have:
   a. Pedogenic structural units with a diameter of 30 cm or less; and
   b. Spacing of cracks that fine, nonwoody roots can enter less than 10 cm apart on average (i.e., is not root-limiting); and
   c. Less than 50% by volume rock structure (including fine stratifications 5 mm or less thick), in all component horizons and layers; and
   d. One or both of the following:
      1) Formed entirely in human-altered or human-transported material (defined below) on or above an anthropogenic landform or microfeature (defined below), or on an excavated and reclaimed surface that mimics the original land contour, or
      2) Is irrigated; or
      3) Has anthraquic conditions; and
   e. 0.6 percent or more organic carbon; and
   f. Moist color value of 3 or less and moist color chroma of 3 or less; and
   g. Non-fluid properties; and

2. The sum thickness of components that meet the properties of part 1 is 25 cm or more.

\(^1\) Component layers of minor thickness in the upper 18 cm may fail one or more of the required characteristics, provided the weighted average of the upper 18 cm meets the requirements.

4. Pretic epipedon: from WRB (black earth). **Copied directly from IUSS Working Group WRB, (2015).** A pretic horizon (from Portuguese preto, black) is a mineral surface horizon that results from human activities including the addition of charcoal. It is characterized by its dark color, the presence of artefacts (ceramic fragments, lithic instruments, bone or shell tools etc.) and high contents of organic carbon, phosphorus, calcium, magnesium and micronutrients (mainly zinc and manganese), usually contrasting with natural soils in the surrounding area. It typically contains visible remnants of charcoal. They generally have high organic carbon stocks. Many of them are dominated by low-activity clays.

Justification: Pretic horizons are widespread in the Amazon Basin, where they are the result of pre-Columbian activities and have persisted over many centuries despite the prevailing humid tropical conditions and high organic matter mineralization rates. These soils with a pretic horizon are known as “Terra Preta de Indio” or “Amazonian Dark
Earths”. Similar soils occur in parts of Africa. These horizons are recognized by WRB and should be added to our system. In order to harmonize, we propose using their definition and criteria.

Required Characteristics
A pretic horizon is a surface horizon consisting of mineral material and has:
1. a Munsell colour value of \( \leq 4 \) and a chroma of \( \leq 3 \), both moist; and
2. \( \geq 1\% \) organic carbon; and
3. exchangeable Ca plus Mg (by 1 M NH4OAc, pH 7) of \( \geq 2 \) cmolc kg\(^{-1}\) fine earth; and
4. \( \geq 30 \text{ mg kg}^{-1} \) of extractable P (Mehlich-1); and
5. one or more of the following:
   a. \( \geq 1\% \) artifacts (by volume, by weighted average); or
   b. \( \geq 1\% \) charcoal (by volume, by weighted average); or
   c. evidences of past human occupation in the surrounding landscape, e.g. constructions, gardens, shell mounds (‘sambaquis’), or earthworks (geoglyphs); and
6. \(< 25\% \) (by volume, by weighted average) of animal pores, coprolites or other traces of soil animal activity; and
7. one or more layers with a combined thickness of \( \geq 20 \text{ cm} \).

5. **Modify Existing Diagnostic Criteria:** (changes in red text or strikethrough)

**1. Artifacts** Justification: The edits in red text and strikethrough are updates.
Artifacts (L. arte, by skill, and factum, to do or make) are materials created, modified, or transported from their source by humans usually for a practical purpose in habitation, manufacturing, agriculture, or construction activities. Examples of discrete (> 2mm) artifacts are bitumen (asphalt), brick, cardboard, carpet, cloth, coal combustion by-products, concrete, glass, metal, paper, plastic, rubber, and both treated and untreated wood products. Examples of particulate artifacts are fly ash, plastic microbeads, midden biochar, processed liquids, explosives residue, and radioactive material. Pavements and sealed surfaces built by humans and associated with habitation or transportation are artifacts, as are manufactured layers. Artifacts include any unweathered ore or raw materials (other than dredged or shallow-excavated sulfidic or sulfuric materials) brought to the surface through human activity such as drilling, mining, or quarrying. They are not evidently chemically weathered by surficial weathering processes. The raw materials are brought and deposited into a soil environment where they do not commonly occur and is substantially different from the environment where they originated. This would include crushed rock, ores, tailings, mine spoil, natural gas, refined hydrocarbons, crude oil, and saline groundwater associated with oil drilling (IUSS Working Group WRB, 2015). Sand and gravel excavated from quarries are artifacts if the sand or gravel is used in construction, manufacturing, engineering, erosion control, landscaping, or some other intended purpose. Often the raw materials and sand and gravel are associated with areas of habitation or transportation corridors, and often
occur on anthropogenic landforms or microfeatures. Mechanically abraded rocks (e.g., rocks with metal scrape marks or gouges), rocks shaped or crushed for construction material, and debitage are artifacts (e.g., stone tool flakes, building stone). Examples of nonpersistent artifacts repeatedly added as needed to soil to temporarily improve conventional agricultural production include compost, organic mulch, manure, crop residues, biosolids, aglime, quicklime, and synthetic inorganic fertilizers. Humans have also added charcoal, biochar, and midden material artifacts to the soil to systematically increase agricultural productivity over centuries or millennia, but and these additions (e.g., bones, shells, and cooking waste and associated charred by-products) have persisted to produce long-term (hundreds to thousands of years) changes in soil properties (e.g., Terra Preta de Indio soils; pretic epipedons). Artifacts also include litter discarded by humans into soils, floodplains, or waters (e.g., aluminum cans) that appears to serve no apparent purpose or function for alteration of soil.

2. Anthropic Epipedon Justification: The edits in red text and strikethrough are updates. The anthropic (from Greek anthropos, human being) epipedon forms in human-altered or human-transported material (defined below). The anthropic epipedon consists of mineral soil material that shows evidence of the purposeful alteration of soil properties or of earth-surface features by human activity. Anthropic These epipedons may form in soils which occur on or above anthropogenic landforms and on or above microfeatures, in transportation corridors and urban areas, in excavated areas, or on soils excavated and replaced to the original contour (e.g., some reclaimed mined soils, graves, or buried pipeline corridors) which are higher than the adjacent soils by as much as or more than the thickness of the anthropic epipedon. Most anthropic epipedons occur in soils of gardens, middens (Hester et al., 1975), transportation corridors, mined, and urban areas. They may also occur in deeply plowed, or excavated and replaced soils. Most Some anthropic epipedons contain artifacts other than those associated with agricultural practices (e.g., quicklime) and litter discarded by humans (e.g., aluminum cans). Most Some anthropic epipedons may have an elevated phosphorus content from human additions of food debris (e.g., bones), compost, or manure, although a precise value is not required. Although anthropic epipedons formed at the soil surface, they may now be buried or subaqueous. Anthropic epipedons are similar to the ochric epipedon but differ because they must form in human-altered or human-transported materials. They differ from the plaggen epipedons because they do not require artifacts and do not contain evidence of additions from sod spreading. They fail to meet the minimum amount of organic carbon and moist color requirements of the anthrohumic, mollic, umbric, melanic, plaggen, and pretic epipedons. They are not made of organic soil materials like the histic and folistic epipedons.

Required Characteristics

The anthropic epipedon consists of mineral soil material that shows evidence of the purposeful alteration of soil properties or of earth-surface features by human activity. The field evidence of alteration is nearly continuous, long-term, and significant and
excludes episodic, traditional or short-term agricultural practices such as shallow plowing or addition of amendments, such as crop residues, episodic organic matter amendments, lime or fertilizer. The anthropic epipedon includes eluvial horizons that are at or near the soil surface, and it extends to the base of horizons that meet all the criteria shown below or it extends to the top of the first shallowest underlying diagnostic illuvial horizon (defined below as an argillic, calcic, cambic, glossic, kandic, natric, petrocalcic, petrogypsic, or spodic horizon) or a fragipan, duripan, or subsurface gypsic horizon. Most anthropic epipdons more than a few years old show accumulation of organic carbon.

1. Component horizons of the anthropic epipedon meets all of the following:
   a. When dry, has structural units with a diameter of 30 cm or less, and
   b. Is not a root-limiting layer (i.e., the spacing of cracks that roots can enter is less than 10 cm apart on average); and
   c. Less than one-half of the volume of all parts has rock structure, including fine stratifications (5 mm or less thick); and
   d. Meets one or more of the following:
      1) Formed entirely in human-altered or human-transported material (defined below) on or above an anthropogenic landform or microfeature (defined below), in an excavated area, or on an excavated and reclaimed surface that mimics the original contour; or and either:
      2) Has one or more of the following throughout in some part:
         (a) Artifacts, other than agricultural amendments (e.g., quicklime) and litter discarded by humans (e.g., aluminum cans); or
         (b) Midden material (i.e., eating and cooking waste and associated charred products); or
         (c) Anthraquic conditions; and
   e. Meets one or more of the following:
      1) Has less than 0.6 percent organic carbon in some part of the upper 25 cm; or
      2) Has moist color value of 4 or more, or
      3) Has moist color chroma of 4 or more; and
   f. Has an n value (defined below) of less than 0.7. Is not fluid; and

42. Component horizons that meet all of the criteria have a sum thickness of 1 cm or more. That is either:
   a. The entire thickness of the soil above a root-limiting layer (defined in Chapter 17) if one occurs within 25 cm of the soil surface; or
   b. 25 cm.

3. Plaggen epipedon (taken directly from WRB, 2015. This is a complete replacement of the current definition and criteria). Delete all of the existing definition. Justification: The plaggen epipedon exists in most part in Europe. It exists in our system already but the WRB has the most modern definition. In order to harmonize, we propose using their definition and criteria.
The plaggen epipedon (from Dutch plag sod) is equivalent to the Plaggic horizon in WRB (IUSS Working Group WRB, 2015). The plaggen epipedon is a thick, human-made mineral surface layer that has been produced by long-continued spreading of sod and manure animal bedding material on naturally infertile fields. It has brownish or blackish colors and the texture class in most cases is sand or loamy sand. Its reaction is mostly slightly to strongly acid. The pH may have risen due to recent liming but without reaching a high base saturation. The soil organic carbon may include carbon added with the plaggen. The P₂O₅ content (extractable in 1 % citric acid) in plaggen epipedons may be high, often ≥ 0.025% at < 20 cm of the soil surface. The plaggen epipedon shows evidence of old agricultural operations in its lower part, such as spade or hook marks, diverse colored or textured earthy fragments (i.e., clods), as well as old cultivation layers or remnants of thin stratified beds of sand that were probably produced on the soil surface by beating rains and were later buried. Thick plaggen epipedons commonly overlie buried soils although the original surface layers may be mixed with the lower part of the plaggen. The lower boundary is typically clear. A map unit delineation of soils with plaggen epipedons would tend to occur on straight-sided anthropogenic landforms that are higher than adjacent land surfaces by as much as or more than the thickness of the plaggen epipedon.

Required Characteristics

The plaggen epipedon consists of mineral soil material and meets all of the following:

1. Occurs in soils on locally raised landforms or land surfaces; and
2. Has a texture class of sand, loamy sand, sandy loam or loam, or a combination of them; and
3. Contains artefacts; and
4. Has a Munsell color with a value of ≤ 4 moist, and ≤ 5 dry, and a chroma of ≤ 4 moist; and
5. Has ≥ 0.6% soil organic carbon; and
6. Has a base saturation (by 1 m NH₄OAC, pH 7) of < 50%, unless the soil has been limed or fertilized; and
7. Has a thickness of ≥ 20 cm.

4. Manufactured Layer Justification: edits in red text and strikethrough are updates.

A manufactured layer is an artificial, root-limiting layer more than 5 cm beneath the soil surface consisting of nearly continuous, human manufactured materials whose purpose is to form an impervious barrier. The materials used to make the layer impervious include geotextile liners, asphalt, concrete, rubber, and plastic. The presence of manufactured layers can be used to differentiate soil series. Ekranic layer (from Polish ekran, shield) is a type of manufactured layer starting < 5 cm from the soil surface (IUSS Working Group WRB, 2015) that is cemented or paved and has ≥ 95 percent lateral continuity. The spacing of cracks that fine roots can enter is 10 cm or more. The material is consolidated in place by humans, typically to support
animal and vehicular traffic (e.g., sidewalks and paved areas) or to convey water (e.g., a concrete-lined ditch). Rupture resistance class of the pavement matrix is strongly cemented to indurated. Vertical walls, fences, and rooftops are excluded.

5. Aquic conditions

Note to reviewers: These edits are related to a better definition of Anthracic conditions as well.

Soils with aquic (L. aqua, water) conditions are those that currently undergo continuous or periodic saturation and reduction. ...snip......

2. The degree of reduction in a soil can be characterized by the direct measurement of redox potentials. ...snip......

A simple field test is available to determine if reduced iron ions are present. **At a time when the soil is not being irrigated**, a freshly broken surface of a field-wet soil sample is treated with alpha,alpha-dipyridyl in neutral, 1N ammonium acetate solution. Test strips treated with alpha,alpha-dipyridyl may also be used. The appearance of a strong pink or red color on the freshly broken surface indicates the presence of reduced iron ions (i.e., Fe2+). **Care should be used to avoid testing soil surfaces cut with an iron-bearing tool.** A positive reaction to ...snip......

time of testing. For soils with very low levels of iron, the use of a field test such as Indicator of Reduction in Soils (IRIS) devices painted with ferric iron may be warranted in order to document reducing conditions (Rabenhorst, 2018). **At a time when the soil is not being irrigated**, after an IRIS device is installed in the soil for a period of approximately 3 weeks, 25% or more of the ferrihydrite paint is removed within a 10-cm section of the device, one can conclude that that the soil is reducing with 100% level of confidence (Castenson and Rabenhorst, 2006).

Use of alpha,alpha-dipyridyl in a 10 percent solution of acetic acid is not recommended because the acid is likely to change soil conditions, for example, by dissolving CaCO3. ...snip......

6. Human-altered material

Justification: edits in red text and strikethrough are updates.

Human-altered material is parent material for soil that has undergone anthropomeration (soil mixing or disturbance) by humans. It occurs in soils that have either been used for gardening, ceremonial burial, been deeply mixed in place, excavated and replaced, artificially impounded, deeply drained, or compacted in place for the artificial ponding of water.

Human-altered material may be composed of either organic or mineral soil material. It may contain artifacts (e.g., shells or bones) used as agricultural amendments, but the majority of the material has no evidence that it was transported from outside of the pedon.

Human-altered material occurs in soils which are disturbed for various reasons. For example, human-altered material occurs in agricultural soils which are deeply-
plowed or ripped to disrupt a root-limiting layer (defined in chapter 17) or other physical restriction. Gravesites in cemeteries contain human-altered material as well as artifacts. Densic contacts formed at the top of wet, slowly permeable (i.e., puddled) layers when they are intentionally compacted by humans and destroy structure and impede water percolation. Puddled and other slowly permeable layers are human-altered when they are intentionally compacted by humans and to destroy structure and impede water percolation. Subsequent artificial ponding in such human-altered material results in anthric saturation (defined above) for the purpose of growing crops like rice in paddy soils. Year-round impoundment of water (e.g., reservoirs and some ponds) results in human-altered subaqueous soils that form in shallow areas. Intentional long-term artificial drainage of wet soils may result in oxidation and either thorough mineralization of formerly saturated organic soil material into mineral human-altered soil material, or in the formation of a human-altered material sulfuric horizon. Intentional burning may remove or mineralize 50 cm or more of organic soil material layers through combustion in drained areas alters formerly saturated organic soil material into mineral human-altered soil material.

Diagnostic horizons formed by significant illuviation (e.g., argillic or petrocalcic horizons) have not been documented as occurring in human-altered material. However, laterally tracing an illuvial diagnostic horizon (e.g., argillic, petrocalcic horizon, or duripan) or diagnostic characteristic can be used to find a discontinuity along often linear anthropogenic landform or microfeature boundaries where the horizon or characteristic is abruptly absent can be used to identify human-altered material. The lateral discontinuity typically along linear boundaries. When the lateral discontinuity occurs at the edge of an anthropogenic landform or microfeature (defined above), it Removal of 50 cm or more of surficial soil material confirms the destructional origin of the landform or feature and identifies the human-altered soil material left behind as human-altered. produced through excavation. It is often the preponderance of evidence (best professional judgment) along with published or historical evidence and onsite observations that allows the most consistent identification of excavated human-altered material.

**Required Characteristics**

Human-altered material meets **both** of the following:

1. It occurs in **one** of the following:
   a. A field tilled with subsoiler equipment to a depth of 50 cm or more to break up an impermeable or root-restrictive layer; or
   b. A destructional (excavated) anthropogenic landform or microfeature (e.g., borrow pit, roadside cut); or
   c. An area excavated to 50 cm or more and then refilled with the original material; or
   d. A field ponded or flood-irrigated for agriculture (e.g., rice paddy); or
   e. Area within the shorelines of a water impoundment (e.g., reservoir); or
   f. An artificially-drained landform; and
2. It does not meet the requirements of human-transported material (defined below) and has evidence of purposeful alteration by humans which results in one of the following:
   a. Artifacts other than incidental litter or conventional agricultural amendments; or
   b. 3 percent or more (by volume) mechanically detached and re-oriented pieces of diagnostic horizons or characteristics in a horizon or layer 7.5 cm or more thick; or
   c. 50 percent or more (by volume) divergent-shaped clods or aggregates structures (from L. divergent, to veer)‡ in a horizon or layer 7.5 cm or more thick formed from traffic or mechanical pressure exceeding the shear strength of moist or saturated loamy or clayey soil material; or
   d. Excavated and replaced soil material overlying either bones or artifacts arranged in ceremonial position or human body parts prepared to prevent decay; or
   e. Mechanically-abraded rock fragments or artifacts; or
   f. Excavated and replaced soil material containing mechanically detached and re-oriented pieces of diagnostic horizons or characteristics directly unconformably overlying features (e.g., scrape marks) that indicate excavation by mechanical tools has taken place in some part of the pedon; or
   g. An abrupt lateral discontinuity of subsurface horizons and characteristics at the edge of a refilled or unfilled destructional (excavated) anthropogenic landform or microfeature; or
   h. Anthraquic conditions in a horizon or layer 7.5 cm or more thick; or
   i. A densic contact or thick platy structure in at least 50 percent of a pedon accompanied by additional evidence (e.g., scrape marks, abrupt lower boundary of a plow layer) that it was formed through human-induced mechanical compaction or earth-moving with heavy equipment; or,
   j. Soil horizons or layers left in place following intentional excavation and removal of surficial soil material (e.g., a sulfuric horizon in an excavated area or a kandic horizon at the soil surface); or
   k. Mineral soil material produced by combustion or artificial drainage and oxidation of formerly saturated organic soil materials into mineral soil material; or
   l. Rock fragments with precipitated secondary mineral pendants rearranged in randomly oriented fashion across the pedon by mechanical disturbance; or
   m. Evidence of intentional burning or mining to remove organic soil materials.