CBP Land Use Classification Scheme 2013 - 2021 07.13.2021

Purpose:
Several outcomes specified in the 2014 Chesapeake Bay Program Agreement and the proposed Chesapeake Bay Regional Hydrologic Model will benefit from the enhancement of the 2013 Chesapeake Bay Program land use dataset[1]. The current 2013 land use dataset was designed to inform the development of Phase III Watershed Implementation Plans as part of the 2017 Mid-Point Assessment. All unique classes, except for "wetlands", were required to exhibit proven unique nutrient and/or sediment loading rates. While this approach was very effective for informing water quality management decisions, it limited the utility of the data for informing other Chesapeake Bay outcomes. Limitations of the current data include:

- Inaccuracies associated with class confusion, e.g., solar fields mapped as impervious surfaces, forest fragments mapped as "mixed open";
- Loss of land cover information (e.g., Tree Canopy, herbaceous, Scrub-Shrub) within wetlands and "fractional" classes (areas estimated to contain part cropland, pasture, turf grass, mixed open, and/or impervious surfaces);
- Over-estimation of agricultural land in areas with extensive mining and oil & gas development;
- Inability to clearly communicate high-resolution net changes in forests and urban Tree Canopy due to inherent data bias towards detecting loss and absence of successional classes;
- Inability to inform models about forest succession due to the absence of successional classes;
- Inability to accurately portray the spatial extent and shading of streams

To remedy these issues, a new land use classification scheme based on updated decision rules and additional ancillary data is proposed for translating land cover into land use for the years 2013/14, 2017/18, and 2021/22. The proposed new classification was developed in the fall of 2019 through consultation with the Land Use Workgroup, Forestry Workgroup, Wetlands Workgroup, Climate Resiliency Workgroup, Agricultural Workgroup, Scientific Technical Assessment and Reporting team, and both the Habitat and Healthy Watersheds Goal Implementation Teams. It has been reviewed from a feasibility perspective by the Chesapeake Conservancy and the University of Vermont's Spatial Analysis Laboratory. The proposed classification is both feasible and within the scope of the USEPA's 2018 Cooperative Agreement with the Chesapeake Conservancy.

The proposed classification will not impact the WIPs, Milestones, or annual Progress runs. Land use changes based on the new classification will be directly cross-walked and aggregated into the Phase 6 thirteen mapped land use classes to compute change from 2013/14 to 2017/18 to 2021/22. These changes will then be applied to the original 2013 land use dataset to update it to more current conditions. Nutrient and sediment loads will change as a result of changes in land use and management practices but not as a result of changes in the classification.

[1] https://chesapeakeconservancy.org/conservation-innovation-center-2/high-resolution-data/land-use-data-project/

The following pages outline the proposed new classification scheme from two perspectives. The Phase 6 perspective illustrates how fifteen proposed new classes nest under the original thirteen land uses. The new classification disaggregates four Phase 6 classes into additional subclasses. Water is disaggregated into four new classes: estuary, lakes & ponds, streams, and ditches. This disaggregation will help the CBP partners distinguish different types of shoreline change and leverage recent investments in mapping streams and ditches from 1-meter resolution LiDAR imagery. Mapping all streams and distinguishing them from ditches will inform riparian buffer assessments, planting opportunities, and targeting efforts. It will also enable assessments of shaded vs daylighted stream miles. For impervious surfaces, solar fields will be identified as a unique class and railroad rights-of-way will be included within existing impervious classes. Solar fields do not exhibit the same hydrologic functions as other types of impervious cover. Mapping them explicitly will enable their consideration in the development of future hydrologic models. Moreover, solar fields are a rapidly growing feature on the rural landscape that contribute to climate resiliency. For the cropland class, orchards/vineyards and idle/fallow lands will be explicitly mapped to reduce confusion with forest and mixed open classes, thereby improving the accuracy of multiple classes.

Most efforts invested in the new classification will focus on disaggregating the “mixed open” class. For Phase 6, “mixed open” represents a catch-all class including Barren lands (e.g., waterbody margins and surface mines), areas undergoing managed or natural succession (e.g., timber harvests, abandoned and reclaimed mines, fallow lands), and areas maintained as herbaceous or Scrub-Shrub vegetation (e.g., landfills, unconventional oil and gas development, and utility rights-of-way). Such areas compose a significant portion of the landscape in some counties. Insufficient ancillary data defining these different types of lands and over-reliance on local land use and zoning data led to an under-classification of “mixed open” in rural areas corresponding to an over-classification of agriculture. Understanding the composition of mixed open is vital for mapping wildlife habitats, projecting future changes in land use, and assessing alternative land management opportunities. Proposed classes previously represented as “mixed open” include: natural succession, suspended succession, bare developed, bare shore, extractive, and fragmented forest. “Natural Succession” represents unmanaged, non-forested lands that are slowly transitioning to forest such as fallow lands and reclaimed mines. “Suspended Succession” represents areas maintained as herbaceous or Scrub-Shrub such as transmission line, highway, and rail rights-of-ways. “Bare Developed” represent patches of bare land in urban and suburban landscapes. “Bare Shore” represents beaches, gravel bars, and lake margins not included in wetland ancillary data. “Extractive” represents active surface mines, quarries, and gas pads.

Because these new classes do not all logically nest under the thirteen Phase 6 land uses, the second outline, “General-Purpose Land Use Perspective”, rearranges the new classes into a more logical land use classification and intersects them with land cover so that all mapped land use/cover information is represented in a single dataset. Thus, a single dataset with these 61 classes will be the basis for multiple derived datasets such as the Phase 6 land use classification, the original land cover map, or a detailed land use map. The CBPO will develop various GIS layer files to facilitate the visualization of these alternative classifications.

Phase 6 Land Use (crosswalk with general-purpose land use)
(15 additional classes):

1. ***Water (WAT; from 1 to 4 classes)***
   1.1. Estuary
   1.2. Lakes & Ponds
   1.3. Streams

2. ***Impervious, Roads (IR; no change)***

3. ***Impervious, Non-Roads (INR; 2 to 4 classes)***
   3.1. Structures
   3.2. Other Impervious
   3.3. Solar fields (impervious portions)

4. ***Tree Canopy over Impervious (TCI; no change)***

5. ***Turf Grass (TG; no change)***

6. ***Tree Canopy over Turf Grass (TCT; no change)***

7. ***Forest (FORE; change in name only)***
   7.1. Forest (>1 acre, 240-ft width)
   7.2. Tree Canopy in Agriculture

8. ***Tidal Wetland (WLT; no change)***

9. ***Non-Tidal Floodplain Wetland (WLF; update mapping to include headwaters)***

10. ***Non-Tidal Other Wetlands (WLO; no change)***

11. **Mixed Open (1 to 7 classes)**
    11.1. Natural Succession
    11.2. Harvested Forest
    11.3. Suspended Succession
    11.4. Bare Developed
    11.5. Extractive
    11.6. Bare Shore
    11.7. Solar Fields (pervious portions)

12. ***Cropland (CRP; 1 to 2 classes)***
    12.1. Cropland
    12.2. Orchard/vineyard

13. ***Pasture (PAS; no change)***

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General-Purpose Land Use (59 classes)

1. ***Water (8)***
   - **1.1. Lentic**
     - *1.1.1.Estuary (tidal)*
     - 1.1.2.Lakes & Ponds
   - ***1.2. Lotic***
     - *1.2.1.Streams*
       - *1.2.1.1. Open Channel*
       - *1.2.1.2. TC over Channel*
       - *1.2.1.3. Culverted/Buried Channel*
     - *1.2.2.Ditches*
       - *1.2.2.1. Open Ditch*
       - *1.2.2.2. TC over Ditch*
       - *1.2.2.3. Culverted/Buried Ditch*

2. ***Developed (12)***
   - **2.1. Impervious**
     - 2.1.1.Roads
     - 2.1.2.Structures
     - 2.1.3.Other Impervious, e.g., Parking Lots, Driveways, Railroads, etc.
     - 2.1.4.TC over Impervious
       - 2.1.4.1. TC over Roads
       - 2.1.4.2. TC over Structures
       - 2.1.4.3. TC over Other Impervious
   - **2.2. Pervious**
     - 2.2.1.Turf Grass
     - 2.2.2.Bare Developed
     - 2.2.3.Suspended Succession
       - 2.2.3.1. Barren
       - 2.2.3.2. Herbaceous
       - 2.2.3.3. Scrub-Shrub
     - 2.2.4.TC over Turf Grass

3. ***Forest (7)***
   - **3.1. Forest (>= 1 acre, 240-ft width)**
   - **3.2. TC in Agriculture**
   - **3.3. Harvested Forest (<= 3 years)**
     - 3.3.1.Barren
     - 3.3.2.Herbaceous
   - **3.4. Natural Succession (> 3 years)**
     - 3.4.1.Barren
     - 3.4.2.Herbaceous
     - 3.4.3.Scrub-Shrub

4. ***Production (16)***
   - **4.1. Agriculture**
     - 4.1.1.**Cropland**
       - 4.1.1.1. Barren
       - 4.1.1.2. Herbaceous
     - 4.1.2.**Pasture/ Hay**
       - 4.1.2.1. Barren
       - 4.1.2.2. Herbaceous
     - 4.1.3.**Orchard/ Vineyard**
       - 4.1.3.1. Barren
       - 4.1.3.2. Herbaceous
       - 4.1.3.3. Scrub-Shrub
     - *4.1.4.**Idle/Fallow***
       - *4.1.4.1. Barren*
       - *4.1.4.2. Herbaceous*
       - *4.1.4.3. Scrub-Shrub*
   - **4.2. Solar fields**
     - 4.2.1.Impervious
     - 4.2.2.Pervious
       - 4.2.2.1. Barren
       - 4.2.2.2. Herbaceous
       - 4.2.2.3. Scrub-Shrub
   - **4.3. Extractive (active)**
     - 4.3.1.Barren
     - 4.3.2.Other Impervious

5. ***Wetlands and Water Margins (16)***
   - **5.1. Tidal**
     - 5.1.0.1. Barren
     - 5.1.0.2. Herbaceous
     - 5.1.0.3. Scrub-Shrub
     - 5.1.0.4. Tree Canopy
     - 5.1.0.5. Forest
   - **5.2. Riverine (Non-Tidal)**
     - 5.2.0.1. Barren
     - 5.2.0.2. Herbaceous
     - 5.2.0.3. Scrub-Shrub
     - 5.2.0.4. Tree Canopy
     - 5.2.0.5. Forest
   - **5.3. Terrene/Isolated (Non-Tidal)**
     - 5.3.0.1. Barren
     - 5.3.0.2. Herbaceous
     - 5.3.0.3. Scrub-Shrub
     - 5.3.0.4. Tree Canopy
     - 5.3.0.5. Forest
   - **5.4. Bare shore**

Water Classes

Definition: all surface water and water conveyance features including estuaries, lakes, ponds, streams (sunlit, shaded, buried), and ditches (sunlit, shaded, buried).

2013 LU Issues: most fluvial surface water features were not represented in the 1-meter land use classification because streams were derived at 10-meter resolution using an average drainage-area threshold (60-acres) estimated from the 1:24K NHD-HR end nodes. Stream widths were modeled similarly throughout the watershed using a statistical formula based on drainage area developed for Maryland.

Summary Methods: Overlay Tree Canopy and impervious land cover on the new hyper-resolution (1-meter) raster channel data under development by CIC and UMBC. Reclass the channel cells as daylighted or shaded (including culverts). Data representing buried streams (e.g., "pipelines" in the 1:24K NHD or stretches of network discontinuity within urban areas) will be examined to potentially represent "buried" sections of the hyper-res vector network developed by CIC and UMBC.

CIC and UMBC will use a Machine Learning model to automate separation of gullies/ditches from streams followed by minor manual classification.

Assess and assign stream flow permanence attributes to reaches in the using state-specific low-flow regression equations relating 7-day 2-year low flows to drainage area under dry (summer) and wet (winter) periods as recommended by UMBC and CIC as part of their CBT grant. Channels exhibiting extreme low flows, <0.1 cfs, in both wet and dry periods will be classed as "ephemeral." Channels exhibiting extreme low flows in the dry season only will be classed as "intermittent." Channels exhibiting extreme low flows in neither season will be classed as "perennial."

Technical Methods:

<u>Estuary (tidal) (pending decision):</u>

<u>Lakes and Ponds (pending decision):</u>

I. Extract water segments from land cover and vectorize it:
    a. Extract water from land cover
    b. Region group water (eight neighbor rule)
    c. Vectorize region grouped water patches
    d. For each polygon calculate the following:
        i. Perimeter-area ratio (PAR) (Informs shape complexity. Large values are less complex and smaller values are more complex)
        ii. Polsby-popper score (PPS) (informs shape compactness. 1 is circular/compact and 0 is not compact and irregular)

II. Identify ponds from open water segments using ancillary data sets such as National Hydrographic Dataset (NHD) Area and Waterbody and 60-acre drainage thresholded streams (60-ac streams). The 60-ac streams are going to be used for first draft/version and subsequently replaced with hyper-res hydrography when it becomes available for entire Chesapeake Bay watershed counties.
    a. The workflow reclassifies open water polygons from the land cover as either terrestrial and/or still water bodies versus moving water
    b. To identify moving ponds in open water that's either a river/stream:
        i. Open water polygons are intersected with 60-ac streams (buffered). This is called water inside channel (WIC)
        ii. Create NHD Waterbody mask (without estuary class) if they intersect with 60-ac streams. This is to ensure that NHD WBodies are on the DEM aligned 60-ac stream network

iii. **Any water polygon that intersects with NHD_WB_Mask then that's a pond. This captures most large lakes, ponds, or reservoirs along with several small ponds**
iv. Above layer is then intersected with Chesapeake Bay water polygon to remove any bay inlets or esturine areas accidentally classified as ponds
v. Create NHD Area mask from FTypes of streams and rivers (460), if any WIC polygons intersect with NHD_Area_Mask then they remain as open water
vi. In the above subset, shape and morphology indices are used to identify pond like features in or near river channels that have been classed as open water
    1. Polygons with PPS > 0.01 and PAR > 0.16 are elongated features that resemble like river channels, so they remain open water
    2. **Non-elongated features are classed as ponds**
    3. PPS and PAR thresholds were determined by visually inspection and general trends of shape morphology. These can be easily tweaked and potentially replaced with availability of hyper-res data

c. To identify moving ponds in open water that's either a river/stream:
    i. Inverse of WIC is water outside channel (WOC). This step filters out accidental tidal water segments classed as ponds, removes artificial artifacts and water polygon slivers.
    ii. WOC polygons that do not intersect with NHD_Area_mask and have an area greater than 202 sq. meters (or 1/20th acre) is classed as ponds. The 1/20th acre rule is to exclude form channel fragments and small artificial artifacts created from raster to vector conversion.

Streams and Ditches (TBD for V2; pending decision):

I. When a "Water", "Wetland", "Herbaceous", "Scrub-Shrub", or "Barren" pixel intersect with the Objective 1 hydrography "stream" or "ditch" class, classify as "Open Channel" or "Open Ditch", respectively.
II. When "Tree Canopy" pixels intersect with Objective 2 hydrography "stream" or "ditch" class, classify as "Tree Canopy over Channel or "Tree Canopy over Ditch", respectively.

Developed Classes

Definition: All impervious and pervious lands associated with residential, commercial, and industrial development and associated infrastructure including roads, structures, other impervious (e.g., parking lots, driveways), turf grass, bare developed, and utility rights-of-way (i.e., suspended succession), and Tree Canopy obscuring roads, structures, other impervious, and turf grass.

Summary Methods: Continue to rely on the land cover data to directly map all types of impervious surfaces and Tree Canopy over all types of impervious surfaces. Buffer all rail lines in Open Street Map by 3m and reclassify these areas either "Other Impervious" or "Tree Canopy over Other Impervious." Identify all herbaceous land on developed parcels or on residential, commercial, or industrial lands as "turf grass." Use ancillary data on transmission lines,, and landfills to identify herbaceous, Scrub-Shrub, and Barren lands as "Suspended Succession." Use solar model AI output polygons to reclassify land as "solar impervious", "solar Barren", "solar herbaceous", and "solar Scrub-Shrub." Map Tree Canopy rules are defined based on what type of parcel it is in (Agriculture, densely developed, less densely developed, and forested) and adjacency to other classes. Identify lands likely undergoing construction by their Barren cover type and neighborhood context (i.e., adjacent to developed lands), or lands that are any other type of compacted barren land that do not fall under any other land use class. This does not include dirt roads, as dirt roads are considered "Other Impervious".

Technical Methods:

Structures:

I. Same as Land Cover

Other Impervious:

I. Same as Land Cover. Buffer all rail lines from Open Street Map by 3 meters and reclassify "Herbaceous", "Barren", "Scrub-Shrub", and "Wetlands" as "Other Impervious."

Impervious roads:
I. Same as Land Cover.

Tree Canopy over Structures:
I. Same as Land Cover.

Tree Canopy over Other Impervious:
I. Same as Land Cover. Buffer all rail lines in Open Street Map by 3 meters on either side and reclassify "Tree Canopy" as "Tree Canopy over Other Impervious."

Tree Canopy over Impervious Roads:
I. Same as Land Cover.

Turf Grass (Pending Decision):
I. Subset HERE data (LandUseA and LandUseB layers) to include only the following classes: 'AIRCRAFT ROADS', 'AIRPORT', 'AMUSEMENT PARK', 'CEMETERY', 'GOLF COURSE', 'HOSPITAL', 'PARKING LOT', 'SEAPORT/HARBOUR', 'SHOPPING CENTRE', 'SPORTS COMPLEX'
II. If a parcel is less than or equal to 1 acre, and has greater than or equal to 93 square meters of impervious surface, classify all "Herbaceous" as "Turf Grass."
III. If the "Herbaceous" segment intersects with the subset HERE data from step I., classify as "Turf Grass."

Suspended Succession (Pending Decision):
I. "Herbaceous", "Scrub-Shrub", and "Barren" image segments that intersect with digitized landfill dataset, classify as "Suspended Succession."
II. "Herbaceous" and "Scrub-Shrub" image segments that intersect with active and abandoned mines digitized dataset, classify as "Suspended Succession."
III. "Herbaceous", "Scrub-Shrub", and "Barren" image segments that are less than or equal to 50 square meters and touch "Impervious Road", classify as "Suspended Succession."
IV. Buffer transmission line dataset from Homeland Infrastructure Foundation by 25 meters. If "Herbaceous", "Scrub-Shrub", and "Barren" segments intersect the buffered transmission line dataset and are less than or equal to 1,000 square meters, classify as "Suspended Succession."

Tree Canopy over Turf Grass (Pending Decision):
I. "Turf Grass" and "Agriculture" methods applied first.
II. Agriculture parcels, defined by:
    a. Any parcels with any "Agriculture" class ("Cropland", "Pasture/Hay", ~~"Idle/Fallow",~~ or "Orchard/Vineyard").
III. Densely Developed areas, defined by:
    a. Parcels in Census Urban Area Clusters that do not contain agriculture
IV. Forested parcels, defined by:
    a. "Tree Canopy" coverage greater than or equal to 25% of the parcel;
    b. "Structure" is present in the parcel;
    c. No "Agriculture" classes are present in the parcel;
    d. Parcel is not already classed as Dense
V. Less Densely Developed areas, defined by:
    a. Areas remaining after Densely Developed, Forested, and Agriculture parcels are assigned as Less Densely Developed areas
VI. In Densely Developed areas:
    a. Buffer "Structures" and "Other Impervious" and "Turf Grass" sharing boundary of "Structure" segments by 20 meters. Classify any "Tree Canopy" within buffer as "Tree Canopy over Turf Grass".

VII. In Forested parcels:
   a. Buffer “Structures” and “Other Impervious” and “Turf Grass” sharing boundary of “Structure” segments by 10 meters. Classify any “Tree Canopy” within buffer that is in a forested parcel as “Tree Canopy over Turf Grass”.

VIII. In Less Densely Developed areas:
   a. Buffer “Structures” and “Other Impervious” and “Turf Grass” sharing boundary of “Structure” segments by 10 meters. Classify any “Tree Canopy” within buffer as “Tree Canopy over Turf Grass”.

IX. In Agriculture parcels:
   a. Buffer “Structures” and “Other Impervious” and “Turf Grass” sharing boundary of “Structure” segments by 10 meters. Reclassify any “Tree Canopy” within buffer as “Tree Canopy over Turf Grass”.

X. “Tree Canopy” patches from all types of parcel environments are dissolved together. However, if the patches share their border with at least 85% “Cropland”, “Pasture”, or “Orchard/Vineyard” they are considered windbreaks and are not dissolved. The TCT buffers from the previous steps are removed from the “Tree Canopy” patches.

XI. Remaining “Tree Canopy” patches that are less than an acre:
   a. If the patch shares the majority of its border with developed classes ”Turf Grass”, “Structure” and “Other Impervious”, classify as “Tree Canopy over Turf Grass”.

XII. Remaining “Tree Canopy” patches that are greater than an acre and less than 72 meter’s wide:
   a. If the patch shares the majority of its border with developed classes ”Turf Grass”, “Structure” and “Other Impervious”, classify as “Tree Canopy over Turf Grass”.

<u>Tree Canopy in Agriculture (Pending Decision)</u>:

I. Run “Tree Canopy over Turf Grass” workflow.

II. Remaining “Tree Canopy” patches that are less than an acre:
   a. If the patch does not share the majority of its border with developed classes ”Turf Grass”, “Structure” and “Other Impervious”, classify as “Tree Canopy in Agriculture”.

III. Remaining “Tree Canopy” patches that are greater than an acre and less than 72 meter’s wide:
   a. If the patch does not share the majority of its border with developed classes ”Turf Grass”, “Structure” and “Other Impervious”, classify as “Tree Canopy in Agriculture”.

<u>Bare Developed</u>:

I. All other land use methods that analyze barren lands are applied first. This includes: “Suspended Succession”, “Natural Succession”, all “Agriculture” classes, “Timber Harvest”, “Solar Fields”, “Extractive”, all “Wetland” classes, and “Bare Shore”.

II. Barren in parcels with an area <= 4046 m^2 and 93m^2 of impervious other, roads, or buildings.

III. Remaining “Barren” segments are classified as “Bare Developed”.

LUWG Decisions:

09-02-20: Reclass cover type within railroad right-of-ways. Use railroad centerline dataset from Open Street Map (OSM). Buffer center lines by 3-meters on either side (for multi-line rails, overlapping buffers will not be double counted). Reclass land cover within the buffer as follows: “low vegetation” + “Barren” + “Scrub-Shrub” + “wetlands” = “other impervious.” “Tree Canopy” = “Tree Canopy over other impervious.” No change to existing “roads”, “structures”, “other impervious”, “Tree Canopy over roads”, “Tree Canopy over structures”, “Tree Canopy over other impervious”, and “water.”

Forest Classes

Definition: all areas covered by Tree Canopy that are presumed to have an unmanaged understory including contiguous forest (patches >= 1 acre), fragmented forest (patches < 1 acre), and lands undergoing natural succession.

2013 LU Issues: Small fragments of trees (< 1 acre) were classed as "mixed-open." Patch width was not accounted for when distinguishing forests from mixed open such that narrow strips of trees >= 1 acre were classed as "forest." Forests were not included as a sub-class of wetlands. Reliance on focal windows (e.g., 3x3, 5x5, etc.) for distinguishing trees over turf from forests is prone to producing change artifacts if applied over multiple years. In addition, areas undergoing natural or managed succession back to forest were not explicitly mapped preventing accurate assessments of net changes in forest cover and preventing the modeling of successional processes into the future.

Summary Methods: After accounting for Tree Canopy over Turf Grass, Tree Canopy in Agriculture, and Tree Canopy over impervious cover, map all remaining Tree Canopy as "Forest." Areas undergoing natural succession are patches of Barren, herbaceous, or Scrub-Shrub lands that are not classed as agriculture, turf grass, wetlands, or timber harvest. Natural Succession consists of areas of "barren", "herbaceous", or "scrub/shrub" assumed to be in an early to mid successional stage of regrowth such as abandoned or fallow fields. Land use histories from LCMAP data help inform this class.

Technical Methods:

Forest (Pending Decision):

I. Classify "Tree Canopy over Turf Grass" and "Tree Canopy in Agriculture" first.
II. All remaining "Tree Canopy" is classified as "Forest".

Natural Succession:

I. "Turf Grass", "Agriculture", and "Suspended Succession" methods applied first.
II. If greater than or equal to 10% of "Herbaceous" or "Barren" segment is timber harvest according to data mined LCMAP, classify as "Natural Succession."
III. Low Vegetation, Scrub Shrub, and barren segments where the majority local land use or zoning is natural succession
IV. Low vegetation and scrub shrub segments are classed to natural succession if
    a. the parcel contains a large percentage (~70% parcel coverage) of tree canopy and the segment area < 1000
    b. there is less than 15% CDL coverage of any kind and there is less than 93m^2 of road or building (opposite of "occupied parcel")
    c. the parcel has >70% TC, < 30% CDL of any kind, segment area < 150m^2, and parcel is > 4046
V. A third classification rule is applied where low vegetation, barren, or scrub shrub is adjacent to tree canopy segments >= 10,000m^2 in parcels > 4046m^2

Production Classes

Definition: All lands used for the production of food, fiber, energy, or minerals including cropland, pasture, orchards/vineyards, idle/fallow cropland, timber harvests, mines/quarries, and solar fields.

2013 LU Issues: Agricultural lands were not directly mapped due to the confidentiality of high-resolution farm field data (e.g., the Farm Service Agency's Common Land Unit data). Instead, all other land uses were mapped directly or with the aid of ancillary data and the left-over, unclassified lands were classed as agriculture by default. This resulted in overestimating agriculture in some rural counties where extractive activities and/or agricultural abandonment are prevalent and underestimating agriculture in some suburban counties due to overestimate of turf grass. Extractive lands such as mines and quarries and solar fields were not explicitly mapped and often classed as mixtures of impervious surfaces and turf grass. Timber harvests were not mapped resulting in an overestimation of forest loss and contributing to local overestimates of agriculture.

Summary Methods: Cropland, Pasture, and orchards/vineyards will be mapped simultaneously or directly after turf grass, using parcel and image segment characteristics and ancillary data from NASS Cropland Data Layer (CDL) (2017-2019) and USGS National Land Cover Database (NLCD) (2016). Solar fields will be mapped by

Chesapeake Conservancy using point data identifying potential solar field arrays from the United States Energy Information Administration and the Solar Energy Industries Association. Active mines and quarries will be mapped by Chesapeake Conservancy and Washington College using national, state, and local data. Timber harvests will be mapped using state data coupled with the USGS' Land Change Monitoring, Assessment, and Projection (LCMAP) database. The LCMAP data can be used to identify parcel-image segments that have exhibited forest rotations over the past 30 years (1985-2017). Note that the LCMAP data are only useful for identifying clear cuts. They have limited utility for identifying selective cuts. Moreover, once a harvested site regenerates to the point where samplings reach a height of ~6 meters and can then be identified in LiDAR and/or NAIP imagery as "Tree Canopy", the harvested site will be classified as "forest." It's important to distinguish succession following a harvest from natural succession because managed succession occurs at a faster rate than natural succession. This information is needed to accurately forecast forest dynamics into the future.

Technical Methods:

Cropland (Pending Decision):

I. Reclassify CDL into non-agricultural, cropland, pasture, idle/fallow, and orchards/vineyards.
II. If "Herbaceous", "Barren", or "Scrub-Shrub" segments have an area greater than or equal 1 hectare of the reclassified CDL cropland pixels, classify as "Cropland."
III. Identify adjacent "Herbaceous", "Barren", or "Scrub-Shrub" segments after "Turf Grass", successional and other non-cropland classes have been assigned in previous passes. If the segment is touching cropland and no other segments with confusable classes, classify as "Cropland."
    a. Repeat
IV. Identify adjacent "Herbaceous", "Barren", or "Scrub-Shrub" segments after "Turf Grass", successional and other non-cropland classes have been assigned in previous passes.

Pasture (Pending Decision):

I. If "Herbaceous", "Barren", or "Scrub-Shrub" segments have an area greater than or equal 1 hectare of the reclassified CDL pasture pixels, classify as "Pasture."
II. If "Herbaceous", "Barren", or "Scrub-Shrub" segments have an area greater than or equal 1 hectare and include 20% or greater coverage of pasture NLCD class, classify as "Pasture."
III. Identify adjacent "Herbaceous", "Barren", or "Scrub-Shrub" segments after "Turf Grass", successional and other non-pasture classes have been assigned in previous passes. If the segment is touching pasture and no other segments with confusable classes, classify as "Pasture."
    a. Repeat
IV. Identify adjacent "Herbaceous", "Barren", or "Scrub-Shrub" segments after "Turf Grass", successional and other non-pasture classes have been assigned in previous passes.

Orchards/Vineyards (Pending Decision):

I. If "Herbaceous", "Barren", or "Scrub-Shrub" segments have an area greater than or equal 1 hectare and include 20% or greater coverage of the reclassified CDL orchards/vineyards pixels, classify as "Orchards/Vineyards."
II. Identify adjacent "Herbaceous", "Barren", or "Scrub-Shrub" segments after "Turf Grass", successional and other non-orchards/vineyards classes have been assigned in previous passes. If the segment is touching orchards/vineyards and no other segments with confusable classes, classify as "Orchards/Vineyards".
    a. Repeat
III. Identify adjacent "Herbaceous", "Barren", or "Scrub-Shrub" segments after "Turf Grass", successional and other non-orchards/vineyards classes have been assigned in previous passes.

Solar Fields:

I. Identify “Herbaceous”, “Barren”, or “Scrub-Shrub” segments after “Turf Grass”, successional and other non-solar field classes have been assigned in previous passes. Intersect segments where their centroid falls within digitized solar field boundaries or AI solar field outputs and classify as “Solar Fields”

Harvested Forest:

I. “Herbaceous” or “Barren” segment contains greater than or equal to 10% of LCMAP detected timber harvest + deforestation, and the clearing occurred between 2015 and 2017, classify as “Harvested Forest.”

Extractive:

I. “Barren” or “Other Impervious” segments that intersect with ancillary active and abandoned mines dataset, classify as “Extractive.”

LUWG Decisions:
10-07-20: Solar fields will be mapped as four separate classes: “solar impervious”, “solar Barren”, “solar herbaceous”, and “solar Scrub-Shrub.”

Wetland and Water Margin Classes

Definition: Wetlands are areas that are perennially or intermittently saturated and exhibit related soil and vegetation characteristics including “tidal” wetlands, non-tidal “floodplain” wetlands, and isolated non-tidal “other” wetlands. Bare shore represents non-wetland Barren areas adjacent to surface waters and includes lake margins, beaches, exposed mudflats, and gravel bars.

2013 LU Issues: Because wetland characteristics are challenging to map using just LiDAR and NAIP imagery, field reconnaissance is required to verify hydric soil conditions, hydrologic connections, and the presence of wetland-dependent plant species. Lacking the resources to conduct a field campaign, the CBP Partners relied on existing data such as the National Wetlands Inventory (NWI) coupled with state wetland maps developed for Delaware, Maryland, and Virginia to map wetlands. For Pennsylvania, a modeling effort was supported in 2016 to map probabilistic wetlands (Raney and others, 2017) that could augment the NWI. In addition, manual updates to emergent wetland footprints in Maryland and Delaware were performed by the Chesapeake Conservancy and University of Vermont for wetlands recently impacted by development. While NWI attribute data can be used to discriminate between tidal and non-tidal wetlands, sole reliance on the NWI attributes for identifying tidal NWI wetlands resulted in classifying some isolated wetlands as tidal.

Emergent wetlands mapped by the Chesapeake Conservancy and University of Vermont were classed as “tidal” if they were within 2-meters of surface water based on a 10-meter Digital Elevation Model downloaded in 2015. Newer, high-resolution DEM’s now exist for some counties along the Bay shoreline.

Floodplains were mapped using County Soil Survey data on frequently flooded soils coupled with FEMA 100-year Digital Flood Insurance Rate Maps. These data are helpful but may omit potential floodplains along lower-order, headwater streams.

The extent of bare shore areas visible in NAIP imagery varies over time due to changes in water levels associated with the tides, rainfall, and reservoir management plans. Bare shore is included in the Phase 6 “mixed open” class. By mapping bare shore specifically, the CBP Partners may consider whether to include its change in future updates to CAST.

Summary Methods: Map all “Barren” land close to a large body of water as “bare shore.” Continue to rely on the NWI and state wetland datasets, and the probabilistic wetland dataset for Pennsylvania but expand this dataset to the entire watershed to represent the universe of verified and potential wetlands in the watershed. Update the tidal zone map using a 2-ft. rise above Mean Higher High Water as modeled by NOAA’s Sea Level Rise Viewer. Update the floodplain zone map using the latest available LiDAR imagery and the USGS’ Floodplain and Channel Evaluation Tool (FACET).

Technical Methods:

Data needed: LC Water, NWI (vector), UVM Wetlands (raster), NHFL FEMA 100-yr floodplain, SSGURGO hydric and frequently flooded soils, FACET 24k stream network (with channel metrics) or Hyper-resolution streams (2K)

Riverine and Terrene (Non-Tidal Wetlands): (pending decision):

I. Exclude "Freshwater Pond" and "Lake" from NWI wetland types and calculate the following for each polygon:
   a. Area
   b. Length
   c. Perimeter-area ratio (PAR) (Informs shape complexity. Large values are less complex and smaller values are more complex)
   d. Polsby-popper score (PPS) (informs shape compactness. 1 is circular/compact and 0 is not compact and irregular)
II. Latest version of NWI added elongated channel like features around NWI wetlands. This confounds stream versus wetland data for LU mapping purposes, so we eliminate any elongated features using PPS threshold (PPS > 0.1). The channelized features exist in the following wetland types:
   a. Freshwater Emergent Wetland
   b. Freshwater Forested/Shrub Wetland
   c. Riverine
III. Exclude any wetland polygons that intersect with open water layer classified as ponds
IV. Merge any supplemental wetlands with NWI such as Emergent Wetlands or any local wetland data
V. Create riverine mask to differentiate riverine verses terrene wetlands:
   a. Create hydric soils layer from SSURGO where 'hydclprs' >= 1
   b. Create frequently flooded soils layer from SSURGO where 'flodfreqdc' is 'Frequent'
   c. Use FEMA 100-year floodplain
   d. Use 60-ac stream network
   e. Riverine mask is combination of:
      i. Any hydric SSURGO segments that intersect with stream network
      ii. Any FEMA 100-yr floodplains that intersect with stream network
      iii. All frequently flooded soils
   f. Any wetlands that intersect with riverine mask is classed as "Riverine (Non-Tidal)" and rest are classed as "Terrene (Non-tidal)".

Tidal Wetlands (pending decision):

I. Only applies to tidal counties or where following wetlands exist 'Estuarine and Marine Wetland' and 'Estuarine and Marine Deepwater'
II. Extract Estuarine and Marine Wetland and Deepwater classes and dissolve the geometry call it NWI_Estuarine
III. Create a layer of "Freshwater Emergent Wetlands", dissolve the geometries and convert them from multipart to single part call it NWI_Emergent
IV. Intersect any NWI_Emergent wetlands that touch NWI_Estuarine
V. Merge both resulting polygons to create NWI Tidal Overlay

Bare Shore:

I. "Barren" segment is within 3 meters of water and is less than or equal to 15 square meters
II. Exclude "Barren" segments that are less than or equal to 100,000 square meters and intersect "Wetland" segments greater than or equal to 15 square meters
III. Exclude "Barren" segments that intersect with: mines, landfills, and local land use classes (suspended succession, extractive, agriculture, wetlands)
IV. Classify those Barren segments as "Bare Shore."

LUWG Decisions:

10-07-20: Bare shore = Barren land that is not wetland and adjacent to water

Schedule of Tasks and Coordination for CAST 21

2017 Land Use Production Schedule		2020			2021											
Order	Task	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	Local review of 2017 Land Cover Data	University of Vermont Spatial Analysis Laboratory														
2	Draft Hyper-resolution Hydrography	UMBC, Chesapeake Conservancy Conservation Innovation Center (CIC)														
3	Cropland, Pasture, Orchards, and Turf Grass	AGWG		AGWG	AGWG	AGWG	LUWG	AGWG, LUWG	AGWG, LUWG							
4	Suspended Succession, Bare Shore, and Solar Fields	LUWG				LUWG	USWG	USWG, LUWG	LUWG							
5	Tidal & NonTidal Wetlands	WWG		WWG		WWG		WWG, LUWG	WWG, LUWG							
6	Forests, Tree Canopy, Timber Harvests, and Natural Succession			FWG		FWG		FWG, LUWG	FWG, LUWG							
7	Bare Construction, P6 Roll-up Decision Rules, FedFac Land Uses				LUWG		USWG, FedFac	LUWG	LUWG							
8	Prototype Land Use in 14 counties			Chesapeake Conservancy (CIC)												
9	Approve 2017 LU Mapping and P6 Roll-up Methods (14 counties)								LUWG, WQGIT							
10	Complete 2017 Land Use Dataset (all 206 counties)						CIC									
11	Revise 2013 Land Use (to match 2017 for all counties)						CIC		LUWG	CIC						
12	Update MS4s, Sewer, Zoning, and Population Projections						CBP Land Data Team									
13	Revise Agricultural Forecast Methodology	AGWG					AGWG		AGWG							
14	Update Land Policy BMPs (future LULC scenarios)										LUWG					
15	Update 2013, 2017, and 2025 data for CAST-21										LUWG	WQGIT				
16	Public release- with streams, potential wetlands, minor fixes													WWG	LUWG	WQGIT