Mapping Proposed Phase 6 Land Uses and Related Information

I. INTRODUCTION

The goal for developing the Phase 6 Watershed Model Land Use Dataset is to spatially represent all major and unique source areas for nutrients and sediment. This paper outlines the intended meaning of each of the proposed Phase 6 land uses and related information (e.g., MS4 and Federal property boundaries), explains why the land use is relevant to water quality, and outlines various approaches for mapping each land use. The methods for mapping are described very generally at three levels corresponding to data resolution and effort. Level 1 methods are immediately feasible using nationally or regionally available moderate-resolution (30m) datasets. Level 2 methods require higher spatial resolution (1-5m) data, greater thematic resolution (land use), and/or greater amounts of analysis effort. Level 3 methods represent the highest resolution data and/or greatest amount of effort and therefore they will only be possible to implement for a minority of jurisdictions. Note that there are more than three ways to map these land uses. The three levels outlined in this paper are meant to provide a general sense of what is possible given the land use/cover data received to date from local jurisdictions (Figure 1). Final methods will vary by state and/or by county and developing these methods will be a major focus of the Land Use Workgroup over the next year. While this approach will introduce spatial variation in errors and uncertainty across the Chesapeake Bay watershed, it is assumed that those errors will be more than compensated for by the increased accuracy of the data in places where the CBPO has received local land cover/use information. For some land uses, following the method descriptions is a list of POTENTIAL sub-classes for inclusion. These sub-classes further discriminate the type of land use and were suggested by CBP workgroups to be included in the Phase 6 land use based on one or more decision criteria: 1) land use exhibits unique nutrient and sediment load/processing characteristics; 2) land use is associated with a particular type(s) of Best Management Practice(s); and 3) land use is needed to help target local implementation of BMPs.

As a reviewer of this document, please consider whether the proposed sub-classes, e.g., residential vs. non-residential impervious cover, have water quality relevant characteristics that are unique from their parent land use, e.g., impervious cover. For example, if we know how much impervious cover is hydrologically connected vs. disconnected, does there remain a need to distinguish residential from commercial impervious? Can this be addressed outside of the CBP watershed model (i.e., by a County overlaying their land use data on the Phase 6 land use data)? Some potential land classes, such as low-density residential or protected forests, may be desired to inform various policy decisions or CBP Partnership commitments but are not relevant to estimating nutrient and sediment loads via the Phase 6 Watershed Model. Such land uses should not be included in this list.

Acronyms

AFOs	Animal Feeding Operations
BMPs	Best Management Practices
CAFOs	Confined Animal Feeding Operations
CBP	Chesapeake Bay Program
CSS	Combined Sewer Systems
DEM	Digital Elevation Model
DFIRMS	Digital Flood Insurance Rate Maps

FEMA	Federal Emergency Management Agency
Landsat TM	Landsat Thematic Mapper (Landsat satellites #5, 7, or 8)
LiDAR	Light Detection and Ranging
MODIS	Moderate Resolution Imaging Spectroradiometer
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agricultural Statistics Service
NAVTEQ	Name of private mapping company
NHD-H	National Hydrography Dataset- High resolution (1:24,000 scale)
NHD-Plus	National Hydrography Dataset- Plus (1:100,000 scale)
NWI	National Wetlands Inventory
PAD_US	Protected Areas Database- United States
STAC	Scientific and Technical Advisory Committee
USDA	United States Department of Agriculture

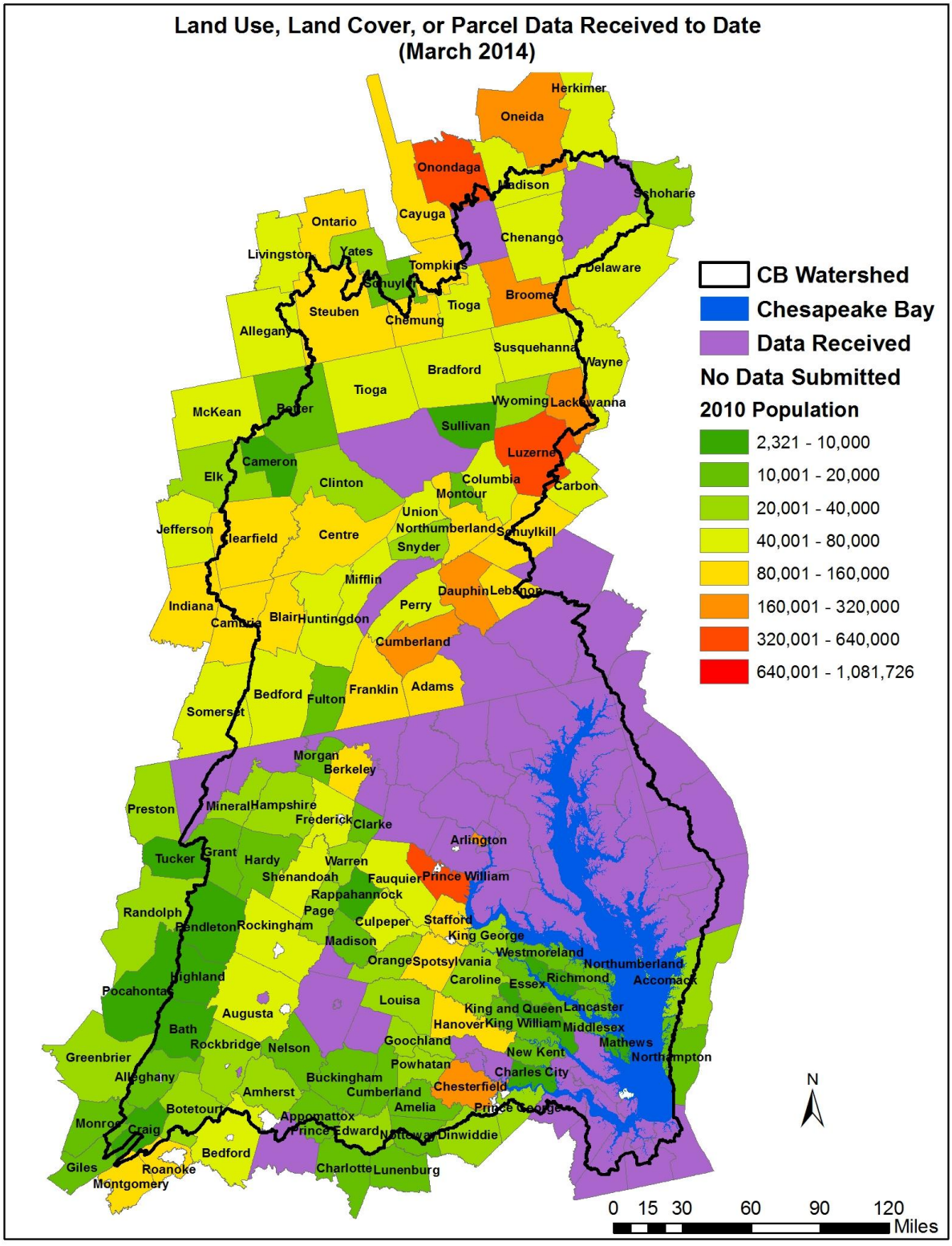

Figure 1. Coverage of counties that have supplied some local data.

II. DEVELOPED LAND COVER/USE

Impervious surfaces

What: Paved surfaces (e.g., roads, parking lots, driveways, and sidewalks), building footprints (e.g., houses, commercial/industrial, confined animal operations and other out-buildings), and rock outcrops.

Why: Impervious surfaces alter stream flows, reduce groundwater recharge, and convey nutrients, sediments, and contaminants into waterways.

How...

Level 1: Classified moderate-resolution (Landsat) imagery in combination with data on roads, housing, and associated impervious surface coefficients (approach used in Phase 5.3.2)

Level 2: Planimetric data (roads, buildings, and parking lots represented as vectors) or parcel data coupled with impervious surface coefficients.

Level 3: Classified high-resolution remotely sensed imagery coupled with LiDAR and/or planimetric data.

Potential sub-classes: Residential, Non-residential (e.g., Commercial, Industrial, Institutional), and Roads.

Relevant activities: STAC Peculiarities of Perviousness Workshop, Tetra Tech Literature Review

Pervious developed surfaces

What: Turf grass and herbaceous/woody landscaped areas within residential, commercial, industrial, and institutional parcels and major transportation corridors. May include golf courses, and urban/suburban cemeteries and landfills.

Why: Residential lawns and golf courses may receive fertilizer inputs and may be compacted and/or saturated, functioning similarly to impervious surfaces.

How...

Level 1: Classified moderate-resolution (Landsat) imagery in combination with data on roads, housing, and associated impervious surface coefficients (approach used in Phase 5.3.2)

Level 2: Local land use and/or tax parcel data coupled with high or moderate-resolution land cover data.

Level 3: Classified high-resolution remotely sensed imagery coupled with land use and/or planimetric and tax parcel data.

Potential sub-classes: Residential, Non-residential, Golf Courses, High-fertilized Turf, Low-fertilized Turf, Landscaped/Scrub-shrub.

Relevant activities: STAC Peculiarities of Perviousness Workshop, Tetra Tech Literature Review

Dirt and Gravel Roads

What: Unimproved roads with dirt or gravel substrate (e.g., logging roads, fire breaks, etc.)

Why: Dirt and gravel roads have unique loading rates, particularly for sediment, and unique BMPs.

How...

Level 1: Utilize state vector datasets representing the location and extent of dirt and gravel roads. In absence of such data, use NAVTEQ database to identify unimproved roads.
Level 2: Identify/classify dirt and gravel roads using high-resolution aerial or satellite imagery.
Level 3: None.

Relevant activities: Tetra Tech literature review on urban source loads.

Connected impervious surfaces (implies all other impervious surfaces are disconnected)

What: Impervious surfaces that are hydrologically connected to stream channels via stormwater conveyance systems or spatial contiguity (e.g., dense urban areas). In contrast, runoff from disconnected impervious surfaces may detained/ intercepted by pervious surfaces and/or ponds on its pathway downslope to the stream channel.
Why: Hydrologically connected impervious surfaces have a disproportionate impact on stream flow and the delivery of nutrients and sediments relative to disconnected surfaces.
How...
Level 1: Contiguous patches of impervious surfaces adjacent to stream channels and/or high-density developed areas mapped with moderate-resolution data.
Level 2: Contiguous patches of impervious surfaces adjacent to stream channels and/or high-density developed areas mapped with high-resolution data.
Level 3: Impervious surfaces within stormwater conveyance system drainage areas and/or spatially contiguous to stream channels.

Potential sub-classes: Residential, Non-residential (e.g., Commercial, Industrial, Institutional), and Roads.
Relevant activities: STAC Peculiarities of Perviousness Workshop, Tetra Tech literature Review

Connected pervious developed surfaces (implies all other pervious developed surfaces are disconnected)

What: Pervious surfaces that are assumed to function similarly to impervious surfaces due to frequent saturation and/or presumed compaction and that are hydrologically connected to stream channels via stormwater conveyance systems or spatial contiguity (e.g., dense urban areas).
Why: Hydrologically connected pervious surfaces have a disproportionate impact on stream flow and the delivery of nutrients and sediments relative to disconnected surfaces.
How...
Level 1: The reciprocal value of the impervious surface percentages within contiguous patches of developed areas adjacent to stream channels and/or high-density developed areas mapped with moderate-resolution data.
Level 2: Non-impervious lands within some distance of contiguous patches of impervious surfaces adjacent to stream channels and/or high-density developed areas mapped with high-resolution data.
Level 3: Non-impervious lands within stormwater conveyance system drainage areas and/or spatially contiguous to stream channels.

Potential sub-classes: Residential, Non-residential, Golf courses, High-fertilized turf, Low-fertilized turf, Landscaped/scrub-shrub.
Relevant activities: STAC Peculiarities of Perviousness Workshop, Tetra Tech Literature Review

Urban Tree Canopy

What: Small patches of tree canopy (the area encompassed by the canopy of individual trees) within developed areas and assumed to have a managed understory consisting of turf grass, herbaceous vegetation, shrubs, and/or impervious surfaces. Examples include trees in residential lots, small urban parks, landscaped areas, and adjacent to roads.

Why: Tree canopies intercept and dissipate the energy from precipitation events. The roots of trees uptake water and promote infiltration through the soil. These functions result in reduced runoff volumes from impervious and pervious developed surfaces.

How...

Level 1: Tree canopy (National Tree Canopy Dataset, 2001) patches smaller than some size threshold within 2010 Census Urbanized Areas and Urban Clusters.

Level 2: Moderate-resolution tree canopy within developed land uses

Level 3: High-resolution tree canopy data within developed land uses

Potential sub-classes: Urban Street Trees, Urban Lawn Trees.
Relevant activities: STAC Peculiarities of Perviousness Workshop, Riparian Buffer and Tree Canopy Expert Panel

Urban Stream Corridor

What: Urban stream channels (potentially including adjacent riparian zone/floodplain).

Why: Urban stream corridors exhibit high levels of bank erosion and high dissolved inorganic nitrogen loads during dry weather via illicit discharges, sewage overflows and sewage exfiltration.

How...

Level 1: Identify all NHD-Plus (1:100K) stream reaches within 2010 Census Urbanized Areas

Level 2: Identify all NHD-H (1:24K) stream reaches with drainage areas composed of >=10% impervious surfaces.

Level 3: Identify all NHD-H (1:24K) stream reaches and/or locally mapped stream reaches associated with connected impervious surfaces.

Relevant activities: STAC Peculiarities of Perviousness Workshop

Construction

What: Lands under construction are in the early process of becoming developed and are regulated by each state through their respective Erosion and Sediment Control permitting systems.

Why: Lands under construction generate the most sediment per unit area compared to all other land uses they are also significant (per unit area) sources of sediment.

How... (not mappable)

Level 1: Acreage under active E&S permit reported by county and distribute to modeling segments based on relative amount of land cover/housing change occurring within each segment.
Level 2: Acreage under active E&S permit reported directly by modeling segment.
Level 3: None.

Extractive

What: Surface mines, quarries, gravel pits, and abandoned mine lands.
Why: Extractive lands do not generate the same high levels of sediment and nutrients as lands under construction but they still constitute an independently managed source that may be locally significant.
How...
Level 1: Acreage of mined areas reported as point attributes with inferred acreage of active or "disturbed" area.
Level 2: Acreage of mined areas reported as polygons with inferred acreage of active or "disturbed" area.
Level 3: Acreage of actively and reclaimed mined areas reported as polygons with complete date attributes (year of initial disturbance and year of completed reclamation).

Potential sub-classes: Active mines, Reclaimed mines.

Regulated Areas

What: Municipal Separate Storm Sewer Systems (MS4s) and Combined Sewer Systems (CSSs).
Why: National Pollutant Discharge Elimination System (NPDES) permit requirements require management of runoff transported through municipally managed storm sewers. Combined Sewer Systems exist in the District of Columbia and in a few other older urban areas throughout the Bay watershed. They are unique in that runoff from impervious surfaces draining to these systems is treated during low and moderate intensity/duration storm events but during high intensity/duration storm events, both untreated sanitary waste and urban runoff will overflow untreated into receiving waters.
How...
Level 1: Use 2010 Census Urban Area boundaries combined with data provided by state agencies to characterize the extent of MS4 and CSS boundaries.
Level 2: Supersede state and Census data with municipal and/or county defined regulated areas.

Potential sub-classes: MS4 service area, CSS service area.

Federal Property Boundaries

What: Properties owned and managed by federal agencies.
Why: Federal agencies are responsible for managing their load contributions and federal property managers are intimately knowledgeable about the land use within their parcel. Often, open land on federal properties is confused with agricultural lands. Identifying which facilities are, and are not, managing or leasing land for agricultural purposes will help refine the spatial allocation of the Census of Agriculture.
How...

Level 1: Continue to collect federal property boundary data from directly from agencies and PAD US and attribute the properties with land use information using the techniques described in this paper.
Level 2: Develop a web service to enable federal property managers to review, add and edit the boundaries of their properties and their proportions of major land uses.
Level 3: Acquire high-resolution land cover and land use data from facility managers.

Potential sub-classes: US Forest Service, Department of Defense, National Park Service, US Fish and Wildlife Service, Other; or list top 24 or all 31 federal agencies.
Relevant activities: Federal Facilities Team input.

Population on Sewer

What: Population residing within areas served by sewer.
Why: Sewer systems generally have lower per-capita nitrogen loads (depending on treatment technology) compared with typical onsite individual septic systems.
How...
Level 1: Collect polygon data on sewer service areas and where such data is not available, model sewer service areas based on 2010 population density and 1990 Census population served by sewer attributes (last year such data were reported). Overlay sewer service areas with 1990, 2000, and 2010 population distributed to 30m cells.
Level 2: Aggressively collect sewer service area data for Wastewater Treatment Plants that have not provided such data.
Level 3: Implement Level 2 plus map sewer service areas for all Wastewater Treatments Plants that lack such data.

Population on Septic

What: Population residing outside areas served by sewer.
Why: Onsite individual septic systems generally have higher per-capita nitrogen loads (depending on treatment technology) compared to Wastewater Treatment Plants.
How...
Level 1: Collect polygon data on sewer service areas and where such data is not available, model sewer service areas based on 2010 population density and 1990 Census population served by sewer attributes (last year such data were reported). Overlay sewer service areas with 1990, 2000, and 2010 population distributed to 30m cells.
Level 2: Aggressively collect sewer service area data for Wastewater Treatment Plants that have not provided such data and collect information from local jurisdictions on septic system type.
Level 3: Implement Level 2 plus map sewer service areas for all Wastewater Treatments Plants that lack such data.

Potential sub-classes: Commercial/Retail, Mass Drain Fields, Shallow Drain Fields, Failing Systems, Direct Discharges
Relevant activities: Additional Onsite Septic System Expert Panel to address soil attenuation.

III. NATURAL LAND COVER/USE

Forest

What: Large patches of tree canopy above a size threshold that are assumed to have an unmanaged understory. The size threshold is used to infer unmanaged understory conditions and is yet to be determined but it could be in the range of 1-3 acres. Smaller tracks of tree canopy within urban areas would be considered Urban Tree Canopy and outside of urban areas would be considered Mixed Open. Note that wooded pasture may have to be subtracted from total forest area unless the two are conflated.

Why: Forests (and wetlands) are the lowest loading land uses for nutrients and sediments and therefore warrant distinction from all other land uses.

How...

Level 1: Contiguous patches of tree canopy (National Tree Canopy Dataset, 2001) over a particular size threshold and/or at a specified distance from developed areas.

Level 2: Contiguous patches of tree canopy (high-resolution land cover) over a particular size threshold and/or at a specified distance from developed areas.

Level 3: Contiguous patches of tree canopy (high-resolution land cover) over a particular size threshold and outside developed land uses.

Disturbed Forest

What: Disturbance is forest that has been harvested or defoliated by insects or fire.

Why: Harvested forests have sediment loads approximately 10x the load for undisturbed forests. Forests that are defoliated by insects, acid deposition, and fire also process nutrients less efficiently compared with undisturbed forests.

How...

Level 1: Continue to assume 0.33% of all forests are harvested during any particular year. Overlay analysis of forest disturbance from MODIS data to estimate annual extent of disturbance post 2001 or use Landsat to estimate annual extent of disturbance post 1984.

Level 2: Estimate forest harvest rates uniquely for different regions of the CBW using Forest Inventory and Analysis Data and/or forest product tax receipts. Use MODIS and Landsat to map canopy disturbance as described above.

Level 3: Collect annual timber harvest data from state agencies. Use MODIS and Landsat to map canopy disturbance as described above.

Potential sub-classes: Clear Cuts, Selective Cuts, Fire Scars, Insect defoliation

Mixed Open (rural herbaceous/ scrub-shrub/ small-patch tree canopy)

What: Former forests undergoing secondary succession, fallow/idle/abandoned agricultural lands, rural landfills and cemeteries, rural institutional lands, small patches of trees outside developed areas. Mixed Open areas are unfertilized, hydrologically disconnected, and lack the canopy and root structure of forests. They differ from disconnected pervious developed surfaces only because they are rural and lack fertilizer inputs.

Why: These areas are prevalent in some parts of the watershed and may have loads that are distinct and lower than disconnected pervious developed surfaces due to their lack of fertilizer inputs.

How...

Level 1: Estimate (don't map) by subtracting area of all other classes from the total modeling segment area.

Level 2: Map using local land use or zoning data to distinguish from agricultural and developed lands.
Level 3: Map using a combination of high-res land cover and land use/zoning data.

Floodplains

What: Flat valley bottom landforms adjacent to streams that are periodically inundated during 1-2 year frequency storm events.
Why: Floodplains trap sediment and attenuate flow velocities during storm events.
How...
Level 1: Overlay of FEMA Digital Flood Insurance Rate Maps (DFIRMs), frequently flooded soils (SSURGO), National Wetlands Inventory, and GAP land cover.
Level 2: Overlay of FEMA DIRMs coupled with floodplain landforms derived from a 10m-resolution Digital Elevation Models (DEMs).
Level 3: Locally defined and mapped floodplains or floodplain landforms mapped using a combination of LiDAR, 10m-resolution DEMs, and stream gauge records.

Relevant activities: STAC Peculiarities of Perviousness Workshop, USGS pilot study to map floodplains using multi-resolution DEMs and ancillary data.

Riparian Forests

What: Forests immediately adjacent to and within some specified distance (usually 25 – 100ft) of stream channels
Why: Riparian forests intercept overland and shallow subsurface flows, trapping sediment and uptaking water and associated nutrients in the process. Riparian forests also stabilize banks and trap sediment associated with flood flows.
How...
Level 1: Buffer all 1:100K National Hydrology Dataset (NHD-Plus) stream flowlines, waterbodies, water areas that are connected to the flowlines by 30m. Subtract out all open water areas. Intersect with moderate-resolution tree canopy.
Level 1a: Use a variable buffer width based on flowpath length derived from a 30m DEM through agricultural lands intersecting each portion of the buffer (i.e., riparian buffers downslope of extensive agricultural areas should be wider than those downslope of smaller agricultural areas).
Level 2: Buffer all 1:24K National Hydrology Dataset (NHD-H) stream flowlines, waterbodies, water areas that are connected to the flowlines by 30m. Subtract out all open water areas. Intersect with moderate-resolution tree canopy.
Level 2a: Use a variable buffer width based on flowpath length derived from a 10m DEM through agricultural lands intersecting each portion of the buffer.
Level 3: Buffer locally mapped streams by 100-ft and intersect with high-resolution tree canopy.
Level 3a: Use variable width derived from LiDAR DEM coupled with high-resolution land cover and land use data.

Relevant activities: STAC Peculiarities of Perviousness Workshop, Riparian Buffer and Tree Canopy Expert Panel

Wetlands

What: Tidal and freshwater marshes, upland and floodplain depressional areas with obligate vegetation and hydric soils.
Why: Non-tidal wetlands store water and may trap sediments and retain, uptake, and transform nutrients. Tidal wetlands dissipate wave energy, metabolize

nutrients, and both stabilize and trap sediments. These functions are variable over space and time.

How...

Level 1: National Wetlands Inventory (NWI) and state/local wetland inventories.

Level 2: NWI and state/local wetland inventories coupled with salinity data and Topographic Wetness Index and elevation (for marshes) derived from a 10m Digital Elevation Model.

Level 3: NWI and state/local wetland inventories coupled with salinity data and Topographic Wetness Index and elevation (for marshes) derived from 1-2m LiDAR imagery.

Potential sub-classes: Tidal vs. Non-tidal; or Tidal, Riverine, Palustrine/Lacustrine; or Tidal Salt, Tidal Brackish, Tidal Fresh, High Marsh, Low Marsh, Swamps, Riverine, Palustrine/Lacustrine.

Relevant activities: Habitat GIT input, Wetlands Expert Panel

Open Water

What: Lakes, reservoirs, ponds, and rivers visible in Landsat TM imagery (those with exposed widths of 30'-50').

Why: Open water areas store water and therefore may have a major influence on stream response to storm events.

How...

Level 1: Land cover data (30m) coupled with 1:100K or 1:24K National Hydrography Dataset water bodies and water areas.

Level 2: Local land cover data or stormwater pond databases coupled with Level 1 methods.

Potential sub-classes: Lakes, Ponds, and Streams

Beaches

What: Beaches are sandy areas adjacent to the Bay. Beaches are concentrated in the Norfolk/Hampton Roads area.

Why: Beaches are concentrated in the Norfolk/Hampton Roads area and compose a sizable portion for urban jurisdictions such as Virginia Beach. Sandy beaches are highly porous and do receive fertilizer although they may function similarly to open water for the purposes of modeling loads to the Bay.

How...

Level 1: Land cover data (30m) coupled with 1:100K or 1:24K National Hydrography Dataset water bodies and water areas.

Level 2: Local land cover data or stormwater pond databases coupled with Level 1 methods.

Potential sub-classes: Lakes, Ponds, and Streams

IV. AGRICULTURAL LAND USES

Farmsteads

What: Structures including houses, garages, livestock facilities, manure storage sheds, paddocks, and pervious land surrounding structures on farms. Note that the Census of Agriculture reports "Land in Farmsteads, buildings, livestock facilities, ponds, roads, wasteland, etc." The acreage reported in this category

represents the remainder of land on the farm after accounting for all other categories and according to NASS little effort is invested in verifying the accuracy of these particular data.

Why: Impervious and pervious surfaces surrounding farm structures may have unique loads due to the transport of chemical fertilizers and manure and localized ammonia emissions.

How...

Level 1: Drop this class and assume it is accounted for under disconnected impervious and pervious surfaces. Add a new category just for AFOs/CAFOs.

Level 2: Multiply the number of farms by sampled estimates of farmstead area per state derived from aerial imagery.

Level 3: Overlay high-resolution land cover and land use to determine impervious farmstead area.

Potential sub-classes: AFOs, CAFOs, Non-AFOs

Cropland

What: Fields planted with row crops such as corn, soybeans, wheat, hay, and vegetables.

Why: Row crops generally have the highest nutrient loads per unit area compared with all other land uses except moderate-high density urban coupled with wastewater loads. Row crops also receive unique BMPs.

How...

Level 1: Use five-year Census of Agriculture to determine the acreage of each crop type by county. Use annual NASS data to determine annual variation (% changes) in major crop extents between Census years. Use the USDA Cropland Data Layer to spatially distribute major crops to non-urban, non-forest lands within each modeling segment.

Level 2: Same as Level 1 except refine spatial location of agriculture using local land use data.

Level 3: Same as Level 2 except further refine spatial location using land use AND high-res land cover data.

Potential sub-classes: Corn for Grain followed by Fallow, Corn for Silage followed by Fallow, Corn for Grain followed by Small Grains, Corn for Silage followed by Small Grains, Soybean followed by Small Grains, Soybean followed by Fallow, Fallow or Failed Crops

Pasture

What: Pasture (herbaceous/grass land cover) used for grazing. Note that wooded pasture will most likely be confused with forest and therefore should either be subtracted from forest acres or subtracted from mixed open unless local data enable the discrimination of wooded pasture.

Why: Pasture receives direct inputs of manure from grazing farm animals.

How...

Level 1: Use five-year Census of Agriculture to determine the acreage of pasture/hay by county. Use annual NASS data to determine annual variation (% changes) in pasture area between Census years. Use the USDA Cropland Data Layer to spatially distribute pasture acres to non-urban, non-forest lands within each modeling segment.

Level 2: Same as Level 1 except refine spatial location of agriculture using local land use and FSA Common Land Unit data.
Level 3: Same as Level 2 except further refine spatial location using land use AND high-res land cover data.

Potential sub-classes: Open Pasture, Wooded Pasture, Degraded Riparian Pasture.

Legume and Other Forage

What: Alfalfa and other types of hay/forage.

Why: Legume and other forage have unique loading and management characteristics.

How...

Level 1: Use five-year Census of Agriculture to determine the acreage of hay by county. Use annual NASS data to determine annual variation (% changes) in hay area between Census years. Use the USDA Cropland Data Layer to spatially distribute pasture and hay acres to non-urban, non-forest lands within each modeling segment.
Level 2: Same as Level 1 except refine spatial location of agriculture using local land use and FSA Common Land Unit data.
Level 3: Same as Level 2 except further refine spatial location using land use AND high-res land cover data.

Potential sub-classes: Legume Forage, Other Forage.

Nurseries, Orchards, and Sod farms

What: Nurseries are places that sell herbs, shrubs, and trees used for residential, commercial, and institutional gardens and landscaping purposes. Sod farms produce rolls of turf grass for residential and commercial, and institutional landscaping. Orchards are farms with groves of fruit or nut trees with some specializing in Christmas trees.
Why: Nurseries, orchards, and sod farms all have unique loads and unique management characteristics.

How...

Level 1: Use five-year Census of Agriculture to determine the acreage of nurseries, orchards, and sod farms by county. Use annual NASS data to determine annual variation (% changes) in area between Census years. Use the USDA Cropland Data Layer to spatially distribute the acres of nurseries, orchards, and sod farms to non-urban, non-forest lands within each modeling segment.
Level 2: Same as Level 1 except refine spatial location of agriculture using local land use and FSA Common Land Unit data.
Level 2a: include industry location data
Level 3: Same as Level 2 except further refine spatial location using land use AND high-res land cover data.
Level 3a: include industry location data

Potential sub-classes: Covered Nurseries, Uncovered Nurseries, Orchards, and Sod Farms

Idle/Fallow Agricultural Land

What: Idle/fallow lands are fields that not actively managed for one or more years. They receive no fertilizer or manure and essentially undergo secondary succession until placed back into production. This class may load similarly to mixed open and therefore could be combined with mixed open.

Why: Because idle/fallow lands are not in production, their loads are lower than pasture and cropland and may be distinct from mixed open due to high residual nutrient concentrations remaining in the soil horizon.

How...

Level 1: Use five-year Census of Agriculture to determine the acreage of pasture by county. Use annual NASS data to determine annual variation (% changes) in idle/fallow area between Census years. Distribute idle/fallow acres proportionally based on distribution of mixed open.

Level 2: Same as Level 1 except refine spatial location of agriculture using local land use and FSA Common Land Unit data.

Level 3: Same as Level 2 except further refine spatial location using land use AND high-resolution land cover data.