NONPOINT SOURCE ASSESSMENT AND PRIORITIZATION

The assessment of nonpoint source (NPS) pollution potential is performed at the 6th level (12-digit) hydrologic units of the National Watershed Boundary Dataset (NWBD) (referred to as hydrologic units or units). It has been prepared by the Virginia Department of Conservation and Recreation (DCR) and the Virginia Department of Environmental Quality (DEQ) to provide a comparative evaluation of the state's waters on a hydrologic unit basis. This comparative evaluation can be used to target limited resources and funds for NPS pollution reduction activities to areas where they are most needed (for example the Virginia Agricultural Cost Share Program, VACS). The key results of the assessment include statewide nutrient and sediment load quantification and a ranking of hydrologic units as high, medium, or low priority based on those loads. The twelve pollutant-based priority rankings are presented in a series of maps and tables for each major source sector including agriculture, forestry, and urban, with an additional series of maps representing the combined pollutant ranking.

Both the assessment and prioritization rely on data and processes provided by the following organizations: DCR, DEQ, Virginia Department of Forestry (VDOF), US Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS), local Soil and Water Conservation Districts (SWCDs), Department of Biological Systems Engineering (BSE) at Virginia Tech (VT), Virginia Department of Health (VDH), Virginia Department of Wildlife Resources (DWR), Virginia Energy (VE), Center for Environmental Studies (CES) at Virginia Commonwealth University (VCU), US Environmental Protection Agency (EPA), Chesapeake Bay Program (CBP), US Geological Survey (USGS), Virginia Geographic Information Network (VGIN), US Department of Interior – Census Bureau, American Community Survey, and Climate Forecast System Re-analysis (CFSR).

NPS Potential Pollution Loadings

The NPS Assessment estimation of pollutant loadings is based on a calculation of the estimated edge of stream (EOS) loadings of nitrogen, phosphorus, and sediment per hydrologic unit using the Generalized Watershed Loading Functions (GWLF) model. The estimation of NPS pollutant loads as a basis for assessing water quality by hydrologic unit is consistent with Virginia's participation as a partner with the EPA's CBP in the calculations of NPS pollutant loads using the Chesapeake Bay Watershed Model (CBWM). Although Virginia uses CBWM results (particularly in CBP-related activities), they are obtainable only for the Chesapeake Bay Watershed (James, York, Rappahannock, Potomac, and Bay Coastal basins) portion of Virginia. Other state programs benefit from having measures similar to the CBWM loads for the non-Bay portion of the state. Since 2002, Virginia has used the GWLF model[1] to produce statewide NPS pollutant load results similar to those of the CBWM.

The 2022 GWLF assessment runs used and produced data for 1,240 of the 1,251 6th level hydrologic units in Virginia; the other 11 are exclusively water.

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[1] GWLF was chosen because it was configured for continuous simulation and produced EOS loads based on land-based loadings, fate, and the transport of pollutants, as does the CBWM. Both models also simulate seasonal variations, include surface and subsurface components, and represent both dissolved and particulate pollutants.

Model input data for the simulation period included:

1. Land uses from information compiled from the USDA-NASS cropland data layer, Ag census, and DCR.
2. Farm animal numbers and distribution, as well as corresponding manure generated.
3. Dominant crops by HU and correspondingly, the manure spreading periods by HU.
4. BMP generalized pass-through factors for active NPS BMPs.

The land use input was a model-specific form of classes. Table 5-1 lists the land use classification system used in the GWLF assessment runs and the equivalent generalized model output land use classes.

Original Source Class*	**Derived/Class**	**NPS Assessment**
Forest (VHRL)	Forest	Forest
Wetland (VHRL) - Emergent Wetland (CDL)	Forest	Forest
Trees (VHRL - portion)	Forest	Forest
Shrub/Scrub (VGIN)	Disturbed Forest	Forest
Barren Land (VGIN)	Disturbed Forest	Forest
Cropland (VHRL)	Conventional Tillage	Agriculture
Cropland (VHRL)	Conservation Tillage	Agriculture
Pasture (VHRL) and Farm Animals (VA, USDA)	Pasture Cattle-Grazed Pasture Litter Applied Unimproved Pasture	Agriculture
Hay (CDL)	Hay	Agriculture
Trees (VHRL - portion)	Pasture Cattle-Grazed	Agriculture
Farm Animals (USDA, VA)	Pasture Poultry Litter	Agriculture
	Manure Acres	Agriculture
Impervious Extracted (VHRL, CDL))	Impervious Urban	Urban
Impervious Local Data	Impervious Urban	Urban
Grass (VHRL)	Pervious Urban	Urban
Pervious Urban (CDL)	Pervious Urban	Urban
Trees (VHRL – portion)	Pervious Urban	Urban
Barren Land (VHRL)	Extraction/Barren	Part of Total Only
Open Water (VHRL)	Not Modeled	
Emergent Wetland (CDL)	Not Modeled	

Table 5-1: Land Use Classification

*VHRL: Virginia High Resolution Land use; CDL: USDA Cropland Data Layer; VGIN: Virginia Geographic Information Network

Output from the GWLF assessment runs is in the form of average annual loads (L) of each NPS pollutant (p: TN, TP, and TS) per modeled land use per unit. From this, two forms of unit area loads (UAL) were calculated: (1) per hectare (h) of general output land use class (l: agriculture, urban, and forest) per hydrologic unit (w) load (luUAL) and (2) per hectare of total modeled land (a) per hydrologic unit (w) load (UAL).

The luUAL value is preferable to the load values themselves when comparing the loading impacts of the individual output land use classes between hydrologic units. They are normalized in that the size of the hydrologic unit does not impact this value. This measure can isolate high loading rates of the general land use classes. It is calculated as:

$$luUAL(plw) = L(plw) / h(lw)$$

While the above calculation is useful, it does not necessarily identify those hydrologic units in which NPS reduction activities should be focused.[2] Therefore, the non-land use UAL was used for ranking hydrologic units in this assessment report, but significant luUAL values were used in flagging units in need of attention. The UAL per output land use class per pollutant for each hydrologic unit is calculated as follows:

$$UAL(plw) = L(plw) / h(aw)$$

The ranking of hydrologic units for NPS pollution is based on UAL values. The highest 20% of the values for each component are classified as “high,” the next 30% are classified as “medium,” and the remaining 50% are grouped as “low.” This ranking methodology applies to NPS pollutant loads only. These range definitions are not absolute, since units with equal or very similar loading values were not divided into different classes.

Statewide loadings by pollutant and amount of land in Virginia by general land use class based on edge of stream loads are in Table 5-2. Loading values in this table reflect the loads after reductions are applied from active BMPs installed over the nineteen-year period (1998-2017) by DCR, DEQ, VDOF, USDA-NRCS, local stormwater management agencies, and private nutrient management plan writers. Spatially attributed BMP and nutrient management plan effects are measured as both land use changes to the land use/land cover data set and as fractional reductions to the loadings by modeled land use.

[7] For instance, units with high loading rates for agricultural land may only have a small amount of this land use and therefore small total loads of pollutants from agricultural uses. Furthermore, any action (if possible) in any year could encompass all reasonable reduction activities, thus making this hydrologic unit less worthy of further attention.

	Units	Agricultural Class	Urban Class	Forestry Class	Other (Barren, Extractive, Channel Erosion, Septic)	Totals
Total VA Land Area #	Acres	4,685,724	2,900,455	17,463,440	69,952	25,118,571
% of VA Land	%	18.7	11.6	69.5	0.3	100
Total Nitrogen	10^6 Kg/year	27.8	9.2	14.4	10.4	62
% of all NPS N ^	%	45.0	14.9	23.3	16.8	100
Total Phosphorus	10^6 Kg/year	1.4	1.0	0.7	0.3	3.4
% of all NPS P ^	%	41.6	30.4	19.8	8.2	100
Total Sediment	10^6 Kg/year	1160	185	586	422	2,353
% of all NPS S ^	%	49.3	7.9	24.6	17.9	100

Table 5-2: 2022 Statewide NPS Pollutant Loads, Post BMP Reduction

Value does not include acres of non-forested wetlands (see Table 5-1).

^ Loads from Channel Erosion and Septics, which may sometimes be attributed to other Land Use classification (e.g. urban), from hydromodification and other impacts, were separated into their own category 'Other' with Barren and Extractive sources.

Agricultural NPS Pollution Loads

Agriculture is a large and diverse industry in Virginia and accounted for almost 19% of Virginia's land use in the year being assessed. While this percentage is significantly lower than the national average and continues to decline in Virginia, agricultural activities remain the most significant source of NPS pollution in the state. As shown in Table 5-2 for 2022 and as all past assessment model results likewise suggest, agricultural land in Virginia contributes NPS pollutant loads in greater proportion to the area they comprise than do other land use classes. Nonpoint source pollutants from agriculture originate from several different sources and have different associated impacts. Deposition to agricultural lands in the form of fertilizers and animal manures affect water quality when they reach groundwater reserves, are directly deposited to streams, or are washed into surface waters during rain events in either a dissolved state or with eroding soils. These sources produce pollutants which include bacteria (including possible pathogens) and nutrients. Farming practices can contribute to or retard runoff and can certainly affect the amount of soil lost from fields, which can potentially pollute water.

This assessment estimated the nutrient and sediment loads from agricultural areas, but not pathogen loadings. Factors in this assessment which affect the amount of nutrient loads reaching water from agricultural lands include soil erodibility, types of agricultural practices, types and numbers of farm animals, land cover, stream density, rainfall, seasonal variations in plant growth and nutrient applications, existence and type of agricultural BMPs, soil saturation, and slope.

UALs ranked by hydrologic unit of nitrogen, phosphorus, and sediment from agricultural land uses are displayed in linked Figures 5-1, 5-2, and 5-3, respectively. The rankings are also listed in Table 5-3.

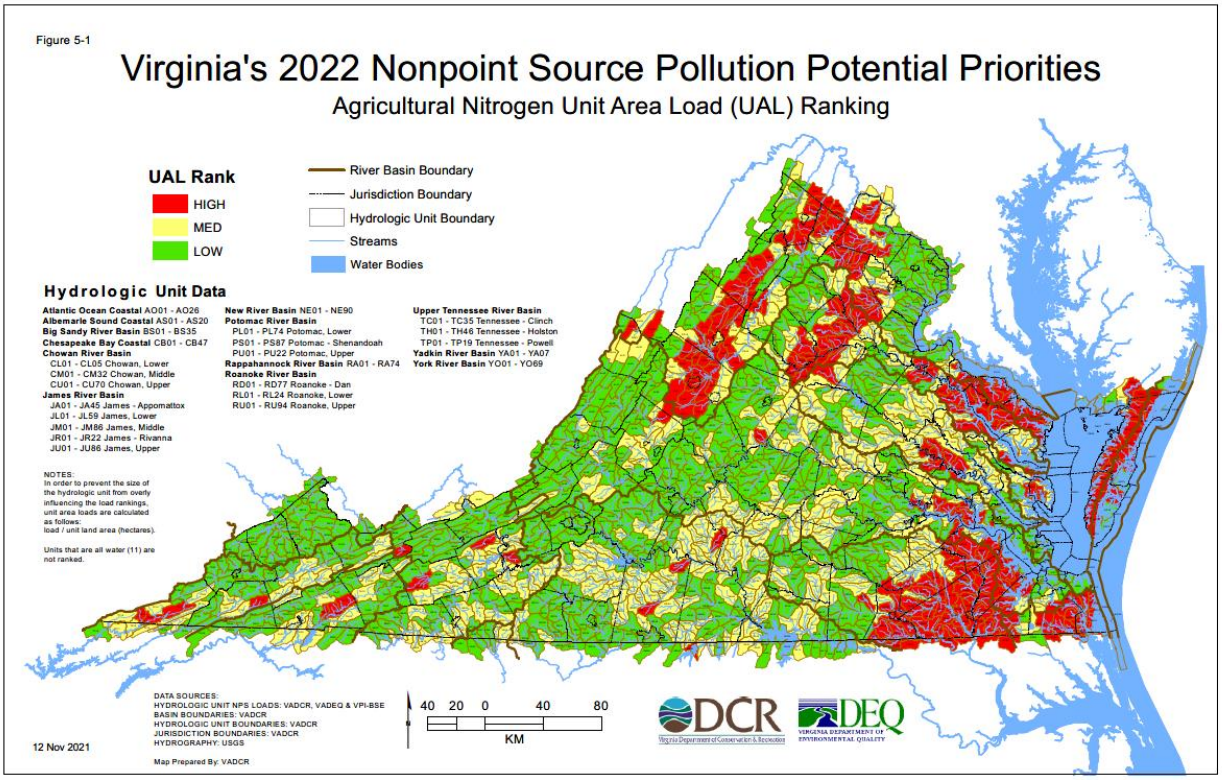

Figure 5-1: Agricultural Nitrogen Unit Area Load Ranking

Urban NPS Pollution Loads

Around 11.6% of the land in Virginia was considered urban for the year being assessed. Urbanized land produces NPS pollutants as the result of precipitation washing nutrients, sediment, and toxic substances from the impervious surfaces found in these areas. The sources of these surface contaminants include: air and rain deposition of atmospheric pollution; littered and dirty streets; traffic by-products such as petroleum residues, exhaust products, heavy metals, and tar residuals from the roads; chemicals applied for fertilization, control of ice, rodents and other pests; and sediment from construction sites. Improper industrial, commercial, and domestic connections to storm sewers also contribute various pollutants to waterways, as do inadequate and/or improperly maintained sewage disposal systems for both municipalities and individual homes.

This assessment estimated only nutrient and sediment NPS loads from urban areas. Factors that affect the amount of surface and channel erosion loads reaching water from urban lands include the degree of imperviousness, total impervious area, NPS pollutant build-up rates, stream density, rainfall, septic system use, direct discharges, soil saturation, and slope.

Septic loads were excluded from the urban load. Because septic loadings are not exclusive to the urban environment, they were simulated as an individual loading source in this assessment.

UALs ranked by hydrologic units for nitrogen, phosphorus, and sediment (as described in Table 5-2) from urban land uses are displayed in Figures 5-4, 5-5, and 5-6, respectively. The rankings are also listed in Table 5-3. Urban load measures are based on pollution potential and do not compensate for many of the urban runoff pollution control measures that may be in place in some areas. Such pollutant reduction measures are often installed by the private sector or municipal and local governments.

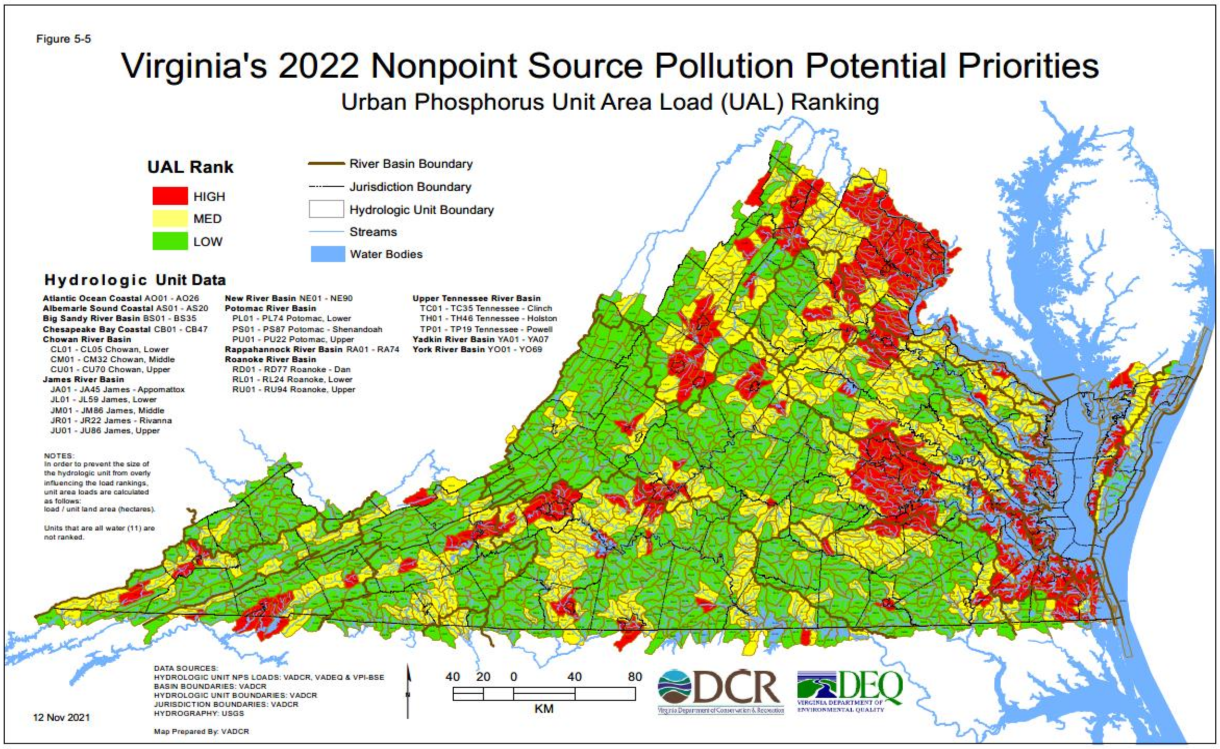

Figure 5-5: Urban Phosphorus Unit Area Load Ranking

Forestry NPS Pollution Loads

About 69.5% of Virginia's land area was forested in the year being assessed. Forestland in general produces lower NPS pollutant loads[3] per unit area than other land uses. Certain forest disturbing activities such as tree harvesting, site preparation, and reforesting, however, do contribute loads. As Table 5-2 shows, these activities contribute more to the sediment load than they do to other NPS pollutants.

Forestland can be harvested as part of a land use change such as residential development, clearing for agricultural fields, or surface mining. Due to the similar spectral signatures in classified land cover imagery of these land activities, as well as those of non-temporary land covers such as bare rock and beaches, it can be difficult to discern them from one another

[3]Airborne nutrient pollution is accounted for as part of the load of the land use it falls upon. The majority of the airborne nutrient load falls on forestland in Virginia and is therefore associated more with forestland than other uses.

without other associated data. VDOF tracks forest harvesting activities to facilitate the proper management of Virginia's forest resources relative to water quality.

Agricultural activities operate on a yearly or seasonal cycle on agricultural lands, but a single cycle of forest harvesting, site-preparation, and reforestation occurs over many years. Due to temporal and spatial overlap in silviculture cycles, measurement of these forest-disturbing activities in this assessment is more of a snapshot than a trend. Thus, the ranking of hydrologic units for forest-based loads varies more between NPS Assessments for forest harvesting units than do the loads of other land use classes when modeling and its parameters are kept constant.

Factors in this assessment that affect the amount of loads reaching water from forestland include soil erodibility, existence of disturbed forestland, stream density, rainfall, existence and effectiveness of forest (silviculture) BMPs, soil saturation, and slope.

UALs ranked by hydrologic units for nitrogen, phosphorus, and sediment produced by forestland are displayed in Figures 5-7, 5-8, and 5-9 respectively. The rankings are also listed in Table 5-3.

NPS Pollution Loads from Other Land Uses

Extraction and non-urban barren lands have not been lumped into any of the output land use classes regarding reporting loads or unit area loads (see Table 5-1); they are only reported as part of total loads. Therefore, they do not influence the ranking of units for any of the specific land use load classes. Likewise, loads from the non-sewered population and channel erosion are not reported as associated with any specific land use.

Resource extraction spatial data from VE allowed for the isolation of true extraction activities from reforesting sites, urbanization, or other land-disturbing activities. The spatial distribution of extraction land use was used in conjunction with county level recordings of extraction activity.

Approximately 8% of the phosphorous, 17% of the nitrogen, and 18% of the sediment load in the 2022 NPS Assessment was associated with loads from the non-sewered population, channel erosion, barren, and extractive land uses. The largest contributor of this group is the nitrogen load from failing septic systems and straight pipes (untreated). The most significant extraction land use loads occurred in the Tennessee and Big Sandy River basins.

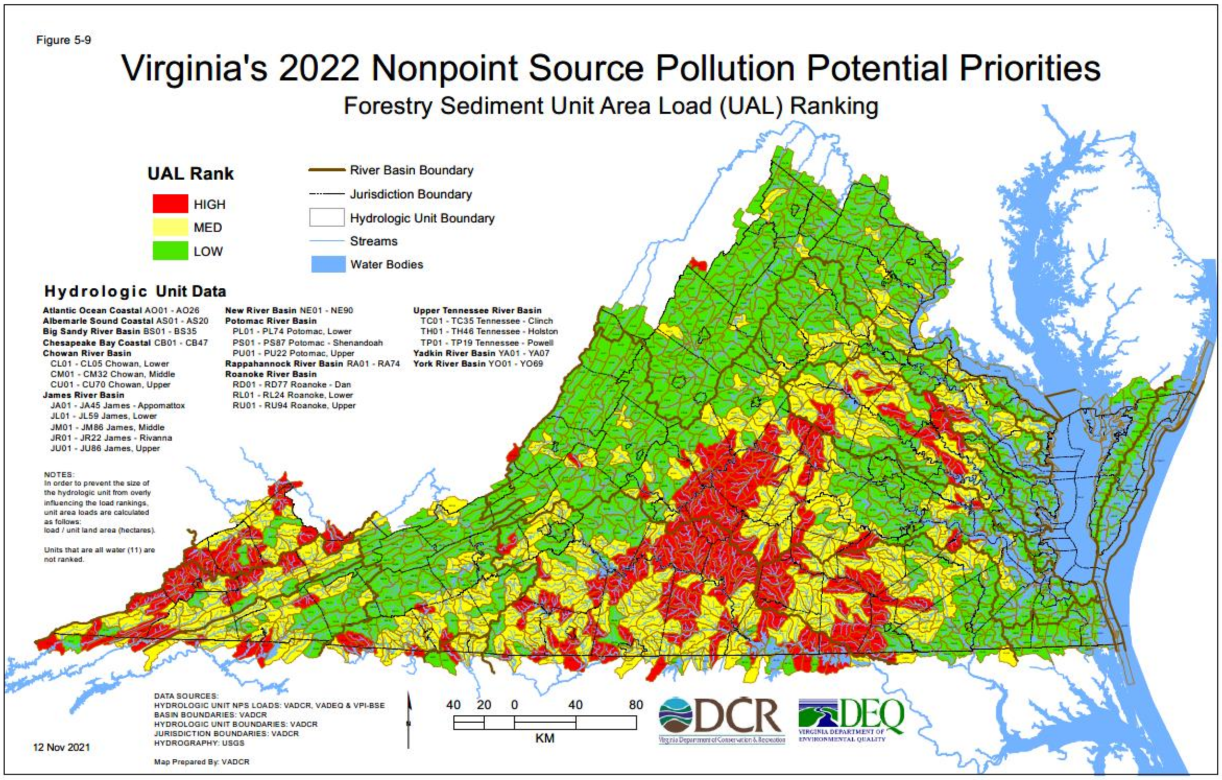

Figure 5-9: Forestry Sediment Unit Area Load Rankings

Total Loads by NPS Pollutant

Calculated total nitrogen, total phosphorus, and total sediment UAL from all land uses combined including the other uses noted above are displayed in linked Figures 5-10, 5-11, and 5-12, respectively and listed in Table 5-3. Total nitrogen is composed of septic nitrogen, groundwater nitrogen, dissolved nitrogen from various land uses, wash-off nitrogen from impervious surfaces, and sediment-attached nitrogen. Total phosphorus is composed of septic phosphorus, groundwater phosphorus, dissolved phosphorus from various land uses, wash-off phosphorus from impervious surfaces, and sediment-attached phosphorus. Total sediment instream load is the sediment yield from all land uses plus instream erosion.

The summing of NPS pollutant loads by land use into total NPS pollutant loads in this assessment is achieved simply by the addition of values with equivalent units (kg/ha/yr of nitrogen or phosphorus, Mg/ha/yr of sediment). The relative amount of the estimated NPS pollutants coming from one land use versus another is directly comparable and this comparison shows that NPS pollutants from agricultural lands dominate the total NPS pollutant loads although barren lands can be heavy contributors where they occur in greater frequency.

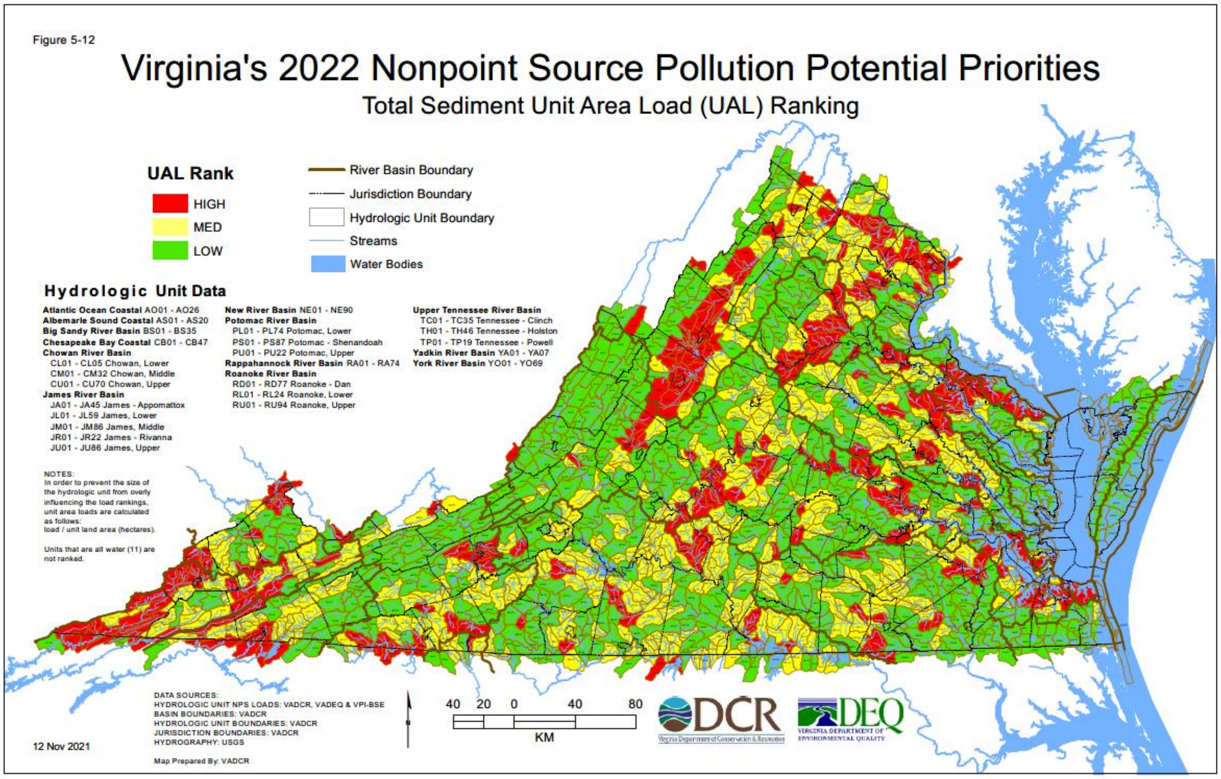

Figure 5-12: Total Sediment Unit Area Load Rankings

Water Quality Impairments

In accordance with EPA Clean Water Act (CWA) guidance and protocol, DEQ assembled a list of the impaired riverine, lacustrine, and estuarine waters of Virginia (303d report) in 2020. That list and associated assessment geodatabase are the basis for the impaired waters portion of this NPS Assessment. Similar to the rankings of estimated pollutant loads, the impaired waters ranking presents a series of maps depicting, by hydrologic unit, the relative proportion of waters that appear to be impaired due to NPS pollution.

Among the many defined attributes in the impaired waters assessment geodatabase are the names of the impaired waters, the beginning and ending spatial limits of the impaired portions, impairment causes, and impairment sources. Following is a brief overview of the generation of this prioritization ranking list and the evaluation of NPS-impacted waters, a subset of this assessment geodatabase. Included first were all the waters identified by DEQ staff as having NPS-related pollution sources. Additionally, this ranking included impaired waters which either did not list any point-source-related causes or if sources were unknown, those in which the source was likely NPS (i.e., urban or natural),[4] as corroborated by visual inspection of high-

[4] This included all fecal bacteria unknown sources since approximately 90% of non-urban fecal bacteria problems are surmised to be due to agricultural or natural animal loadings. Similarly, because about 85% of benthic impairments are believed to be sediment related, and because DEQ personnel are more likely to know and document point sources of benthic impairments, all benthic impairments of unknown sources are considered NPS-related. Impairments with nutrient sources were also included.

resolution imagery of the surrounding watershed(s). Excluded from the ranking list are those waters listed as impaired for toxics or occurring in primarily estuarine-influenced areas.

Waters in the impaired waters layer that are suspected of being impaired due to nonpoint sources were divided by the hydrologic unit boundaries into segments to allow for the summation of impaired water lengths or areas by these units. The same process was performed on all waters in the state to determine the total miles of riverine, acres of lacustrine, and square miles of estuarine waters per hydrologic unit; this allows for comparison of the total miles with the impaired portions.

The 2022 NPS Assessment focuses on nutrients and sediment; however, most of the NPS-impaired waters from the 2020 303(d) report are listed due to the presence of excess fecal bacteria. Total Maximum Daily Load (TMDL) studies have shown that pet wastes can contribute to high pathogen counts in some urban streams. Concentrations of wildlife can have a similar effect in various land use/land cover settings. Likewise, human wastes from straight pipe disposal, failing septic systems, or malfunctioning water treatment plants and their permitted collection system infrastructure can all contribute to the impairment of waters due to high levels of fecal bacteria.

A significant number of the waters that are impaired due to fecal bacteria are believed to be impaired because of farm animal wastes. The nutrient load calculation accounts for the number of farm animals by type and by unit, since most farm animal wastes are recycled back to the ground by the animals or in a more controlled mode by farmers who want to fertilize fields and/or remove wastes from confined animal sites. The controlled dispersal of wastes is a goal of nutrient management planning and a practice that DCR cost-shares with farmers to implement. The fencing-off of streambanks and construction of alternative water sources are two such practices specifically designed to keep cattle out of and away from streams to avoid both sediment loading from eroded streambanks and direct deposition of manure and its associated bacteria load.

The following rankings of hydrologic units by water regime consider only non-shellfish NPS-associated impairments.

Riverine Impairments

The summed lengths of NPS-impaired riverine water features in 2020 as miles per hydrologic unit were compared to the total assessed miles of riverine systems available per unit at the same scale[5] to determine the percentage of assessed riverine water miles per unit that were potentially NPS-impaired. The resulting ranking of this value is based on the value itself and not on a pre-set distribution of the range of calculated percentage values. The rankings of units for impaired assessed riverine waters are displayed in Figure 5-13 and listed in Table 5-3.

Estuarine Impairments

Most of the impaired mainstem estuarine water bodies in Virginia have listed impairment causes

[4] Since 2014 the scale has been 1:24,000, augmented by the inclusion of smaller streams designated as impaired.

that are not considered to be due to practices occurring in the immediate units that they flow through. There may be very little land associated with some of these units. Estuarine waters are also tidal and may show pollution effects from multiple areas, even if they are not mainstem estuarine waterbodies. For these reasons, the estuarine waters were not used in this assessment to rank the hydrologic units they pass through. Although there are NPS-impaired estuarine waters, it is difficult to associate them with specific upland NPS pollutant sources.

Lacustrine Impairments

Summed areas of impaired lacustrine waters in 2022 as acres per hydrologic unit were compared to the total assessed acres of lacustrine waters available per unit to determine the percentage of assessed lake and reservoir waters in a unit that were impaired. Although the land area of these units can be a source of NPS pollutants, so too can the incoming streams.

The ranking of this value is based on the value itself and not on a pre-set distribution of the range of calculated percentage values. Most of the hydrologic units in Virginia contained no impaired lake or reservoir waters in 2022. About 20% of the remaining units had very high percentages of impaired lacustrine waters. This distribution is in part due to the decreased unit sizes of the 6th level NWBD units but also attribution regarding their impairment source. The rankings of hydrologic units for impaired assessed lacustrine waters are displayed in Figure 5-14 and listed in Table 5-3.

Measures of Biological Health

Additional tools for evaluating the effects of NPS pollution include the VDH public surface water sources and their protection zones and an evaluation of the health of aquatic species in the state's waters conducted by the Center for Environmental Studies (CES) at VCU. These geospatial metrics provide additional means to prioritize water quality protection, the protection of public drinking water sources and of natural aquatic communities, respectively.

Public Source Water Protection

As part of their Source Water Area Protection (SWAP) Program, VDH determined the area upstream of public surface water intakes that must be investigated for threats to water quality. The most immediate area of concern is referred to as Zone 1 for each intake. Zone 1 areas extend out to a five-mile radius upstream from a water supply intake or five miles around a lake containing an intake without crossing watershed boundaries, except those upstream. DCR uses the population served by an intake (provided by VDH) and the portion of a hydrologic unit that is within a Zone 1 area to calculate the concentration of persons served per unit by these public surface water supplies. The concentration values serve as a measure of the importance of high water quality by hydrologic unit for public drinking water supply protection.

The categorized values and rankings for indicating concentration by unit are displayed in Figure 5-15 and listed in Table 5-3. Unlike the NPS loading variables in this assessment where high ranked units represent units of concern, the high ranking public source water units are those with a greater need for water quality protection because a significant amount of their area lies immediately upstream from surface drinking water intakes that are used by many people.

Most hydrologic units contained no Zone 1 protection zones or portions of Zone 1 protection zones. Of those with some Zone 1 content, the majority had low levels (< 10) of the calculated measure for concentrations of people served within a watershed. Of the remaining units, a few had significantly higher value measures (> 100) and were therefore classified as having a “Very High” need for source water protection. The rest were divided amongst a moderate category (10-30) and a high category (30-100).

Aquatic Species Measures

The presence or absence of certain aquatic species can serve as an indication of the overall ecological quality of a particular waterway. The Aquatic Species Measures described below are a different metric than the Virginia Stream Condition Index (VSCI) and are used as part of the DCR’s VACS funding prioritization ranking process. They can also indicate where the most biological damage can occur from water quality degradation. Accordingly, the NPS Assessment and Prioritization study provides a ranking of hydrologic units for stream-dependent living resources (including fish, mollusks, and crayfish) using a multi-metric index calculated by CES at VCU as part of their Interactive Stream Assessment Resource (INSTAR).

These indices (referred to as the mIBI - a modified version of the Index of Biological Integrity) are calculated by CES using databases originally developed by DCR, DWR, and VCU.[6] More than 162,000 database records from over 2,000 aquatic collections have been gathered since INSTAR’s inception. As a result, it is possible to calculate a mIBI value for more than 93% of the 6th level units of the NWBD. An equally beneficial result of having more records available for any unit is the decreased likelihood of a false prioritization based on minimal information.

While the maintenance or enhancement of water quality for the protection of all native aquatic life is the preferred goal, these aquatic species priorities should help direct NPS pollution mitigation efforts and other water quality improvement projects toward hydrologic units with the most important aquatic resources. DEQ collects additional fish and macroinvertebrate data that were not used in this assessment. This data is collected primarily in support of the freshwater probabilistic monitoring program. Additionally, the agency uses multimetric indices like the mIBI such as the Virginia Stream Condition Index, and the Virginia Coastal Plain macroinvertebrate index. These indices were developed for water quality assessment, rather than prioritization for NPS reduction planning. However, they may provide useful information for assessing potential nonpoint sources of pollution, as well. Future iterations of this report development process should include an evaluation of the usefulness of other methods and data sources for incorporating aquatic species measures.

By associating a hydrologic unit code with each of the stream segments for which aquatic species information was available in the various databases, metric scores by unit were developed for each of six metrics. These metrics are as follows:

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[5] More information about the mIBI and the other components of INSTAR can be found at INSTAR Healthy Waters.

- Metric 1 – Number of Intolerant Species: refers to the total number of unique water quality intolerant species found in a unit.
- Metric 2 – Native Species Richness: refers to the number of indigenous (local) species present in a unit.
- Metric 3 – Number of Rare, Threatened, and Endangered Species: refers to the number of species that are considered rare, threatened, or endangered due to their low population levels present in a unit.
- Metric 4 – Number of Non-indigenous Species: refers to the number of non-native species present in a unit. These are introduced species that would not normally be found in this location.
- Metric 5 – Number of Critical Species: refers to the number of species found in a unit that are considered critical because of some important role they play, such as being a food source or a major recreational fishery.
- Metric 6 – Number of Tolerant Species: refers to the number of species found in a unit that are tolerant of degraded stream conditions and can survive even in these sub-optimal conditions.

A score of 0 – 5 was assigned by CES for each metric based on the metric's values. In general, high metric values were assigned high metric scores indicative of high stream health. A score of zero was given if insufficient data were available. Of the 1,251 hydrologic units, 90 (7%) were assigned a zero for this reason. Metrics 4 and 6 were reversed in the scoring, since a low value for either of these metrics would indicate high stream health and because a high number of non-native species and/or a high number of species that are tolerant to stream degradation are less desirable characteristics for a stream. Therefore, a high score was given for low metric values for these two measures.

Scores for each metric for each unit were totaled to give an overall mIBI score per hydrologic unit. These summed scores per hydrologic unit were then tiered relative to the summed scores of the other units in the same basin by assigning a category value of "High" (score of 5), "Medium" (score of 3), or "Low" (score of 1) on a per metric per basin basis. The resulting total mIBI scores are used to place each hydrologic unit into ranked categories reflecting biotic integrity and resource importance.

Since there were six metrics and a maximum score of 5 could be obtained for each metric, the overall maximum score a unit could receive was 30 (6 x 5). Fewer than 8% of the units (100) are considered to have very high biodiversity with total mIBI scores of 20 or more. Another 202 units have total mIBI scores of at least 18. At the other end of the spectrum, 24% of the units (296) with sufficient data have total metric scores of 12 or less, indicating low biodiversity. These units likely contain waters with some degree of degradation.

The categorization of the mIBI scores by hydrologic unit is displayed in Figure 5-16, and listed in Table 5-3. In this figure and table, high mIBI scores equate to areas of high biotic integrity, which should be protected for their exceptional biodiversity. Low mIBI-ranked units represent units of concern regarding low water quality based on aquatic species measures. There has been very little change in total mIBI scores over the past few years.

Collective Use of Rankings

This assessment assigns sixteen total rankings to each hydrologic unit. There are twelve rankings that are for three nonpoint source pollutants (nitrogen, phosphorus, and sediment) classified by land use class (agricultural, forest, urban, and total). The four additional rankings include two for impaired waters occurrence and two for biological health. Each of these four is evaluated at six different levels (very high, high, moderate, low, none, and insufficient data); the remaining twelve rankings are evaluated at three different levels (high, medium, and low). The rankings can be used in various combinations to evaluate statewide conditions and prioritize NPS reduction activities. Which measures are included in each prioritization process and how one weighs in comparison to another depend on the activity to be prioritized. Primarily, DCR uses the NPS pollution rankings as variables in the targeting of agricultural best management practices (BMPs) (see VACS).

When constructing prioritization processes using these rankings, it is important to be aware of the different measures used in the rankings. Some measures are simulated NPS potential pollutant loads at the hydrologic unit of interest. Other measures reflect existing conditions at the unit of interest, such as aquatic species health, which may be partly due to pollutant loading activities occurring in upstream units. The source water concentration values directly account for the upstream effect by virtue of their being based on a designated upstream protection zone.

Another consideration is the potential to incorrectly infer cause and effect. Waters in a hydrologic unit may be impaired due to nonpoint sources, but the cause of impairment is not necessarily related to potential nitrogen, phosphorus, and sediment loadings in either the unit of concern or one upstream of it. Likewise, point source loadings may cause low biological integrity index scores and aquatic species ranks in a unit.

For prioritization purposes, some units have been flagged for conditions that can be determined by comparing the rankings of the described measures. The six conditions are:

1. Exceptional aquatic biodiversity. Eleven (11) units with biological integrity index (see Aquatic Species Measures discussion, below) scores of 24 or greater.

2. High aquatic biodiversity with high potential NPS pollutant loads. Twenty-four (24) units with biological integrity index (see Aquatic Species Measures discussion, below) scores of 20 or greater and a total NPS pollutant load ranked “high.”

3. High public water supply protection need with high potential NPS pollutant loads. Six (6) units with source water concentration values greater than 30 and a total NPS pollutant load ranked “high.”

4. High public water supply protection need with NPS-impaired surface water at intake. Six (6) units with NPS-impaired waters (see Public Source Water Protection, below) immediately upstream of the source water intake.

5. Excessive agricultural nutrient loadings. Ten (10) units with potential agricultural

nutrient unit area loads (either N or P) greater than four times the standard deviation from the mean agricultural nutrient unit area load.

6. Excessive agricultural sediment loadings. Nine (9) units with a potential agricultural sediment unit area load greater than four times the standard deviation from the mean agricultural sediment unit area load.

The measure ranks and prioritization flags are found in Table 5-3.