COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER PLANNING DIVISION
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Subject: Guidance Memo No. 09-2005
Monitoring and Assessment of Lakes and Reservoirs

To: Regional Directors

From: Jutta Schneider, Water Planning Division Director

Date: April 1, 2019

Copies: Regional Water Quality Planning Managers and staff, Water Planning Division Managers, WMA Staff

Summary:
This guidance supersedes all agency Lake Monitoring Guidance prior to 2019 and provides direction to agency staff on how to implement lake/reservoir water quality monitoring and assessment. Significant updates to this guidance since 2009 include implementing updates to the surface water quality standard regulation (9 VAC 25-260-50), effective as of June 5, 2017, which applies pH criterion only to the epilimnion in thermally stratified man-made lakes or reservoirs. pH criteria apply throughout the water column when these waters are not stratified. The most recent Triennial Review updates also included the addition of two (2) lakes to the significant lakes list.

Electronic Copy:
Once effective, an electronic copy of this guidance will be available on:

- The Virginia Regulatory Town Hall under the Department of Environmental Quality (http://www.townhall.virginia.gov/L/gdocs.cfm?agencynumber=440); or,
- The Department's website at: https://www.deq.virginia.gov/Programs/Water/Laws,Regulations,Guidance/Guidance/MonitoringAssessmentGuidance.aspx

Contact Information:
Please contact Sandra Mueller, Manager of the Office of Water Monitoring and Assessment at sandra.mueller@deq.virginia.gov , or via phone at (804) 698-4324 with any questions regarding the application of this guidance.

Certification:
As required by Subsection B of § 2.2-4002.1 of the APA, the agency certifies that this guidance document conforms to the definition of a guidance document in § 2.2-4101 of the Code of Virginia.

Disclaimer:
This document has been developed based on Virginia's Water Quality Standards Regulation (9 VAC 25-260), with amendments approved by the State Water Control Board resulting from iterative Triennial Reviews or periodic rulemakings. It is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate nor prohibit any particular method for the analysis of data, establishment of a wasteload allocation, or establishment of a permit limit. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

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MONITORING AND ASSESSMENT OF LAKES AND RESERVOIRS

I. Introduction

The purpose of this guidance is to ensure that consistent and accurate processes are employed for the monitoring and assessments of lakes and reservoirs. In particular, this guidance focuses on proper implementation of the amended nutrient and pH criteria for these waterbodies.

II. Background

The Water Quality Standards Regulation (at 9VAC25-260-187) was amended in August 2007 to add numerical and narrative criteria to protect the designated aquatic life (fishery) use of man-made lakes/reservoirs, as well as the two natural lakes in the Commonwealth, Mountain Lake and Lake Drummond (at 9VAC25-260-310-dd), from the impacts of nutrients. The rulemaking:

- clarified that the dissolved oxygen (DO) criterion applies ONLY to the epilimnion ONLY during times of thermal stratification; at all other times DO criteria applies throughout the water column within all zones of the water body,

- clarified that water quality assessment of the applicable nutrient criteria (chlorophyll-*a* and total phosphorus) for lakes and reservoirs listed in 9VAC25-260-187 will be based on the results of two out of three monitoring years with available data that are in agreement showing attainment or non-attainment.

- added a process for confirmation of use impairments when the criteria in 9VAC25-260-187are exceeded, and

- allowed for site specific regulatory modifications to the criteria if the nutrient criteria specified for a lake or reservoir do not provide for the attainment and maintenance of the water quality standards of downstream waters.

This guidance is intended to:

1. provide additional technical information related to the development of the adopted nutrient criteria,

2. address when and where (temporally and spatially) within a lake or reservoir the nutrient, dissolved oxygen and pH criteria should be applied for assessment purposes,

3. make recommendations on how to determine where to monitor within a lake or reservoir to gather the data needed for assessments, and

4. provide information on monitoring of all lakes and reservoirs in Virginia.

III. Authority

§ 62.1-44.15(3a) of the Code of Virginia, as amended, mandates and authorizes the State Water Control Board to establish water quality standards and policies for any State waters consistent with the purpose and general policy of the State Water Control Law, and to modify, amend or cancel any such standards or policies established. Section 303(c) of the federal Clean Water Act mandates the State Water Control Board to review and, as appropriate, modify and adopt water quality standards. The corresponding federal water quality standards regulation at 40 CFR 131.6 describes the minimum requirements for water quality standards. The minimum requirements are use designations, water quality criteria to protect the designated uses and an anti-degradation policy. All of the citations mentioned describe mandates for water quality standards.

IV. Definitions

"Algaecides" means chemical substances, most commonly copper-based, used as a treatment method to control algal growth.

"Assessment period" refers to a "period of time (currently six years) for which data are used in a Water Quality Assessment."

"Thermal stratification" of lakes refers to a change in the temperature at different depths in the lake, and is due to the change in water's density with temperature. Cold water is denser than warm water and the epilimnion generally consists of water that is not as dense as the water in the hypolimnion.

"Epilimnion" means the upper layer of nearly uniform temperature in a thermally stratified man-made lake or reservoir listed in 9 VAC 25-260-187.B.

"Hypolimnion" means the lower layer of nearly uniform temperature in a thermally stratified man-made lake or reservoir listed in 9 VAC 25-260-187.B.

"Lacustrine" means the zone within a lake or reservoir that corresponds to non-flowing lake-like conditions with areas that are deeper than 3m (10 feet). The other two zones within a reservoir are riverine (flowing, river-like conditions) and transitional (transition from river to lake conditions).

"Lake/Reservoir" means a constructed impoundment and refers to Virginia man-made lakes and reservoirs

"Monitoring period" refers to "April 1 through October 31."

"Monitoring year" refers to "seven months from April 1 through October 31."

"Natural Lake" means a lake that is natural in origin. There are two natural lakes in Virginia: Mountain Lake in Giles County and Lake Drummond located within the boundaries of Chesapeake and Suffolk in the Great Dismal Swamp.

"Publicly accessible" means any legal passage to any public waters of the state by way of contiguous designated public land.

"Strahler Order" is a simple method of classifying stream segments based on the number of tributaries upstream. A stream with no tributaries (headwater stream) is considered a first order stream. A segment downstream of the confluence of two first order streams is a second order stream. Thus, a n^{th} order stream is always located downstream of the confluence of two $(n-1)^{th}$ order streams. In addition, the following definitions of fishery type were used in making nutrient criteria assignments based on fishery type and nutrient ecoregion as described in section V. of this guidance document:

"Coldwater fishery" means a fishery in a man–made lake or reservoir for the year-round support of brook, brown, and rainbow trout.

"Coolwater fishery" means a fishery in a man–made lake or reservoir for the year-round support of game fish species such as striped bass, hybrid striped bass, or walleye.

"Fertilized fishery" means man-made lakes or reservoirs managed by the Virginia Department of Game and Inland Fisheries (DGIF) with fertilizers applied as a management input for centrarchid species (for example, sunfish, crappie, and black bass) or catfish species. These lakes are generally quite small, and fish production is the primary use.

"Warmwater fishery" means a fishery in a man–made lake or reservoir for the year-round support of warmwater fish such as largemouth and smallmouth bass, sunfish and catfish, and not explicitly classified as a coldwater, coolwater or fertilized fishery.

V. Guidance

A. Sources for Lakes and Reservoirs Listed in the Table in 9 VAC 25-260-187

Current Listings: The original list of lakes and reservoirs in Section 187 was developed from three DEQ sources: 1) the significant lake list for the agency (2002 targeted lake monitoring guidance), 2) the revised significant lakes list for 2006, and 3) 59 lakes and reservoirs monitored by DEQ between 1990 and 2003; these were included in DEQ's Academic Advisory Committee (AAC) analysis for nutrient criteria development. Subsequent lakes and reservoirs have been added through the Water Quality Standards Triennial Review process updating Section 187.B. These are the lakes and reservoirs that DEQ has monitored previously, currently is monitoring or will be monitoring in the upcoming assessment cycle.

Future Listings: DEQ anticipates that additional lakes and reservoirs will be added to the regulation during triennial review and will propose adding to the list of Section 187.B additional lakes and reservoirs which the agency has recently monitored or included in the monitoring plan for future monitoring. Prior to the initiation of a rulemaking to add or modify a current listing in Section 187.B, staff from the Fish Division of the Virginia DGIF must be contacted to confirm the appropriate fishery type for that particular lake/ reservoir.

Removal from List: In rare instances, DEQ may receive a request to remove a lake/reservoir from Section 187.B. Removal of a lake/reservoir would be subject to the DEQ Public Participation Guidelines, state Administration Process Act requirements and EPA approval.

B. Basis for Nutrient Criteria Assignment by Fishery Type and Nutrient Ecoregion in Section 187.B

The table in Section 187.B provides the numerical chlorophyll-*a* and total phosphorus criterion applicable to that particular lake/reservoir. It is simplified in this guidance for reference (Table 1), but the actual Section 187.B table should be utilized for agency monitoring purposes to ensure that updated information is being used.

Virginia Nutrient Ecoregions: The following three aggregate nutrient ecoregions developed (see below Figure 1) by the Environmental Protection Agency (EPA) were used in development of the nutrient criteria.

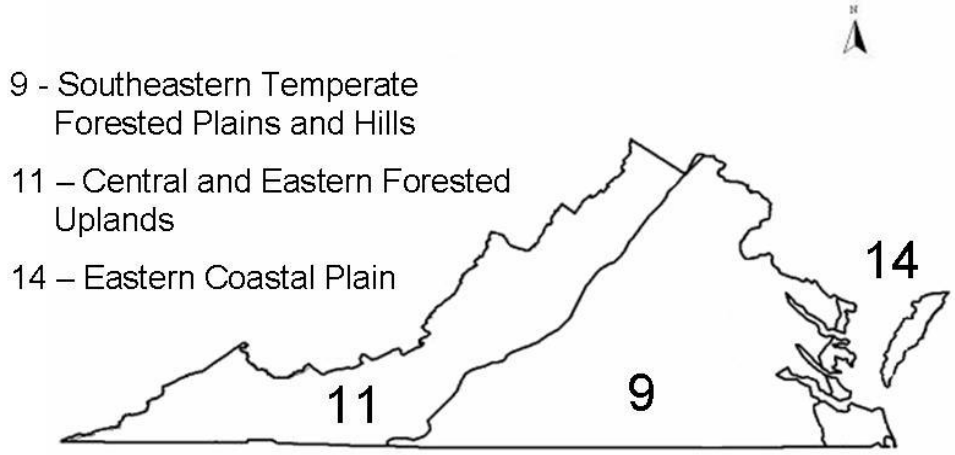


Figure 1 Virginia Nutrient Ecoregions

Listing of Fishery Type and Ecoregion for Each Man-made Lake/Reservoir: Appendix I summarizes a known name applicable to a particular body of water, city or county location of the water body, fishery type, ecoregion and name of the USGS topographic map.

Fishery Type Assignments: Pages 10 - 11 and 16 - 33 of the AAC January 2005 Report http://www.deq.virginia.gov/export/sites/default/wqs/pdf/AAC05report.pdf discuss the use of fishery data by ecoregion and fishery type for setting criteria for chlorophyll-*a* and total phosphorus.

*Applicable Criteria by Fishery Type and Ecoregion***:** Table 1 (below) provides the candidate criteria recommended by the AAC July 2005 Addendum One to the January Report http://www.deq.virginia.gov/export/sites/default/wqs/documents/Nutrient_Criteria/AAC_Report_Addendum_5_26_05.doc to accommodate fishery recreation and protect aquatic life.

Table 1. Applicable Criteria by Fishery Type and Ecoregion in Virginia

Fishery Type	Warm-water	Cool-water	Cold-water (trout)	Managed / Fertilized	Warm-water	Cool-water	Cold-water (trout)	Managed / Fertilized
Eco-region	- - - - - - - - chl-a (µg/L)[a]- - - - - - - - -				- - - - - - - - TP (µg/L)[b]- - - - - - - - -			
11	35	25	10		40	20	10	
9	35	25		60	40	30		40
14	60	25			40	20		

[a] Chl-a are 90th percentile values representative of the April – October period.
[b] TP is the median values representative of the April – October period.

C. Monitoring

C.1. Determination of Section 187 Lake/Reservoir Boundaries

Description of Lake/Reservoir boundaries: The nutrient criteria only apply in the lacustrine zone of the lakes/reservoirs listed in 9VAC25-260-187.B. The other two zones within a lake/reservoir are riverine (flowing, river-like conditions) and transitional (transition from river to lake conditions). Lakes and reservoirs usually have these three zones along a longitudinal gradient (See Figure 2.). For assessment purposes, DEQ defines the lacustrine zone as the area of the lake where the depth is greater than 3 meters (10ft).

The littoral zone of a lake/reservoir is often described as the near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. It is sometimes defined as a shallow area approximately three meters or less deep extending from the shoreline lake ward, but it depends on water clarity, light transmission and where rooted plants can grow. Therefore, no sampling should be done where there are rooted aquatic plants during the growing season. Chlorophyll-*a* or total phosphorus data collected at less than 3 meters (10 ft.), e.g. within the littoral zone will not be used in the assessment for impairment due to nutrients.

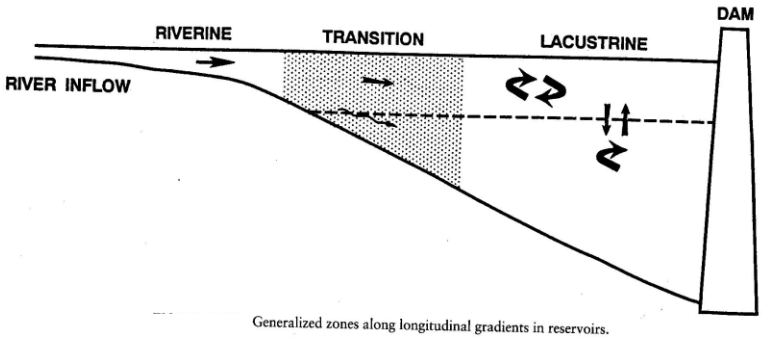


Figure 2 Generalized Zones along Longitudinal Gradients in Reservoirs (Wetzel, 2001)

The riverine zone is located at the most upstream sections (near the inlets) of lakes and reservoirs and displays "river-like" flow characteristics. At the riverine end of the lake/reservoir, thermal stratification tends to be unstable and turbidity and sedimentation rates are higher than downstream in the lacustrine zone. The transition zone is deeper than the riverine zone and flows are generally slower. The lacustrine zone behaves most like a lake, where thermal stratification would most likely occur (from late spring to early fall.) There may be arms of the lake/reservoir that are considered lacustrine, exhibiting nonflowing, lake-like conditions. In this scenario, the lake monitoring team should use their best professional judgment in the assessment of arms, coves, etc.

In small, shallow (less then 3m in depth (10ft)) lakes and reservoirs where the classic lacustrine, transition and riverine zones are not pronounced, the lacustrine zone and nutrient criteria in Section 187 of the water quality standards regulation apply in a representative area of the water body.

Figure 3, taken from Kimmel and Groeger (1984), illustrates the transition from a riverine to lacustrine environment in lakes and reservoirs along a longitudinal gradient and describes the differences in the characteristics of these three zones.

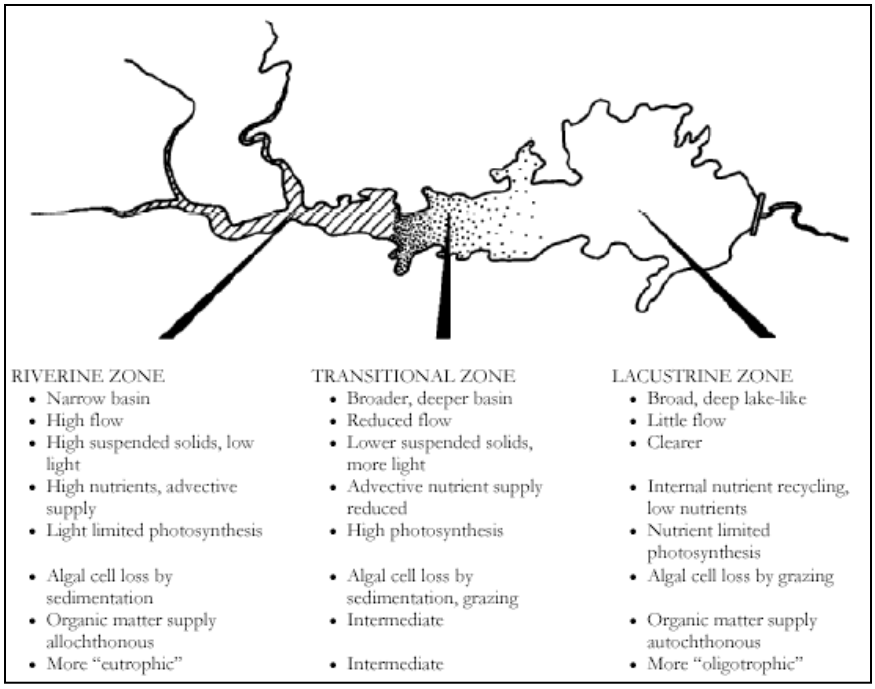


Figure 3 General Characteristics of the Riverine, Transitional and Lacustrine Zones in Reservoirs

C.2. Guidelines for identification of lake/reservoir zones for assessment

For the assessment of lakes and reservoirs sampled during the assessment period of targeted lake/reservoir monitoring, regional monitoring staff will:

- Identify lakes/reservoirs where algaecides are used during DEQ's monitoring period so assessment staff will know to use the total phosphorus criterion as well as chlorophyll-*a*,
- All sample collections and field measurements should be made in the deepest mid-channel of any zone, cove or inlet within a lake/reservoir's boundary
- Identify station location (with all associated ID's, i.e. CEDS) where:

    - Chlorophyll-*a* and total phosphorus (if documented use of algaecide) samples were collected in the lacustrine zone (greater than 3 meters (10ft.)).

    - <u>dissolved oxygen/pH/temperature profile measurements were recorded anywhere in the lake/reservoir.</u>

Description of lacustrine boundaries:

1. The lacustrine zone is the area that corresponds to nonflowing, lake-like conditions, which is usually the deepest part of the lake/reservoir, typically 3m (10ft) or deeper, where stratification normally occurs from spring through fall. (If a lake has a round shape, the lacustrine zone may be in the center of the lake. If the lake is shallow (less than 3m), without defined depths, sample in a representative portion of the lake/reservoir)

2. The upper boundary of the lacustrine zone is where a slope and broadening of the basin begins.

The other two zones of a lake include; *Transition*: The transition zone falls between the upper end of the lacustrine zone and the lower end of the riverine. *Riverine*: Depths less than one-third of the depth of the upper boundary of the lacustrine zone can be assumed to be located within the riverine zone at the upper end of the impoundment.

C. 3. Sampling littoral zone and coves and inlets.
Sampling near-shore or littoral zones (depths less than 3 meters (10ft)) should be avoided when sampling for nutrients in Section 187 waters; data collected from the littoral zone of a lake/reservoir by agency staff or outside groups will not be used for assessment of nutrients and possibly dissolved oxygen (DO) (see Section D.1). All other parameters apply throughout a lake/reservoir.

The perimeters of irregular lakes or reservoirs are often characterized by various types of inlets. For the purpose of this guidance, two types of inlets are differentiated:

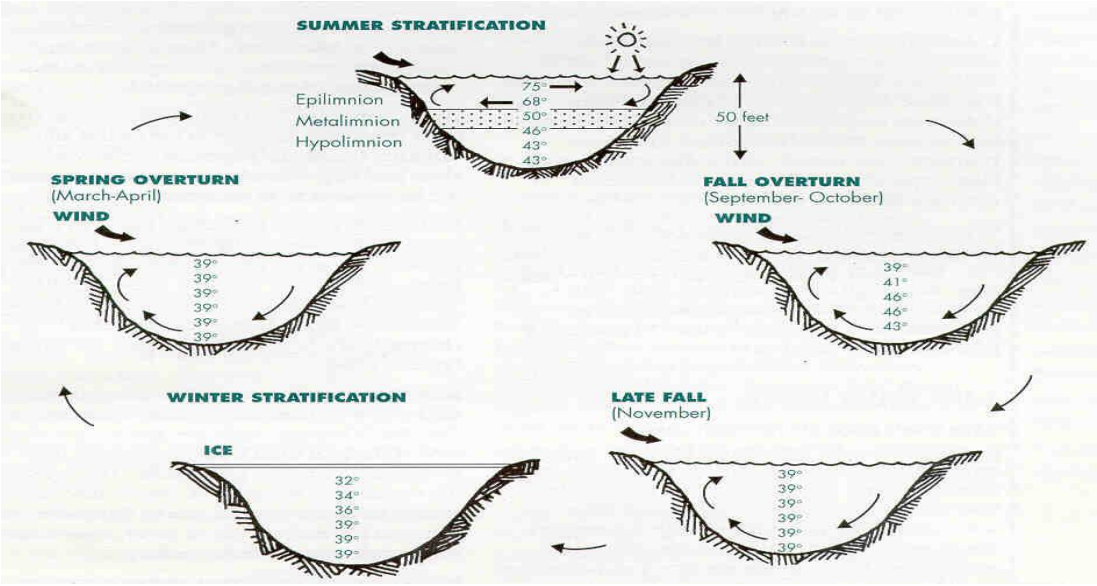
- **Riverine** tributary inlets are defined as inlets with well-defined channels produced by the inflow of a tributary stream of 2nd or higher Strahler order. Waters in these inlets are likely to be more characteristic of the inflowing stream than of the receiving lake, and should not be sampled during monitoring events.
- **Coves (including arms and fingers)** are defined as inlets that are longer than they are broad. They should only be sampled from the center of their channel and only when their depth is greater than 3 meters (10 ft).

C.4. Determination of thermal stratification

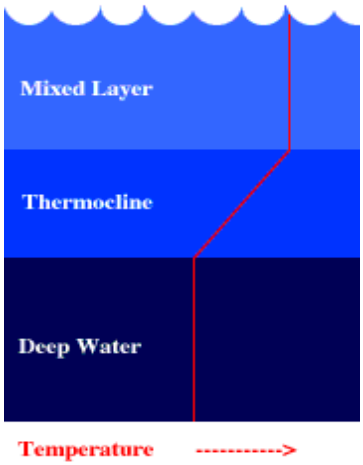
During periods of thermal stratification of the lakes/reservoirs listed in Section 187, attainment of the minimum dissolved oxygen criterion and pH criterion range are only assessed in the epilimnion at monitoring stations where stratification is observed. Dissolved oxygen and pH criteria do not apply below the epilimnion during thermal stratification. The usual procedure is to plot temperature vs. depth to determine where a strong gradient occurs in the temperature/dissolved oxygen profile measurement.

In deeper lakes or reservoirs, it may be possible to use the classical textbook definition of lake stratification developed for natural lakes if the temperature profile meets the following definition for a thermocline: the temperature decrease reaches 1 degree C or more per meter of descent. When evaluating an entire lake profile from the surface to the bottom, the first instance of the 1 degree C change over 1 meter should indicate the presence of the epilimnion. If the thermocline cannot be delineated (*i.e.*, the temperature decrease is less than 1°C for each meter of descent), then it is not considered to be thermally stratified. However, many lakes/reservoirs are shallow, often less than twenty feet deep, and exhibit stratification but do not meet the "classical" 1 degree C per meter of descent definition of stratification. In such situations, staff will need to use best professional judgment to determine whether a lake/reservoir is exhibiting stratification by sampling the entire water column to determine stratification or a measurable

slope in temperature change. Examples of annual temperature cycles in stratified lakes are given in Figure 4.



(WDNR)



(University of Illinois)

Figure 4 Annual temperature cycles in stratified lakes, Wisconsin DNR (WDNR) and University of Illinois

C.5. Monitoring period, frequency of sampling, and location of monitoring stations for nutrients

A monitoring year is considered to be April 1 through October 31 with a monthly sampling frequency during one calendar year. Man-made lakes/reservoirs listed in Section 187 must be sampled with one or more observations per month for at least six of the seven sampling months

within the same calendar year to be considered a valid assessment year. If the water body is sampled with one or more observations per month for less than six of the seven sampling months, the water body is considered to have insufficient data for assessment and sampling is required in a subsequent year, preferably the following year. Nutrient collections at the monitoring frequency of once per month during six of seven consecutive months (April 1 – October 31) within one calendar year during the Assessment Cycle (six years) will continue. However, there are two situations where additional sampling should be done in a subsequent year:

- If sampled for fewer than six of the seven sampling months within a calendar year, the lake or reservoir is placed in Category 3 (insufficient data) for assessment purposes and sampling is conducted in the next calendar year.
- Based on regional prioritization and available resources, each Section 187 listed lake/reservoir should have two monitoring years within the six year Assessment Cycle data window. The regional office should schedule a second year of monitoring for a lake/reservoir, within the same assessment period in order to conduct an assessment of the nutrient criteria. Assessment is based on the two most recent monitoring years that data are available within the assessment period.

Sampling location in lacustrine zone: The number of monitoring stations within the lacustrine zone depends on the size and shape of the lake or reservoir. The 2001 edition of the North American Lake Association's "Managing Lakes and Reservoirs" is a good reference to use to determine location of monitoring stations. If it is a shallow (under 3meters (10ft.)) lake/reservoir, there might be only one station sampled per monthly visit. The monitoring station should be placed in the deepest part of the reservoir or in the deep center portion of natural lakes, with collections monthly over the seven month period of April through October.

Only data from the lacustrine portion of the lake/reservoir, down to a depth of one meter will be assessed for attainment of the chlorophyll-*a* and total phosphorus criteria. That should not preclude regional sampling for nutrients in the riverine and transition zones or coves and arms or the littoral zone as new nutrient criteria are being developed for wadeable waters.

C. 6. Parameter Selection for Analysis

Minimum parameter lists and monitoring frequency are identified by lake/reservoir monitoring assessment goal (Table 2). Regional offices may elect to have the laboratory analyze samples for additional parameters to meet other regional needs. For example, some regional offices with significant VPDES discharges to a lake/reservoir might elect to run biochemical oxygen demand and suspended solids. For assessment purposes, the recommended minimum parameter list is dissolved oxygen, pH, Chlorophyll-*a*, temperature, bacteria, nutrients, conductivity and salinity (where appropriate). To determine trophic status, the following parameters need to be collected: conductivity, Secchi disk depth, chlorophyll-*a*, dissolved oxygen/pH/temperature depth profile, total nitrogen, total phosphorus and orthophosphorus. Ammonia is collected to make a toxic assessment. Table 3 lists lake/reservoir monitoring parameter group codes for samples submitted to the state laboratory (DCLS) for analysis.

Table 2. Minimum Required Parameter List by Type of Assessment:

- Dissolved Oxygen-Entire profile top to bottom (Epilimnion assessed only if stratified or 0.3 meter below surface if not stratified)
- pH-Entire profile top to bottom (Epilimnion assessed only if stratified or 0.3 meter below surface if not stratified)
- Temperature
- E. coli (0.3 meters below surface)
- Conductivity
- Salinity (where appropriate) Trophic State/Nutrient Enrichment
- Secchi Disk Depth
- Chlorophyll-*a* (0.3 meters below surface)
- Dissolved Oxygen/Temperature Depth Profile
- Total Phosphorous
- Total Orthophosphorous
- Total Nitrogen
- Nitrite (NO^2)
- Nitrate (NO^3)
- Ammonia Concentrations in water

Table 3. Lake Monitoring Suggested Parameter Group Codes for Samples Submitted to DCLS for Analysis

- **Field -** DO, pH, Conductivity, Temperature
- **FCHLR**-Chlorophyll-*a*
- **ECQT10 –** E.Coli
- **TPLL –** Total Phosphorus
- **LAKE-2 –** Ammonia, Total Nitrogen, Orthophosphorus, Nitrite plus Nitrate

C. 7. Field Measurements

Field measurements at each sampling station should include a temperature, dissolved oxygen and pH profile (beginning at 0.3 meter below surface using a combined temperature- dissolved oxygen meter). Field measurements should also include pH, conductivity and Secchi depth. All of these field measurements, including the dissolved oxygen/temperature depth profile data, should be entered into the CEDS Water Quality Management database.

D. Assessment

Two years of monitoring data must be used for assessment of nutrient criteria. If assessment results for two years conflict with each other, then that water body will be categorized as having insufficient data (Assessment Category 3) and a subsequent monitoring year will be required. In such cases, an assessment determination for nutrients will be based on the results of two out of the three monitoring years that are in agreement. If a third year of data is needed, monitoring should occur as soon as feasible but within one six-year assessment data window.

Implement Amendments in 305(b)/303(d) integrated report: This guidance explains how nutrients and dissolved oxygen data collected will be assessed. (If monitoring data are available for assessment of lakes and reservoirs not captured in recent amendments, the nutrient criteria would not be applicable to such a water body and the water body would not be assessed for nutrients. However, the methodology described in this section for assessment of dissolved oxygen criteria would be applicable.)

Both DO and nutrient data (chlorophyll-*a* and also total phosphorus with documented use of algaecides at any time during the monitoring period of April to October) are assessed for aquatic life use. Bacterial data are used to assess recreational use. Observations regarding nuisance algal or plant growths or discolored water are assessed using the general standard as the basis; the recent criteria amendments for lakes/reservoirs did not modify these existing criteria.

Trophic State Index (TSI) replaced by regulatory nutrient criteria in 2008 305(b) assessment report for Section 187 lakes: The assessment guidance for 2006 reflected the combined TP (total phosphorus)/DO (dissolved oxygen) TSI approach of assessing non-187 lakes for nutrients which EPA found to be an acceptable method in lieu of regulatory nutrient criteria. Beginning with the 2008 assessment report, the regulatory nutrient criteria, to be determined for Section 187 waters only, replaced the TSI approach for Virginia Section 187 lakes/reservoirs. Since modifications were made to the dissolved oxygen criteria for lakes/reservoirs listed in Section 187, where nutrient criteria were developed, the use of TSI for determining natural dissolved oxygen impairment of the waters in Section 187 will no longer be applicable for future assessments in Section 187 waters. TSI will **ONLY** be used in non-187 lakes when related to DO exceedances.

*When to Apply TSI: (in non-Section 187 lakes **ONLY**)* Secchi Depths (SD), Chlorophyll-*a* (CA), and Total Phosphorus (TP) will be calculated only on stratified lakes using aggregated station data in the epilimnion from mid-June through mid-September (at 0.3 m for TP and CA).

A trophic state index value of 60 or greater for any one of the 3 indices will indicate that nutrient enrichment from anthropogenic sources are adversely interfering, directly or indirectly, with the designated uses. A TSI value of 60 corresponds to a CA concentration of 20 ug/l, a SD of 1 meter, and a TP concentration of 48 ug/l.

Following are the TSI equations:

TSI(SD) = 10(6 - (ln SD / ln 2))
TSI(CA) = 10(6 - ((2.04 - 0.68 ln CA) / (ln 2)))
TSI(TP) = 10(6 - ((ln (48 / TP)) / (ln 2)))

SD = meters
CA = ug/l
TP = ug/l

The following rules apply:

1. Do not calculate chlorophyll-*a* in TSI lakes that are treated with algaecides.
2. The Chlorophyll-*a* TSI will normally be the preferred indicator in un-treated lakes.

3. Assume that typical Virginia freshwater lakes and reservoirs are phosphorus limited.
4. Do not use the secchi depth index in the assessment if it is much larger than the CA and TP indices in the same assessment unit (prevalence of inorganic matter).
5. The appropriate TSIs should be calculated based on all summer sample data collected in the segment using the spreadsheet that has been developed for easier data processing.

For each monitoring station, if one or more of the TSIs ≥ 60, the lake/reservoir will be assessed as impaired partially due to one or more pollutants from anthropogenic sources. The assessment unit or entire lake/reservoir will be placed in category 5A for TMDL development.

For each monitoring station, if each of the TSIs < 60, the lake/reservoir will be assessed as impaired due to pollution from natural sources and placed in category 4C. A TMDL is not needed for the assessment unit represented by the monitoring station(s) and appropriate DO criteria will be developed for the hypolimnion.

Based on the results of calculating TSI indices, the reservoir trophic status will be assigned in the Assessment Database (ADB) See Table 4.

Table 4. Trophic Index and Assessment Categories in Virginia

Trophic State	Carlson Trophic State Index	Assessment Category
Hypereutrophic	80 – 100	5A
Eutrophic	60 – Less than 80	5A
Mesotrophic	40 – Less than 60	4C
Oligotrophic	0 – Less than 40	4C
Unknown	Insufficient Data	3A

Non-agency data for non-187 lakes/reservoirs

DEQ will potentially follow up with agency monitoring, however data that are older than the six year Assessment Cycle data window will not be considered for agency follow-up unless previously listed. Additionally, to be considered for follow up monitoring, water parameters associated with numeric standards must have observed effects and stratification must be determined and noted.

D. 1. Assessment of nutrient criteria for aquatic life (fishery) use impairments

*Assessment for aquatic life (fishery) use of Virginia man-made lakes and reservoirs for chlorophyll-a and total phosphorus (if documented algaecide use)**:*** The nutrient criteria only apply in the lacustrine zone of man-made lakes and reservoirs listed in Section 187 of the water quality standards regulation. If total phosphorus or chlorophyll-*a* data are collected outside the lacustrine zone in the riverine or transitional zone, the data from these two zones cannot be used in the assessment for lake/reservoir impairment due to nutrients. In addition, the nutrient criteria

cannot be used for assessment of lakes and reservoirs that are not listed in Section 187 of the regulation.

The regional office staff will base their determination of algaecide use on discussions with the lake owner and/or DEQ monitoring staff observations of algaecide applications during their monitoring runs. (The intent is to use both chlorophyll-*a* and total phosphorus when algaecides are applied within any zone of the reservoir.)

Section 187 of the water quality standards regulation specifically states that assessment of nutrient data is based on two monitoring years where data are available and that nutrient data from these two monitoring years are assessed separately. The aquatic life (fishery) use of any lake assessment unit is considered impaired for nutrients if the criterion for either chlorophyll *a* or total phosphorus is exceeded at a station or pooled stations in each of the two most recent monitoring years. (Note: total phosphorus data is used only if there is documentation of algaecide use during the monitoring period**). For lake or reservoir assessment units with multiple stations, chlorophyll-*a* and total phosphorous data should be pooled by calculating the median of same-month observations from April to October of any given year.** (Note: Only observations collected at stations where depth is greater than 3 meters (10 ft) will be assessed.) The 90th percentile of monthly chlorophyll-*a* medians is the value used to compare to the chlorophyll-*a* criterion for a particular lake/reservoir. The median of monthly TP medians should be used to assess against the applicable total phosphorous criterion.

Assessment for aquatic life (fishery) use for nutrients in the two natural lakes: Assessments of the two natural lakes in the special standards section will follow the guidelines above for chlorophyll-*a* and total phosphorus for two monitoring years except that orthophosphate-P rather than total phosphorus applies to Mountain Lake.

Use of citizen and other external data: In order to use citizen data in assessments for nutrient impairments, the collector must provide documentation that the data meet QA/QC requirements for chlorophyll-*a* and total phosphorus (orthophosphate-P for Mountain Lake) and that the location of the sampling was within the lacustrine portion of the lake/reservoir and outside the littoral (near shore) zone. If a citizen station is located in the same assessment unit as a DEQ station and the two are sampled during the same months, the median of same-month samples should be calculated, and the appropriate statistic (90^{th} percentile for chlorophyll-*a*, median for phosphorus) should be calculated from the monthly composite samples.

D. 2. Assessment of dissolved oxygen, temperature and pH criteria for aquatic life use impairments

The dissolved oxygen, temperature and pH criteria are based on the appropriate criteria established for that class of waters in Section 9 VAC 25-260-50. This information is used for assessment of aquatic life use.

The 10.5% rule is applicable to assessments for the minimum criterion of dissolved oxygen, and criteria for temperature and pH at each station in all lakes/reservoirs in Section 187 and the two natural lakes in Section 310 “cc” and “dd” for which nutrient criteria have been adopted. When

individual stations (whether sampled by DEQ or a non-agency/citizen groups) are located in the same assessment unit and they are sampled on the same day, the median of same-day dissolved oxygen, pH and temperature measurements should be taken at each depth interval. If (when looked at independently) the assessment results of these stations differ, the assessor should consider potentially splitting the assessment unit to properly characterize the hydrological conditions of the lake. Stations that are located within the same assessment unit and sampled in the same month, could be assessed independently.

Dissolved oxygen and pH range criteria will be assessed from all water monitoring observations at each station within the assessment period. The assessment will be based on observations from the epilimnion if thermally stratified or throughout the water column if not stratified. Two or more exceedances for data sets containing less than 10 samples or greater than 10.5% exceedances for larger data sets are required before a water body is listed as impaired (Figure 5) under §§ 62.1-44.19:5 and 7 of the Code of Virginia.

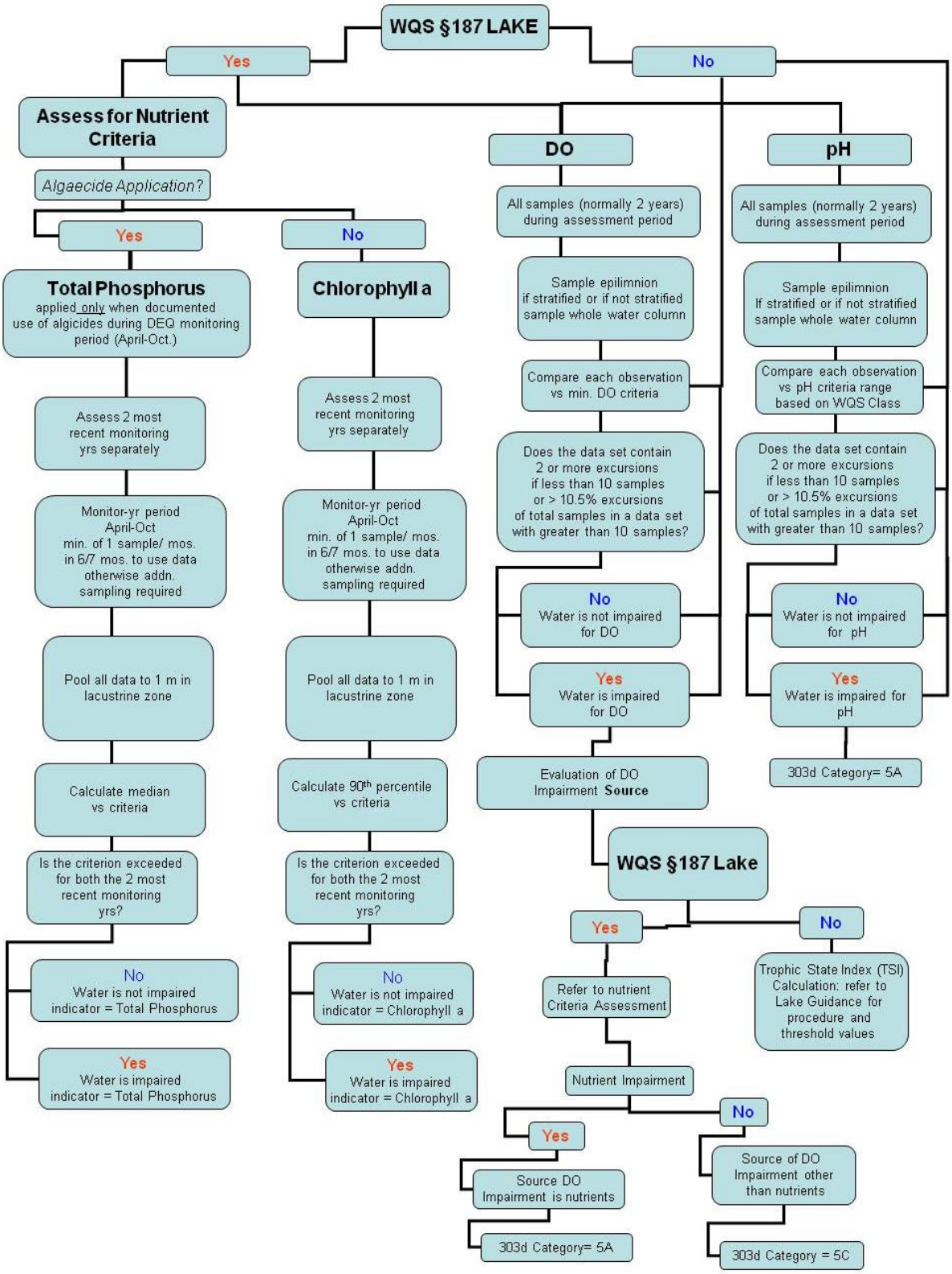


Figure 5 Flow Chart of WQS for Section 187 Lakes/Reservoirs

E. Process for confirmation of use impairments when nutrient criteria are exceeded

Section 187.B includes a process for confirmation of the aquatic life (fishery) use impairments via a consultation with the Virginia Department of Game and Inland Fisheries (VDGIF) when the nutrient criteria in Section 187.B are exceeded. Where the nutrient criteria are exceeded but the designated uses of the water body are being attained, the water will still be considered impaired in accordance with § 62.1-44.19.5 of the Code of Virginia until site-specific criteria are adopted and become effective in order to remove the lake/reservoir from the impaired waters list.

Consultation Process with VDGIF: When DEQ determines that the applicable nutrient criteria in Section 187.B of the water quality standards regulation for a specific lake/reservoir are exceeded, the DEQ central office water quality standards program coordinator, or his/her designee, may contact the VDGIF Regional Fisheries Manager regarding the status of the fishery in determining whether or not the designated use for that water body is currently being attained. Since the nutrient criteria for lakes/reservoirs were developed using water chemistry data from those lakes/reservoirs where VDGIF biologists rated the fishery as good or excellent, documentation should support this level of fishery. Appropriate documentation for confirmation of maintenance of the designated fishery use would include the most recent information available on:

- catch per unit effort of specific size classes of managed fish populations
- population size structure
- observations or records regarding changes in fishing use or
- general trends in community structure.

DEQ procedure for developing lake/ reservoir specific criteria: The process for developing lake/reservoir specific chlorophyll-*a* and/or total phosphorus criteria is as follows:

- For each parameter, pool (as described at https://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityStandards/AAC05report.pdf in the AAC Report 2005) all data taken down to one meter in the lacustrine portions of the lake/reservoir over all sampling observations made between April and October for two years or two of the three most recent years of monitoring data.

- For total phosphorus use the statistics (median values) described in the referenced AAC Report 2005 and for chlorophyll-*a use* the statistics (90^{th} percentile values) described at https://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterQualityStandards/NutrientCriteria/AAC_Report_Addendum_5_26_05.doc the AAC 2005 Report Addendum 1.

- Initiate a rulemaking to amend the water quality standards regulation to adjust an existing nutrient criterion in cases where the regulatory nutrient criterion is exceeded but the fishery is documented via consultation with VDGIF as good or excellent.

F. Lake Selection

Source List of Lakes: 9VAC25-260-187 (Section 187) serves as the source list of lakes for prioritization and selection for monitoring by DEQ. The current list can also be found as

Appendix H of DEQ's Water Quality Assessment Guidance Manual. Significant lakes are defined as "All publicly accessible lakes that are either public water supplies or 100 acres or more in size." This definition includes the federally owned lakes that meet these criteria, but other federally owned lakes are excluded from the agency's Lake Monitoring Program. Under the current (2018) classification, 123 reservoirs and one lake are included in the prioritization list. Seventy-five (75) of these are identified as Public Water Supply (PWS) sources. Only one of Virginia's two natural lakes, Lake Drummond within the Great Dismal Swamp National Wildlife Refuge, is currently included in the prioritization list. The other, Mountain Lake (48 acres), is privately owned and is intensively monitored by the University of Virginia.

Periodic Updates to the List: It is the responsibility of each region to periodically review Section 187 of the Virginia Water Quality Standards (WQS) and coordinate corrections to the list with Central Office. Although this list may be updated and change slightly from one two-year assessment cycle to the next, most major reservoirs and lakes meet the criteria for inclusion and are monitored on a permanent basis. The mapping precision provided by Geographic Information Systems (GIS) has also resulted in more accurate area determinations, which may influence the inclusion or not of small reservoirs. An improved WQS layer, better representing all of the significant and assessed lakes in the state, was completed in 2018 using the high resolution National Hydrography Dataset. This layer will be used to more efficiently complete assessments for the Integrated Report, as well as to provide information to the public through internet mapping applications.

Prioritization for Monitoring: All lakes must be publicly accessible to be considered for monitoring resources. After the lakes are prioritized, each region determines how many lakes they have resources to monitor in any given year.

Documentation of Alternative Basis for Selection for Monitoring: Section 187 is a starting point for prioritizing lakes in need of monitoring, but it is not intended to prevent a region from using a different approach if required by a unique circumstance, i.e. citizen concerns over recreation impacts in public lakes.

G. Additional Information

All Virginia DEQ and AAC referenced reports can be found at https://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityStandards/NutrientCriteriaDevelopment.aspx

APPENDIX I

Listing of Fishery Type and Ecoregion for Man-made Lakes and Reservoirs in Virginia

Man-made Lake/Reservoir Name	Location	Fishery Type	Ecoregion	USGS 1:24,000 Topo Map Name
Able Lake	Stafford County	Warmwater	9	Stafford
Airfield Pond	Sussex County	Warmwater	9	Manry
Amelia Lake	Amelia County	Warmwater	9	Chula
Aquia Reservoir (Smith Lake)	Stafford County	Warmwater	11	Stafford
Bark Camp Lake (Corder Bottom Lake, Lee/Scott/Wise Lake)	Scott County	Warmwater	11	Fort Blackmore
Beaver Creek Reservoir	Albemarle County	Warmwater	9	Crozet
Beaverdam Creek Reservoir (Beaverdam Reservoir)	Bedford County	Warmwater	11	Stewartsville
Beaverdam Reservoir	Loudoun County	Warmwater	9	Leesburg
Bedford Reservoir (Stony Creek Reservoir)	Bedford County	Warmwater	11	Peaks of Otter
Big Cherry Lake	Wise County	Warmwater	11	East Stone Gap
Breckenridge Reservoir	Prince William County	Warmwater	9	Joplin
Briery Creek Lake	Prince Edward County	Warmwater	9	Hampden Sydney
Brunswick Lake (County Pond)	Brunswick County	Warmwater	9	Smokey Ordinary
Burke Lake	Fairfax County	Fertilized	9	Fairfax
Carvin Cove Reservoir	Botetourt County	Warmwater	11	Daleville/Roanoke
Cherrystone Reservoir	Pittsylvania County	Warmwater	9	Chatham
Chickahominy Lake	Charles City County	Warmwater	9	Walkers
Chris Green Lake	Albemarle County	Warmwater	9	Luray
Claytor Lake	Pulaski County	Coolwater	11	Dublin/Radford South
Clifton Forge Reservoir (Smith Creek Reservoir)	Alleghany County	Warmwater	11	Clifton Forge
Coles Run Reservoir	Augusta County	Coldwater	11	Big Levels
Curtis Lake	Stafford County	Fertilized	9	Storck

Diascund Creek Reservoir	**New Kent County**	**Warmwater**	**9**	**Walkers**
Douthat Lake	**Bath County**	**Coolwater**	**11**	**Healing Springs**
Elkhorn Lake	**Augusta County**	**Coldwater**	**11**	**Stokesville**
Emporia Lake (Meherrin Reservoir)	**Greensville County**	**Warmwater**	**9**	**Emporia**
Fairystone Lake	**Henry County**	**Warmwater**	**11**	**Philpott Lake**
Falling Creek Reservoir	**Chesterfield County**	**Warmwater**	**9**	**Drewrys Bluff**
Fluvanna Ruritan Lake	**Fluvanna County**	**Fertilized**	**9**	**Simon/Boyd Tavern**
Fort Pickett Reservoir	**Nottoway/Brunswick County**	**Warmwater**	**9**	**Danieltown/Blackstone East**
Gatewood Reservoir	**Pulaski County**	**Warmwater**	**11**	**Longspur/Pulaski**
Georges Creek Reservoir (Gretna Lake)	**Pittsylvania County**	**Warmwater**	**9**	**Gretna**
Goose Creek Reservoir	**Loudoun County**	**Warmwater**	**9**	**Leesburg**
Graham Creek Reservoir (Elon Waterworks Reservoir)	**Amherst County**	**Warmwater**	**9**	**Lynchburg**
Great Creek Reservoir	**Lawrenceville**	**Warmwater**	**9**	**Alberta**
Harrison Lake	**Charles City County**	**Warmwater**	**9**	**Westover**
Harwoods Mill Reservoir	**York County**	**Warmwater**	**14**	**Poquoson West**
Hidden Valley Lake	**Washington County**	**Warmwater**	**11**	**Brumley**
Hogan Lake	**Pulaski County**	**Warmwater**	**11**	**Pulaski**
Holiday Lake	**Appomattox County**	**Warmwater**	**9**	**Holiday Lake**
Hungry Mother Lake	**Smyth County**	**Warmwater**	**11**	**Chatam Hill/Marion**
Hunting Run Reservoir	**Spotsylvania County**	**Warmwater**	**9**	**Chancellorsville**
J. W. Flannagan Reservoir	**Dickenson County**	**Coolwater**	**11**	**Clintwood/Haysi**
Kerr Reservoir, Virginia portion (Buggs Island Lake)	**Halifax County,**	**Coolwater**	**9**	**John H. Kerr Dam/ Tungsten/Clarksville South/Clarkesville North**
Keysville Reservoir	**Charlotte County**	**Warmwater**	**9**	**Eureka/Keysville**
Lake Albemarle	**Albemarle County**	**Warmwater**	**9**	**Crozet**

Lake Anna	**Louisa County**	**Coolwater**	**9**	**Lake Anna East/Lake Anna West/Mineral**
Lake Arrowhead	**Page County**	**Warmwater**	**11**	**Luray**
Lake Burnt Mills	**Isle of Wight County**	**Warmwater**	**14**	**Chuckatuck/Windsor**
Lake Chesdin	**Chesterfield County**	**Warmwater**	**9**	**Sutherland/Beach/Winterpock**
Lake Cohoon	**Suffolk City**	**Warmwater**	**14**	**Windsor**
Lake Conner	**Halifax County**	**Warmwater**	**9**	**Conner Lake**
Lake Frederick	**Frederick County**	**Warmwater**	**11**	**Stephens City**
Lake Gaston, (Virginia portion)	**Brunswick County**	**Coolwater**	**9**	**South Hill SE/Bracey**
Lake Gordon	**Mecklenburg County**	**Warmwater**	**9**	**South Hill**
Lake Keokee	**Lee County**	**Warmwater**	**11**	**Big Stone Gap**
Lake Kilby	**Suffolk City**	**Warmwater**	**14**	**Suffolk**
Lake Lawson	**Virginia Beach City**	**Warmwater**	**14**	**Little Creek**
Lake Manassas	**Prince William County**	**Warmwater**	**9**	**Thoroughfare Gap**
Lake Meade	**Suffolk City**	**Warmwater**	**14**	**Chucktuck/Suffolk**
Lake Moomaw	**Bath County,**	**Coldwater**	**11**	**Falling Spring/Mountain Grove**
Lake Nelson (Nelson Lake)	**Nelson County**	**Fertilized**	**9**	**Arrington**
Lake Nottoway (Lee Lake, Nottoway Lake)	**Nottoway County**	**Warmwater**	**9**	**Wellville**
Lake Orange	**Orange County**	**Warmwater**	**9**	**Orange**
Lake Pelham	**Culpeper County**	**Warmwater**	**9**	**Culpeper West**
Lake Prince	**Suffolk City**	**Warmwater**	**14**	**Windsor**
Lake Robertson	**Rockbridge County**	**Warmwater**	**11**	**Collierstown**
Lake Smith	**Virginia Beach City**	**Warmwater**	**14**	**Little Creek**
Lake Whitehurst	**Norfolk City**	**Warmwater**	**14**	**Little Creek**
Lake Wright	**Norfolk City**	**Warmwater**	**14**	**Little Creek**
Lakeview Reservoir	**Chesterfield County**	**Warmwater**	**9**	**Chester**
Laurel Bed Lake	**Russell County**	**Warmwater**	**11**	**Saltville**
Lee Hall Reservoir	**Newport News**	**Warmwater**	**14**	**Yorktown**

(Newport News Reservoir) (City Reservoir)				
Leesville Reservoir (Leesville Lake)	**Bedford County**	**Coolwater**	**9**	**Leesville**
Little Creek Reservoir	**Virginia Beach City**	**Warmwater**	**14**	**Little Creek**
Little Creek Reservoir	**James City County**	**Coolwater**	**9**	**Norge**
Little River Reservoir	**Montgomery County**	**Warmwater**	**11**	**Radford South**
Lone Star Lake F (Crystal Lake)	**Suffolk City**	**Warmwater**	**14**	**Chuckatuck**
Lone Star Lake G (Crane Lake)	**Suffolk City**	**Warmwater**	**14**	**Chuckatuck**
Lone Star Lake I (Butler Lake)	**Suffolk City**	**Warmwater**	**14**	**Chuckatuck**
Lunga Reservoir	**Prince William County**	**Warmwater**	**9**	**Joplin**
Lunenburg Beach Lake (Victoria Lake)	**Town of Victoria**	**Warmwater**	**9**	**Kenbridge West**
Martinsville Reservoir (Beaver Creek Reservoir)	**Henry County**	**Warmwater**	**9**	**Martinsville East/ Snow Creek**
Mill Creek Reservoir	**Amherst County**	**Warmwater**	**9**	**Piney River**
Modest Creek Reservoir	**Town of Victoria**	**Warmwater**	**9**	**Rubermont**
Motts Run Reservoir	**Spotsylvania County**	**Coolwater**	**9**	**Salem Church**
Mount Jackson Reservoir	**Shenandoah County**	**Warmwater**	**11**	**Hamburg**
Mountain Run Lake	**Culpeper County**	**Warmwater**	**9**	**Culpeper West**
Ni Reservoir	**Spotsylvania County**	**Warmwater**	**9**	**Salem Church/ Spotsylvania/Brokenburg/ Chancellorsville**
North Fork Pound Reservoir (North Fork Pound River Lake)	**Wise County**	**Warmwater**	**11**	**Flat Gap**
Northeast Creek Reservoir	**Louisa County**	**Warmwater**	**9**	**Pendleton**
Occoquan Reservoir	**Fairfax County**	**Warmwater**	**9**	**Occoquan**
Pedlar Lake (Lynchburg Reservoir)	**Amherst County**	**Warmwater**	**11**	**Buena Vista**

Philpott Reservoir (Philpott Lake)	**Henry County**	**Coolwater**	**9**	**Philpott Lake**
Phelps Creek Reservoir (Brookneal Reservoir)	**Campbell County**	**Warmwater**	**9**	**Brookneal**
Powhatan Lakes (Upper and Lower)	**Powhatan County**	**Warmwater**	**9**	**Powhatan**
Ragged Mountain Reservoir (Charlottesville Reservoir)	**Albemarle County**	**Warmwater**	**9**	**Charlottesville West**
Rivanna Reservoir (South Fork Rivanna Reservoir)	**Albemarle County**	**Warmwater**	**9**	**Charlottesville East/ Charlottesville West**
Roaring Fork	**Pittsylvania County**	**Warmwater**	**9**	**Chatham**
Rural Retreat Lake	**Wythe County**	**Warmwater**	**11**	**Cedar Springs**
Sandy River Reservoir	**Prince Edward County**	**Warmwater**	**9**	**Rice**
Shenandoah Lake (Lake Shenandoah)	**Rockingham County**	**Warmwater**	**11**	**Harrisonburg**
Silver Lake	**Rockingham County**	**Warmwater**	**11**	**Bridgewater**
Smith Mountain Lake	**Bedford County**	**Coolwater**	**9**	**Goodview/Moneta SW/ Smith Mountain Dam**
South Holston Reservoir	**Washington County**	**Coolwater**	**11**	**Abingdon/Shady Valley/ Holston Valley**
Speights Run Lake	**Suffolk City**	**Warmwater**	**14**	**Buckhorn**
Spring Hollow Reservoir	**Roanoke County**	**Coolwater**	**11**	**Elliston**
Staunton Dam Lake (Staunton Reservoir)	**Augusta County**	**Warmwater**	**11**	**Stokesville**
Stonehouse Creek Reservoir	**Amherst County**	**Fertilized**	**9**	**Piney River**
Strasburg Reservoir	**Shenandoah County**	**Warmwater**	**11**	**Strasburg**
Stumpy Lake	**Virginia Beach**	**Warmwater**	**14**	**Kempsville**
Sugar Hollow Reservoir (Charlottesville Reservoir)	**Albemarle County**	**Coolwater**	**11**	**Browns Cove**
Swift Creek Lake	**Chesterfield County**	**Warmwater**	**9**	**Chesterfield**
Swift Creek Reservoir	**Chesterfield County**	**Warmwater**	**9**	**Hallsboro**

Switzer Lake	**Rockingham County**	**Coldwater**	**11**	**Brandywine**
Talbott Reservoir	**Patrick County**	**Warmwater**	**11**	**Meadows of Dan**
Thrashers Creek Reservoir	**Amherst County**	**Warmwater**	**9**	**Forks of Buffalo**
Totier Creek Reservoir	**Albemarle County**	**Warmwater**	**9**	**Esmont**
Townes Reservoir	**Patrick County**	**Coolwater**	**11**	**Meadows of Dan**
Troublesome Creek Reservoir	**Buckingham County**	**Warmwater**	**9**	**Buckingham**
Waller Mill Reservoir	**York County**	**Coolwater**	**9**	**Williamsburg**
Western Branch Reservoir	**Suffolk City**	**Coolwater**	**14**	**Chuckatuck**
Wise Reservoir	**Wise County**	**Coolwater**	**11**	**Wise**

APPENDIX II

Significant Lakes and Reservoirs by Region

Northern Regional Office – 17 Reservoirs/Lakes
Abel Lake Stafford Co. 174 (Acres) PWS
Lake Anna Louisa Co., Spotsylvania Co., Orange Co. 9,595
Aquia Reservoir Stafford Co. 131 PWS
(Smith Lake)
Beaverdam Reservoir Loudoun Co. 301 PWS
Breckenridge Reservoir Prince William Co. 47 PWS
Burke Lake Fairfax Co. 208 VDGIF
Curtis Lake Stafford Co. 58
Goose Creek Reservoir Loudoun Co. 40 PWS
Hunting Run Reservoir Spotsylvania Co. 440 PWS
Lake Manassas Prince William Co. 675 PWS
Lake Orange Orange Co. 124
Lunga Reservoir Prince William Co. 477 PWS
Motts Run Reservoir Spotsylvania Co. 137 PWS
Mountain Run Lake Culpeper Co. 73 PWS
Ni Reservoir Spotsylvania Co. 408 PWS
Northeast Creek Res. Louisa Co. 178 PWS
Occoquan Reservoir Fairfax, Prince William Co. 1333 PWS
Lake Pelham Culpeper Co. 250 PWS

Piedmont Regional Office – 22 Reservoirs/Lakes
Amelia Lake Amelia Co. 98 VDGIF
Briery Creek Lake Pr. Edward Co. 825 VDGIF
Brunswick Lake Brunswick Co. 138 VDGIF
Lake Chesdin Chesterfield Co. 3164 PWS
Chickahominy Lake Charles City Co. 1049 PWS
Diascund Reservoir New Kent Co. 1055 PWS
Emporia Lake Greensville Co. 290 PWS
Falling Creek Reservoir Chesterfield Co. 88
Fort Pickett Reservoir Nottoway Co. 319
Great Creek Reservoir Lawrenceville 219
Harrison Lake Charles City Co. 60
Holiday Lake Appomattox Co. 113
Lake Nottoway Nottoway Co. 161
Lakeview Reservoir Chesterfield Co. 43
Little Creek Reservoir James City Co. 926 PWS
Lunenburg Beach Lake Town of Victoria 12 PWS
Modest Creek Reservoir Town of Victoria 20 PWS
Powhatan Lake (U & L) Powhatan Co. 61
Sandy River Reservoir Prince Edward Co. 718
Swift Creek Lake Chesterfield Co. 102

Swift Creek Reservoir Chesterfield Co. 1581 PWS
Troublesome Creek Reservoir Buckingham Co. 53 PWS
(SCS Impoundment #2)

Southwest Regional Office – 11 Reservoirs
Bark Camp Lake Scott Co. 29 USFS
Big Cherry Lake Wise Co. 103 PWS
Hidden Valley Lake Russell Co. 58 VDGIF
Hungry Mother Lake Smyth Co. 100 DCR
J. W. Flannagan Reservoir Dickenson Co. 1177 ACOE/PWS
Lake Keokee Lee Co. 97 VDGIF
Laurel Bed Lake Russell Co. 312 VDGIF
North Fork Pound Reservoir Wise Co. 116 ACOE/PWS
South Holston Reservoir Washington Co. 1699 TVA/PWS
Wise Reservoir Wise Co. 46 WISE/PWS
Rural Retreat Lake Wythe Co. 85 VDGIF

Tidewater Regional Office – 21 Reservoirs/Lakes
Airfield Pond Sussex Co. 120 VDGIF
Lake Cahoon Suffolk City 454 PWS
Lake Burnt Mills Isle of Wight Co. 638 PWS
Harwood Mills Reservoir York Co. 258 PWS
Lake Kilby Suffolk City 200 PWS
Lake Lawson Virginia Beach 75
Lee Hall Reservoir Newport News 290 PWS
Little Creek Reservoir Norfolk City 200 PWS
Lone Star Lake F Suffolk City 19 PWS
Lone Star Lake G Suffolk City 90 PWS
Lone Star Lake I Suffolk City 33 PWS
Lake Meade Suffolk City 490 PWS
Lake Prince Suffolk City 709 PWS
Lake Smith Norfolk City 185 PWS
Speights Run Lake Suffolk City 118 PWS
Stumpy Lake Virginia Beach 263
Waller Mill Reservoir York Co. 288 PWS
Lake Whitehurst Norfolk City 495 PWS
Lake Wright Norfolk City 12
Western Branch Reservoir Norfolk City 1205 PWS
Lake Drummond Suffolk City 3242

Valley Regional Office – 21 Reservoirs/Lakes
Beaver Creek Reservoir Albemarle Co. 96 PWS
Chris Greene Lake Albemarle Co. 57 PWS
Douthat Lake Bath Co. 47
Coles Run Reservoir Augusta Co. 11 USFS/PWS
Elkhorn Lake Augusta Co. 51 USFS/PWS

Fluvanna Ruritan Lake Fluvanna Co. 51
Lake Albemarle Albemarle Co. 37
Lake Arrowhead Page Co. 36
Lake Frederick Frederick Co. 67 VDGIF
Lake Nelson Nelson Co. 41
Lake Robertson Rockbridge Co. 24
Mount Jackson Reservoir Shenandoah Co. 1
Ragged Mount Reservoir Albemarle Co. 71 PWS
Rivanna Reservoir Albemarle Co. 399 PWS
Shenandoah Lake Rockingham Co. 36
Silver Lake Rockingham Co. 11 PWS
Staunton Dam Lake Augusta Co. 21 PWS
Strasburg Reservoir Shenandoah Co. 5
Switzer Lake Rockingham Co. 99 USFS/PWS
Sugar Hollow Reservoir Albemarle Co. 47 PWS
Totier Creek Reservoir Albemarle Co. 37 PWS

BRRO Roanoke Office – 31 Reservoirs/Lakes
Beaverdam Creek Reservoir Bedford Co. 70 PWS
Bedford (Stony Cr.) Reservoir Bedford Co. 28 PWS
Carvin Cove Reservoir Botetourt Co. 632 PWS
Cherrystone Reservoir Pittsylvania Co. 104 PWS
Claytor Lake Pulaski Co. 4287 PWS
Clifton Forge (Smith Cr.) Reservoir Alleghany Co. 10 PWS
Lake Conner Halifax Co. 98 VDGIF
Fairystone Lake Henry Co. 127
Gatewood Reservoir Pulaski Co. 176 PWS
Georges Creek Reservoir Pittsylvania Co. 8 PWS
Graham Creek Reservoir Amherst Co. 40 PWS
Hogan Lake Pulaski Co. 36 PWS
Kerr Reservoir (Va.'s portion) Halifax Co. 33300 ACOE/PWS
Keysville Reservoir Charlotte Co. 36 PWS
Lake Gordon Mecklenburg Co. 115 VDGIF
Lake Gaston (Va.'s portion) Brunswick Co. 5614 PWS
Leesville Reservoir Bedford Co. 2630 PWS
Little River Reservoir Montgomery Co. 60 PWS
Martinsville Reservoir Henry Co. 181 PWS
Mill Creek Reservoir Amherst Co. 190
Lake Moomaw Bath Co. 2389 ACOE
Pedlar Lake Amherst Co. 118 PWS
Phelps Creek Reservoir Campbell Co. 19 PWS
Philpott Reservoir Henry Co. 2813 ACOE
Roaring Fork Reservoir Pittsylvania Co. 19 PWS
Smith Mountain Lake Bedford Co. 19820 PWS
Spring Hollow Reservoir Roanoke Co. 113 PWS
Stonehouse Creek Reservoir Amherst Co. 34

Talbott Reservoir Patrick Co. 141
Thrashers Creek Reservoir Amherst Co. 32
Townes Reservoir Patrick Co. 28

Total 123 Significant Reservoirs/Lakes statewide
PWS = Public Water Supply
VDGIF = Virginia Department of Game and Inland Fisheries
ACOE = Army Corps of Engineers
TVA = Tennessee Valley Authority
Bold = Nutrient WQ Stand