



## VIRGINIA SOIL AND WATER CONSERVATION BOARD GUIDANCE DOCUMENT ON THE USE OF OVERTOPPING PROTECTION SYSTEMS ON EXISTING DAMS

(Approved December 6, 2017)

### **Summary:**

This guidance document provides the requirements an owner must meet in order to utilize certain overtopping protection systems on an existing impounding structure. These systems may be used to meet the spillway design flood requirements established in 4VAC50-20-50 (Performance standards required for impounding structures). Examples of acceptable overtopping protection systems include roller compacted concrete, articulated concrete blocks, and HydroTurf™ CS. This guidance document sets out the Board's expectations regarding the use of overtopping protection systems on existing impounding structures. The Director of the Department should adhere to these expectations when approving the use of overtopping protection systems pursuant to the authority set out in 4VAC50-20-320.

### **Electronic Copy:**

An electronic copy of this guidance in PDF format is available on the Regulatory Town Hall under the Virginia Soil and Water Conservation Board at <http://townhall.virginia.gov/L/GDocs.cfm>.

### **Contact Information:**

Please contact the Department of Conservation and Recreation's Division of Dam Safety and Floodplain Management at [dam@dcr.virginia.gov](mailto:dam@dcr.virginia.gov) or by calling 804-371-6095 with any questions regarding the application of this guidance.

### **Disclaimer:**

This document is provided as guidance and, as such, sets forth standard operating procedures for the Department of Conservation and Recreation in administering the Dam Safety Program on behalf of the Virginia Soil and Water Conservation Board (Board) in accordance with § 10.1-605.1. This guidance provides a general interpretation of the applicable Code and Regulations but is not meant to be exhaustive in nature. Each situation may differ and may require additional interpretation of the Dam Safety Act and attendant regulations. This guidance is not intended and cannot be relied on to create any rights, substantive or procedural, on the part of any person or entity.

## **Overtopping Protections for Impounding Structure Embankments**

### **I. Background:**

The Virginia Dam Safety Act, §10.1-605 entitled Promulgation of regulations by the Board; guidance document, states that the Virginia Soil and Water Conservation Board (Board) shall

adopt regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated.

Section 4VAC50-20-210 of the Impounding Structure Regulations authorizes the Board to establish a consulting committee "[w]hen the board needs to satisfy questions of safety regarding plans and specifications, construction, alteration, or operation and maintenance, or when requested by the owner, the board may appoint a consulting committee to report to it with respect to those questions of the impounding structure's safety". At the April 20, 2017 meeting, the Board directed the Department to establish a consulting committee to evaluate the use of HydroTurf™ [synthetic turf with a cementitious infill] in the Commonwealth of Virginia for dam overtopping protection particularly in situations where it is being recommended in order to meet spillway design flood requirements. The Committee was required to investigate, at a minimum, whether the product is protective of public safety, durable, and reliable, and if found to be so, under what conditions and engineering protocols it might be properly utilized; the procedures and criteria used must be proven to be current, sound engineering practices.

This guidance document reflects the recommendations of the Consulting Committee as presented to the Board on November 16, 2017. The Committee endorsed the use of HydroTurf™ CS for existing dams without regard to the hazard classification of the dam.

This document sets out additional conditions and protocols that should be followed in order to address public safety, durability, and reliability when utilizing overtopping protection systems to meet spillway design.

## **II. Definitions (pursuant to 4VAC50-20-30):**

"Alteration" means changes to an impounding structure that could alter or affect its structural integrity. Alterations include, but are not limited to, changing the height or otherwise enlarging the dam, increasing normal pool or principal spillway elevation or physical dimensions, changing the elevation or physical dimensions of the emergency spillway, conducting necessary structural repairs or structural maintenance, or removing the impounding structure. Structural maintenance does not include routine maintenance.

"Alteration permit" means a permit required for any alteration to an impounding structure.

"Existing impounding structure" means any impounding structure in existence or under a construction permit prior to July 1, 2010.

"Impounding structure" or "dam" means a man-made structure, whether a dam across a watercourse or structure outside a watercourse, used or to be used to retain or store waters or other materials. The term includes: (i) all dams that are 25 feet or greater in height and that create an impoundment capacity of 15 acre-feet or greater, and (ii) all dams that are six feet or greater in height and that create an impoundment capacity of 50 acre-feet or greater. The term "impounding structure" shall not include: (a) dams licensed by the State Corporation Commission that are subject to a safety inspection program; (b) dams owned or licensed by the United States government; (c) dams operated primarily for agricultural purposes which are less

than 25 feet in height or which create a maximum impoundment capacity smaller than 100 acre-feet; (d) water or silt retaining dams approved pursuant to § 45.1-222 or 45.1-225.1 of the Code of Virginia; or (e) obstructions in a canal used to raise or lower water.

### **III. Authority:**

The Dam Safety Act in the *Code of Virginia* contains the following authorities applicable to this guidance:

**§ 10.1-605. Promulgation of regulations by the Board; guidance document.**

The Board shall adopt regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated...

**§ 10.1-607. Safety inspections.**

No one shall maintain a dam which unreasonably threatens the life or property of another. The Board shall cause safety inspections to be made of impounding structures on such schedule as it deems appropriate...

**§ 10.1-610.1. Monitoring progress of work.**

A. During the maintenance, construction, or alteration of any dam or reservoir, the Department shall make periodic inspections for the purpose of securing conformity with the approved plans and specifications...

Appendix 1 contains the *Code of Virginia* authorities (extended) applicable to this guidance and Appendix 2 contains the *Impounding Structure Regulations* authorities applicable to this guidance. These include:

§ 10.1-605. Promulgation of regulations by the Board; guidance document.

§ 10.1-607. Safety inspections.

§ 10.1-610.1. Monitoring progress of work.

4VAC50-20-20. General Provisions.

4VAC50-20-30. Definitions.

4VAC50-20-40. Hazard Potential Classifications of Impounding Structures.

4VAC50-20-50. Performance Standards Required for Impounding Structures.

4VAC50-20-60. Required Permits.

4VAC50-20-80. Alterations Permits.

4VAC50-20-105. Regular Operation and Maintenance Certificates.

4VAC50-20-180. Inspections.

4VAC50-20-210. Consulting Committee.

4VAC50-20-240. Design of Structures.

4VAC50-20-260. Spillway Design.

4VAC50-20-300. Additional Design Requirements.

4VAC50-20-310. Plans and Specifications.

4VAC50-20-320. Acceptable Design Procedures and References.

4VAC50-20-330. Other Applicable Dam Safety References.

#### **IV. Discussion and Interpretation:**

The Virginia Dam Safety Program's mission is to protect the lives and property of the Commonwealth's citizens from natural and manmade flooding in accordance with 4VAC 50-20-20.A. In an effort to ensure that dams in Virginia are operated and maintained in a safe condition, the Board established performance criteria to ensure the safety of the impounding structure during significant storm events (4VAC50-20-50); these requirements vary depending on the hazard potential classification of the structure. Many existing dams need spillway modifications to meet the requirements. Prior to any modification being made to the structure, the Department must approve the modification and issue an alteration permit.

Over recent years, extensive research has been conducted on the use and effectiveness of various overtopping protection methods that protect an embankment during an overtopping event. If protection of embankments from erosion due to overtopping prevents the structure from failure during significant storm events, economic impacts could potentially be reduced and additional flexibility could be provided to owners and their engineers.

Many of the overtopping protection methods are widely known such as roller compacted concrete and articulated concrete blocks; however, HydroTurf<sup>TM</sup> CS, is not as widely known or currently utilized.

#### **What is HydroTurf<sup>TM</sup> CS?**

HydroTurf<sup>TM</sup> CS is a proprietary slope erosion control product best described generally as "synthetic turf with cementitious infill" or "synthetic turf revetment system". The product is manufactured by Watershed Geosynthetics/Watershed Geo® of Alpharetta, Georgia. The manufacturer has done extensive testing of the product in conjunction with the Colorado State University - Engineering Research Center (CSU) in Fort Collins, Colorado.

HydroTurf<sup>TM</sup> CS is a composite system consisting of a structured geomembrane overlain by an engineered synthetic turf which is infilled with a cementitious mix known as HydroBinder®. General identifiable components of the HydroTurf<sup>TM</sup> CS system are as follows:

1. Structured high density polyethylene geomembrane with an integrated drainage layer;
2. Engineered polyethylene monofilament yarn synthetic turf with a backing polypropylene geotextile;
3. Cementitious hydrobinder infill (Portland Cement ASTM C150 Type I or II, also known as Quikrete®); and
4. Penetrating catalyzed colloidal silicate concrete treatment of hydrobinder infill (if freeze-thaw issues are present).

#### **Conditions applicable to the use of overtopping protection systems on existing dams**

Depending on the type of overtopping protection system, and prior to the Department approving the use of any such system to meet the spillway design flood requirements, the applicable conditions set out in 1, 2, and 3 below should be met. These conditions are in addition to the requirements set out in 4VAC50-20-60 (Required permits) and 4VAC50-20-80 (Alterations

permits). All necessary documentation should be submitted to the regional engineer in both paper and electronic formats. The regional engineer may request additional information if needed to determine if the appropriate analysis has been conducted to meet these conditions.

### **1. Conditions required for all overtopping protection systems**

The conditions and engineering protocols listed below apply to all systems used for dam overtopping protection, including HydroTurf<sup>TM</sup> CS.

- a. The overtopping protection system design should address the frequency of overtopping as documented in the FEMA Publication P-1015, Technical Manual: Overtopping Protection for Dams, Best Practices for Design, Construction, Problem Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair, May 2014. Specifically, a careful analysis of all potential failure modes for the dam and appurtenant features should be performed for both the existing (baseline) conditions and for the proposed modified conditions.
- b. The overtopping protection system design should consider the frequency, depth, and duration of overtopping flows.
- c. A seepage evaluation should be conducted to demonstrate that the phreatic surface would be controlled by appropriate drainage systems (e.g. toe drains, underdrains), even under extreme conditions.
- d. Properly designed underdrains should be adopted in cases where the phreatic surface exits on the downstream embankment.
- e. Penetrations should be minimized or otherwise considered in the hydraulic evaluation and design of the overtopping protection system.

### **2. Conditions applicable for the utilization of certain overtopping protection systems**

The conditions and engineering protocols listed below apply to several systems used for dam overtopping protection including articulated concrete blocks and HydroTurf<sup>TM</sup> CS.

- a. The overtopping protection system design should demonstrate that the toe anchor trench be located beyond the turbulent region resulting from a hydraulic jump.
- b. Trench evaluations should account for the comparatively more critical soil shear strength values and seepage configuration that apply during overtopping events.
- c. In addition to conventional trench design, a local stability analysis should be completed to account for all driving forces including but not limited to soil weight, revetment weight, soil properties, seepage forces, interface strengths, and tensile elements such as cables, geotextiles, geogrids, and geomembranes acting near the anchor trench.
- d. Veneer stability analysis should be conducted for any layered revetment system under conditions corresponding to the design loads. Interface shear strength parameters for the layers should be determined in accordance with ASTM D5321. For revetment systems with a geomembrane, maximum wind velocity should be considered as one of the design loads.

- e. The overtopping protection system design should document the maximum tensile forces acting on the critical layer of the revetment system near the top anchor trench under extreme conditions. Estimated forces should be compared to the admissible tensile strength of the individual layered elements. For revetment systems with geomembrane elements, prediction of the maximum tensile forces should account for the potential loss in interface shear resistance induced by wind uplift acting along the slope. Determination of the admissible tensile strength should account for appropriate factors of safety, as well as for reduction factors due to installation damage and degradation.
- f. The design documentation should address the ability of the design flow conditions to carry potentially damaging debris that could damage the overtopping protection system.
- g. The design documentation should demonstrate that the overtopping hydraulic conditions are within the tested range.
- h. The design documentation should demonstrate that the maximum expected hydraulic conditions be evaluated and the system demonstrates a factor of safety of 2 for overtopping flows. Two-dimensional hydraulic evaluations may be necessary to satisfy this requirement. The maximum permissible value of velocity and shear stress for overtopping protection systems shall be determined in accordance with ASTM D 7277 with the test results being analyzed in accordance with ASTM D 7276.

### **3. Additional conditions applicable for the utilization of HydroTurf<sup>TM</sup> CS**

The conditions and engineering protocols listed below apply when utilizing HydroTurf<sup>TM</sup> CS for overtopping protection.

- a. That factor of safety for HydroTurf<sup>TM</sup> CS shall be calculated by dividing the lift generated at the maximum permissible velocity by the lift computed at the design velocity for the specific overtopping application.
- b. Project-specific determination of interface shear strength parameters between the HydroTurf<sup>®</sup> geomembrane and site-specific subgrade should be conducted. Tests should be conducted according to ASTM D5321 ("Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear").
- c. An installation quality control program should confirm that the nominal thickness of ¾ inch of infill has been achieved during product installation in accordance with manufacturer's recommendations. Pictures and other type of document that ensures the HydroTurf<sup>TM</sup> CS was installed in accordance with the manufacturer's recommendations should be provided to the Department when requested.
- d. The dam owner or the owner's engineer should follow the Inspection and Monitoring guidelines provided by the manufacture, Watershed GeoSynthetics, as documented in HydroTurf<sup>®</sup> CS and Z Monitoring and Maintenance Guidelines."
- e. If at all possible, Watershed GeoSynthetics should be involved in the design and installation of HydroTurf<sup>TM</sup> CS applications.

- f. An owner should replace or partially replace the infilled turf layer, as part of a maintenance program, when visible signs of cracking, deterioration or loss of turf fibers or infill material are apparent. The condition of the HydroTurf™ CS system should be monitored and documented as part of the annual inspection of the dam.

### **Additional Reference Documents related to Overtopping Protection for Impounding Structures**

These documents provide additional guidance regarding the use of overtopping protection on impounding structures. The Department will utilize these documents when reviewing alteration permit applications which include the use of overtopping protection systems.

FEMA Publication P-1014, Overtopping Protection for Dams, Best Practices for Design, Construction, Problem Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair, May 2014.

FEMA Publication P-1015, Technical Manual: Overtopping Protection for Dams, Best Practices for Design, Construction, Problem Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair, May 2014.

### **V. Adoption, Amendments, and Repeal:**

This document shall remain in effect until rescinded or superseded.

## **Appendix 1**

Applicable *Code of Virginia* Authorities.

The *Code of Virginia* contains the following authorities applicable to this Guidance:

### **§ 10.1-605. Promulgation of regulations by the Board; guidance document.**

A. The Board shall adopt regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated. Dam safety regulations promulgated by the State Water Control Board shall remain in full force until amended in accordance with applicable procedures.

B. The Board's Impounding Structure Regulations shall not require any impounding structure in existence or under a construction permit prior to July 1, 2010, that is currently classified as high hazard, or is subsequently found to be high hazard through reclassification, to upgrade its spillway to pass a rainfall event greater than the maximum recorded within the Commonwealth, which shall be deemed to be 90 percent of the probable maximum precipitation.

1. Such an impounding structure shall be determined to be in compliance with the spillway requirements of the regulations provided that (i) the impounding structure will pass two-thirds of the reduced probable maximum precipitation requirement described in this subsection and (ii) the dam owner certifies annually and by January 15 that such impounding structure meets each of the following conditions:

a. The owner has a current emergency action plan that is approved by the Board and that is developed and updated in accordance with the regulations;

b. The owner has exercised the emergency action plan in accordance with the regulations and conducts a table-top exercise at least once every two years;

c. The Department has verification that both the local organization for emergency management and the Virginia Department of Emergency Management have on file current emergency action plans and updates for the impounding structure;

d. That conditions at the impounding structure are monitored on a daily basis and as dictated by the emergency action plan;

e. The impounding structure is inspected at least annually by a professional engineer and all observed deficiencies are addressed within 120 days of such inspection;

f. The owner has a dam break inundation zone map developed in accordance with the regulations that is acceptable to the Department;

g. The owner is insured in an amount that will substantially cover the costs of downstream property losses to others that may result from a dam failure; and

h. The owner shall post the dam's emergency action plan on his website, or upon the request of the owner, the Department or another state agency responsible for providing emergency management services to citizens agrees to post the plan on its website. If the Department or another state agency agrees to post the plan on its website, the owner shall provide the plan in a format suitable for posting.

2. A dam owner who meets the conditions of subdivisions 1 a through 1 h, but has not provided record drawings to the Department for his impounding structure, shall submit a complete record report developed in accordance with the construction permit requirements of the Impounding Structure Regulations, excluding the required submittal of the record drawings.

3. A dam owner who fails to submit certifications required by subdivisions 1 a through 1 h in a timely fashion shall not enjoy the presumption that such impounding structure is deemed to be



in compliance with the spillway requirements of the Board's Impounding Structure Regulations (4VAC50-20).

4. Any dam owner who has submitted the certifications required by subdivisions 1 a through 1 h shall make (i) such certifications, (ii) the emergency action plan required by subdivision 1 a, and (iii) the certificate of insurance required by subdivision 1 g available, upon request and within five business days, to any person. A dam owner may comply with the requirements of this subdivision by providing the same information on a website and directing the requestor to such website. A dam owner who fails to comply with this subdivision shall be subject to a civil penalty pursuant to § 10.1-613.2.

C. The Board's regulations shall establish an incremental damage analysis procedure that permits the spillway design flood requirement for an impounding structure to be reduced to the level at which dam failure shall not significantly increase downstream hazard to life or property, provided that the spillway design flood requirement shall not be reduced to below the 100-year flood event for high or significant hazard impounding structures, or to below the 50-year flood event for low hazard potential impounding structures.

D. The Board shall consider the impact of limited-use or private roadways with low traffic volume and low public safety risk that are downstream from or across an impounding structure in the determination of the hazard potential classification of an impounding structure.

#### **§ 10.1-607. Safety inspections.**

No one shall maintain a dam which unreasonably threatens the life or property of another. The Board shall cause safety inspections to be made of impounding structures on such schedule as it deems appropriate. The time of the initial inspection and the frequency of reinspection shall depend on such factors as the condition of the structure and its size, type, location and downstream hazard potential. The owners of dams found to have deficiencies which could threaten life or property if not corrected shall take the corrective actions needed to remove such deficiencies within a reasonable time. All safety inspections shall be conducted by or under the supervision of a licensed professional engineer. Each report shall bear the seal and signature of the licensed professional engineer responsible for the inspection.

#### **§ 10.1-610.1. Monitoring progress of work.**

A. During the maintenance, construction, or alteration of any dam or reservoir, the Department shall make periodic inspections for the purpose of securing conformity with the approved plans and specifications. The Department shall require the owner to perform at his expense such work or tests as necessary to obtain information sufficient to enable the Department to determine whether conformity with the approved plans and specifications is being secured.

B. If, after any inspections, investigations, or examinations, or at any time as the work progresses, or at any time prior to issuance of a certificate of approval, it is found by the Director that project modifications or changes are necessary to ensure conformity with the approved plans and specifications, the Director may issue an administrative order to the owner to comply with the plans and specifications. Within 15 calendar days after being served by personal service or by mail with a copy of an order issued pursuant to this section, any owner shall have the right to petition the Board for a hearing. A timely filed petition shall stay the effect of the administrative order. The hearing shall be conducted before the Board or a designated member of the Board pursuant to § 2.2-4019. The Board shall have the authority to affirm, modify, amend, or cancel the administrative order. Any owner aggrieved by a decision of the Board after a hearing shall

have the right to judicial review of the final Board decision pursuant to the provisions of the Administrative Process Act (§ 2.2-4000 et seq.).

C. Following the Board hearing, subject to judicial review of the final decision of the Board, if conditions are revealed that will not permit the construction of a safe dam or reservoir, the certificate of approval may be revoked. As part of the revocation, the Board may compel the owner to remove the incomplete structure sufficiently to eliminate any safety hazard to life or property.

## **Appendix 2**

### *Applicable Impounding Structure Regulations Authorities.*

The *Impounding Structure Regulations* contains the following authorities applicable to this Guidance.

#### **4VAC50-20-20. General Provisions.**

A. This chapter provides for the proper and safe design, construction, operation and maintenance of impounding structures to protect public safety. This chapter shall not be construed or interpreted to relieve the owner or operator of any impoundment or impounding structure of any legal duties, obligations or liabilities incident to ownership, design, construction, operation or maintenance.

B. Approval by the board of proposals for an impounding structure shall in no manner be construed or interpreted as approval to capture or store waters. For information concerning approval to capture or store waters, see Chapter 8 (§ 62.1-107) of Title 62.1 of the Code of Virginia, and other provisions of law as may be applicable.

C. In promulgating this chapter, the board recognizes that no impounding structure can ever be completely "fail-safe," because of incomplete understanding of or uncertainties associated with natural (earthquakes and floods) and manmade (sabotage) destructive forces; with material behavior and response to those forces; and with quality control during construction.

D. All engineering analyses required by this chapter, including but not limited to, plans, specifications, hydrology, hydraulics and inspections shall be conducted or overseen by and bear the seal of a professional engineer licensed to practice in Virginia.

E. Design, inspection and maintenance of impounding structures shall be conducted utilizing competent, experienced, engineering judgment that takes into consideration factors including but not limited to local topography and meteorological conditions.

F. The forms noted in this chapter are available from the department at the department's website.

#### **4VAC50-20-30. Definitions.**

The following words and terms when used in this chapter shall have the following meanings unless the context clearly indicates otherwise:

"Acre-foot" means a unit of volume equal to 43,560 cubic feet or 325,853 gallons (equivalent to one foot of depth over one acre of area).

"Agricultural purpose" means the production of an agricultural commodity as defined in § 3.2-3900 of the Code of Virginia that requires the use of impounded waters.

"Agricultural purpose dams" means impounding structures which are less than 25 feet in height or which create a maximum impoundment smaller than 100 acre-feet, and operated primarily for agricultural purposes.

"Alteration" means changes to an impounding structure that could alter or affect its structural integrity. Alterations include, but are not limited to, changing the height or otherwise enlarging the dam, increasing normal pool or principal spillway elevation or physical dimensions, changing the elevation or physical dimensions of the emergency spillway, conducting necessary structural repairs or structural maintenance, or removing the impounding structure. Structural maintenance does not include routine maintenance.

"Alteration permit" means a permit required for any alteration to an impounding structure.

"Annual average daily traffic" or "AADT" means the total volume of vehicle traffic of a highway or road for a year divided by 365 days and is a measure used in transportation planning and transportation engineering of how busy a road is.

"Board" means the Virginia Soil and Water Conservation Board.

"Conditional Operation and Maintenance Certificate" means a certificate required for impounding structures with deficiencies.

"Construction" means the construction of a new impounding structure.

"Construction permit" means a permit required for the construction of a new impounding structure.

"Dam break inundation zone" means the area downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam.

"Department" means the Virginia Department of Conservation and Recreation.

"Design flood" means the calculated volume of runoff and the resulting peak discharge utilized in the evaluation, design, construction, operation and maintenance of the impounding structure.

"Director" means the Director of the Department of Conservation and Recreation or his designee.

"Drill" means a type of emergency action plan exercise that tests, develops, or maintains skills in an emergency response procedure. During a drill, participants perform an in-house exercise to verify telephone numbers and other means of communication along with the owner's response. A drill is considered a necessary part of ongoing training.

"Emergency Action Plan or EAP" means a formal document that recognizes potential impounding structure emergency conditions and specifies preplanned actions to be followed to minimize loss of life and property damage. The EAP specifies actions the owner must take to minimize or alleviate emergency conditions at the impounding structure. It contains procedures and information to assist the owner in issuing early warning and notification messages to responsible emergency management authorities. It shall also contain dam break inundation zone maps as required to show emergency management authorities the critical areas for action in case of emergency.

"Emergency Action Plan Exercise" means an activity designed to promote emergency preparedness; test or evaluate EAPs, procedures, or facilities; train personnel in emergency management duties; and demonstrate operational capability. In response to a simulated event, exercises should consist of the performance of duties, tasks, or operations very similar to the way they would be performed in a real emergency. An exercise may include but not be limited to drills and tabletop exercises.

"Emergency Preparedness Plan" means a formal document prepared for Low Hazard impounding structures that provides maps and procedures for notifying owners of downstream property that may be impacted by an emergency situation at an impounding structure.

"Existing impounding structure" means any impounding structure in existence or under a construction permit prior to July 1, 2010.

"Freeboard" means the vertical distance between the maximum water surface elevation associated with the spillway design flood and the top of the impounding structure.

"Height" means the hydraulic height of an impounding structure. If the impounding structure spans a stream or watercourse, height means the vertical distance from the natural bed

of the stream or watercourse measured at the downstream toe of the impounding structure to the top of the impounding structure. If the impounding structure does not span a stream or watercourse, height means the vertical distance from the lowest elevation of the downstream limit of the barrier to the top of the impounding structure.

"Impounding structure" or "dam" means a man-made structure, whether a dam across a watercourse or structure outside a watercourse, used or to be used to retain or store waters or other materials. The term includes: (i) all dams that are 25 feet or greater in height and that create an impoundment capacity of 15 acre-feet or greater, and (ii) all dams that are six feet or greater in height and that create an impoundment capacity of 50 acre-feet or greater. The term "impounding structure" shall not include: (a) dams licensed by the State Corporation Commission that are subject to a safety inspection program; (b) dams owned or licensed by the United States government; (c) dams operated primarily for agricultural purposes which are less than 25 feet in height or which create a maximum impoundment capacity smaller than 100 acre-feet; (d) water or silt retaining dams approved pursuant to § 45.1-222 or 45.1-225.1 of the Code of Virginia; or (e) obstructions in a canal used to raise or lower water.

"Impoundment" means a body of water or other materials the storage of which is caused by any impounding structure.

"Life of the impounding structure" and "life of the project" mean that period of time for which the impounding structure is designed and planned to perform effectively, including the time required to remove the structure when it is no longer capable of functioning as planned and designed.

"Maximum impounding capacity" means the volume of water or other materials in acre-feet that is capable of being impounded at the top of the impounding structure.

"New construction" means any impounding structure issued a construction permit or otherwise constructed on or after July 1, 2010.

"Normal or typical water surface elevation" means the water surface elevation at the crest of the lowest ungated outlet from the impoundment or the elevation of the normal pool of the impoundment if different than the water surface elevation at the crest of the lowest ungated outlet. For calculating sunny day failures for flood control impounding structures, stormwater detention impounding structures, and related facilities designed to hold back volumes of water for slow release, the normal or typical water surface elevation shall be measured at the crest of the auxiliary or emergency spillway.

"Operation and Maintenance Certificate" means a certificate required for the operation and maintenance of all impounding structures.

"Owner" means the owner of the land on which an impounding structure is situated, the holder of an easement permitting the construction of an impounding structure and any person or entity agreeing to maintain an impounding structure. The term "owner" may include the Commonwealth or any of its political subdivisions, including but not limited to sanitation district commissions and authorities, any public or private institutions, corporations, associations, firms or companies organized or existing under the laws of this Commonwealth or any other state or country, as well as any person or group of persons acting individually or as a group.

"Planned land use" means land use that has been approved by a locality or included in a master land use plan by a locality, such as in a locality's comprehensive land use plan.

"Spillway" means a structure to provide for the controlled release of flows from the impounding structure into a downstream area.

"Stage I Condition" means a flood watch or heavy continuous rain or excessive flow of water from ice or snow melt.

"Stage II Condition" means a flood watch or emergency spillway activation or impounding structure overtopping where a failure may be possible.

"Stage III Condition" means an emergency spillway activation or impounding structure overtopping where imminent failure is probable.

"Sunny day dam failure" means the failure of an impounding structure with the initial water level at the normal reservoir level, usually at the lowest ungated principal spillway elevation or the typical operating water level.

"Tabletop Exercise" means a type of emergency action plan exercise that involves a meeting of the impounding structure owner and the state and local emergency management officials in a conference room environment. The format is usually informal with minimum stress involved. The exercise begins with the description of a simulated event and proceeds with discussions by the participants to evaluate the EAP and response procedures and to resolve concerns regarding coordination and responsibilities.

"Top of the impounding structure" means the lowest point of the nonoverflow section of the impounding structure.

"Watercourse" means a natural channel having a well-defined bed and banks and in which water normally flows.

#### **4VAC50-20-40. Hazard Potential Classifications of Impounding Structures.**

A. Impounding structures shall be classified in one of three hazard classifications as defined in subsection B of this section and Table 1.

B. For the purpose of this chapter, hazards pertain to potential loss of human life or damage to the property of others downstream from the impounding structure in event of failure or faulty operation of the impounding structure or appurtenant facilities. Hazard potential classifications of impounding structures are as follows:

1. High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. "Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways, except those having an AADT volume of 400 vehicles or less in accordance with 4VAC50-20-45.

2. Significant Hazard Potential is defined where an impounding structure failure may cause the loss of life or appreciable economic damage. "May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads, personal property, and agricultural interests. "Secondary roadways" include, but are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways, except those having an AADT volume of 400 vehicles or less in accordance with 4VAC50-20-45.

3. Low Hazard Potential is defined where an impounding structure failure would result in no expected loss of life and would cause no more than minimal economic damage. "No expected loss of life" means no loss of human life is anticipated.

C. To support the appropriate hazard potential classification, dam break analysis shall be conducted by the owner's engineer or the department in accordance with one of the following alternatives and utilizing procedures set out in 4VAC50-20-54.

1. The owner of an impounding structure that does not currently hold a regular or conditional certificate from the board, or the owner of an impounding structure that is already under certificate but the owner believes that a condition has changed downstream of the impounding structure that may reduce its hazard potential classification, may request in writing that the department conduct a simplified dam break inundation zone analysis to determine whether the impounding structure has a low hazard potential classification. The owner shall pay a fee to the department in accordance with 4VAC50-20-395 for conducting each requested analysis. The department shall address requests in the order received and shall strive to complete analysis within 90 days; or

2. The owner may propose a hazard potential classification that shall be subject to approval by the board. To support the proposed hazard potential classification, an analysis shall be conducted by the owner's engineer and submitted to the department. The hazard potential classification shall be certified by the owner.

D. Findings of the analysis conducted pursuant to subsection C of this section shall result in one of the following actions:

1. For findings by the department resulting from analyses conducted in accordance with subdivision C 1 of this section:

a. If the department finds that the impounding structure appears to have a low hazard potential classification, the owner may be eligible for general permit coverage in accordance with 4VAC50-20-103.

b. If the department finds that the impounding structure appears to have a high or significant hazard potential classification, the owner's engineer shall provide further analysis in accordance with the procedures set out in 4VAC50-20-54 and this chapter. The owner may be eligible for grant assistance from the Dam Safety, Flood Prevention and Protection Assistance Fund in accordance with Article 1.2 (§ 10.1-603.16 et seq.) of Chapter 6 of Title 10.1 of the Code of Virginia.

2. For findings by the owner's engineer resulting from analyses conducted in accordance with subdivision C 2 of this section:

a. If the engineer finds that the impounding structure has a low hazard potential classification, the owner may be eligible for general permit coverage in accordance with 4VAC50-20-103; or

b. If the engineer finds that the impounding structure appears to have a high or significant hazard potential classification, then the owner shall comply with the applicable certification requirements set out in this chapter.

E. An incremental damage analysis in accordance with 4VAC50-20-52 may be utilized as part of a hazard potential classification by the owner's engineer.

F. Impounding structures shall be subject to reclassification by the board as necessary.

#### **4VAC50-20-50. Performance Standards Required for Impounding Structures.**

A. In accordance with the definitions provided by § 10.1-604 of the Code of Virginia and 4VAC50-20-30, an impounding structure shall be regulated if the impounding structure is 25 feet or greater in height and creates a maximum impounding capacity of 15 acre-feet or greater, or the impounding structure is six feet or greater in height and creates a maximum impounding capacity of 50 acre-feet or greater and is not otherwise exempt from regulation by the Code of Virginia. Impounding structures exempted from this chapter are those that are:

1. Licensed by the State Corporation Commission that are subject to a safety inspection program;
2. Owned or licensed by the United States government;
3. Operated primarily for agricultural purposes that are less than 25 feet in height or that create a maximum impoundment capacity smaller than 100 acre-feet;
4. Water or silt-retaining dams approved pursuant to § 45.1-222 or 45.1-225.1 of the Code of Virginia; or
5. Obstructions in a canal used to raise or lower water.

Impounding structures of regulated size and not exempted shall be constructed, operated and maintained such that they perform in accordance with their design and purpose throughout the life of the project. For impounding structures, the spillway capacity shall perform at a minimum to safely pass the appropriate spillway design flood as determined in Table 1. For the purposes of utilizing Table 1, Hazard Potential Classification shall be determined in accordance with 4VAC50-20-40.

TABLE 1 Impounding Structure Regulations			
Applicable to all impounding structures that are 25 feet or greater in height and that create a maximum impounding capacity of 15 acre-feet or greater, and to all impounding structures that are six feet or greater in height and that create a maximum impounding capacity of 50 acre-feet or greater and is not otherwise exempt from regulation by the Code of Virginia.			
Hazard Potential Class of Dam	Spillway Design Flood (SDF) <sup>B</sup> for New Construction <sup>F</sup>	Spillway Design Flood (SDF) <sup>B</sup> for Existing Impounding Structures <sup>F, G</sup>	Minimum Threshold for Incremental Damage Analysis
High	PMF <sup>C</sup>	0.9 PMP <sup>H</sup>	100-YR <sup>D</sup>
Significant	.50 PMF	.50 PMF	100-YR <sup>D</sup>
Low	100-YR <sup>D</sup>	100-YR <sup>D</sup>	50-YR <sup>E</sup>

B. The spillway design flood (SDF) represents the largest flood that need be considered in the evaluation of the performance for a given project. The impounding structure shall perform so as to safely pass the appropriate SDF. Reductions in the established SDF may be evaluated through the use of incremental damage analysis pursuant to 4VAC50-20-52. The SDF established for an impounding structure shall not be less than those standards established elsewhere by state law or regulations, including but not limited to the Virginia Stormwater Management Program (VSMP) Regulation (9VAC25-870). Due to potential for future development in the dam break inundation zone that would necessitate higher spillway design flood standards or other considerations, owners may find it advisable to consider a higher spillway design flood standard than is required.



C. PMF: Probable Maximum Flood is the flood that might be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF shall be calculated from the probable maximum precipitation (PMP) derived from the Probable Maximum Precipitation Study for Virginia (and associated PMP Evaluation Tool and Database) (November 2015). The owner's engineer must develop PMF hydrographs for 6-, 12-, and 24-hour durations. The hydrograph that creates the largest peak outflow is to be used to determine capacity for nonfailure and failure analysis. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

D. 100-Yr: 100-year flood represents the flood magnitude expected to be equaled or exceeded on the average of once in 100 years. It may also be expressed as an exceedance probability with a 1.0% chance of being equaled or exceeded in any given year. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

E. 50-Yr: 50-year flood represents the flood magnitude expected to be equaled or exceeded on the average of once in 50 years. It may also be expressed as an exceedance probability with a 2.0% chance of being equaled or exceeded in any given year. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

F. For the purposes of Table 1 "Existing impounding structure" and "New construction" are defined in 4VAC50-20-30.

G. An existing impounding structure as defined in 4VAC50-20-30, that is currently classified as high hazard, or is subsequently found to be high hazard through reclassification, shall only be required to pass the flood resulting from 0.6 PMP instead of the flood resulting from the 0.9 PMP SDF if the dam owner meets the requirements set out in 4VAC50-20-53.

H. PMP: Probable maximum precipitation means the theoretically greatest depth of precipitation for a given duration that is meteorologically possible over a given size storm area at a particular geographical location at a particular time of year with no allowance made for future long-term climatic trends. In practice, this is derived by storm transposition and moisture adjustment to observed storm patterns. In Virginia, the 0.9 PMP is meant to characterize the maximum recorded rainfall event within the Commonwealth.

#### **4VAC50-20-60. Required Permits.**

##### **Part II. Permit Requirements**

A. No person or entity shall construct or begin to construct a new impounding structure until the board has issued a construction permit.

B. No person or entity shall alter or begin to alter an existing impounding structure until the board has issued an alteration permit. If an owner or the owner's engineer has determined that circumstances are impacting the integrity of the impounding structure that could result in the imminent failure of the impounding structure, temporary repairs may be initiated prior to approval from the board. The owner shall notify the department within 24 hours of identifying the circumstances impacting the integrity of the impounding structure. Such emergency notification shall not relieve the owner of the need to obtain an alteration permit as soon as may be practicable, nor shall the owner take action beyond that necessary to address the emergency situation.

C. When the owner submits an application to the board for any permit to construct or alter an impounding structure, the owner shall also inform the local government jurisdiction or jurisdictions that might be affected by the permit application.

D. In evaluating construction and alteration permit applications the director shall use the design criteria and standards referenced in 4VAC50-20-320.

#### **4VAC50-20-80. Alterations Permits.**

A. Alterations which would potentially affect the structural integrity of an impounding structure include, but are not limited to, changing the height or otherwise enlarging the dam, increasing normal pool or principal spillway elevation or physical dimensions, changing the elevation or physical dimensions of the emergency spillway, conducting necessary repairs or structural maintenance, or removing the impounding structure. Structural maintenance does not include routine maintenance.

B. An applicant for an Alteration Permit shall submit a design report. A form for the design report is available from the department (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures). The design report shall be prepared in accordance with 4VAC50-20-240. The design report shall include, but not be limited to, the following information:

1. Project information including a description and benefits of the proposed alteration, name of the impounding structure, inventory number if available, name of the reservoir, and the purpose of the reservoir.
2. The hazard potential classification in conformance with Table 1 in 4VAC50-20-50.
3. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude.
4. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication.
5. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number.
6. Impounding structure data including type of material (earth, concrete, masonry or other) and the following configurations (note both existing and design configurations for each):
  - a. Top of impounding structure (elevation);
  - b. Downstream toe – lowest (elevation);
  - c. Height of impounding structure (feet);
  - d. Crest length – exclusive of spillway (feet);
  - e. Crest width (feet);
  - f. Upstream slope (horizontal to vertical); and
  - g. Downstream slope (horizontal to vertical).
7. Reservoir data including the following (note both existing and design configurations for each):
  - a. Maximum capacity (acre-feet);
  - b. Maximum pool (elevation);
  - c. Maximum pool surface area (acres);
  - d. Normal capacity (acre-feet);
  - e. Normal pool (elevation);
  - f. Normal pool surface area (acres); and

g. Freeboard (feet).

8. Spillway data including the type, construction material, design configuration, and invert elevation for the low level drain, the principal spillway, and the emergency spillway.

9. Watershed data including drainage area (square miles); type and extent of watershed development; time of concentration (hours); routing procedure; spillway design flood used and state source; design inflow hydrograph volume (acre-feet), peak inflow (cfs), and rainfall duration (hours); and freeboard during passage of the spillway design flood (feet).

10. Evidence that the local government has been notified of the alteration and repair plan.

11. Plans and specifications as required by 4VAC50-20-310. The plan view of the impounding structure site should represent all significant structures and improvements that illustrate the location of all proposed work.

12. A report of the geotechnical investigations of the foundation soils, bedrock, or both in the areas affected by the proposed alterations and of the materials to be used to alter the impounding structure.

13. Design assumptions and analyses sufficient to indicate that the impounding structure will be stable during the alteration of the impounding structure under all conditions of reservoir operations.

14. Calculations and assumptions relative to design of the improved spillway or spillways, if applicable.

15. Provisions to ensure that the impounding structure and appurtenances during the alteration will be protected against unacceptable deterioration or erosion due to freezing and thawing, wind, wave action and rain or any combination thereof.

16. Other pertinent design data, assumptions and analyses commensurate with the nature of the particular impounding structure and specific site conditions, including when required by this chapter, a plan and water surface profile of the dam break inundation zone.

17. If applicable, a description of the techniques to be used to divert stream flow during alteration work so as to prevent hazard to life, health and property, including a detailed plan and procedures to maintain a stable impounding structure during storm events, a drawing showing temporary diversion devices, and a description of the potential impoundment during the alteration. Such diversion plans shall be in accordance with the applicable environmental laws.

18. A plan for project construction monitoring and quality control testing to confirm that materials used in the alteration work and that performance standards meet the design requirements set forth in the specifications.

19. Certification by the owner's engineer that the information provided pursuant to this subsection is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal.

20. Owner's signature certifying receipt of the information provided pursuant to this subsection.

C. A plan of construction is a required element of complete permit application and shall include:

1. A construction sequence with milestones.

2. Elements of the work plan that should be considered include, but are not limited to, foundation and abutment treatment, excavation and material fill processes, phased fill and

compaction, testing and control procedures, construction of permanent spillway and drainage devices, if applicable.

3. The erosion and sediment control plan, as approved by the local government, which minimizes soil erosion and sedimentation during all phases of construction.

D. Within 120 days of receipt of a complete Alteration Permit Application, the board shall act on the application. If the application is not acceptable, the director shall inform the applicant within 60 days of receipt and shall explain what changes are required for an acceptable application. A complete Alteration Permit Application consists of the following:

1. A final design report with attachments as needed, and certified by the owner;
2. A plan of construction that meets the requirements of subsection C of this section;
3. Any necessary interim provisions to the current Emergency Action Plan or Emergency Preparedness Plan. Interim provisions shall be submitted to the local organization for emergency management, the Virginia Department of Emergency Management, and the department; and
4. If the owner is requesting the deregulation of an impounding structure, the application shall specify whether the impounding structure is to be removed so that the impounding structure is incapable of storing water, either temporarily or permanently; or whether the impounding structure is to be altered in such a manner that either the height or storage capacity of the impounding structure causes the impounding structure to be of less than regulated size.

E. During the alteration work, the owner shall provide the director with any proposed changes from the approved design, plans, specifications, or a plan of construction. Approval shall be obtained from the director prior to the alteration or installation of any changes that will affect the integrity or impounding capacity of the impounding structure.

F. The Alteration Permit shall be valid for the construction sequence with milestones specified in the approved Alteration Permit Application.

G. Work identified in the Alteration Permit must commence within the time frame identified in the Alteration Permit. If work does not commence within the prescribed time frame, the permit shall expire, except that the applicant may petition the board for extension of the prescribed time frame and the board may extend such period for good cause with an updated construction sequence with milestones.

H. The board, the director, or both may take any necessary action consistent with the Dam Safety Act (§ 10.1-604 et seq. of the Code of Virginia) if any terms of this section or of the permit are violated, if the activities of the owner are not in accordance with the approved plans and specifications, if the alteration is conducted in a manner hazardous to downstream life or property, or for other cause as described in the Act.

I. Within 90 days after completion of the alteration of an impounding structure, the owner shall submit a complete Record Report. A form for the Record Report is available from the department (Record Report for Virginia Regulated Impounding Structures). The Record Report shall be signed and sealed by a licensed professional engineer and signed by the owner and shall be sent to the department indicating that the modifications made to the structural features of the impounding structure have been completed. This report is not required when the Alteration Permit has been issued for the removal of an impounding structure. The Record Report shall include the following:

1. Project information including the name and inventory number of the structure, name of the reservoir, and whether the report is associated with a new or old structure;

2. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude;
3. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
4. Information on the design report, including who it was prepared by, the date of design report preparation, whether it was for new construction or for an alteration, and the permit issuance date;
5. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number;
6. Impounding structure data including type of material (earth, concrete, masonry or other) and the following configurations:
  - a. Top of impounding structure (elevation);
  - b. Downstream toe – lowest (elevation);
  - c. Height of impounding structure (feet);
  - d. Crest length – exclusive of spillway (feet);
  - e. Crest width (feet);
  - f. Upstream slope (horizontal to vertical); and
  - g. Downstream slope (horizontal to vertical).
7. Reservoir data including the following:
  - a. Maximum capacity (acre-feet);
  - b. Maximum pool (elevation);
  - c. Maximum pool surface area (acres);
  - d. Normal capacity (acre-feet);
  - e. Normal pool (elevation);
  - f. Normal pool surface area (acres); and
  - g. Freeboard (feet).
8. Spillway data including the type, construction material, design configuration, and invert elevation for the low level drain, the principal spillway, and the emergency spillway; a description of the low level drain and principal spillway including dimensions, trash guard information, and orientation of intake and discharge to impounding structure if looking downstream; and a description of the emergency spillway including dimensions and orientation to impounding structure if looking downstream;
9. Watershed data including drainage area (square miles); type and extent of watershed development; time of concentration (hours); routing procedure; spillway design flood used and state source; design inflow hydrograph volume (acre-feet), peak inflow (cfs), and rainfall duration (hours); and freeboard during passage of the spillway design flood (feet);
10. Impounding structure history including the date construction was completed, who it was designed by and the date, who it was built by and the date, who performed inspections and dates, description of repairs, and confirmation as to whether the impounding structure has ever been overtopped;
11. A narrative describing the impounding structure procedures for operation, maintenance, emergency action plan implementation, and structure evaluation;
12. A narrative describing the hydraulic and hydrologic data on the spillway design flood, hydrologic records, flood experience, flood potential, reservoir regulation, and comments or recommendations regarding these attributes;

13. A narrative describing stability of the foundation and abutments, embankment materials, and a written evaluation of each;
14. A complete set of record drawings signed and sealed by a licensed professional engineer and signed by the owner;
15. Certification by the owner's engineer that the information provided pursuant to this subsection is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal; and
16. Owner's signature certifying receipt of the information provided pursuant to this subsection.

J. For altered impounding structures, a certification from a licensed professional engineer who has monitored the alteration of the impounding structure that, to the best of the engineer's judgment, knowledge, and belief, the impounding structure and its appurtenances were altered in conformance with the plans, specifications, drawings and other requirements approved by the board.

#### **4VAC50-20-105. Regular Operation and Maintenance Certificates.**

##### **Part III. Certificate Requirements**

A. A Regular Operation and Maintenance Certificate is required for an impounding structure. Such six-year certificates shall include the following based on hazard classification:

1. High Hazard Potential Regular Operation and Maintenance Certificate;
2. Significant Hazard Potential Regular Operation and Maintenance Certificate; or
3. Low Hazard Potential Regular Operation and Maintenance Certificate.

B. The owner of an impounding structure shall apply for the renewal of the six-year Regular Operation and Maintenance Certificate 90 days prior to its expiration. If a Regular Operation and Maintenance Certificate is not renewed as required, the board shall take appropriate enforcement action.

C. Any owner of an impounding structure that does not have a Regular Operation and Maintenance Certificate or any owner renewing a Regular Operation and Maintenance Certificate shall file an Operation and Maintenance Certificate Application. A form for the application is available from the department (Operation and Maintenance Certificate Application for Virginia Regulated Impounding Structures). Such application shall be signed by the owner and signed and sealed by a licensed professional engineer. The following information shall be submitted on or with the application:

1. The application shall include the following required information:
  - a. The name of structure and inventory number;
  - b. The proposed hazard potential classification;
  - c. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
  - d. An operating plan and schedule including a narrative on the operation of control gates and spillways and the impoundment drain;
  - e. For earthen embankment impounding structures, a maintenance plan and schedule for the embankment, principal spillway, emergency spillway, low-level outlet, impoundment area, downstream channel, and staff gages;

- f. For concrete impounding structures, a maintenance plan and schedule for the upstream face, downstream face, crest of dam, galleries, tunnels, abutments, spillways, gates and outlets, and staff gages;
  - g. An inspection schedule for operator inspection, maintenance inspection, technical safety inspection, and overtopping situations;
  - h. A schedule including the rainfall amounts, emergency spillway flow levels or storm event that initiates the Emergency Action or Preparedness Plan and the frequency of observations;
  - i. A statement as to whether or not the current hazard potential classification for the impounding structure is appropriate and whether or not additional work is needed to make an appropriate hazard potential designation;
  - j. For newly constructed or recently altered impounding structures, a certification from a licensed professional engineer who has monitored the construction or alteration of the impounding structure that, to the best of the engineer's judgment, knowledge, and belief, the impounding structure and its appurtenances were constructed or altered in conformance with the plans, specifications, drawings and other requirements approved by the board;
  - k. Certification by the owner's engineer that the Operation and Maintenance Certificate Application information provided pursuant to subdivision 1 of this subsection is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal; and
  - l. Owner's signature certifying the Operation and Maintenance Certificate Application information provided pursuant to subdivision 1 of this subsection and that the operation and maintenance plan and schedule shall be conducted in accordance with this chapter.
2. An Inspection Report (Annual Inspection Report for Virginia Regulated Impounding Structures) in accordance with subsection E of this section;
  3. An Emergency Action Plan in accordance with 4VAC50-20-175 or an Emergency Preparedness Plan in accordance with 4VAC50-20-177 and evidence that the required copies of such plan have been submitted to the local organization for emergency management and the Virginia Department of Emergency Management;
  4. Any additional analysis determined necessary by the director, the board or the owner's engineer to address public safety concerns. Such additional analysis may include, but not be limited to, seismic stability, earthen spillway integrity, adequate freeboard allowance, stability assessment of the impoundment's foundation, potential liquefaction of the embankment, overturning or sliding of a concrete structure and other structural stress issues; and
  5. If applicable, a current certification from the dam owner in accordance with 4VAC50-20-53.

D. If the Operation and Maintenance Certificate Application submittal is found to be not complete, the director shall inform the applicant within 30 days and shall explain what changes are required for an acceptable submission. Within 60 days of receipt of a complete application the board shall act upon the application. Upon finding that the impounding structure as currently operating is in compliance with this chapter, the board shall issue a Regular Operation and Maintenance Certificate. Should the board find that the impounding structure as currently operating is not in compliance with this chapter, the board may deny the permit application or issue a Conditional Operation and Maintenance Certificate in accordance with 4VAC50-20-150.

E. Inspections shall be performed on an impounding structure annually.

1. Inspection Reports (Annual Inspection Report for Virginia Regulated Impounding Structures) signed and sealed by a licensed professional engineer shall be submitted to the department in accordance with the following schedule:

- a. For a High Hazard Potential impounding structure, every two years;
- b. For a Significant Hazard Potential impounding structure, every three years;
- c. For a Low Hazard Potential impounding structure, every six years; or
- d. For a High Hazard Potential impounding structure, annually in accordance with 4VAC50-20-53, where applicable.

In years when an Inspection Report signed and sealed by a licensed professional engineer is not required, an owner shall submit the Annual Inspection Report for Virginia Regulated Impounding Structures.

2. The Inspection Report shall include the following required information:

- a. Project information including the name and inventory number of structure, name of the reservoir, and purpose of the reservoir;
- b. City or county where the impounding structure is located;
- c. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
- d. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number;
- e. Inspection observation of the impounding structure including the following:
  - (1) Earthen embankment information including any embankment alterations; erosion; settlement, misalignments or cracks; seepage and seepage flow rate and location;
  - (2) Upstream slope information including notes on woody vegetation removed, rodent burrows discovered, and remedial work performed;
  - (3) Intake structure information including notes on deterioration of concrete structures, exposure of rebar reinforcement, need to repair or replace trash rack, any problems with debris in the reservoir, and whether the drawdown valve operated;
  - (4) Abutment contacts including notes on seepage and seepage flow rate and location;
  - (5) Earthen emergency spillway including notes on obstructions to flow and plans to correct, rodent burrows discovered, and deterioration in the approach or discharge channel;
  - (6) Concrete emergency spillway including notes on the deterioration of the concrete, exposure of rebar reinforcement, any leakage below concrete spillway, and obstructions to flow and plans to correct;
  - (7) Downstream slope information including notes on woody vegetation removed, rodent burrows discovered, whether seepage drains are working, and any seepage or wet areas;
  - (8) Outlet pipe information including notes on any water flowing outside of discharge pipe through the impounding structure and a description of any reflection or damage to the pipe;
  - (9) Stilling basin information including notes on the deterioration of the concrete, exposure of rebar reinforcement, deterioration of the earthen basin slopes, repairs made, and any obstruction to flow;
  - (10) Gates information including notes on gate malfunctions or repairs, corrosion or damage, and whether any gates were operated and if so how often and to what extreme;



(11) Reservoir information including notes on new developments upstream of the dam, slides or erosion of lake banks, and general comments to include silt, algae, or other influence factors;

(12) Instruments information including any reading of instruments and any installation of new instruments; and

(13) General information including notes on new development in the downstream dam break inundation zone that would impact hazard classification or spillway design flood requirements, the maximum stormwater discharge or peak elevation during the previous year, whether general maintenance was performed and when, and actions that need to be completed before the next inspection.

f. Evaluation rating of the impounding structure and appurtenances (excellent, good, or poor), general comments, and recommendations;

g. Certification by the owner and date of inspection; and

h. Certification and seal by the owner's engineer and date of inspection, as applicable.

F. The owner of an impounding structure shall notify the department immediately of any change in the use of the area downstream that would impose hazard to life or property in the event of failure.

#### **4VAC50-20-180. Inspections.**

##### Part IV. Procedures

A. The director may make inspections during construction, alteration or operation and maintenance as deemed necessary to ensure that the impounding structure is being constructed, altered or operated and maintained in compliance with the permit or certificate issued by the board. The director shall provide the owner a copy of the findings of these inspections. The department's inspection does not relieve the owner from the responsibility of providing adequate inspection during construction, alteration, or operation and maintenance. During the maintenance, construction, or alteration of any impounding structure or reservoir, the director shall require the owner to perform, at the owner's expense, such work or tests as necessary to obtain information sufficient to enable the director to determine whether conformity with the plans and specifications approved by the certificate is being secured.

B. Periodic inspections during construction or alteration shall be conducted under the direction of a licensed professional engineer who shall provide for monitoring, review of contractor submittals, and appropriate confirmatory testing of all facets of construction affecting the safety of the impounding structure in accordance with the construction or alteration permit issued by the board.

C. Required inspections during operation and maintenance shall be conducted under the supervision of a licensed professional engineer at intervals designated under 4VAC50-20-105.

D. Every owner shall provide for an inspection by a licensed professional engineer after overtopping of the impounding structure or after flows cause damage to the emergency spillway. A copy of the findings of each inspection with the engineer's recommendations shall be filed with the board within a reasonable period of time not to exceed 30 days subsequent to completion of the inspection.

#### **4VAC50-20-240. Design of Structures.**

##### Part V. Design Requirements

A. The owner shall complete all necessary investigations prior to submitting the design report (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures). The design report shall contain those components outlined in 4VAC50-20-70 for construction activities or those outlined in 4VAC50-20-80 for alteration activities. The scope and degree of precision required is a matter of engineering judgment based on the complexities of the site and the hazard potential classification of the proposed structure.

B. Surveys shall be made with sufficient accuracy to locate the proposed construction site and to define the total volume of storage in the impoundment. Locations of center lines and other horizontal and vertical controls shall be shown on a map of the site. The area downstream and upstream from the proposed impounding structure shall be investigated in order to delineate the areas and extent of potential damage in case of failure or backwater due to flooding.

C. The drainage area shall be determined. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area. The most severe of these conditions shall be included in the design calculations which shall be submitted as part of the design report.

D. The geotechnical engineering investigation shall consist of borings, test pits and other subsurface explorations necessary to adequately define the existing conditions. The investigations shall be performed so as to appropriately define the soil, rock and ground water conditions.

E. All construction materials shall be adequately researched and selected so as to ensure that their as constructed behavior will reasonably conform to design criteria. If on-site materials are to be utilized, they shall be located and determined to be adequate in quantity and quality.

#### **4VAC50-20-260. Spillway Design.**

A. Every impounding structure shall have a spillway system with adequate capacity to discharge the design flood without endangering the safety of the impounding structure.

B. Vegetated earth or an unlined emergency spillway may be approved when the applicant demonstrates that it will pass the spillway design flood without jeopardizing the safety of the impounding structure (such as by allowance of overtopping of a structure not designed to permit overtopping). In no case shall impounding structure owners permit the growth of trees and other woody vegetation in the emergency spillway area.

C. Lined emergency spillways shall include design criteria calculations, plans and specifications for suitable energy dissipators and for spillways that include crest control structures, chutes, walls, panel lining, sills, blocks, and miscellaneous details. All joints shall be reasonably water-tight and placed on a foundation capable of sustaining applied loads without undue deformation. Provision shall be made for handling under seepage and uplift pressures from the foundation which might adversely affect the structural integrity and structural stability of the impounding structure.

#### **4VAC50-20-300. Additional Design Requirements.**

A. Flood routings shall start at or above the elevation of the crest of the lowest ungated outlet. Freeboard determination and justification must be addressed by the owner's engineer.

B. All elements of the impounding structure shall conform to sound engineering practice. Safety factors, design standards and design references that are used shall be included with the design report.

C. Inspection devices may be required by the director for use by inspectors, owners or the director in conducting inspections in the interest of structural integrity during and after completion of construction and during the life of the impounding structure.

#### **4VAC50-20-310. Plans and Specifications.**

The plans and specifications for a proposed impounding structure required in 4VAC50-20-70 for construction activities and in 4VAC50-20-80 for alteration activities shall consist of a detailed engineering design report (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures) and engineering drawings and specifications, with the following as a minimum:

1. The name of the project; the name of the owner; classification of the impounding structure as set forth in this chapter; designated access to the project and the location with respect to highways, roads, streams and existing impounding structures and impoundments that would affect or be affected by the proposed impounding structure.
2. Cross-sections, plans, profiles, logs of test borings, laboratory and in situ test data, drawings of principal and emergency spillways, impounding structures, outlet works, drain system and appurtenances, and other project components in sufficient detail to indicate clearly the extent and complexity of the work to be performed.
3. Contract drawings should include, but not be limited to, foundation and abutment treatment, stream or river diversion, excavation and material fill processes, phased fill and compaction and drainage devices.
4. The erosion and sediment control plan, as approved by the local government, which minimizes soil erosion and sedimentation during all phases of construction or alteration.
5. Technical specifications, as may be required to describe the materials, performance, and methods of the construction and construction quality control for the project.

#### **4VAC50-20-320. Acceptable Design Procedures and References.**

To ensure consistency of approach, within the major engineering disciplines of hydrology, hydraulics, soils and foundations, structures, and general civil design, criteria and approaches from multiple sources shall not be mixed for developing the design of a given feature or facility without approval of the director. In all cases the owner's engineer shall identify the source of the criteria.

The following are acceptable as design procedures and references:

1. The design procedures, manuals and criteria used by the United States Army Corps of Engineers.
2. The design procedures, manuals and criteria used by the United States Department of Agriculture, Natural Resources Conservation Service.
3. The design procedures, manuals and criteria used by the United States Department of the Interior, Bureau of Reclamation.
4. The design procedures, manuals and criteria used by the United States Department of Commerce, National Weather Service.
5. The design procedures, manuals and criteria used by the United States Federal Energy Regulatory Commission.
6. Other design procedures, manuals and criteria that are accepted as current, sound engineering practices, as approved by the director prior to the design of the impounding structure.

**4VAC50-20-330. Other Applicable Dam Safety References.**

A. Manuals, guidance, and criteria used by the Federal Emergency Management Agency, including the following:

1. Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners, U.S. Department of Homeland Security, Federal Emergency Management Agency, October 1998, Reprinted January 2004; FEMA 64 or as revised.

2. Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, U.S. Department of Homeland Security, Federal Emergency Management Agency, October 1998, Reprinted April 2004; FEMA 94 or as revised.

B. Manuals, guidance, and forms provided by the department. Such materials may be located on the department's website at: <http://www.dcr.virginia.gov>.