

# DAMS

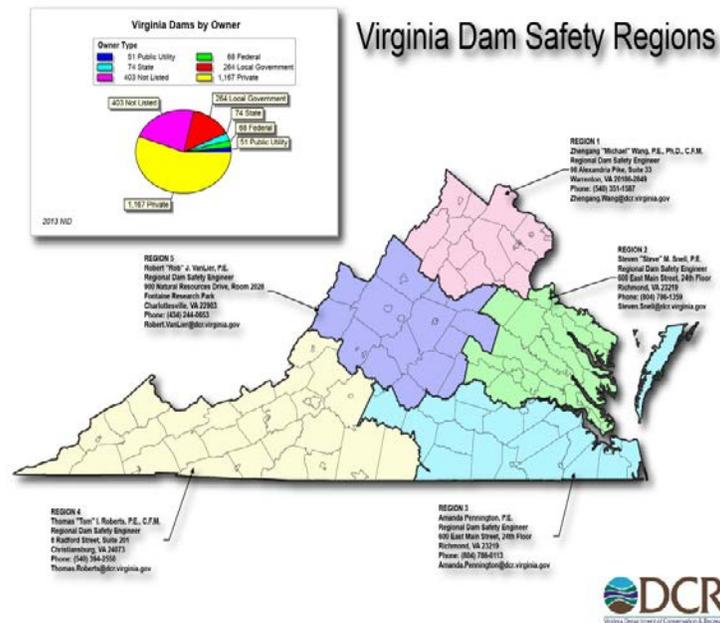
## SUMMARY

Dams provide numerous benefits to Virginia citizens including recreation, water supply, irrigation, flood control, and hydroelectric power generation. There are only two natural lakes in Virginia, Lake Drummond and Mountain Lake; all other lakes in Virginia have been created by dams. Virginia has about 4 dams within every 100 square miles in the state. Virginia’s dam inventory continues to grow older and more susceptible to damage. The majority of dams in the state are were constructed between 1950-75, and their average age is over 50 years old. With 2,741 regulated dams, Virginia ranks 11<sup>th</sup> nationally for most regulated dams. Dam safety officials regulate 357 high hazard dams, which is an increase of 1272 dams since 2011, and 101 of these dams have a Conditional O&M Certificate, indicating that they do not meet current dam safety standards. The bulk of Virginia’s dams are privately owned but proof of long term financial stability isn’t required which is problematic as rehabilitation and regular maintenance can be expensive. The estimated rehabilitation cost for 795 high and significant hazard dams in Virginia is \$592 million. While funding for dam safety has increased significantly since 2008, it is still insufficient to rehabilitate dams to meet current dam safety standards and ensure the safety of those downstream.

## BACKGROUND

Dams provide numerous benefits to Virginia citizens including places for recreation, water supply, irrigation, flood control, and hydroelectric power generation. Dams improve water quality, act to moderate flooding, and are important components of our urban and rural infrastructure; therefore, it is critical that they are constructed, operated and maintained in accordance with state and federal standards to preserve all of these vital functions. It is interesting to note there are only two natural lakes in Virginia, Lake Drummond in the Dismal Swamp and Mountain Lake in Giles County; all other lakes in Virginia have been created by dams.

Numerous federal agencies are also involved with dam regulation, management, and technical assistance in Virginia. They include the US Department of Agriculture’s National Resources Conservation Service (USDA/NRCS), Federal Energy Regulatory Commission (FERC),



Virginia DCR Regions and Virginia Dams on NID, Source: VADCR/2014 NID

Nuclear Regulatory Commission (NRC), US Army Corps of Engineers, Mine Safety and Health Administration (MSHA) and the Federal Emergency Management Agency (FEMA). However, the bulk of dams in Virginia are privately owned and depend on private funds to maintain and operate these structures. Unfortunately, Virginia regulations do not require proof of long term financial stability as part of dam construction permitting; therefore, the long term viability of privately owned dams is often problematic as rehabilitation can be expensive and regular maintenance can be easily overlooked.

## SAFETY

Dam safety is directly tied to land use, population density, and the ability to pay for dam operation, maintenance, and rehabilitation. Dams are designated high hazard dams when failure or mis-operation is expected to result in loss of life or cause significant economic losses, including damages to downstream property or critical infrastructure, environmental damage, or disruption of lifeline facilities. The Department of Conservation and Recreation (DCR), Division of Dam Safety and Floodplain Management regulates 357 high hazard dams, an increase of 127 dams since 2011; of these dams:

- 101 have a Regular Operation and Maintenance (O&M) Certificate, indicating that they meet current dam safety standards.
- 182 of these dams have a Conditional O&M Certificate, indicating that they do not meet current dam safety standards, in most cases, due to such reasons as needing increased spillway capacity, inundation mapping, and/or an emergency action plan (EAP).
- 74 high hazard dams have no O&M Certificate and one has an agricultural exemption.

According to the National Inventory of Dams (NID), 77 (62%) of the high and significant hazard dams in Virginia, respectively, have EAPs which is higher than the national average. The Virginia dam safety program includes a staff of five regional dam safety engineers, a dam safety consultant for Soil and Water Conservation District (SWCD) and State Park dams, a dam safety engineer for the Simplified Dam Breach inundation Mapping Program, an enforcement attorney, and a program director. Three staff members are new since 2009; however, the monitoring and inspection program remains under-staffed for the number of dams that must be inspected. Each field official is responsible for managing about 62 high hazard dams as well as significant and low hazard dams, assuming equal distribution of structures. This exceeds the Association of State Dam Safety Officials recommended ratio of 50 dams per inspector.

Virginia's Dam Safety Regulations were updated in 2008 to significantly expand the scope and coverage of the Commonwealth's program. These regulations have gone from below average to becoming a model for many other dam safety programs in the nation. They are a positive step towards providing the regulatory tools needed by DCR staff to assist dam owners with bringing the inventory of dams up to acceptable levels. However, with these stronger regulations there comes an ever-increasing cost of dam ownership. Virginia has made a strong effort to mitigate this burden by including ground breaking provisions in the regulations which attempt to control downstream development in the dam break inundation zones, and by establishing the Dam Safety, Flood Prevention and Protection Assistance

Fund, which has been a recent source of funding for dam engineering evaluations and some rehabilitation work.

While funding for dam safety has increased significantly since 2008, it is still inadequate to rehabilitate dams to meet current dam safety standards. Meanwhile, Virginia's dam inventory continues to grow older and more susceptible to damage. The majority of dams in the state are earthen embankments originally constructed between 1950 and 1975, with an average age of over 50 years. Virginia's population has also grown by 4.9 million people between 1950 and 2012 placing increasing numbers of people and valuable property within dam break inundation zones, increasing the consequences of a dam failure. Recognizing these risks, the new regulations classify a dam as high hazard if inundation studies project that the failure of a dam will result in the probable loss of one or more lives, or significant property damage. Recent inundation studies have resulted in re-classification of many former significant and low hazard dams as high hazard dams.

## CONDITION AND ADEQUACY

In 2004, tropical storm Gaston dropped 10-12 inches of rain in Central Virginia, causing serious damage to 22 dams and breaching or overtopping 29 more. The majority of these failures occurred in a two-day period in Chesterfield, Henrico, and Hanover Counties, some of the more populated areas of the state. The vulnerability of these structures to larger storm events was clearly demonstrated. Storm damage in Richmond alone totaled over \$20 million, and there were three fatalities associated with the storm.

This event and other similar events led DCR to the use of the 100% Probable Maximum Flood (PMF) as the spillway design flood for dams in the 2008 regulations, consistent with federal dam safety criteria. In Virginia this PMF relates to receiving between 28-38 inches of rain in a 24-hour duration, which is the Probable Maximum Precipitation (PMP). While this seems a very conservative design practice, storms approaching this magnitude occur periodically in the Mid-Atlantic region as evidenced in Nelson County in 1969 (28 inches of rain in eight hours) and in Madison County in 1995 (30 inches of rain in 16 hours). These storms are estimated to have exceeded 80% of the PMP in these local areas.

Working with the Virginia General Assembly, the House and Senate recently passed and the Governor signed two bills requiring a study to update statewide PMP values for Virginia. Since existing PMP studies are over 35 years old, additional storms will be analyzed and new PMP values will be determined using updated methodologies and local data, drawing on lessons from other states. Potential reductions in PMP for Virginia may have an impact on the auxiliary spillway requirements for high and significant hazard dams and may reduce rehabilitation costs to dam owners. Whatever the outcome, a new scientifically based study will be completed by the end of 2015, supporting PMP values and enabling increased enforcement of the required auxiliary spillway capacity for high and significant hazard dams.

According to DCR records, 17 high hazard dams are currently being altered without state or federal funding. Many other dams in the Commonwealth have been subject to little or no appropriate maintenance. Despite regulatory requirements for inspection and maintenance of impoundments, most property owners' associations with small lakes do not budget annually for dam maintenance.

## INVESTMENT NEEDS AND FUNDING

As of 2011, it is estimated that 117 of the 221 identified high hazard dams were in need of rehabilitation for a total cost of \$168 million. DCR also estimated that 323 of 398 significant hazard dams were in need of rehabilitation for a total cost of \$424 million. Thus, the total estimated rehabilitation cost for 440 high and significant hazard dams in Virginia was \$592 million. This cost, which will be borne primarily by dam owners, averages a cost of \$1.36 million per dam, based on the projected number of structures requiring upgrades.

DCR's Division of Dam Safety currently does not have enough staff or funding to manage the additional dams and requirements that must be addressed under the new regulations. The Division's direct funding has decreased by about \$1 million since 2009; however, an increase in grant funding has partially compensated for that reduction. Based on Virginia's 2015-2016 biennial budget, total funding for dams will increase significantly.

Recent Funding for Dams							
Year	DCR Dam Safety Division Funding	DCR Grant Funding for Dam Safety & Flood Prevention and Protection	Assistance to SWCDs Used for Dams*	State Parks (Capital Projects Only)	Game & Inland Fisheries (Capital Projects Only)	Other State Owned Dams	Total Funding for Dams
2009	\$ 2,564,174	\$ -	\$ 858,185				\$ 3,422,359
2010	\$ 1,951,612	\$ -	\$ 922,860				\$ 2,874,472
2011	\$ 1,528,671	\$ 885,000	\$ 752,372				\$ 3,166,043
2012	\$ 1,542,213	\$ 765,000	\$ 687,725				\$ 2,994,938
2013	\$ 1,542,213	\$ 939,193	\$ 1,170,251		\$ 9,700,000	\$ 5,823,900	\$ 19,175,557
2014	\$ 1,542,213	\$ 900,000	\$ 956,764	\$ 660,000			\$ 4,058,977
2015	\$ 2,802,779	\$ 1,596,000	\$ 1,156,109				\$ 5,554,888
2016	\$ 2,802,779	\$ 1,596,000	\$ 1,156,109				\$ 5,554,888

\*Estimate based on 10% of financial assistance plus 100% funding for maintenance and small repairs

Available funding is used to cover many aspects of the dam program. For example, \$20 million funding provided by the 2008 Virginia Public Building Authority for rehabilitation to state owned dams has been used to perform dam breach inundation studies and prepare inundation maps for all 104 SWCD dams and 15 State Park dams. Also, rehabilitation of four SWCD dams is planned with the remainder of these bond funds. At relatively low cost, the Division has implemented a series of initiatives to improve dam safety and assist dam owners:

- Begun implementation of a DamWatch, an early warning system that will collect rainfall and stream gauge data from live sources and distribute alerts and notifications of potential heavy storms to dam owners and emergency responders.
- Implemented a Dam First Aid Initiative that provides training to dam owners and emergency responders and has placed, throughout the state, trailers equipped with siphons, pumps, generators, and other equipment to provide emergency repairs to dams.
- Communicate regularly with stakeholders through a new E-Newsletter.

- Utilize the DCR Grant Funding for Dam Safety & Flood Prevention and Protection to provide grants and loans to dam owners to improve dam safety.
- Conduct four dam safety workshops per year for dam owners and one per year for engineers.
- Enforcement actions for urgent dam safety issues.
- Added three staff members since 2008.
- Implemented a new provision of the dam safety regulations by performing a simplified dam break inundation zone analysis for owners of low hazard dams without current inundation maps. This analysis will aid in reducing development in inundation zones and keeping low hazard dams from becoming high or significant hazard.
- Developed Flood Risk, a Virginia-North Carolina partnership for floodplain mapping.
- Continuing Dam Dragnet program to identify unpermitted dams and to establish contact with the dam owners to communicate the risks and requirements involved. Fifty two unregulated dams, with the potential to be classified as high hazard dams, have been identified.

In addition, recent funding of \$16 million (shown in the above table) is being used for design and construction of rehabilitation to SWCD- and Commonwealth-owned dams.

Federal funding of dam rehabilitation work in Virginia has improved over the past several years, with DCR and the Natural Resources Conservation Service (NRCS) partnering to fund work on Marrowbone Dam in Henry County; Inch Branch Dam, Mills Creek Dam, Robinson Hollow Dam, and Toms Branch Dam in Augusta County; and Huntsman Lake Dam and Royal Lake Dam in Fairfax County. Construction was completed on the Marrowbone Creek Dam in 2005 at a cost of \$2.6 million. Costs for the rehabilitation of the Augusta County dams were about \$5.4 million; Royal Lake upgrades cost \$2.5 million; and Huntsman Lake Dam is projected to cost \$2.4 million. Additional rehabilitation, funded in part with stimulus money, was performed for Lake Barton Dam (\$2.6 million) and Woodglen Lake Dam (\$2.1 million) in 2009; both of these lakes are also in Fairfax County. In addition, some of the additional funding (\$1.2 million) will be used for state match of NRCS funding for the rehabilitation of Todd Lake Dam in Augusta County.

Also, in 2014, Congress passed the Farm Bill which included an appropriation of \$250 million for dam rehabilitation nationwide. Virginia received funding for the rehabilitation of seven dams in July 2014.

## CONCLUSIONS AND RECOMMENDATIONS

The Dam Safety Program in Virginia has improved significantly over the past few years. The improvements in the available resources and the state and federal level demonstrate progress but continued investments in dam safety are needed in the years ahead. The new dam safety regulations have provided measurable performance standards consistent with federal dam safety criteria. These regulations continue to be refined to allow the dams in most need of rehabilitation to be identified. Guidelines for implementation of these regulations continue to be developed. Relatively low-cost

initiatives allow dam owners to better maintain their dams and to begin the process of rehabilitation of their dams. While at a slow pace, dams are being rehabilitated and state funding for dam safety has increased. Unfortunately, other regulated dams continue to age. While numerous high hazard dams within Virginia have continued on extensions to conditional permits for many years, several appear to be progressing toward upgrades required for safe operation.

Virginia has a growing inventory of defined rehabilitation and upgrade needs for dam structures around the state. Current investments and funding mechanisms have improved but need to be continued and significantly supplemented to address the growing needs of this vital aspect of our infrastructure. At the Commonwealth level, this could include increased funding for the rehabilitation of SWCD- and Commonwealth-owned dams and expansion of the revolving loan fund to assist the owners of privately owned dams.

The dam safety regulation changes are a positive step. Only legislation that strengthens dam safety regulations should be considered due to the safety implications for those living, working, or traveling downstream of dams. DCR is to be commended for steps taken to implement these regulations and the significant initiatives. The following key recommendations should also be pursued:

- DCR should continue to place a priority on completing Emergency Action Plans (EAPs) on all regulated dams to ensure downstream citizens are aware of potential dam hazards and to reduce development in flood inundation zones through effective local land use planning. This effort will assist with public education and outreach and build support for sustained funding of Virginia's dam safety program.
- DCR's Division of Dam Safety staffing levels should be aligned with the Association of Dam Safety Officials recommendations with one staff person per 50 dams being regulated. Initial staff focus should be on updating the regulated dam inventory, conducting an accurate statewide needs assessment, and developing EAPs for all regulated structures.
- DCR should finalize guidelines and standards for dam break inundation zone mapping to provide statewide program consistency. This would expedite preparation of plan development and regulatory review and reduce errors and inconsistency in analysis.
- DCR should simplify and streamline the process of submittal and approval of information on dams to the state inventory to improve efficiency as more dams will need to be managed with limited resources. E-filing would be of great benefit. Detailed and accurate data will be instrumental in obtaining continued federal funding.
- DCR should continue to implement the current initiatives to improve dam safety, to assist dam owners maintaining their dams, and to bring them up to current dam safety standards, on a case by case basis.
- DCR should develop a standard enforcement guideline for dam safety issues, ensuring timely and responsive direction to owners, focused on minimizing immediate and significant threats to public safety and property.

- DCR should require a financial plan and life-cycle stability certification for new dam construction permits identifying a permanent source of revenue for the entity with legal responsibility to maintain and operate new dams constructed in Virginia.