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**COMMONWEALTH of VIRGINIA**  
**DEPARTMENT OF CONSERVATION AND RECREATION**

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**November 1, 2018**

The Honorable Ralph S. Northam  
Governor of the Commonwealth of Virginia  
1111 East Broad Street  
Richmond, VA 23219

The Honorable Emmett W. Hanger, Jr.  
Co-Chairman, Senate Finance Committee  
P.O. Box 2  
Mount Solon, VA 23843-0002

The Honorable Thomas K. Norment, Jr.  
Co-Chairman, Senate Finance Committee  
P.O. Box 6205  
Williamsburg, VA 23188

The Honorable S. Chris Jones  
Chairman, House Appropriations Committee  
P.O. Box 5059  
Suffolk, VA 23435-0059

**SUBJECT:** Department of Conservation and Recreation's 2018 Final Report on the Rehabilitation of High Hazard Soil and Water Conservation District Impounding Structures (Dams)

Dear Governor Northam, Senator Hanger, Senator Norment, and Delegate Jones:

The Department of Conservation and Recreation's (Department) District Dam Rehabilitation Committee (Committee) comprised of members of the Department, the Soil and Water Conservation Districts (Districts), and the Natural Resources Conservation Service (NRCS) respectfully submits this final report regarding the Plan for Rehabilitation of District Owned High Hazard Dams (Rehabilitation Report). This final report is being submitted to satisfy the requirements of Item 362 K. of Chapter 2 of the 2018 Special Session 1 Virginia Acts of Assembly:

K. The department, in collaboration with Soil and Water Conservation Districts, shall develop a plan containing cost estimates, for the rehabilitation of high hazard Soil and Water Conservation District owned and managed impounding structures. An interim plan shall be provided to the Governor and the Chairmen of the House Appropriations and Senate Finance Committees by November 1, 2016, with a final plan due by November 1, 2018.

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*State Parks • Soil and Water Conservation • Outdoor Recreation Planning  
Natural Heritage • Dam Safety and Floodplain Management • Land Conservation*

**Overview:**

Staff began the process by reviewing all 66 High Hazard dams owned by the Districts. After eliminating dams from further consideration that had adequate spillway capacity or that had been, or were in the process of being, rehabilitated by NCRS, a list of 43 dams was left to study further (included as Appendix A). Please note this list has now been updated to show the dam in order of prioritization as well as rehabilitation cost.

Once the list of 43 dams was developed, staff initiated analyses to complete Tasks 1-4 as described in the interim report submitted in November of 2016 and described further in the progress report submitted in November of 2017. Additional details on these tasks and their progress are provided below. Funding to support the engineer costs and to fund the ongoing necessary analyses was secured from the Department of Planning and Budget (DPB) utilizing prior dam safety bond balances of \$3,100,000.00 in September of 2018.

**Progress on Tasks:****Task 1 - Fully Evaluate the 2016 Probable Maximum Precipitation (PMP) Values**

In the 2017 report, nine dams were identified that could potentially benefit from a reduction in PMP values. These dams had been identified based on the overall reduction in the PMP depth and the relationship between this reduction and the inundation zone limits and/or existing spillway capacity. A lower PMP will result in less runoff to the dam, which potentially has an effect on the spillway capacity (i.e. spillways deemed inadequate may have the capacity to pass the required storm event with the reduction in PMP). New inflow hydrographs were created for these nine dams; the hydrograph shows the distribution of the rainfall event over time, ultimately identifying how much runoff is entering the lake. Using the results of the hydrographs and a computer program, two of these nine dams were identified as having adequate spillway capacity to pass the PMF storm due to the reduction in PMP values. These dams are noted in Table 1 below and have been removed from the rehabilitation list in Appendix A.

In addition to the new PMP values, the Department's Division of Dam Safety and Floodplain Management released new PMP temporal distribution curves in the late summer of 2018. Applied Weather Associates created these temporal distribution curves, which is the same company that performed the original study that resulted in the new PMP values. These curves more accurately depict how the PMP rainfall will be distributed over time during the rain event and were used to create new inflow hydrographs.

Additionally, NRCS has updated hydrologic soil group (HSG) classifications for Virginia. HSG classifications have an impact on how much of the rainfall is absorbed by certain types of soil and how much runs off those soils. The re-classification of HSG resulted in additional reductions in runoff for some parts of the state. New inflow hydrographs were created for all of the dams remaining on the rehabilitation list. For the nine dams noted in the 2017 Progress Report as needing further analysis due to a significant reduction in PMP values, this analysis has been completed and the results are indicated in Table 1 below. The dams noted below as meeting the spillway capacity have been removed from the rehabilitation list.

Staff are in the process of fully evaluating the effects of the new PMP distribution curves and the new HSG classifications; nine additional dams were identified for further analysis due to significant reduction in flows. See Table 1 below for a list of these dams.

**Table 1: PMP Analyses that Require Additional Review**

Dam ID #	County	Dam Name	District	Results
067002	Franklin	Upper Blackwater #4	Blue Ridge	Analysis complete-Spillway does not have capacity
045003	Craig	Johns Creek #3	Mountain Castles	Analysis complete-Spillway does not have capacity
089007	Henry	Leatherwood Creek #6	Blue Ridge	Analysis complete-Spillway does not have capacity
029001	Buckingham	Willis River #1A	Peter Francisco	Analysis complete-Spillway does not have capacity
089009	Henry	Horse Pasture Creek #2	Blue Ridge	Analysis complete-Spillway does not have capacity
165011	Rockingham	Shoemaker River #3B	Shenandoah Valley	Adequate Spillway Capacity
165010	Rockingham	Shoemaker River #4C	Shenandoah Valley	Adequate Spillway Capacity
089012	Henry	Horse Pasture Creek #1C	Blue Ridge	Analysis complete-Spillway does not have capacity
037013	Charlotte	Roanoke Creek #54	Southside	Analysis complete-Spillway does not have capacity
<b>Additional Nine Dams Identified for Further Analysis</b>				
Dam ID #	County	Dam Name	District	Results
165007	Rockingham	Lower North River #82	Shenandoah Valley	Adequate Spillway Capacity-Pending Approval
165002	Rockingham	Lower North River #78	Shenandoah Valley	Adequate Spillway Capacity-Pending Approval
165003	Rockingham	Lower North River #83	Shenandoah Valley	Analysis Ongoing
165001	Rockingham	Lower North River #80	Shenandoah Valley	Analysis Ongoing
045002	Craig	Johns Creek #1	Mountain Castles	Analysis Ongoing
165004	Rockingham	Lower North River #22B	Shenandoah Valley	Analysis Ongoing
045001	Craig	Johns Creek #2	Mountain Castles	Analysis Ongoing
045004	Craig	Johns Creek #4	Mountain Castles	Analysis Ongoing
045003	Craig	Johns Creek #3	Mountain Castles	Analysis Ongoing

**Tasks 2 and 3 - Perform ACER-11 Analysis and Incremental Damage Analysis (IDA) for Spillway Reduction**

The 2017 Progress Report identified 11 dams that could potentially qualify for spillway capacity reduction using an IDA and/or reduction in Hazard Classification using the ACER-11 classification process. ACER-11 is a hazard classification process developed by the Bureau of Reclamation that considers the incremental effects of the dam failure versus the natural flooding. IDA uses a very similar process, but it is only used to potentially reduce the spillway design flood requirement.

Since that report, staff has decided to analyze all of the dams on the list for potential reduction. At the time of this final report, these analyses have been completed for 25 of the dams on the rehabilitation list. Because these analyses require accurate elevation information, LIDAR elevation information is, at a minimum, required. LIDAR is highly accurate topographic information; a survey would be the only more accurate source of information. LIDAR information is not yet available in all counties; therefore, this analysis has only been

completed for the dams that are located in counties with this information. Analyses will be completed on the remaining dams once LIDAR information is released, potentially later this year.

Of the 25 dams that have had analyses completed, one resulted in a reduction to the required spillway capacity through an IDA. The IDA is currently under review by the Department's Dam Safety Regional Engineer. The remainder did not qualify for a reduction in the required spillway capacity or hazard classification. See Table 2 for an updated list of dams that are being, or have already been, analyzed as a part of this task, and the associated results. If a dam is not listed but is on the rehabilitation list, the analysis has been completed and it does not qualify for a reduction in spillway capacity or hazard classification.

**Table 2: Dams that May Benefit from ACER-11 Analysis and Incremental Damage Analysis (IDA) for Spillway Reduction**

Dam ID#	County	Dam Name	District	Results
029008	Buckingham	Willis River #6A	Peter Francisco	Qualifies for reduction in SDF through IDA-Under Review
147036	Prince Edward	Bush River #7	Piedmont	Qualifies for reduction in SDF through IDA, spillway does not have the capacity to pass the reduced in SDF
045002	Craig	Johns Creek #1	Mountain Castles	Waiting on LIDAR
089002	Henry	Leatherwood Creek #5	Blue Ridge	Waiting on LIDAR
045001	Craig	Johns Creek #2	Mountain Castles	Waiting on LIDAR
089005	Henry	Leatherwood Creek #2A	Blue Ridge	Waiting on LIDAR
045004	Craig	Johns Creek #4	Mountain Castles	Waiting on LIDAR
089004	Henry	Leatherwood Creek #3	Blue Ridge	Waiting on LIDAR
045003	Craig	Johns Creek #3	Mountain Castles	Waiting on LIDAR
067002	Franklin	Upper Blackwater River #4	Blue Ridge	Waiting on LIDAR
037010	Charlotte	Roanoke Creek #4A	Southside	Waiting on LIDAR
089007	Henry	Leatherwood Creek #6	Blue Ridge	Waiting on LIDAR
089012	Henry	Horse Pasture Creek #1C	Blue Ridge	Waiting on LIDAR
037013	Charlotte	Roanoke Creek #54	Southside	Waiting on LIDAR
067001	Franklin	Upper Blackwater River #6	Blue Ridge	Waiting on LIDAR
037009	Charlotte	Roanoke Creek #67	Southside	Waiting on LIDAR
089006	Henry	Leatherwood Creek #4	Blue Ridge	Waiting on LIDAR
037005	Charlotte	Roanoke Creek #5B	Southside	Waiting on LIDAR
037006	Charlotte	Roanoke Creek #6A	Southside	Waiting on LIDAR
089009	Henry	Horse Pasture Creek #2	Blue Ridge	Waiting on LIDAR

The 2017 Progress Report included three dams that were in the process of having new inundation studies performed. The Department has received these reports and they have been accepted by the Dam Safety Regional Engineer. These new inundation studies used the new PMP values. One of the dams now has adequate spillway capacity due to the significant reduction in PMP depths. The second dam is considered adequate through the IDA process, and the third dam's study results in inadequate spillway capacity. It is important to note that both dams which now considered to have adequate spillway capacity due to either

educated PMP flows and/or IDA have had additional analysis performed which indicates the spillway does not have integrity.

SITES, a NRCS computer program for earthen/vegetated auxiliary spillway erosion predication for dams, has previously been completed on these dams; the results indicated that the spillway will erode and lead to an uncontrolled release of water under full PMF conditions. These SITES analyses were not performed with the new, lower flows. The Department is currently in the process of running new analyses to determine the effects of the lower flows on the vegetated spillway. Please see Table 3 below for a list of these dams.

**Table 3: Dams Have Received New Inundation Studies**

Dam ID#	County	Dam Name	District	Results
015014	Augusta	South River #19	Headwaters	IDA shows spillway capacity
015022	Augusta	South River #7	Headwaters	Has 0.9 PMP capacity
015009	Augusta	South River #6	Headwaters	Does not have spillway capacity

In summary, the rehabilitation list provided in the 2017 Progress Report contained 43 dams. The following dams have been removed or added since that report:

- Added 165004, Lower North River #22B - This dam was not originally identified as having inadequate spillway capacity. This was discovered during a thorough review of inundation studies and associated information for all of the District-owned High Hazard dams.
- Added 045002, Johns Creek #1 - This dam has received funding for the planning process from NRCS; however, the funds may not be available for a full design and construction. In case funds are not available, this dam has been added to this rehabilitation list. The planning and minimal design plans produced through the NRCS process can be used when considering a complete design plan.
- Removed 165011, Shoemaker River #3B - This dam was originally included on this list; however, it was discovered during a thorough review of inundation studies and associated information that it does meet dam safety regulatory requirements.
- Removed 165010, Shoemaker River #4C - This dam was originally included on this list; however, it was discovered during a thorough review of inundation studies and associated information that it does meet dam safety regulatory requirements.
- As noted above, three dams are included on the rehabilitation list that are undergoing review by Department staff for IDA and/or reduction of flows to the lake. These dams may be removed from the list:
  - 029008-Willis River 6A
  - 165007-Lower North River #82
  - 165002-Lower North River #78

In closing, there are still 43 dams on the rehabilitation list. Several of the dams on the list have changed since the 2017 Progress Report, and three have the potential to be removed, pending reviews by Dam Safety Regional Engineers.

#### Task 4 - Dam Prioritization

Staff has completed the prioritization process using the *Priority Ranking System for Rehabilitation of Aging Watershed Dams*, developed by NRCS. When using this prioritization process, a risk index is assigned to each dam based on conditions at the dam as well as downstream impacts, such as population at risk, roads,

residences, and businesses. This risk index is used to prioritize the dams and is listed in the table found in Appendix A. Please note that some of the information previously included, such as roads overtopped and residences impacted, has been removed and replaced with the risk index.

Because of the ongoing analyses discussed above, and potential future changes in the dam watersheds and downstream development and changes, this list is a living document and is subject to change in the future.

#### Task 5 - Preliminary Engineering and Cost Information

The first step for the final task was to develop rehabilitation alternatives for the top five prioritized dams. The Department met with the District staff who are responsible for the maintenance of these dams, District Board members, and county officials to discuss possible alternatives. It is important that, during this process, stakeholder buy-in is achieved to prevent any issues during the design and construction process. For the top five prioritized dams, the Districts selected a preferred alternative.

For the remainder of the dams on the list, cost information was developed based on the Department preferred alternative. Please note that these alternative selections may change in the future as meetings with the stakeholders are held; however, selection of an alternative is necessary to develop cost information for this report. Development of the rehabilitation alternatives is performed by assessing the viability of six main alternatives. When assessing these options, they are considered in the order listed below:

1. Widen existing vegetated spillway provided SITES shows the spillway has integrity (will not erode and lead to an uncontrolled release of water);
2. Add a second spillway on the other side of the dam, assuming integrity;
3. Raise dam with earth fill;
4. Raise dam with parapet wall;
5. Structural spillway option if vegetated spillway does not have integrity (e.g. articulated concrete block (ACB), roller compacted concrete (RCC), cut off wall, etc);
6. Dam overtopping protection (e.g. RCC); and
7. Combination of the above alternatives.

The alternatives for each dam were selected based on site limitations, geotechnical issues, environmental impacts, property owner impacts, access issues, and cost. In addition to construction costs, the cost information provided considered design, inspections, easement acquisition, permits, testing, and contingencies. Please see Appendix A for a complete list of cost information for all 43 dams.

#### **Full Design and Rehabilitation:**

With much of the preliminary work complete, the next step is to contract with private engineering firms to develop complete designs that can be used during the construction phase. There is currently an unexpended balance of \$3.1 million in a dam safety bond issued to the Department; the Department will use this balance to begin design work on the two top prioritized dams. This unexpended balance is also being used to pay the salaries of two Department employees (one Professional Engineer and one Engineer-in-Training) dedicated full time to this project.

In addition to upgrading auxiliary spillways to pass the required spillway design flood, several other repairs will need to be considered during rehabilitation. These include, but may not be limited to, riser tower upgrades, gate valve repairs, seepage issues, or zone compatibility (the materials originally used to construct the dam may not be “working together” to prevent seepage and internal erosion).

**Staffing:**

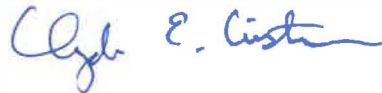
A Professional Engineer (PE) was hired in August of 2017 to oversee the rehabilitation effort. An Engineer in Training (EIT) was hired in October of 2017 to assist the PE in completing this report, specifically to perform the necessary hydrologic and hydraulic modeling and analyses. Further staffing is required to adequately manage rehabilitation projects in the future once funding is secured to begin rehabilitation. A minimum of one additional PE and two Construction Inspectors would be needed. See Table 4 below for staffing schedule and costs.

**Table 4: Staffing Schedule and Associated Costs (includes existing staff)**

Number of Dams Under Design per Year	Number of Dams Under Construction per Year	Staffing Levels Required	Salary plus Benefits	Additional Vehicles/Equipment
3	3	2 Professional Engineers	\$220,000	1 Vehicle, Misc. Equipment: \$40,000
		1 Engineer in Training	\$70,000	
		2 Construction Inspectors	\$140,000	2 Vehicles, Misc. Equipment: \$80,000
		<b>Total Costs</b>	<b>\$430,000</b>	<b>\$120,000</b>

The District Dam Rehabilitation Committee is pleased to share with you this final report regarding the plan for rehabilitation of District-owned dams and we look forward to favorable consideration for funding.

Respectfully submitted,



Clyde E. Cristman

- cc: Russ Baxter, Deputy Director, Department of Conservation and Recreation  
 Samantha Martin, Budget and Policy Analyst, Department of Planning and Budget  
 Anne E. Oman, Legislative Fiscal Analyst, House Appropriations Committee  
 Jason Powell, Legislative Analyst, Senate Finance Committee

**Appendix A**

<b>Prioritization Order</b>	<b>DAM ID #</b>	<b>County</b>	<b>Dam Name</b>	<b>District</b>	<b>Risk Index</b>	<b>Cost Opinion (in millions)</b>
1	165007	Rockingham	Lower North River #82	Shenandoah Valley	15648	\$5.0
2	165002	Rockingham	Lower North River #78	Shenandoah Valley	4122	\$5.8
3	165003	Rockingham	Lower North River #83	Shenandoah Valley	3883	\$5.4
4	165001	Rockingham	Lower North River #80	Shenandoah Valley	1576	\$6.1
5	015014	Augusta	South River #19	Headwaters	1379	\$3.8
6	045002	Craig	Johns Creek #1	Mountain Castles	1160	\$6.0
7	165004	Rockingham	Lower North River # 22B	Shenandoah	996	\$7.1
8	089002	Henry	Leatherwood Creek #5	Blue Ridge	724	\$5.4
9	045001	Craig	Johns Creek #2	Mountain Castles	379	\$3.8
10	089005	Henry	Leatherwood Creek #2A	Blue Ridge	371	\$3.4
11	045004	Craig	Johns Creek #4	Mountain Castles	354	\$3.8
12	089004	Henry	Leatherwood Creek #3	Blue Ridge	206	\$4.2
13	147003	Prince Edward	Buffalo Creek #4	Piedmont	142	\$4.2
14	147041	Prince Edward	Bush River #4B	Piedmont	104	\$5.1
15	113002	Madison	Beautiful Run #2A	Culpeper	69	\$5.5
16	045003	Craig	Johns Creek #3	Mountain Castles	68	\$3.2
17	147036	Prince Edward	Bush River #7	Piedmont	63	\$3.6
18	029001	Buckingham	Willis River #1A	Peter Francisco	60	\$4.4
19	029007	Buckingham	Willis River #6	Peter Francisco	60	\$5.0
20	029006	Buckingham	Willis River #5F	Peter Francisco	56	\$5.0
21	029005	Buckingham	Willis River #5E	Peter Francisco	55	\$5.2
22	029019	Buckingham	Willis River #2	Peter Francisco	48	\$4.8
23	029035	Buckingham	Slate River #8	Peter Francisco	48	\$4.0
24	067002	Franklin	Upper Blackwater River #4	Blue Ridge	44	\$3.3



<b>Appendix A Continued</b>						
<b>Prioritization Order</b>	<b>DAM ID #</b>	<b>County</b>	<b>Dam Name</b>	<b>District</b>	<b>Risk Index</b>	<b>Cost Opinion (in millions)</b>
25	029008	Buckingham	Willis River #6A	Peter Francisco	37	\$3.0
26	037010	Charlotte	Roanoke Creek #4A	Southside	34	\$4.5
27	029002	Buckingham	Willis River #1B	Peter Francisco	33	\$3.3
28	015009	Augusta	South River #6	Headwaters	33	\$4.7
29	089007	Henry	Leatherwood Creek #6	Blue Ridge	32	\$4.2
30	089012	Henry	Horse Pasture Creek #1C	Blue Ridge	29	\$4.0
31	015022	Augusta	South River #7	Headwaters	25	\$3.3
32	037013	Charlotte	Roanoke Creek #54	Southside	22	\$6.0
33	029003	Buckingham	Willis River #3	Peter Francisco	22	\$4.2
34	067001	Franklin	Upper Blackwater River #6	Blue Ridge	20	\$3.8
35	037009	Charlotte	Roanoke Creek #67	Southside	18	\$4.2
36	089006	Henry	Leatherwood Creek #4	Blue Ridge	16	\$3.3
37	029012	Buckingham	Muddy Creek #2	Peter Francisco	14	\$3.3
38	029011	Buckingham	Muddy Creek #1	Peter Francisco	13	\$3.4
39	037005	Charlotte	Roanoke Creek #5B	Southside	13	\$4.3
40	037006	Charlotte	Roanoke Creek #6A	Southside	11	\$4.2
41	089009	Henry	Horse Pasture Creek #2	Blue Ridge	7	\$3.2
42	029010	Buckingham	Willis River #9	Peter Francisco	2	\$4.3
43	029004	Buckingham	Willis River #4	Peter Francisco	1	\$4.9
					<b>Total</b>	<b>\$189.2</b>

