Update On the Dam Embankment Analysis

By Davis Grant

As has been mentioned in previous newsletter articles and during community meetings over the past 12 to 16 months, the Lake Barcroft Watershed Improvement District (LBWID) is responding to requirements from the Virginia Department of Conservation and Recreation/Division of Dam Safety (DCR Dam Safety) to evaluate the Dam's east and west earthen embankments (the areas on either side of the concrete Dam structure) and determine what, if anything, needs to be done to ensure the Dam's continued compliance with Virginia Dam Safety Regulations.

We wish we could say that this effort is simple and straightforward, however, it has been anything but. Dam engineering is very complex and requires the involvement of numerous engineering disciplines. The analysis of the embankments alone involves civil engineering, structural engineering, and hydraulic/hydrologic engineering. We are working with two of the very best engineering firms in the region to perform these analyses. Whitman, Requardt, & Associates (WR&A) is taking the lead on the civil and structural engineering analyses, and GKY & Associates (GKY) is taking the lead on the hydraulic/hydrologic engineering analyses. Together they are coordinating and sharing information so that we have the most thorough assessments possible.

Phase 1 of the project (Evaluation and Information Gathering) was recently completed and after thorough review of the DCR Dam Safety requirements and the structure and configuration of the Dam (specifically the earthen embankments), our engineers have concluded that upgrades to the Dam will be required to maintain compliance with current Virginia Dam Safety Regulations.

You might be wondering what has changed with the regulations, or what has changed since the Dam was upgraded after Hurricane Agnes. Regarding the regulations, very little has changed since 2008 when Virginia implemented the foundation of their modern-day dam safety regulations. That is when High Hazard Potential dams across the state were required to have spillways that can safely discharge the peak flow of a full PMF (Probable Maximum Flow/Flood) without a breach of the dam itself. This has resulted in required upgrades for a number of dams.

A dam's hazard classification is determined by evaluating the potential risk to life and property below the dam, the height of the dam, and the amount of water being impounded behind the dam. In our situation there are numerous homes and businesses that are in the Dam's inundation zone, and the Dam is impounding a very large amount of water. Note that the High Hazard classification is unrelated to the physical condition of the dam or the probability of its failure.

PMF volumes are unique to individual dams and are calculated using very sophisticated hydraulic modeling and rainfall potentials that are determined by NOAA (the National Oceanic and Atmospheric Administration). Within the model are included factors such as the topography of a dam's contributing watershed (the area upstream) and the drainage area below the dam. Please note that Lake Barcroft's contributing watershed is 14.5 square miles, which also has a higher-than-average percentage of impervious land, making for a large PMF for the Lake Barcroft Dam.

In the case of our Dam, the peak flow from the calculated PMF would be approximately 90,000 cubic feet per second (CFS) and would be generated by 25 inches of rain in 6 hours, which NOAA has determined that the atmosphere can produce. We are talking about a storm event that would generate a peak flow 6.3 times

larger than what the dam experienced during Hurricane Agnes in 1972, which was estimated to be 14,500 CFS. The modifications that were made to the Dam after Hurricane Agnes, specifically the installation of the Bascule Gate, did significantly increase the Dam's peak discharge ability without a breach. The peak discharge is now approximately 30,000 CFS, however, this number is still well short of the approximately 90,000 CFS that is required today. The Bascule Gate is only capable of discharging about 1/3 of the peak flow from the PMF event.

Some may also be wondering about the "Emergency Fuse Plug" that exists on the west end of the Dam and what role it plays in this equation. This is where things have changed with the application of modern regulations, which in large part are based on dam and/or spillway failures around the country. Fuse plugs in dams have historically been utilized from time to time, however they are not very common and are very rarely used anymore. One of the main reasons that fuse plugs have mostly been phased out is that the control of flow is very limited once the fuse plug starts to erode. Additionally, their use actually increases the peak flow during a PMF event, which contributes to additional flooding downstream of a dam. In our situation the fuse plug is activated, or technically starts to erode, when the Lake level increases to approximately 3 feet above normal. This is what happened during Hurricane Agnes, and it would likely not stop eroding until the Lake was empty.

Keep in mind that the goal of all dam safety regulations is to protect the communities downstream of a dam. That is achieved by ensuring that the dam is designed and built to safely pass the flow from a PMF event without adding to the peak discharge. In our situation the activation (erosion) of the "Emergency Fuse Plug" would contribute an additional 60,000 CFS to the peak flow being generated by the PMF event itself (increasing the peak discharge from approximately 90,000 to 150,000 CFS). For that reason, DCR Dam Safety is requiring us to abandon the fuse plug component of the Dam and strengthen the embankments at each end of the Dam so they will not erode and can safely discharge the full PMF event without adding to the peak flow. Conceptually, once upgraded, storm water will be able to flow over the entire width/crest of the Dam without any erosion occurring on the earthen embankments.

So, what's next? Now that we have confirmed that modifications are required, WR&A will start Phase 2 of the project (Design Concept and Analysis). This is where they will develop alteration/upgrade options and evaluate them for compliance, difficulty, operational impacts, and cost. Upon completion of this phase, the LBWID will receive a recommendations report from the engineers. We will then work with the engineers to identify the best option, or combination of options, for implementation. As of right now we are expecting to receive the Phase 2 recommendations report by the end of this year. Once a design Plan is agreed upon by the LBWID and our engineers, it will be submitted to DCR Dam Safety for review and approval.

Because the required modifications to the Dam are likely to be very expensive (we are talking at least several million dollars), we have started the process of identifying State and Federal funding assistance opportunities. It is still too early to determine the total expected cost of the project and how much funding assistance we may receive, but we will do everything we can to manage the cost and minimize the financial burden on the community.

As always, it is our promise that we will keep you informed as we conclude Phase 2 and have more information to share regarding funding assistance. To that end we are tentatively planning a community meeting in the fall to further discuss this information and answer questions that you may have.