Making the Case for Developing Realistic Inflow Design Floods in Colorado’s Rocky Mountains

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NOAA Hydrometeorological Reports (HMR) of Probable Maximum Precipitation (PMP) are known to be outdated and unsupported. To overcome these deficiencies, Colorado and New Mexico recently completed a Regional Extreme Precipitation Study (REPS), which includes new PMP and extreme precipitation frequency (PF) estimates. As expected, new PMP estimates are different from past HMR PMP for reasons including better identification and analysis of historical storms, radar data, better dew point and climatological data, and modern GIS analysis tools. Colorado Dam Safety is also completing a hydrology research study with Colorado State University, which aims to define flood production mechanisms accurately in the Rocky Mountains. This study incorporates scientific advances and the results to date suggest infiltration-excess surface runoff may not be the dominant runoff mechanism, as has been traditionally believed. Existing methodologies and tools for rainfall and runoff analysis contain multiple layers of conservatism that were originally necessary to account for uncertainties in the science. However, compounding levels of conservatism sometimes led to unreasonable and physically implausible results, at least in the Rocky Mountain region. The modern rainfall and runoff estimation methods utilized in Colorado take advantage of scientific advances and allow improved accuracy and realistic representation of the physical processes of rainfall and runoff in our mountainous regions. To some, these advances may be construed as being “unconservative.” Confidence and acceptance of these results can, however, be achieved through multiple lines of reasonableness checks. Factors of Safety demonstrated at the end of the analysis have proven to be more defensible than layers of conservatism buried within the process. Checks include: PF annual exceedance probability (AEP) maps, historical peak flow envelope curves (including indirect and paleo-flood peak flow estimates, where available), hydrology model calibration utilizing reconstructed historical storms, modeling AEP events by AEP-neutrality and comparison to flood frequency estimates, and verifying that controlling storm types, runoff mechanisms and seasonality are correct. The Upper tail ratio (Q/Q10) provides a particularly useful check in Colorado’s semi-arid climate, where “long tails” can result in unpredictably large floods compared to normal conditions. This paper and presentation presents the modern analysis and verification methods used by Colorado Dam Safety on recent spillway hydrology case studies. Colorado Dam Safety have successfully derived IDF estimates that appear reasonable based on multiple lines of historical and statistical evidence and contain appropriate factors of safety to protect the facilities and downstream populations at risk.