

Applied Weather Associates Qualifications and Background

Applied Weather Associates (AWA) is a small business located in Monument, Colorado. AWA specializes in environmental information with emphasis on meteorological analyses and geographic information systems applications. Site-specific Probable Maximum Precipitation (PMP) studies have been the primary activity during the last several years with several projects related to weather modification also completed. AWA is a leader in identifying and incorporating new technologies and meteorological data into extreme rainfall studies and provides complete services related to meteorological databases and precipitation analyses. Our Storm Precipitation Analysis System (SPAS) has recently incorporated NEXRAD data calibrated hourly with rain gage observations to provide rainfall for periods as short as every five minutes. Rainfall volumes are computed by clipping the rainfall analysis to basin boundaries for runoff model calibration. Study results have been accepted by several state dam regulatory agencies as well as the Federal Energy Regulatory Commission. AWA has worked cooperatively with Dr Jarrett of the Denver USGS to complete paleoflood analyses of several Colorado watersheds as well as the Chelan drainage basin in Washington State. Basin delineations and profiles have been determined using in-house GIS capabilities.

AWA has completed site-specific PMP studies for many locations across the US from Maine to Washington to Colorado. The sizes of the regions studied vary from the State of Nebraska to two square mile basins in Colorado. Each study is comprehensive in its approach for determining PMP values based on the unique geographic location, topography and climate of the region where the study basin is located. Emphasis is placed on using procedures outlined by the National Weather Service in its Hydrometeorological Reports and the World Meteorological Organization in its PMP manual but applying advancements in analyses techniques and data processing when available.

The most recent regional PMP study was for the State of Nebraska. A complete storm search identified 36 extreme storm events. Ten of these events were new storms that required complete storm analyses including Depth-Area-Duration analyses using AWA's Storm Precipitation Analysis System (SPAS). This study looked explicitly at synoptic storm systems as well as Mesoscale Convective Complexes. Several new historic storms have been identified which appear to combine characteristics of each storm type, producing extreme rainfall amounts at the twenty-four hour duration. NEXRAD weather radar data was incorporated into the storm Depth-Area-Duration analyses resulting in larger point rainfall amounts than have been reported using only rain gage observations. Additionally objective spatial distributions have been incorporated using NEXRAD vs the subjective analyses that have been used historically in storm analyses. A gridded analysis was completed using GIS with standard storm adjustments

made for maximization, transposition and elevation. A new return frequency dew point temperature climatology was developed for the study using variable duration maximum average dew point temperature values. The study has been accepted for use in PMF calculations by the Nebraska State Dam Safety Office.

A site-specific PMP study was completed in August 2008 for the Bleinheim Gilboa drainage basin in the Catskill Mountains for the New York Power Authority. New approaches, consistent with the historically accepted PMP methodology, were developed to enhance the reliability of the storm analyses being used to develop the site-specific PMP values. Explicit moisture barrier depletion analyses were completed for each storm transpositioned over the basin and constraints for design storm centering were recommended. The study was reviewed by a FERC approved Board of Consultants (BOC). The BOC has recommended that the study be accepted for use in PMF computations for the Bleinheim Gilboa drainage basin. This study follows two other FERC approved studies in the northeastern US, Upper and Middle Dams owned by FPLE Maine Hydro and the Great Sacandaga Lake Stewart's Bridge project owned by Reliant Energy.

AWA completed a site-specific PMP study for the Woodcliff Reservoir watershed in northern New Jersey. The result was approximately a 35% reduction in PMP values compared to HMR 51. Newer storms have been evaluated including two storm centers associated with Hurricane Floyd in 1999, a large thunderstorm over Sparta, NJ in 2000, and another large local storm over Tabernacle, NJ in 2004.

Additionally AWA has recently completed a storm analysis for a large rainfall event over the Feather River drainage basin in California. Using SPAS, a complete Depth-Area-Duration analysis was completed. This storm had not previously been analyzed and, for some area sizes and durations, is slightly larger than the largest rainfall event used in HMR 59. AWA has worked with Puget Sound Energy on evaluating extreme rainfall events over northwestern Washington for runoff model calibration and verification. This project may lead to a site-specific PMP study for the Baker River drainage basin.

Another study for the DeForest Reservoir in southeastern New York has been completed. This study is very similar to the Woodcliff Lake study but includes the storm analysis of the April 2007 rainstorm event that occurred over southern New York and northeastern Pennsylvania. Results are very similar to the Woodcliff Lake study results.

Numerous studies have been completed for both dam owners and engineering companies doing Probable Maximum Flood (PMF) analyses. All studies have been peer reviewed, some by a single peer reviewer and other by a Board of Consultants. AWA has presented papers at the national Association of State Dam Safety Organization (ASDSO) annual conferences during the past several years as well as at several regional ASDSO conferences.

A partial list of studies is provided along with a brief description of important issues associated with each study. Several of the most recent studies are still being reviewed.

Magma Flood Retaining Structure, Magma, Arizona, 2008

This study provided an updated PMP analysis for the watershed located approximately 45 miles east of Phoenix. New storms were identified in the storm search phase and three storms were completely analyzed. The basic methodology followed HMR 49 with updates incorporated where possible. This study demonstrated the need to replace the HMR 49 procedures with the methodologies used in more recent HMRS.

Analyses of Thunderstorms over Jimmy Camp Creek, Colorado Springs, 2007

These storm analyses provided GIS storm analyses of the total storm rainfall for each of the largest storms over the Jimmy Camp Creek drainage basin for the previous 12 years using NEXRAD total storm precipitation patterns. Three of these storm received detailed spatial and temporal analyses using the AWA Storm Precipitation Analysis System (SPAS). Hourly calibrations were completed using available hourly rain gage data together with Level II NEXRAD data from Pueblo, Colorado. Spatial and temporal rainfall distributions were provided over the drainage basin on an hourly basis with a spatial resolution of approximately one third square mile.

Climax Mine Tailing Ponds, Fremont Pass, Climax, Colorado, 2005

This high altitude site-specific PMP study provided PMP values that were used to determine the PMF for the Climax Mine tailing ponds located to the north-northeast of Leadville, Colorado, immediately to the north and west of the Continental Divide. One of the largest historic storms in the region (Gladstone 1911) was re-evaluated using paleoflood analyses together with a detailed meteorological analyses and HEC-1 run-off modeling. The result was the determination that the rainfall observation was in error and will no longer be used for PMP studies in Colorado. The site-specific PMP values from this study will potentially be use for closure planning of the mining site.

Overland Reservoir, Grand Mesa, Colorado, 2005

Although downwind of the Uncompahgre Plateau in western Colorado, this drainage basin's elevation was above the rain shadow region of this upwind barrier. However, the site-specific PMP study provided significant reductions in the PMP values primarily because of the high elevation of the watershed. Detailed GIS analyses were used to provide average and effective moisture barrier heights.

Sweitzer Reservoir, Delta, Colorado, 2004

This drainage basin location was affected dramatically by moisture depletion by both the San Juan Mountains to the south and the Uncompahgre Plateau to the west. The moisture depletion analysis together with the elimination of the Gladstone 1911 rainfall observation were key in the significant reduction in PMP values from those in HMR 49.

Dry Creek Reservoir, Berthoud, Colorado, September, 2004

This study provided PMP values for a small basin immediately east of the eastern foothill of the Rocky Mountains. Of particular interest was the identification of significant orographic features, i.e. the hogback ridges at the top of the basin, and its potential influence on enhancing rainfall and/or determining the location of a storm center within the basin.

Milton Reservoir and Barr Reservoir, Brighton, Colorado, March, 2004

These drainage basins are located east of the Rocky Mountain foothills north of Denver. The Barr Reservoir drainage basin is relatively small and PMP determination was based on point rainfall values. The Milton Reservoir watershed is larger and required the transpositioning of extreme rainfall storm isohyetal patterns over the drainage in order to include the within storm rainfall distributions associated with eastern Colorado extreme rainfall events.

Boyd and Horseshoe Lakes, Loveland, Colorado, November, 2003

These adjacent basins were included in a single study. The primary issue centered around an extreme rainfall event in 1935 that occurred south of the basins location. Discussions with the Colorado State Engineer Office resolved significant issues associated with the areal coverage of local vs general storm events.

Black Hollow Reservoir, Windsor, Colorado, November, 2003

This Colorado Front Range drainage basin study was relatively straight-forward based on extreme rainfall events over eastern Colorado. The relatively flat basin topography did not present any significant effects on rainfall production.

Great Sacandaga Lake Drainage Basin, New York, September, 2003

This was a comprehensive site-specific PMP study to include detailed terrain analyses, storm analyses (maximization, transposition, orientation, within-storm rainfall distributions, etc.), and temporal and spatial envelopment. The study was reviewed and accepted by a FERC approved three member board of consultants and subsequently accepted by the FERC. The AWA Storm Precipitation Analysis System (SPAS) software analysis program was used to provide Depth-Area-Duration tables for storms not

analyzed in HMRs 51 and 52. Procedures were developed to provide elevation and upwind barrier adjustments for storm transpositioning.

Cherry Creek Drainage Basin, Colorado, August, 2003

This study was a comprehensive site-specific PMP study to include detailed terrain analyses, storm analyses (maximization, transposition, orientation, within-storm rainfall distributions, etc.), and temporal and spatial envelopment. Detailed analyses of individual storm isohyetal patterns were completed including transpositioning the individual isohyetal patterns to the Cherry Creek basin. The study was reviewed and accepted by a three member review panel and subsequently accepted by the Colorado Water Conservation Board. Acceptance by the US Army Corps of Engineers is pending.

Upper and Middle Dams Drainage Basins, Maine, March, 2003

This site-specific PMP study included detailed terrain analyses, storm analyses (maximization, transposition, orientation, within-storm rainfall distributions, etc.), and temporal and spatial envelopment. The study was reviewed and accepted by a FERC approved three member board of consultants and subsequently accepted by the FERC. Innovative new procedures using sea surface temperatures and GIS barrier analyses were incorporated into the study.

Spring Run No2 Lake, Colorado Springs, Colorado, June 2001

This drainage basin lies at the foot of Cheyenne Mountain. The highly orographic terrain required adjustment of rainfall values to include the rainfall enhancement and storm centering associated with the elevated terrain at the head of the drainage basin. Both slope and aspect of the basin were compared the terrain features associated with extreme rainfall events influenced by steep terrain.

While associated with North American Weather Consultants, Dr. Tomlinson conducted other studies in Colorado including the Williams Fork drainage basin. This study was conducted for Denver Water and addressed site-specific issues such as basin topographic gradient orientation, upwind moisture depletion, precipitation phase variations with elevation and spillover rainfall. This study was accepted by both the Federal Energy Regulatory Commission and the Colorado State Engineer.

Two studies were conducted for the Colorado River Water Conservation District. The first was for the Muddy Creek drainage basin. The results of this study permitted a significant raising of the spillway height, allowing more water to be stored. The second study was for the Elkhead Creek drainage basin and was also sponsored by the City of Craig. With supporting results from the paleoflood study, significant reductions in the PMP were provided and accepted by the Colorado State Engineer.

On the eastern slope, a site-specific PMP study was provided for the City of Bloomfield for the Great Western Reservoir. The primary storm that contributed to the establishment of PMP values was re-evaluated. The NOAA storm analysis used HMR 55A contained errors that were identified in the detailed storm analysis provided as a part of the site-specific PMP study. The site-specific PMP results provided somewhat lower total storm PMP values but also provided significant changes in the one-hour value and the time distribution of the rainfall. These changes resulted in changes in the Probable Maximum Flood (PMF) and a subsequent reduction in the remediation required for the dam to pass the PMF.

Dr Tomlinson was the project manager for a study for Duke Power Company in North Carolina. For that study, the geography of the Carolinas was divided into three separate zones with similar climate and topography to separate the piedmont region from the coastal and mountainous regions. The smaller storms over the piedmont region resulted in a significant decrease in the PMP while a small decrease was realized for the mountains and no significant decrease was noted for the coastal region.

The two-state regional PMP conducted for the Hydroelectric Users Group in Michigan and Wisconsin identified some significant errors in the procedure used historically to analyze Mesoscale Convective Complexes (large thunderstorm systems). Re-analysis of the moisture for these storms resulted in a decrease in the PMP values for small watershed (less than 500 square miles) for short duration events (less than 6 hours). This study has been accepted for use in PMF analyses for dams regulated by the FERC.