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Probable Maximum Precipitation and Local Intense Precipitation Analysis for Arkansas Nuclear One

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NOTICE

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Executive Summary

Applied Weather Associates (AWA) has completed site-specific Probable Maximum Precipitation (PMP) and Local Intense Precipitation (LIP) analyses for Arkansas Nuclear One (ANO) located along the Arkansas River in the state of Arkansas. The purpose of the study was to determine PMP specific to entire drainage basin affecting the site, approximately 153,000 square miles and LIP values at the ANO site. These analyses analyzed storms throughout all twelve months of the year to produce all-season PMP values, and analyzed thunderstorms and Mesoscale Convective Complexes (MCC) for the LIP analysis over the ANO site location. This study took into account topography, climate and storm types that affect this region which could produce the Probable Maximum Flood (PMF). The calculation of the Probable Maximum Flood is not within the scope of this study.

The ANO drainage basin lies within the domains of National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) Hydrometeorological Reports No. 51 (HMR 51) and HMR 55A. The methods and procedures used to derive the PMP and LIP values are similar to other site-specific PMP studies conducted by AWA within the HMR 51 and HMR 55A domains (e.g. Tomlinson 1993, Tomlinson et al 2008, Tomlinson et al 2011, Kappel et al 2012, Tomlinson et al. 2013, Kappel et al. 2013). The approach used in this study is a storm-based approach that utilizes many of the procedures used by the National Weather Service (NWS) in the development of the HMRs. These same procedures are recommended by the World Meteorological Organization (WMO) for PMP determination (WMO 1986, 2009). This approach identifies extreme rainfall events that have occurred in a region that has meteorological and topographical characteristics similar to extreme rain storms that could occur over the ANO basin and over the ANO site location. The largest of these rainfall events are selected for detailed analyses.

The basin affecting the ANO site is large and diverse. Therefore, many different storm types affect the overall basin. A gridded system was set up to capture the spatial variability of storms and extreme rainfall amounts across the large basin. In total, 75 storm events were used in the development of the PMP values and 23 storms were used in the LIP analysis. Each of these storms has characteristics of extreme rainfall production that could potentially occur over some part the ANO basin and could potentially influence PMP values at one or more of the area sizes and/or durations analyzed or influence the LIP values at the ANO site.

HMR procedures for maximization, transposition, and elevation moisture adjustments are used with refinements (e.g. average vs. persisting dew points and 1,000 foot transposition limitations). Updated techniques and databases are used in the study to increase accuracy and reliability, while adhering to the basic procedures in the HMRs and in the WMO Manuals. The updated maximum dew point climatology maps that were developed for previous PMP studies was used in the storm maximization and storm transpositioning processes.

For newly analyzed storms, maximization factors were determined using the updated climatologies and storm representative dew point data. A parcel trajectory model (HYSPLIT) (Draxler and Rolph 2003, 2010) was used along with the National Center for Environmental Prediction (NCEP) Reanalysis (Mesinger 2006) database to assist in the determination of storm inflow moisture vectors.

Each storm on the short storm list (the final 78 storm centers used to derive the PMP and 23 used to derive LIP) was maximized, transpositioned, and elevation adjusted to the ANO site and to each of the 22 grid points as appropriate and used to distribute PMP across this large basin. Depth-Area (DA) plots were made for 6-, 12-, 24-, 48-, and 72-hour durations and for area sizes of 10-, 200-, 1,000-, 5,000-, 10,000-, 20,000-, 50,000-, and 100,000-square miles. Enveloping curves were constructed using storm rainfall values at each grid point and the basin centroid. Depth-Duration (DD) curves were plotted for each duration and envelop curves constructed. The final DD envelop curves provide PMP values for each grid point and the basin centroid. The final step was to spatially interpolate the resulting values using a Geographic Information System (GIS) with manual adjustments to ensure continuity in space and time across the entire basin. The results of this final step allow PMP values for standard durations and area sizes to be determined for any location within the basin.

The PMP values were determined using procedures described in HMR 51. In addition, because the size of the basin is well beyond the 20,000 square mile upper limit in HMRs 51 and 52, the PMP values were determined for area sizes to 100,000 square miles. Further, analysis results were provided to allow for movement of the design storm during PMF calculations, unlike the stationary design storm center provided in HMR 52. Design storm movement allows for a more realistic storm scenario to be used for the application of the PMP values for PMF determination.

GLOSSARY

Adiabat: Curve of thermodynamic change taking place without addition or subtraction of heat. On an adiabatic chart or pseudo-adiabatic diagram, a line showing pressure and temperature changes undergone by air rising or condensation of its water vapor; a line, thus, of constant potential temperature.

Adiabatic: Referring to the process described by adiabat.

Advection: The process of transfer (of an air mass property) by virtue of motion. In particular cases, advection may be confined to either the horizontal or vertical components of the motion. However, the term is often used to signify horizontal transfer only.

Air mass: Extensive body of air approximating horizontal homogeneity, identified as to source region and subsequent modifications.

Average Dew Point: The average dew point value calculated using a simple mathematically running mean over a specific duration of consecutive hours (i.e. 6-hours) at a given station or set of stations. This value is used in the storm maximization calculation as the storm representative dew point.

Barrier: A mountain range that partially blocks the flow of warm humid air from a source of moisture to the basin under study.

Basin centroid: The point at the exact center of the drainage basin as determined through geographical information systems calculations using the basin outline.

Basin shape: The physical outline of the basin as determined from topographic maps, field survey, or GIS.

Cirrus shield: In this study, the area of cirrus cloud that covers a mesoscale convective complex.

Cirrus anvil: The cirrus cloud that is advected downwind from the top of a cumulonimbus cloud.

Cold front: Front where relatively colder air displaces warmer air.

Convective rain: Rainfall caused by the vertical motion of an ascending mass of air that is warmer than the environment and typically forms a cumulonimbus cloud. The horizontal dimension of such a mass of air is generally of the order of 12 miles or less. Convective rain is typically of greater intensity than either of the other two main classes of rainfall (cyclonic and orographic) and is often accompanied by thunder. The term is more particularly used for those cases in which the precipitation covers a large area as a result of the agglomeration of cumulonimbus masses.

Convergence: Horizontal shrinking and vertical stretching of a volume of air, accompanied by net inflow horizontally and internal upward motion.

Cooperative station: A weather observation site where an unpaid observer maintains a climatological station for the National Weather Service.

Cyclone: A distribution of atmospheric pressure in which there is a low central pressure relative to the surroundings. On large-scale weather charts, cyclones are characterized by a system of closed constant pressure lines (isobars), generally approximately circular or oval in form, enclosing a central low-pressure area. Cyclonic circulation is counterclockwise in the northern hemisphere and clockwise in the southern. (That is, the sense of rotation about the local vertical is the same as that of the earth's rotation.)

Depth-Area curve: Curve showing, for a given duration, the relation of maximum average depth to size of area within a storm or storms.

Depth-Area-Duration: The precipitation values derived from Depth-Area and Depth-Duration curves at each time and area size increment analyzed for a PMP evaluation.

Depth-Area-Duration Curve: A curve showing the relation between an averaged areal rainfall depth and the area over which it occurs, for a specified time interval, during a specific rainfall event.

Depth-Area-Duration values: The combination of depth-area and duration-depth relations. Also called depth-duration-area.

Depth-Duration curve: Curve showing, for a given area size, the relation of maximum average depth of precipitation to duration periods within a storm or storms.

Dew point: The temperature to which a given parcel of air must be cooled at constant pressure and constant water vapor content for saturation to occur.

Effective Barrier Height: The height of a barrier determined from elevation analysis that reflects the effect of the barrier on the precipitation process for a storm event. The actual barrier height may be either higher or lower than the effective barrier height.

Envelopment: A process for selecting the largest value from any set of data. In estimating PMP, the maximum and transposed rainfall data are plotted on graph paper, and a smooth curve is drawn through the largest values.

Explicit Transposition: The movement of the rainfall amounts associated with a storm within boundaries of a region throughout which a storm may be transposed with only relatively minor modifications of the observed storm rainfall amounts. The area within the transposition limits has similar, but not identical, climatic and topographic characteristics throughout.

First-order NWS station: A weather station that is either automated, or staffed by employees of the National Weather Service and records observations on a continuous basis.

Front: The interface or transition zone between two air masses of different parameters. The parameters describing the air masses are temperature and dew point.

General storm: A storm event, that produces precipitation over areas in excess of 500-square miles, has a duration longer than 6 hours, and is associated with a major synoptic weather feature.

Gulf Stream Current: A warm, well-defined, swift, relatively narrow, ocean current in the western North Atlantic that originates where the Florida Current and the Antilles Current begin to curve eastward from the continental slope of Cape Hatteras, North Carolina. East of the Grand Banks, the Gulf Stream meets the cold Labrador Current, and the two flow eastward separated by the cold wall.

HYSPLIT: HYbrid Single-Particle Lagrangian Integrated Trajectory. A complete system for computing parcel trajectories to complex dispersion and deposition simulations using either puff or particle approaches. Gridded meteorological data, on one of three conformal (Polar, Lambert, or Mercator latitude-longitude grid) map projections, are required at regular time intervals. Calculations may be performed sequentially or concurrently on multiple meteorological grids, usually specified from fine to coarse resolution.

Implicit Transpositioning: The process of applying regional, areal, or durational smoothing to eliminate discontinuities resulting from the application of explicit transposition limits for various storms.

Isohyets: Lines of equal value of precipitation for a given time interval.

Isohyetal Pattern: The pattern formed by the isohyets of an individual storm.

Isohyetal orientation: The term used to define the orientation of precipitation patterns of major storms when approximated by elliptical patterns of best fit. It is also the orientation (direction from north) of the major axis through the elliptical PMP storm pattern.

Jet Stream: A strong, narrow current concentrated along a quasi-horizontal axis (with respect to the earth’s surface) in the upper troposphere or in the lower stratosphere, characterized by strong vertical and lateral wind shears. Along this axis it features at least one velocity maximum (jet streak). Typical jet streams are thousands of kilometers long, hundreds of kilometers wide, and several kilometers deep. Vertical wind shears are on the order of 10 to 20 mph per kilometer of altitude and lateral winds shears are on the order of 10 mph per 100 kilometer of horizontal distance.

Local storm: A storm event that occurs over a small area in a short time period. Precipitation rarely exceeds 6 hours in duration and the area covered by precipitation is less than 500-square miles. Frequently, local storms will last only 1 or 2 hours and precipitation will occur over areas of up to 200-square miles. Precipitation from local storms will be isolated from general-storm rainfall. Often these storms are thunderstorms.

Low Level Jet: A band of strong winds at an atmospheric level well below the high troposphere as contrasted with the jet streams of the upper troposphere.

Mass curve: Curve of cumulative values of precipitation through time.

Mesoscale Convective Complex: For the purposes of this study, a heavy rain-producing storm with horizontal scales of 10 to 1000 kilometers (6 to 625 miles) which includes significant, heavy convective precipitation over short periods of time (hours) during some part of its lifetime.

Mesoscale Convective System: A complex of thunderstorms which becomes organized on a scale larger than the individual thunderstorms, and normally persists for several hours or more. MCSs may be round or linear in shape, and include systems such as tropical cyclones, squall lines, and MCCs (among others). MCS often is used to describe a cluster of thunderstorms that does not satisfy the size, shape, or duration criteria of an MCC.

Mid-latitude frontal system: An assemblage of fronts as they appear on a synoptic chart north of the tropics and south of the polar latitudes. This term is used for a continuous front and its characteristics along its entire extent, its variations of intensity, and any frontal cyclones along it.
Moisture maximization: The process of adjusting observed precipitation amounts upward based upon the hypothesis of increased moisture inflow to the storm.

Observational day: The 24-hour time period between daily observation times for two consecutive days at cooperative stations, e.g., 6:00PM to 6:00PM.

One-hundred year rainfall event: The point rainfall amount that has a one-percent probability of occurrence in any year. Also referred to as the rainfall amount that on the average occurs once in a hundred years or has a 1 percent chance of occurring in any single year.

Polar front: A semi-permanent, semi-continuous front that separates tropical air masses from polar air masses.

Precipitable water: The total atmospheric water vapor contained in a vertical column of unit cross-sectional area extending between any two specified levels in the atmosphere; commonly expressed in terms of the height to which the liquid water would stand if the vapor were completely condensed and collected in a vessel of the same unit cross-section. The total precipitable water in the atmosphere at a location is that contained in a column or unit cross-section extending from the earth's surface all the way to the "top" of the atmosphere. The 30,000 foot level (approximately 300mb) is considered the top of the atmosphere in this study.

Persisting dew point: The dew point value at a station that has been equaled or exceeded throughout a period. Commonly durations of 12 or 24 hours are used, though other durations may be used at times.

Probable maximum precipitation: Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographic location at a certain time of the year.

Probable maximum flood: The flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area.

Pseudo-adiabat: Line on thermodynamic diagram showing the pressure and temperature changes undergone by saturated air rising in the atmosphere, without ice-crystal formation and without exchange of heat with its environment, other than that involved in removal of any liquid water formed by condensation.

Pseudo-adiabatic: Referring to the process described by the pseudo-adiabat.

Rainshadow: The region, on the lee side of a mountain or mountain range, where the precipitation is noticeably less than on the windward side.

PMP storm pattern: The isohyetal pattern that encloses the PMP area, plus the isohyets of residual precipitation outside the PMP portion of the pattern.

Saturation: Upper limit of water-vapor content in a given space; solely a function of temperature.

Short Storm List: The final list of storms used to derive the PMP values.

Spatial distribution: The geographic distribution of precipitation over a drainage according to an idealized storm pattern of the PMP for the storm area.

Storm transposition: The hypothetical transfer, or relocation of storms, from the location where they occurred to other areas where they could occur. The transfer and the mathematical adjustment of storm rainfall amounts from the storm site to another location is termed "explicit transposition." The areal, durational, and regional smoothing done to obtain comprehensive individual drainage estimates and generalized PMP studies is termed "implicit transposition" (WMO, 1986).

Synoptic: Showing the distribution of meteorological elements over an area at a given time, e.g., a synoptic chart. Use in this report also means a weather system that is large enough to be a major feature on large-scale maps (e.g., of the continental U.S.).

Temperature Inversion: An increase in temperature with an increase in height.

Temporal distribution: The time order in which incremental PMP amounts are arranged within a PMP storm.

Tropical Storm: A cyclone of tropical origin that derives its energy from the ocean surface.

Total storm area and total storm duration: The largest area size and longest duration for which depth-area-duration data are available in the records of a major storm rainfall.

Transposition limits: The outer boundaries of the region surrounding an actual storm location where similar, but not identical, meteorological and topographic characteristics occur. The storm can be transpositioned within the transposition limits without modification of the expected storm dynamics and adjustments can be applied to the difference in elevation and moisture availability between the two locations. Transpositioning greatly increases the available data for evaluating the rainfall potential for a given drainage location.

Undercutting: The process of placing an envelopment curve somewhat lower than the highest rainfall amounts on depth-area and depth-duration plots.

Warm front: Front where relatively warmer air replaces colder air.

Warm sector: Sector of warm air bounded on two sides by the cold and warm fronts extending from a center of low pressure.

Acronyms and Abbreviations used in the report

ALERT: Automated Local Evaluation in Real Time

ANO: Arkansas Nuclear One

AWA: Applied Weather Associates, LLC

COCORAHS: Community Collaborative Rain, Hail, and Snow Network

COOP: Cooperative Observer Program

DA: Depth-Area

DAD: Depth-Area-Duration

DD: Depth-Duration

dd: decimal degrees

DND: drop number distribution

DSD: drop size distribution

EPRI: Electric Power Research Institute

F: Fahrenheit

GIS: Geographical Information System

GRASS: Geographic Resource Analysis Support System

HMR: Hydrometeorological Report

HR: Hour

HYSPLIT: Hybrid Single Particle Lagrangian Integrated Trajectory Model

IPCC: Intergovernmental Panel on Climate Change

km: kilometer

MADIS: Meteorological Assimilation Data Ingest System

mb: millibar

MCC: Mesoscale Convective Complex

MCS: Mesoscale Convective System

mph: miles per hour

NCAR: National Center for Atmospheric Research

NCDC: National Climatic Data Center

NCEP: National Centers for Environmental Prediction

NEXRAD: Next Generation Radar

NOAA: National Oceanic and Atmospheric Association

NWS: National Weather Service

PMF: Probable Maximum Flood

PMP: Probable Maximum Precipitation

PW: Precipitable water

RAWS: Remote Automatic Weather Stations

SMC: Spatially based Mass Curve

SPAS: Storm Precipitation and Analysis System

USACE: US Army Corps of Engineers

USGS: United States Geological Survey

WMO: World Meteorological Organization

1. Introduction

This study provides both Probable Maximum Precipitation (PMP) and the Local Intense Precipitation (LIP) values for use in the computation of the Probable Maximum Flood (PMF) for the Arkansas Nuclear One (ANO) basin and location. The site-specific study builds on the previous PMP studies completed by AWA in the region (e.g., Tomlinson 1993, Tomlinson et al 2002-2012, Kappel et al 2011-2013).

1.1 Background

Definitions of PMP are found in most Hydrometeorological Reports (HMRs) published by the National Weather Service (NWS). The definition used in the most recently published HMR is *"theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographical location at a certain time of the year*." (HMR 59, p. 5). Since the mid-1940s, several government agencies have been developing methods to calculate PMP in various regions of the United States. The NWS (formerly the U.S. Weather Bureau) and the Bureau of Reclamation have been the primary agencies involved in this activity. PMP values from their reports are used to calculate the PMF which, in turn, is often used for the design of significant hydraulic structures.

The generalized PMP studies currently in use in the conterminous United States include HMR 49 (1977) for the Colorado River and Great Basin drainage; HMRs 51 (1978), 52 (1982) and 53 (1980) for the U.S. east of the 105th meridian; HMR 55A (1988) for the area between the Continental Divide and the 103rd meridian; HMR 57 (1994) for the Columbia River Drainage; and HMRs 58 (1998) and 59 (1999) for California. Figure 1.0 shows the coverage of the various HMRs. For the ANO basin, the majority of the region is covered by HMR 51, with areas west of 103° longitude covered by HMR 55A. In addition to these HMRs, numerous Technical Papers and Reports deal with specific subjects concerning precipitation. Examples are NOAA Technical Report NWS 25 (1980) and NOAA Technical Memorandum NWS HYDRO 45 (1995). Topics include maximum observed rainfall amounts; return periods for various rainfall amounts, and specific storm studies. Climatological atlases (Technical Paper No. 40, 1961; NOAA Atlas 2, 1973; and NOAA Atlas 14, 2003) are available for use in determining rainfall amounts for specified return periods for selected regions of the U.S.

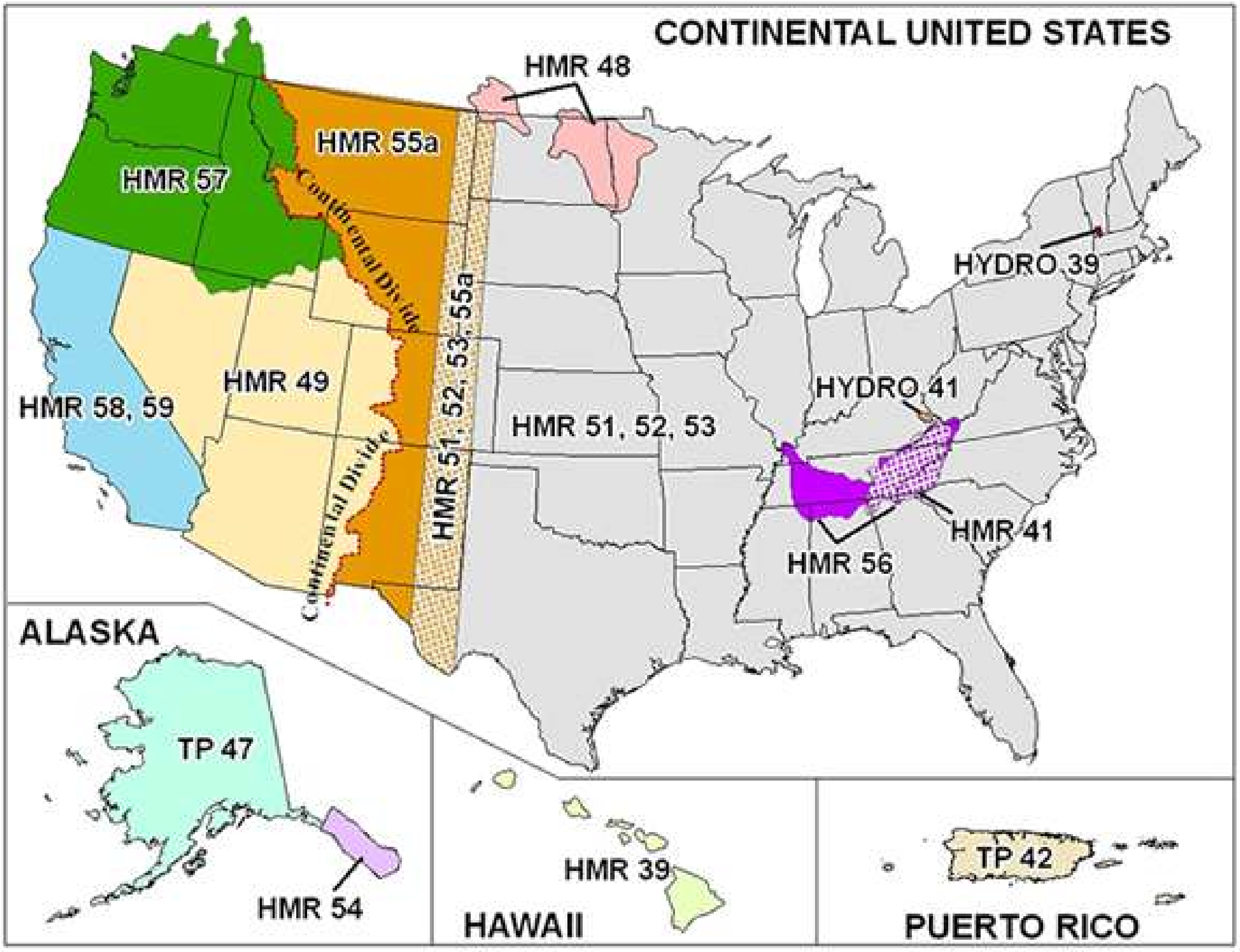

Figure 1.0 Regions covered by current Hydrometeorological Reports.

A number of site-specific and regional PMP studies augment generalized HMRs. These studies are for specific regions or drainage basins within the large areas addressed by HMR 51 and HMR 55A as well as areas covered by other HMRs. The meteorological conditions producing extreme rainfall events vary significantly in different regions within large geographic areas such as the large area covered by the ANO basin. In much of the Midwest, extreme events are usually linked to either Mesoscale Convective Systems (MCSs) or synoptic storms with embedded convection. For the ANO basin, the main storm type leading to PMF level flooding is a synoptic event with embedded convection which moves slowly across the region, generally in a west to east direction. This type of storm provides steady rainfall over long durations and large area sizes, with periods of heavy rainfall over smaller areas. Individual thunderstorms would not lead to PMF level flood across the basin and therefore were not a focus of the overall basin-wide PMP development. Instead, individual thunderstorms and MCSs were the storm type analyzed for the LIP analysis at the ANO site location, as a high intensity, short duration, and localized rainfall over the site would potentially produce the LIP.

The time of year when the storm environment leading to PMP-level rain occurs is during a time of the year when no significant snowpack would be available. In areas of the upper basin where significant snow pack accumulates, significant rainfall that could lead to PMF level flooding at the ANO site does not occur. Therefore, no explicit cool-season PMP values and/or rain-on-snow analyses needed to be completed beyond this quantitative assessment.

Although it provides generalized estimates of PMP values for a large climatologically diverse area, HMR 51 recognizes that studies addressing PMP over specific regions can incorporate more site-specific considerations and provide improved PMP estimates. By periodically reviewing storm data and advances in meteorological concepts, PMP analysts can identify relevant new data and procedures for use in determining PMP values (HMR 51, Section 1.4.1).

As described previously, several site-specific PMP studies have been completed by AWA within the region covered by HMRs 51 and 55A (Figure 1.1). Each of these studies provided PMP values which replaced those from the HMRs. These are examples of PMP studies that explicitly consider the meteorology and topography of the study location along with characteristics of historic extreme storms over climatically similar regions. These regional and site-specific PMP studies have received extensive review and been accepted by the appropriate regulatory agencies. Results have been used in computing the PMF for individual watersheds.

Figure 1.1 Locations of AWA PMP studies as of December 2013.

This report presents details of the ANO PMP study. Section 1 provides an overview of the study. The weather and climate of the upper Midwest and northern Great Plains are discussed in Section 2. Section 3 details the storms types important for PMP development for the basin.

The steps involved with identifying extreme storms are discussed in Section 4 and procedures used to analyze these storms are discussed in Section 5. Discussion on the development of the maximum dew point climatology is provided in Section 6. Adjustments for storm maximization, storm transpositioning, and elevation adjustments are presented in Sections 7 and 8. The final procedure of developing PMP values from the adjusted storm rainfall amounts is provided in Section 9. Section 10 provides information on PMP storm dimensions and movement. Section 11 provides analysis and results of the LIP analysis for the ANO site. PMP results are discussed in Section 12. Section 13 provides discussions related to the sensitivity analysis of the parameters used in the study. The recommended application of results are given in Section 14.

1.2 Objectives

The objective of this study was to perform a PMP analysis to determine reliable estimates of PMP values for the entire ANO basin and LIP analysis to provide the 1-hour 1-square mile PMP value at the ANO site location. The most reliable methods and data currently available have been used, with updated methods, techniques, and data used where appropriate.

1.3 Approach

The approach used in this study follows the same general procedures that were used in the development of the HMRs. These procedures were applied considering the meteorological and topographic characteristics of the basin.

The study maintains as much consistency as possible with the general methods used in HMRs 51 and 55A as well as the numerous site-specific, statewide, and regional AWA PMP studies. Deviations are incorporated where justified by developments in meteorological analyses and available data. The basic approach identifies PMP-type storms that occurred within the central and southern Plains of the United States to the Front Range and mountains of Wyoming, Colorado, and New Mexico east of the Continental Divide. This ensured a sufficiently large region was included in the development of the storm list so that any transpositionable storm that could potentially affect the PMP values at any area size or duration was included.

The moisture content of each of these storms is maximized to provide an estimate of the maximum rainfall for each storm at the location where it occurred. This is accomplished by computing the ratio of the *maximum* amount of atmospheric moisture that could have been entrained into the storm at that time of year to the *actual* atmospheric moisture entrained into the storm as it occurred. After maximization, the storms are transpositioned to each grid point to the extent supportable by similarity of meteorological conditions and topography. Maximized and transpositioned adjusted rainfall values are enveloped at each grid point and then contoured throughout the entire domain to provide PMP estimates for various area sizes and durations at any point within the entire basin. Figure 1.2 shows the flow chart of the major steps in the PMP development process.

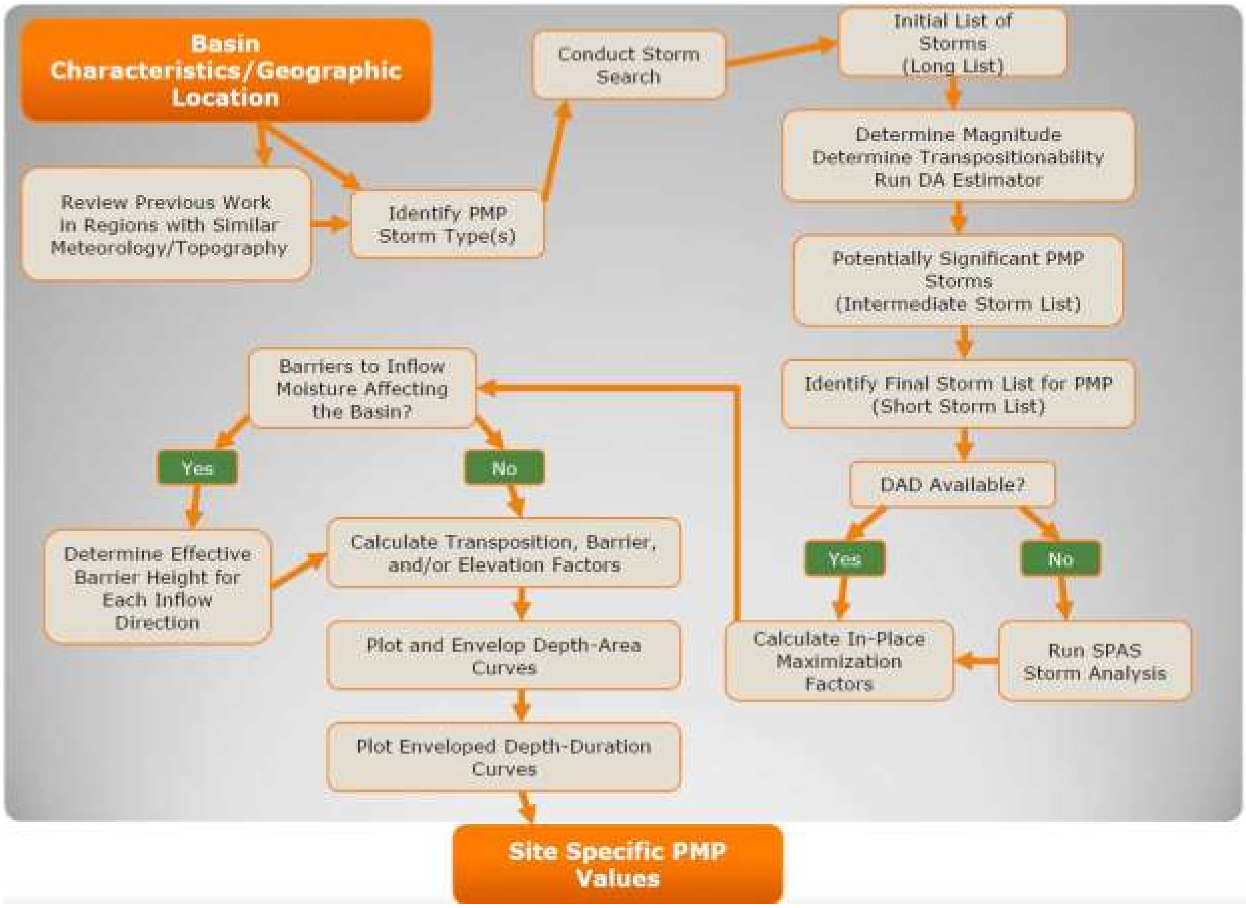

Figure 1.2 Flow chart showing the major steps involved in PMP development.

For some applications, this study applied standard methods (e.g. WMO Operational Hydrology Report No. 1, 1986), while for other applications, improved techniques were used. Advanced computer-based technologies, Weather Service Radar WSR-88D NEXt generation RADar (NEXRAD), and HYSPLIT model trajectories were used for storm analyses along with updated meteorological data sources. Improved technology and data were incorporated into the study when they provided improved reliability, while maintaining as much consistency as possible with previous studies. This approach provides the most complete scientific application compatible with the engineering requirements of consistency and reliability for credible PMP estimates.

Moisture analyses in HMRs 51 and 55A used monthly maximum observed 12-hour persisting dew points to quantify atmospheric moisture. Maximum dew point values used in HMR 51 were provided by *Climatic Atlas of the United States,* published by the Environmental Data Services, Department of Commerce (1968). This study, however, used an updated maximum dew point return frequency analysis developed during several recent and on-going AWA PMP studies. This dew point analysis incorporated data sets with longer periods of record than were available for use in HMRs 51 or 55A. This updated climatology produced 20-, 50-, and 100-year return frequencies for maximum average dew point values for 6-, 12-, and 24-hour duration periods. GIS was used extensively in the development of the updated maximum dew point climatology maps.

A reanalysis of transposition limits was completed that evaluated the elevation of each storm's isohyetal pattern versus the elevation of each grid point used in this study. It was confirmed from this analysis that storms should not be transpositioned more than +/- 1,000 feet in elevation from their original storm elevations. This same conclusion was found in several other AWA PMP studies in the region (e.g. Tomlinson et al. 2008, Kappel et al. 2013) as well as stated in HMR 51 (Section 2.4.2 c.). This procedure provided explicit guidance and constraints on the regions of influence for individual storms. Appendix F details which storms were ultimately transpositioned to various grid point(s).

As mentioned previously, a set of 22 grid points (Figure 1.3) were placed over the region. The gridded analysis procedure was used with the total adjusted rainfall amounts applied across the grid that not only covers the entire basin, but extended into bordering regions to ensure continuity across the basin boundaries. PMP values were analyzed at each grid point using standard procedures. Envelopment of the largest rainfall totals was applied to ensure spatial and temporal continuity of the final PMP values. Once values were derived for each area size and duration, values were spatially and temporally distributed using GIS technologies and manual adjustments. This process produced the final set of PMP maps for the study. It should be noted that the PMP values over the Front Range and up to the Continental Divide of the Rocky Mountains in Colorado and New Mexico used the least amount of data and analyses. This is because no explicit evaluation and quantification of topography and how it relates to rainfall production was completed as part of this study. However, this has minimal to no effect on the resulting PMF at the ANO site, as any flood resulting from rainfall in these locations would have little to no affect effect on the PMF at the ANO site. Instead, values at the grid points in the mountains (7, 13, 14, 21, and 22) provided spatial and temporal continuity of PMP across the western portion of the basin.

A preferred storm orientation analysis was evaluated using storm isohyetal patterns from storms used in this study and results from previous investigations. In addition, an analysis was completed to determine the potential movement of the PMP storm across the basin over the 72-hour period. This procedure was required because the size of the basin is so large that the stationary PMP design storm in HMR 52 does not appropriately replicate a true PMP-type scenario for the basin. Actual storm events used to provide PMP for this study were used to determine the range of movement that could be expected to occur during extreme rainfall events. Recommendations for orientation constraints and storm movement are made.

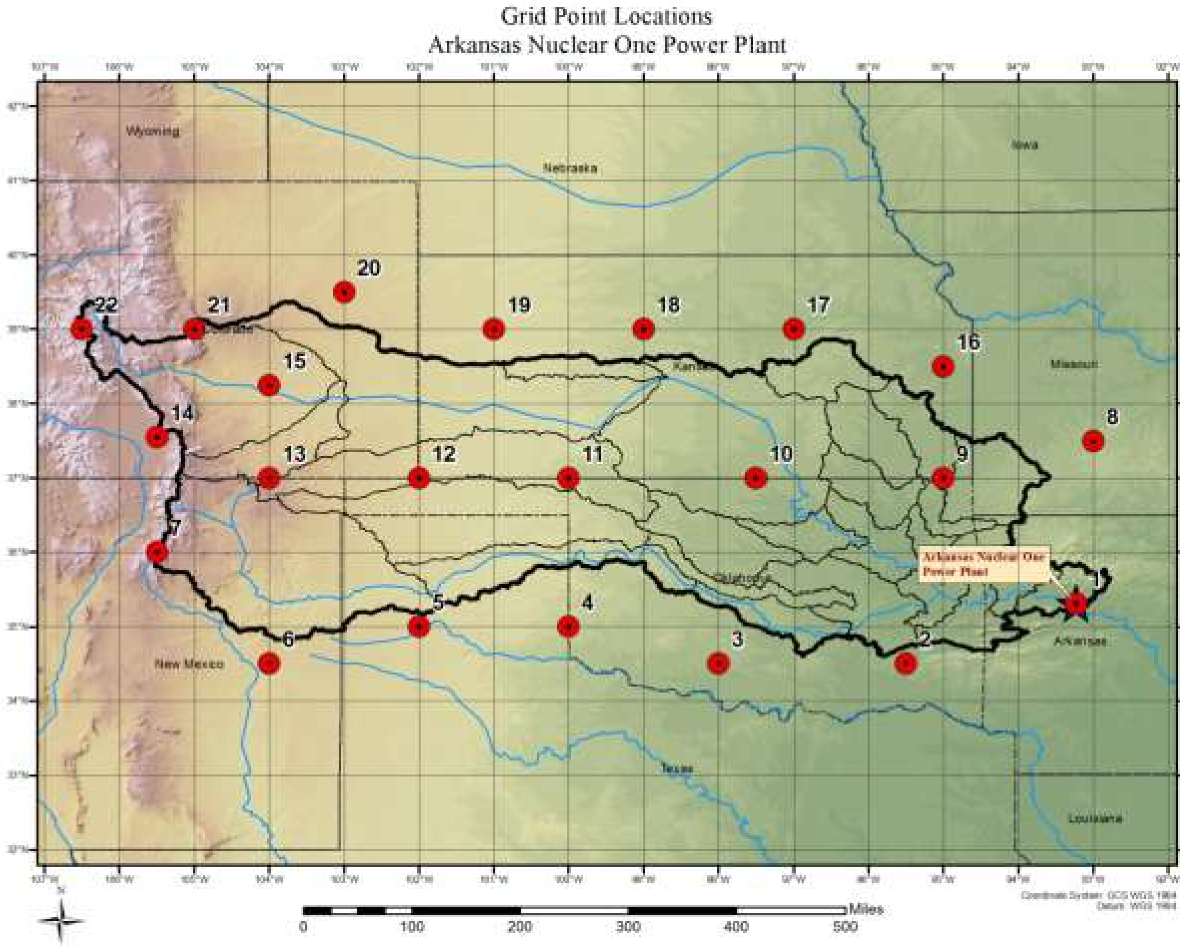

Figure 1.3 Grid points used in the study.

1.4 ANO Location and Description

The drainage basin for the ANO site encompasses the Arkansas River drainage basin, extending from the Continental Divide of Colorado and New Mexico east through northern Texas and the Red River basin to the ANO site location (Figure 1.4). Because this basin extends across a large latitudinal and longitudinal extent, PMP-type storm events can vary across the basin, and any given storm event will not be affecting the entire basin at one time. The large size of the basin and its geographic location have been explicitly evaluated and considered during the study to ensure appropriate PMP development.

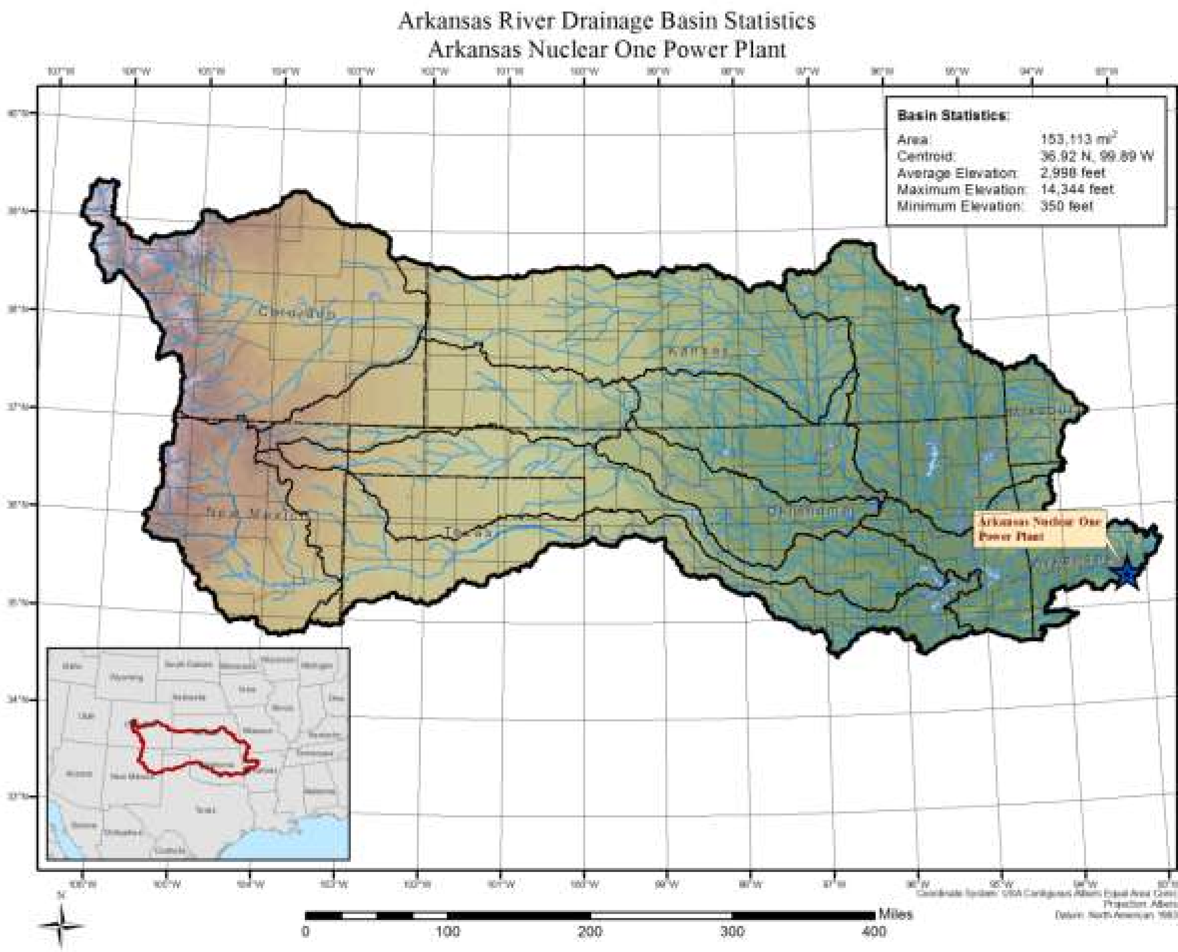

Figure 1.4 ANO regional setting and basin statistics.

Elevations across the basin range from 350 feet along the Arkansas River at the ANO site to over 14,000 feet in Colorado Rockies (Figure 1.6). Elevation changes gradually moving from ANO site west across the basin until reaching eastern Colorado and New Mexico. Elevation gains become dramatic once the Front Range of the Rocky Mountains are reached, generally around 105°W longitude. These elevation changes from east to west within the basin in combination with increased distance from the low-level moisture source (the Gulf of Mexico) create varying storm dynamics and storm types across the basin. Therefore, different storms are used to derive PMP values at various gird points, providing for a significant gradient in PMP values across the basin both in east to west and north to south directions. Therefore, for storm transpositioning, the +/- 1,000 foot limitation was implemented, along with a latitudinal limitation based on distance from the moisture source. This had the most affect on the far western and northern grid points, as many of the central and southern Great Plains storms were not transpositioned to these locations.

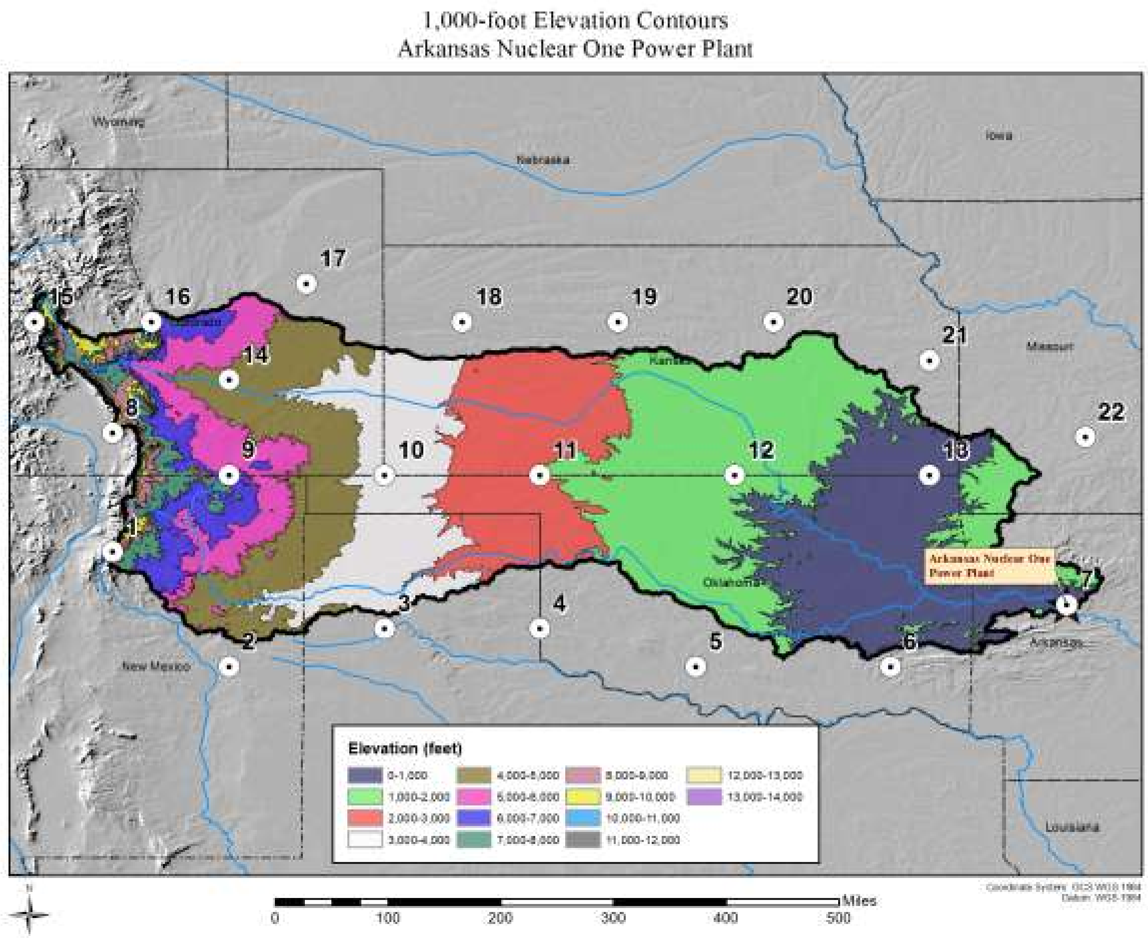

Figure 1.5 Elevations contours across the ANO basin at 500 foot intervals. Grid points used in the study are also shown.

2. Weather and Climate of ANO

2.1 ANO PMP Storm Type Climatology

The region around ANO is influenced by several factors that can potentially contribute to extreme rainfall. First is the proximity of the region to the Gulf of Mexico and the fact that no intervening mountain barriers prevents moisture from moving north (Figure 2.0). This allows high amounts of moisture to move directly into the region. The limiting factor is the duration that these high levels of atmospheric moisture are able to feed into storms in the region. More atmospheric moisture is available over the more southern and eastern regions of the basin compared with the northern and western portions of the basin. Because of the movement and strength of the upper level winds in the region, storm patterns generally do not stay fixed over any location for long periods. Therefore, the synoptic situations which lead to high levels of Gulf of Mexico moisture moving into the region are transient and limit the magnitude of PMP-type rainfall as well as limiting the spatial extent of such storms. This lack of consistent moisture is somewhat compensated for by the stronger storm dynamics associated with synoptic weather systems which move through the region and added lift as the atmospheric moisture is forced to rise over elevated terrain moving south to north and east to west across the basin.

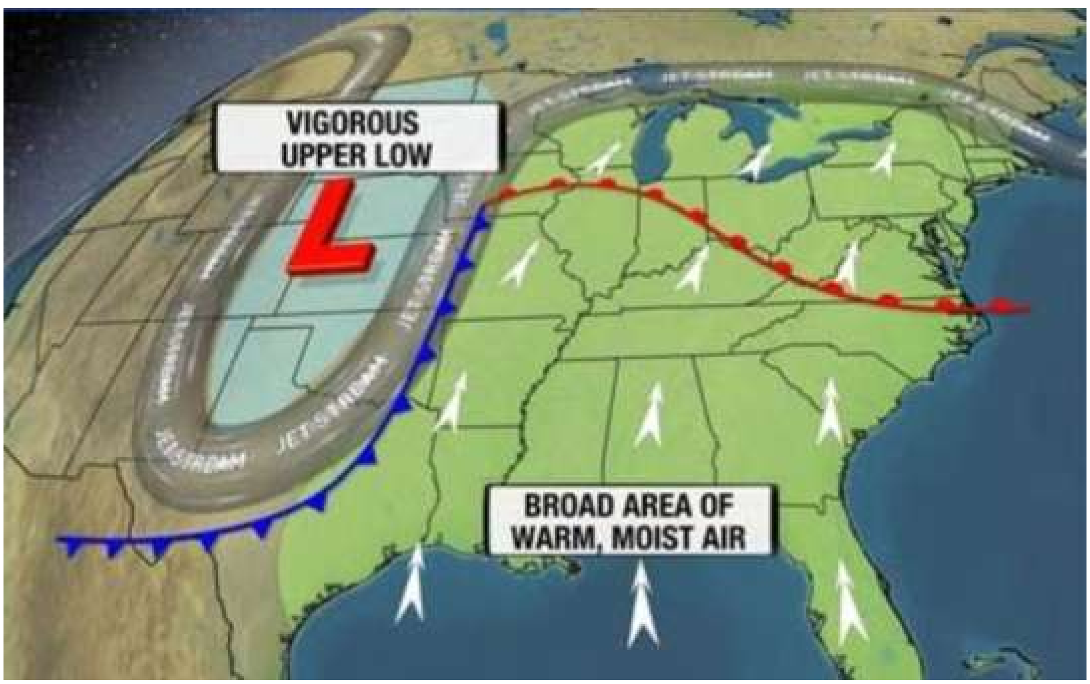

Figure 2.0 Locations of surface features associated with a strong flow of moisture from the Gulf of Mexico into the upper Midwest.

But moisture alone does not create rainfall. Instead a mechanism to lift and condense that moisture is required. The lift required to convert these high levels of atmospheric moisture into rainfall on the ground is provided in several ways in and around the region. Synoptic storm dynamics are very effective in converting atmospheric moisture into rainfall on the ground.

These are most often associated with fronts which affect the region (Figure 2.1). Numerous large scale weather systems with their associated fronts traverse the region throughout the year, with the fewest and weakest occurring in the summer period. The fronts (boundaries between two different air masses) can be a focusing mechanism providing upward motion in the atmosphere. These are often locations where heavy rainfall is produced. Normally, a front will move through with enough speed that no one area receives excessive amounts of rainfall. However, in extreme instances the pattern can become blocked and some of these fronts will stall or move very slowly across the region. This allows large amounts of rainfall to continue for several days in the same general area, which can lead to extreme widespread flooding.

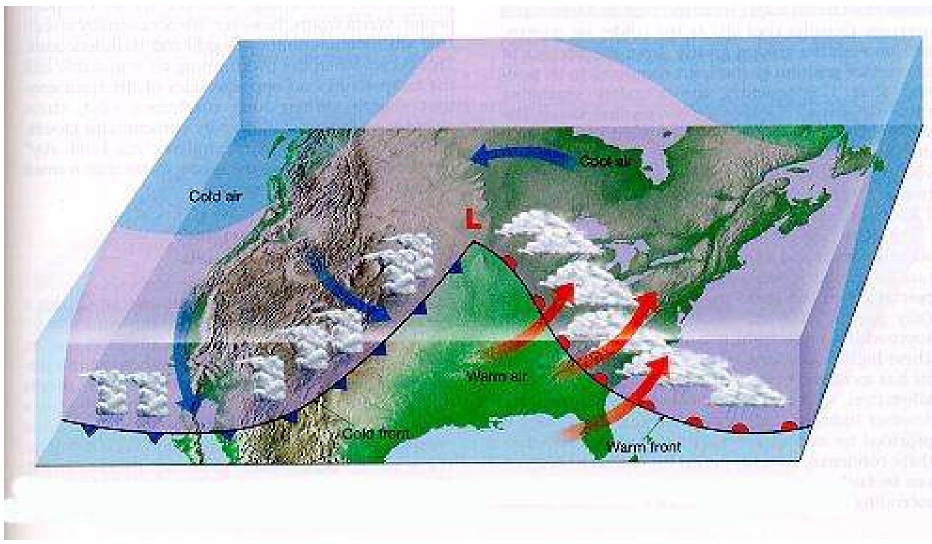

Figure 2.1 Locations of surface features associated with a common synoptic storm pattern across the United States.

Another mechanism which creates lift in the region is heating of the surface and lower atmosphere by the solar radiation. This creates warmer air below colder air resulting in atmospheric instability and leads to rising motions. This will often form ordinary afternoon and evening thunderstorms. However, in unique circumstances the instability and moisture levels in the atmosphere can reach very high levels and stay over the same region for an extended period of time. This can lead to intense thunderstorms and very heavy rainfall. If these storms are focused over the same area for a long period, flooding rains can be produced. This type of storm produces some of the largest point rainfall amounts recorded, but often do not affect larger areas with extreme rainfall amounts. Therefore, this scenario is common in the spring and summer and is often responsible for the LIP storm.. However, this storm scenario does not lead to PMF level flood events across the very large ANO basin. More details on the PMP storm types which produce PMP level rainfalls in and around the basin are given in Section 3.

2.2 General Weather Patterns over the ANO Basin

The weather patterns in the region are characterized by passages of fronts with differing air masses that lead to large ranges in temperatures and rainfall. Fronts are most prevalent in the fall, winter, and spring, with more stagnant patterns common from late spring through early fall.

There are several air mass types that affect the weather and climate of the region and produce heavy rainfall (Figure 2.2). The continental polar (cP) air mass, with origins from the arctic regions of Canada, is most common during the winter months. This air mass is often associated with a strong cold front passage and stratiform snowfall events. When this air mass type arrives, it often collides with a more humid air mass from warmer regions to the south. Low pressure (rising air) often results, and when combined with strong winds aloft, can produce extreme rainfall. However, this air mass type is often highly modified by the time it reaches the southern half of the ANO basin, as it is now a great distance from its original source, has moved over non-snow covered land, and is significantly modified by the warmer conditions from the Gulf of Mexico .

The second type of air mass observed in the region is the maritime polar (mP) which originates in the Gulf of Alaska and Pacific Ocean. This air mass often arrives on strong winds from the west and northwest, but is usually devoid of significant amounts of low-level moisture because it has traveled across several mountain ranges. This storm type often produces precipitation (rain and snow) at these upwind locations, losing much of its low-level moisture on its way to the Central and Southern plains. However, in extreme cases, moisture flowing north from the Gulf of Mexico can replenish low-level atmospheric moisture enough to produce heavy rainfall. If the storm system stalls over the region, flood producing rains can result. This storm type can occur anytime of the year, but is most common from fall through late spring.

Another type of air mass which affects the region and produces rainfall originates from the Gulf of Mexico and can contain copious amounts of atmospheric moisture in a conditionally unstable atmosphere. This type of air mass is called maritime tropical (mT). This type of air mass is most directly responsible for producing heavy rainfall in the region when interacting with a front and as well as an air mass of polar origins moving from the north. Often, the front is located over the basin, allowing high amounts of moisture to stream in from the south, where it is lifted, resulting in widespread rainfall. The release of the conditional instability in the atmosphere provides a very efficient mechanism to convert atmospheric moisture to rain on the ground. This can be enhanced by elevation changes in the underlying topography. If this pattern is able to remain in place for an extended period and to continue to draw in Gulf of Mexico moisture, flooding can result. This storm type is most common from late spring to early fall and is therefore the most common storm type for the PMP scenario.

In rare cases, this type of pattern can include moisture from a decaying tropical system that had previous made landfall along the Gulf Coast states. This scenario has led to the most extreme rainfall events in the historical record for durations of 24-hours and less in the southern portions of the ANO basin. Examples include Albany, TX August, 1978 (AWA 18) and Thrall, TX September, 1921 (AWA 77).

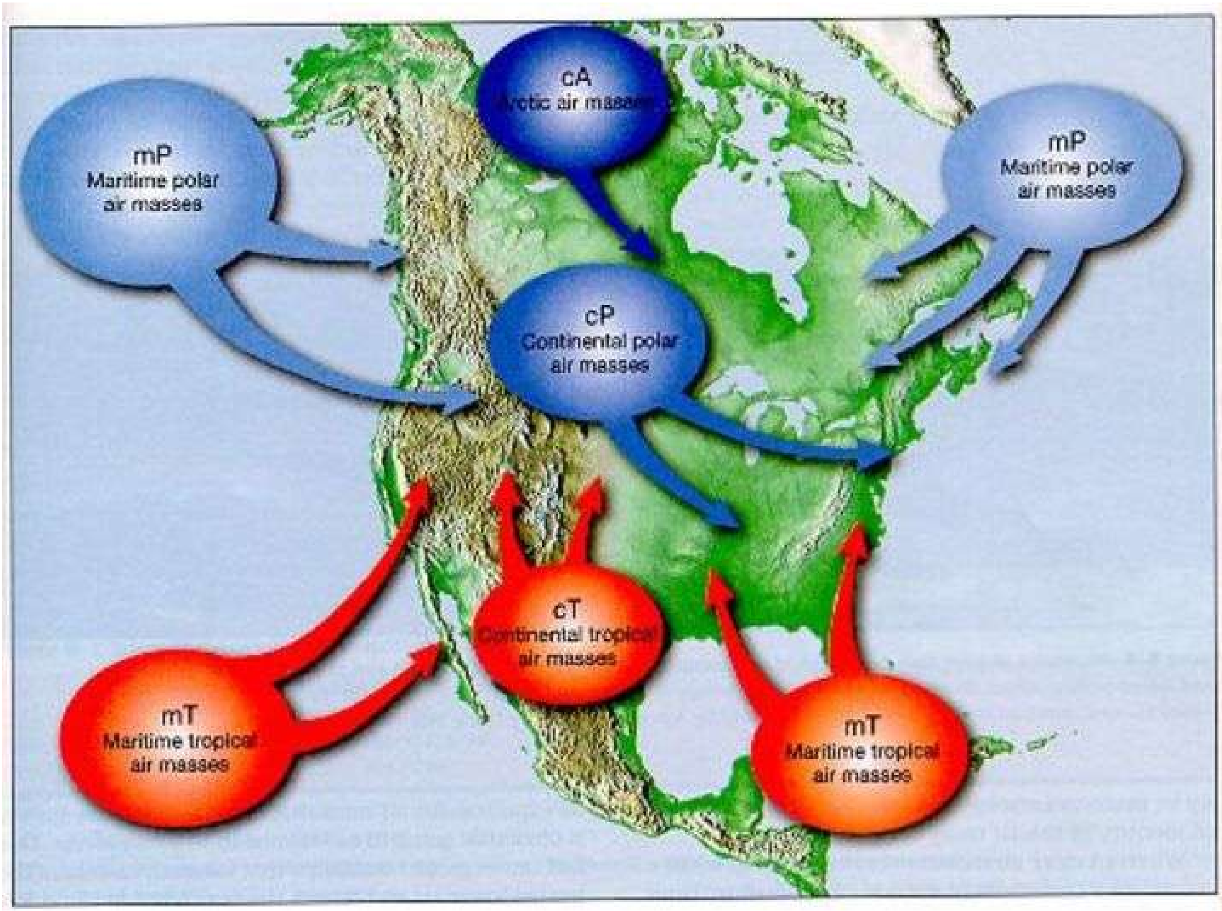

Figure 2.2 Air mass source regions affecting the ANO drainage basin.

3. Extreme Storm types

The ANO basin and the surrounding region have very active and varied weather patterns throughout the year. Consequently heavy rainfall events at both short and long durations are common. By far, the largest amount of moisture available for rainfall over the region comes from the Gulf of Mexico. The major types of extreme rainfall events in the region are produced by Mesoscale Convective Systems (MCS) (short durations and small area sizes), synoptic events/fronts (large areas sizes and longer durations), and remnant moisture from tropical systems which have made landfall along the Gulf of Mexico coastline.

3.1 Synoptic Fronts

The polar front and jet stream, which separate cool, dry Canadian air to the north from warm, moist air to the south, is often a cause of heavy rainfall over large areas and long durations. This boundary provides large amounts of energy and strong storm dynamics to the atmosphere as fronts move through the region. These features are strongest and most active over the area during fall, winter, and spring months. A common type of storm occurrence with the polar front is an overrunning event. Frontal overrunning occurs when warm, humid air carried northward around the western edge of the Bermuda High circulation encounters the frontal zone and is forced to rise over the cooler, drier air mass to the north of the front. This forced ascent condenses atmospheric moisture in the air mass, forming clouds and producing precipitation while releasing latent heat. This process most often results in widespread rainfall over longer durations, but can also help enhance convection. Air that arrives at the frontal location is conditionally unstable, where the lower layers are much warmer and more humid than the air above. This conditionally unstable air mass needs a mechanism to initiate lift to begin energy release, leading to more instability and further lift. The forced ascent over the polar front initiates the lifting of the moist air mass, release of its energy, and initiates the conversion of the atmospheric moisture to rainfall.

A stationary or slow moving polar front located within the ANO basin will often provide the mechanism necessary for this warm, humid air mass to release its convective potential. When this occurs, rainfall is produced, sometimes associated with pockets of convection and extremely heavy rainfall. The pockets of heavy rain are usually associated with a minor wave riding along the frontal boundary, called a shortwave. These are not strong enough to move the overall large scale pattern, but instead add to the storm dynamics and energy available for producing rainfall.

This type of storm environment (synoptic frontal) will usually not produce the highest rainfall rates over short durations, but instead leads to flooding situations as moderate to heavy rain falls over the same regions for an extended period of time. In addition, this scenario can occur in succession with only a few dry days in between and therefore enhance runoff on a previously saturated basin. The rainfall and flooding event which occurred during May 1943 from Oklahoma eastward through the ANO site location is a good example of this type of storm.

3.2 Mesoscale Convective Systems

Mesoscale Convective Systems (MCSs) are capable of producing extreme amounts of rainfall for short durations and over small area sizes, generally 12 hours or less over area sizes of 500-square miles or less. The current understanding of MCS type storms has progressed tremendously with the advent of satellite technology starting in the 1970s and early 1980s. The current name of MCS was first applied in the late 1970s to these type of "flood producing", strong thunderstorm complexes (Maddox 1980). Mesoscale systems are so named because they are small in areal extent (10s to 100s of square miles), whereas synoptic storm events are 100s to 1,000s of square miles. MCSs also exhibit a distinctive signature on satellite imagery where they show rapidly growing cirrus clouds shields with very high cloud tops. Furthermore, the high level cloud shield associated with MCSs usually take on a nearly circular pattern about the size of the state of Iowa with constantly regenerating thunderstorms fed by a low-level-jet (LLJ) bringing an inflow of atmospheric moisture (Figure 3.0).

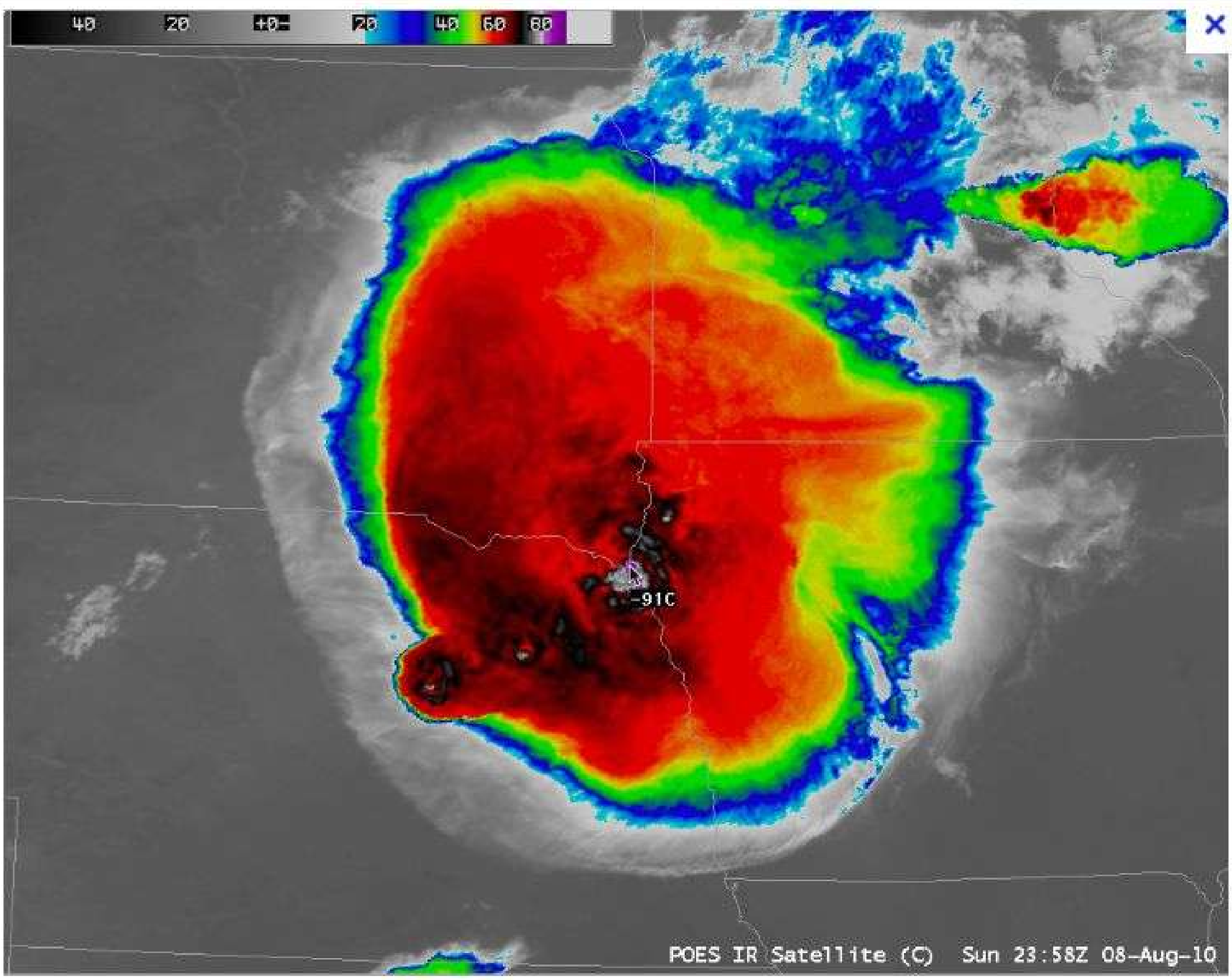

Figure 3.0 Color enhanced infrared satellite image of an MCS. Note the nearly circular structure, very cold cloud tops at the center (red, black, and center white colors), and a size similar to the state of Iowa.

The vast majority of MCSs have distinctive features and evolve in a standard pattern. A typical MCS begins as an area of thunderstorms over the western High Plains or Front Range of the Rocky Mountains. As these storms begin to form early in the day, the predominantly westerly winds aloft move them in a generally eastward direction. As the day progresses, the rain-cooled air below and around the storms begins to form a mesoscale high pressure area. This mesoscale high moves along with the area of thunderstorms. During nighttime hours, the MCS undergoes rapid development as it encounters increasingly warm and humid air from the Gulf of Mexico, usually associated with the LLJ 3,000-5,000 feet above the ground. The area of thunderstorms will often form a ring around the leading edge of the mesoscale high and continue to intensify, producing heavy rain, damaging winds, hail, and/or tornadoes. An MCS will often remain at a constant strength as long as the LLJ continues to provide an adequate supply of moisture. Once the mesoscale environment begins to change, the storms weaken, usually around sunrise, but may persist into the early daylight hours.

MCSs are included in the more general definition of MCCs, which include a wider variety of mesoscale sized storm systems, such as squall lines and tropical cyclones, and MCSs that do not fit the strict definition of size, duration, and/or appearance on satellite imagery. MCSs primarily form during the warm season months (April through October) around the ANO basin region.

Many of the storms previously analyzed by the USACE and NWS Hydrometeorological Branch in support of pre-1979 PMP research have features that indicate they were most likely MCCs or MCSs. However, this nomenclature had not yet been introduced into the scientific literature, nor were the events fully understood. For ANO basin, pure MCS storms do not produce PMF level flood events because of the very large basin size and the relatively small areas of rainfall produced by MCSs. However, intense convection similar to this storm type can occur within an overall synoptic frontal event. This can lead to intense areas of embedded heavy rainfall within the overall lighter rainfall pattern. This combination of synoptic and convective storm types is very important for determining PMP values for the basin.

4. Extreme Storm Identification

4.1 Storm Search Area

A comprehensive storm search covering the region important for the ANO basin has been conducted during previous site-specific and regional PMP studies. This included an analysis of all extreme rainfall storms in meteorological and topographically similar regions, where extreme rainfall storms similar to those that could occur over some part of the ANO basin may have been observed (Figure 4.0). These previous storm search results are current through 2013 and include all 12 months of the year (Figure 4.1). This ensured a large enough area was analyzed to capture all significant storms that could potentially influence the final PMP values for the basin.

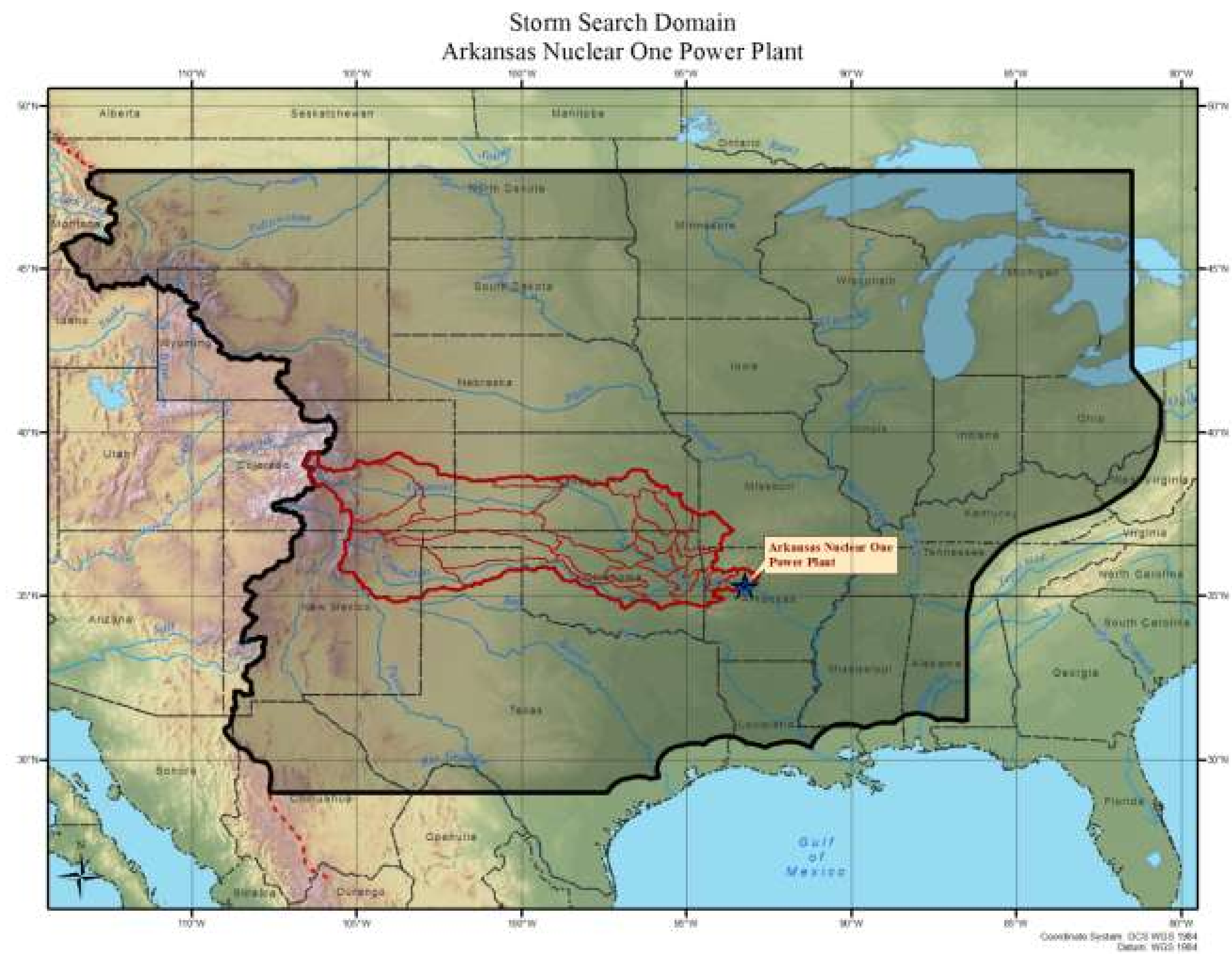

Figure 4.0 AWA storm search domain.

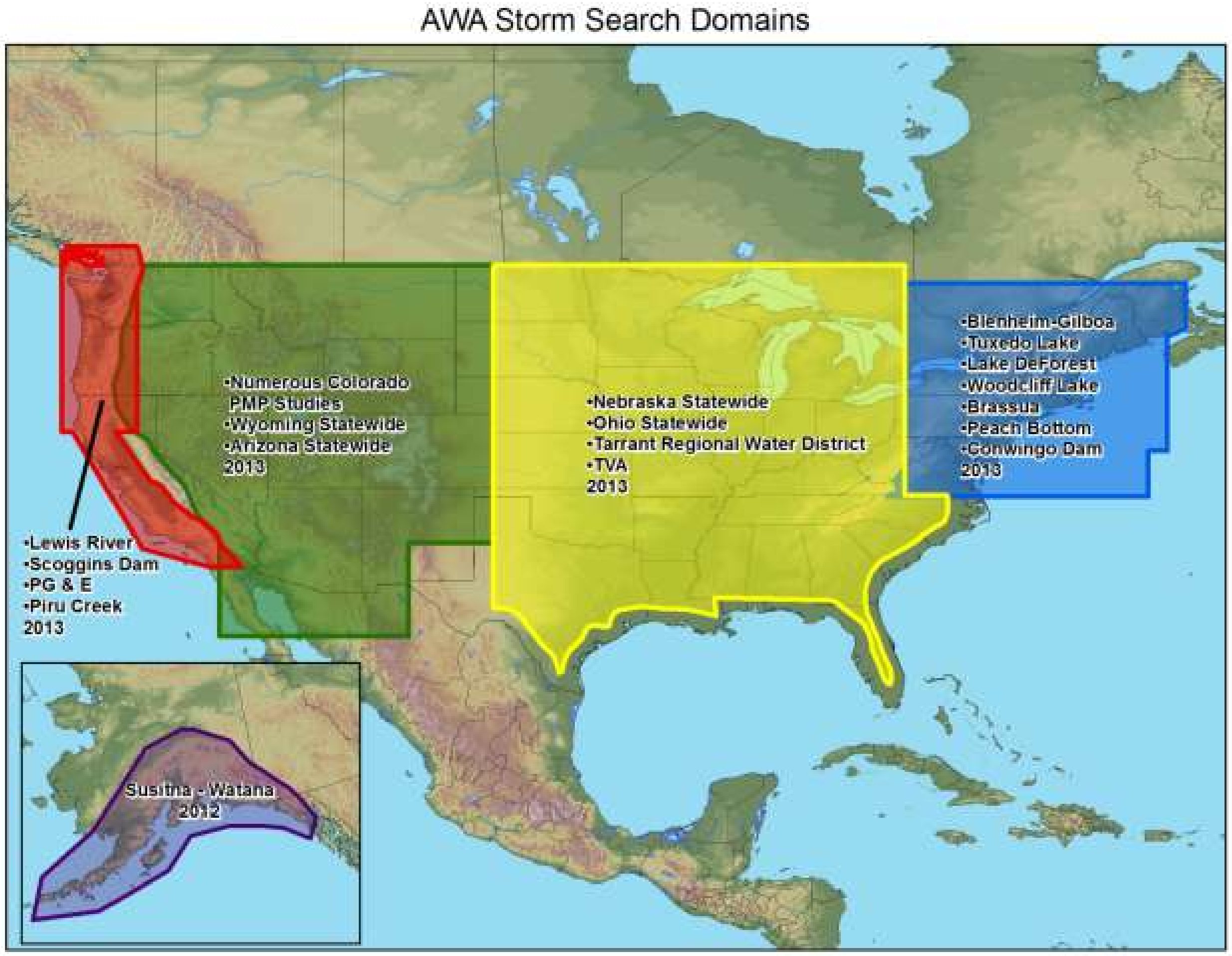

Figure 4.1 AWA storm search domains through 2013. All storms used to develop the PMP values were identified from the storm search results.

4.2 Data Sources

AWA storm searches were conducted by searching the National Climatic Data Center (NCDC) hourly and daily rainfall records for maximum rainfall amounts that occurred during 6-hour, 24-hour/1-day, and 72-hour/3-day periods within the storm search domain. Further searches were conducted from additional sources listed below:

1. Cooperative Summary of the Day / TD3200 through 2013. These data are published by the National Climatic Data Center (NCDC)
2. Hourly Weather Observations published by NCDC, U.S. Environmental Protection Agency, and Forecast Systems Laboratory (now National Severe Storms Laboratory)
3. Hydrometeorological Reports
4. Corps of Engineers Storm Studies
5. Other data published by state climate office
6. American Meteorological Society journals
7. Various weather books
8. Data from supplemental sources, such as Community Collaborative Rain, Snow, and Hail Network (CoCoRaHS), Weather Underground, Forecast Systems Laboratories, RAWS

4.3 Short Storm List Derivation

The final short storm list used to determine the PMP values for the ANO basin was derived using the results of previous PMP studies in regions similar to this basin (Tomlinson 1993, Tomlinson et al. 2008, Kappel et al. 2012, Kappel et al. 2012, Tomlinson et al. 2013).

During this process, the storm lists used in each of these studies was combined and evaluated. The first set of parameters used to delineate the storms was whether they were transpositionable to any grid point used to derive the PMP values for the ANO basin. Factors such as elevation differences of more than +/- 1,000 feet and/or distances from moisture source were considered. Next, the storm type was evaluated. Storm types which would not result in a PMP/PMF scenario for the large ANO watershed were not considered. This included storms which were individual thunderstorms.

These analyses resulted in the final short storm lists used to derive both the PMP values for the basin. Table 4.0 provides the storm list. Figures 4.2 displays the locations of the storms in relation to the basin and ANO site. An AWA Storm Number is used to identify each storm used in this study to derive PMP values.

Table 4.0 Storm list used to calculate PMP, sorted in alphabetical order.

Storm Name	State	AWA Storm Number	Lat	Lon	Year	Month	Day	Maximum Rainfall in Inches	Precipitation Source
ALBANY	TX	18	32.726	-99.350	1978	8	3	32.50	SPAS 1179
ALLEY SPRING	MO	3	37.160	-91.450	2008	3	17	15.10	SPAS 1242
AURORA COLLEGE	IL	10	41.458	-88.070	1996	7	16	18.13	SPAS 1286
BAYFIELD	CO	22	37.562	-107.879	1970	9	3	5.95	SPAS 1075
BEAULIEU	MN	67	47.300	-95.900	1909	7	18	10.50	UMV 1-11A
BIG ELK MEADOW	CO	23	40.267	-105.417	1969	5	4	20.01	SPAS 1253
BIG FORK	AR	15	35.871	-92.121	1982	12	1	15.92	SPAS 1219
BIG RAPIDS	MI	12	43.613	-85.313	1986	9	9	13.42	SPAS 1206
BIG THOMPSON CANYON	CO	19	40.479	-105.429	1976	7	31	12.52	SPAS 1231
BONAPARTE	IA	70	40.767	-91.750	1905	6	10	12.10	UMV 2-5
BOULDER	CO	86	40.015	-105.268	2013	9	8	20.41	SPAS 1302
BOYDEN	IA	60	43.190	-96.010	1926	9	17	24.00	MR 4-24
CHEYENNE	OK	57	35.610	-99.670	1934	4	3	23.00	SW 2-11
CHEYENNE	WY	13	41.354	-104.819	1985	8	1	7.15	SPAS 1213
CHEYENNE MOUNTAIN	CO	85	38.790	-104.870	2013	9	8	18.89	SPAS 1302
CLAYTON	NM	64	36.333	-103.100	1914	4	29	9.60	SW 1-16
CLYDE	TX	16	32.479	-99.479	1981	10	10	23.23	SPAS 1184
COLE CAMP	MO	41	38.460	-93.203	1946	8	12	19.40	MR 7-2A
COLLEGE HILL	OH	30	40.085	-81.648	1963	6	3	19.39	SPAS 1226
COLLINSVILLE	IL	42	38.672	-89.980	1946	8	12	18.70	MR 7-2B
COOPER	MI	65	42.376	-85.610	1914	8	31	12.60	GL 2-16
COUNCIL GROVE	KS	38	38.660	-96.490	1951	7	9	18.50	MR 10-2
DAVID CITY	NE	31	41.213	-97.071	1963	6	24	15.98	SPAS 1030
DUBUQUE	IA	1	42.440	-90.750	2011	7	27	15.14	SPAS 1220
DUMONT	IA	39	42.752	-92.978	1951	6	25	12.00	UMV 3-29
EDGERTON	MO	26	40.413	-95.513	1965	7	18	20.76	SPAS 1183
ELBERT	CO	55	39.238	-104.488	1935	5	30	24.00	SPAS 1295
ENID	OK	21	36.381	-97.868	1973	10	10	19.45	SPAS 1034
FAIRFIELD	TX	58	31.725	-96.165	1932	8	30	19.50	GM 5-16A
FALL RIVER	KS	5	37.630	-96.050	2007	6	30	25.50	SPAS 1228
FOREST CITY	MN	14	45.239	-94.540	1983	6	20	17.00	SPAS 1035
FORT COLLINS	CO	8	40.548	-105.133	1997	7	28	14.48	SPAS 1230
FRIJOLE CREEK	CO	17	37.096	-104.379	1981	7	3	16.33	SPAS 1247
GLADEWATER	TX	25	32.537	-94.943	1966	4	27	25.33	SPAS 1181
GRANT TOWNSHIP	NE	51	42.240	-96.590	1940	6	3	13.00	MR 4-5
GREELEY	NE	76	41.550	-98.533	1896	6	4	12.30	MR 4-3
HALE	CO	56	39.613	-102.263	1935	5	30	18.00	SPAS 1295
HALLETT	OK	52	36.230	-96.570	1940	9	2	24.00	SW 2-18
HAYWARD	WI	48	46.013	-91.485	1941	8	28	15.00	UMV 1-22
HEMPSTEAD	TX	53	30.133	-96.133	1940	11	22	21.10	GM 5-13
HOKAH	MN	6	43.813	-91.363	2007	8	18	18.32	SPAS 1048
HOLLY	CO	27	37.713	-102.404	1965	6	16	19.18	SPAS 1293
HOLT	MO	40	39.453	-94.342	1947	6	18	17.60	MR 8-20
IDA GROVE	IA	32	42.317	-95.467	1962	8	30	12.85	EPRI
INDEX	AR	54	33.547	-94.042	1940	6	30	11.50	LMV 4-25
IRONWOOD	MI	68	46.450	-90.183	1909	7	21	13.20	UMV 1-11B
KELSO	MO	37	37.191	-89.550	1952	8	11	13.00	UMV 3-30
LAKE MALOYA	NM	35	37.009	-104.341	1955	5	19	14.82	SPAS 1251
LAMBERT	MN	75	47.800	-96.000	1897	7	18	8.00	UMV 1-2
LARRABEE	IA	77	42.861	-95.545	1891	9	10	13.00	MR 4-2
LARTO LAKE	LA	4	31.220	-92.130	2008	9	1	23.31	SPAS 1182
MCCOLLEUM RANCH	NM	49	32.167	-104.733	1941	9	20	21.20	GM 5-19
MEDFORD	WI	71	45.133	-90.333	1905	6	4	11.20	GL 2-12
MEEK	NM	63	33.683	-105.183	1919	9	15	9.50	GM 5-15B
MEEKER	OK	69	35.503	-96.903	1908	10	19	16.25	SW 1-11
MINNEAPOLIS	MN	11	44.889	-93.402	1987	7	23	11.55	SPAS 1210
MOUNDS	OK	44	35.877	-96.061	1943	5	16	17.00	SW 2-21
NEOSHO FALLS	KS	61	38.082	-95.701	1926	9	12	14.00	SW 2-1
OGALLALA	NE	7	41.125	-101.717	2002	7	6	14.92	SPAS 1033
PARIS WATERWORKS	IN	34	39.050	-87.700	1957	6	27	12.40	HMB-V18
PAWNEE CREEK	CO	9	40.775	-103.625	1997	7	29	13.58	SPAS 1036
PENROSE	CO	62	38.464	-105.070	1921	6	2	12.20	SPAS 1294
PLUM CREEK	CO	28	39.188	-104.296	1965	6	15	16.70	SPAS 1293
PORTER	NM	59	35.200	-105.283	1930	10	9	9.90	SW 2-6
PRAGUE	NE	33	41.358	-96.879	1959	8	1	13.09	SPAS 1031
PRAIRIEVIEW	NM	50	33.117	-103.200	1941	5	20	8.40	GM 5-18
RANCHO GRANDE	NM	47	34.950	-105.100	1942	8	29	8.00	SW 2-29
RITTER	IA	36	43.244	-95.823	1953	6	7	11.00	MR 10-8
ROCIADA	NM	72	35.867	-105.333	1904	9	26	7.90	SW 1-6
SILVER LAKE	TX	45	32.670	-95.596	1943	6	5	16.50	SW 3-3
STANTON	NE	43	41.867	-97.050	1944	6	10	17.30	MR 6-15
THRALL	TX	77	30.591	-97.297	1921	9	9	39.70	GM 4-12
WAGON WHEEL	CO	66	37.663	-106.938	1911	10	5	7.88	SPAS 1107
WARNER	OK	46	35.490	-95.310	1943	5	6	25.00	SW 2-20
WARNER PARK	TN	2	36.061	-86.906	2010	4	30	19.71	SPAS 1208
WATERTON RED ROCK	AB	75	49.090	-114.050	1975	6	15	14.46	SPAS 1252
WOODBURN	IA	73	41.012	-93.599	1903	8	24	15.50	MR 1-10
WOOSTER	OH	24	40.915	-81.973	1969	7	4	14.95	SPAS 1209

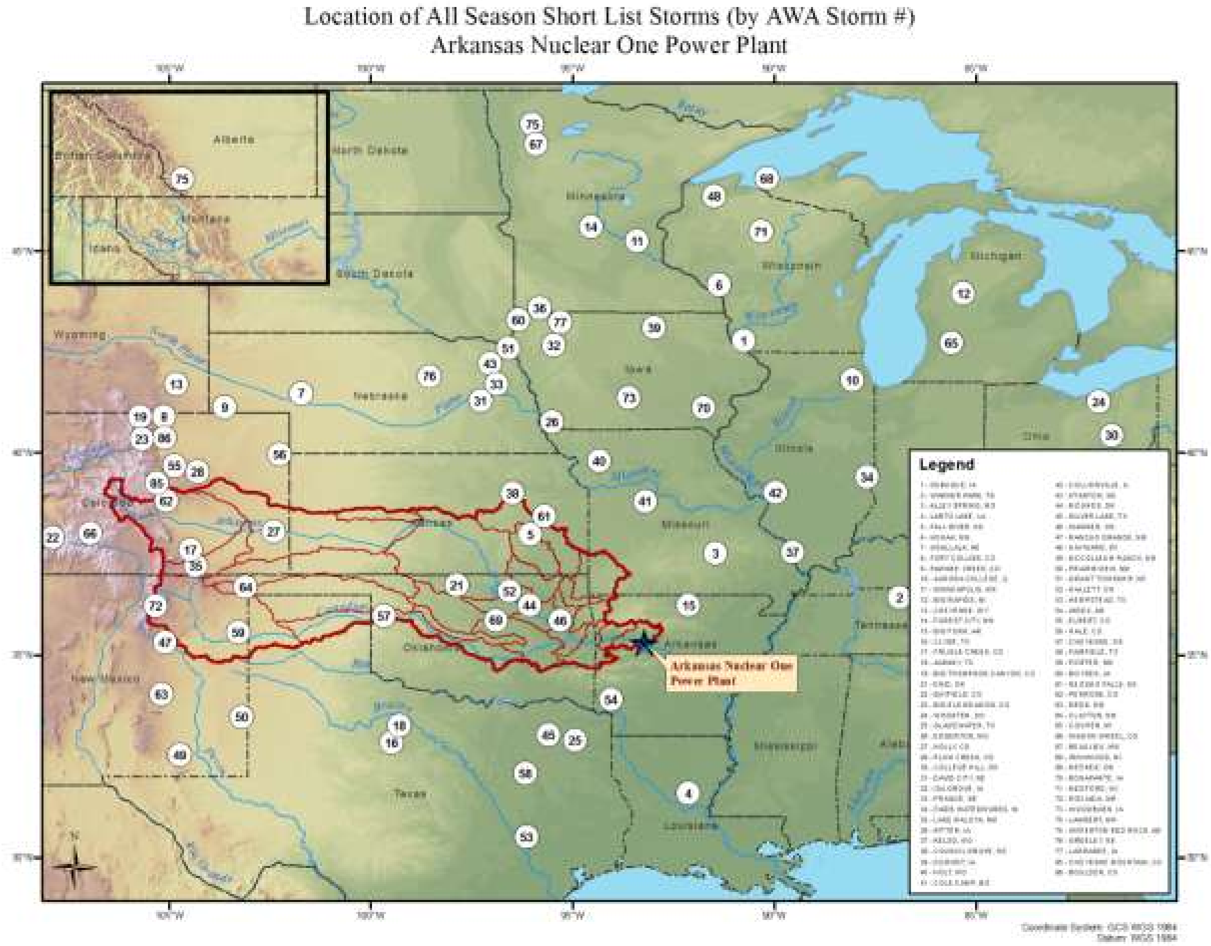

Figure 4.2 Storm locations in relation to the ANO basin by AWA storm number.

4.3.1 New Storm Precipitation Analysis System (SPAS) Storm Analysis

The results of the storm search and short storm list development identified one new storm important for PMP derivation which had not been previously analyzed by either the NWS or AWA. This was the September 2013 rainfall across the Front Range and Eastern Plains of Colorado and Wyoming (SPAS 1302, AWA Storm Number 85/86). A full storm analysis using the Storm Precipitation Analysis System (SPAS) was completed which produced the required storm DAD values (see Section 5 and Appendix G for a full description of the SPAS storm analysis process). The SPAS analysis produced all the necessary rainfall information required to evaluate and utilize the storm in the PMP derivation process. In addition, the current study included 35 previously analyzed SPAS storms used in other PMP studies[1].

[1] The precipitation/storm analysis source for each short list storm is listed in Tables 4.0. Each SPAS storm analysis is assigned a unique SPAS number (e.g. SPAS 1242), "EPRI" refers to storms analyzed during the

5. Storm Depth-Area-Duration (DAD) Analyses for New Storms

For the new extreme rainfall event, a full storm analysis needed to be completed. SPAS was used to compute the Depth-Area-Duration (DAD) table for this storm.

There are two main steps in a SPAS DAD analysis: 1) Creation of high-resolution hourly precipitation grids and 2) Computation of depth-area rainfall amounts for various durations.

Reliability of results from step 2) depends on the accuracy of step 1). Historically the process has been very labor intensive. SPAS utilizes Geographic Information Systems (GIS) concepts to create more spatially-oriented and accurate results in an efficient manner (step 1). Furthermore, the availability of NEXRAD data allows SPAS to better account for the spatial and temporal variability of storm precipitation for events occurring since the early 1990s. Prior to NEXRAD, the National Weather Service (NWS) developed and used a method based on the research of several scientists (Corps of Engineers, 1936-1973). Because this process has been the standard for many years and holds merit, the DAD analysis process developed within the SPAS program attempts to mimic it as much as possible. By adopting this approach, some level of consistency between the newly analyzed storms and the hundreds of storms already analyzed can be achieved. Comparisons between the NWS DAD results and those computed using the new method for two storms (Westfield, MA, 1955 and Ritter, IA, 1953) indicated very similar results (see Appendix G for complete discussion, comparisons, and results). The SPAS program and process is certified in this calculation.

Table 5.0 lists the SPAS storm used in during the development of PMP and LIP values during this study. The results of each SPAS storm analysis are included in Appendix F.

EPRI Michigan/Wisconsin Regional PMP study, while the remaining identifiers reference nomenclature from the NWS/USACE storm studies files.

Table 5.0 SPAS storms used in this study.

Storm Name	State	AWA Storm Number	Lat	Lon	Year	Month	Day	Maximum Rainfall in Inches	Precipitation Source
DAVID CITY	NE	31	41.213	-97.071	1963	6	24	15.98	SPAS 1030
PRAGUE	NE	33	41.358	-96.879	1959	8	1	13.09	SPAS 1031
OGALLALA	NE	7	41.125	-101.717	2002	7	6	14.92	SPAS 1033
ENID	OK	21	36.381	-97.868	1973	10	10	19.45	SPAS 1034
FOREST CITY	MN	14	45.239	-94.540	1983	6	20	17.00	SPAS 1035
PAWNEE CREEK	CO	9	40.775	-103.625	1997	7	29	13.58	SPAS 1036
HOKAH	MN	6	43.813	-91.363	2007	8	18	18.32	SPAS 1048
BAYFIELD	CO	22	37.562	-107.879	1970	9	3	5.95	SPAS 1075
WAGON WHEEL	CO	66	37.663	-106.938	1911	10	3	7.88	SPAS 1107
ALBANY	TX	18	32.726	-99.350	1978	8	3	32.50	SPAS 1179
GLADEWATER	TX	25	32.537	-94.943	1966	4	27	25.33	SPAS 1181
LARTO LAKE	LA	4	31.220	-92.130	2008	9	1	23.31	SPAS 1182
EDGERTON	MO	26	40.413	-95.513	1965	7	18	20.76	SPAS 1183
CLYDE	TX	16	32.479	-99.479	1981	10	10	23.23	SPAS 1184
BIG RAPIDS	MI	12	43.613	-85.313	1986	9	9	13.42	SPAS 1206
WARNER PARK	TN	2	36.061	-86.906	2010	4	30	19.71	SPAS 1208
WOOSTER	OH	24	40.915	-81.973	1969	7	4	14.95	SPAS 1209
MINNEAPOLIS	MN	11	44.889	-93.402	1987	7	23	11.55	SPAS 1210
CHEYENNE	WY	13	41.354	-104.819	1985	8	1	7.15	SPAS 1213
BIG FORK	AR	15	35.871	-92.121	1982	12	1	15.92	SPAS 1219
DUBUQUE	IA	1	42.440	90.750	2011	7	27	15.14	SPAS 1220
COLLEGE HILL	OH	30	40.085	-81.648	1963	6	3	19.39	SPAS 1226
FALL RIVER	KS	5	37.630	-96.050	2007	6	30	25.50	SPAS 1228
FORT COLLINS	CO	8	40.548	-105.133	1997	7	28	14.48	SPAS 1230
BIG THOMPSON CANYON	CO	19	40.479	-105.429	1976	7	31	12.52	SPAS 1231
ALLEY SPRING	MO	3	37.160	-91.450	2008	3	17	15.10	SPAS 1242
FRIJOLE CREEK	CO	17	37.096	-104.379	1981	7	3	16.33	SPAS 1247
LAKE MALOYA	NM	35	37.009	-104.341	1955	5	19	14.82	SPAS 1251
WATERTON RED ROCK	AB	75	49.090	-114.050	1975	6	15	14.46	SPAS 1252
BIG ELK MEADOW	CO	23	40.267	-105.417	1969	5	4	20.01	SPAS 1253
AURORA COLLEGE	IL	10	41.458	-88.070	1996	7	16	18.13	SPAS 1286
PLUM CREEK	CO	28	39.188	-104.296	1965	6	15	16.70	SPAS 1293
HOLLY	CO	27	37.713	-102.404	1965	6	16	19.18	SPAS 1293
PENROSE	CO	62	38.464	-105.070	1921	6	2	12.20	SPAS 1294
ELBERT	CO	55	39.238	-104.488	1935	5	30	24.00	SPAS 1295
HALE	CO	56	39.613	-102.263	1935	5	30	18.00	SPAS 1295
BOULDER	CO	86	40.015	-105.268	2013	9	8	20.41	SPAS 1302
CHEYENNE MOUNTAIN	CO	85	38.790	-104.870	2013	9	8	18.89	SPAS 1302

6. Updated Data Sets Used in this Study

Several new data sets not used in the development of HMRs 51 and 55A were employed as part of this study in the development of the PMP and LIP values. These include the development of updated maximum dew point climatology maps for use in storm maximization and transposition, as well as the use of the HYSPLIT trajectory model to help in identifying the moisture source region for individual storm events. The identification and use of these data sets provide a significant improvement in storm adjustments, especially relating to the determination of each storm's moisture source and derivation of appropriate maximization factors.

6.1 Development of the Updated Dew Point Climatology

Updated maximum average dew point climatologies provide 20-year, 50-year, and 100-year return frequency values for 6-hour, 12-hour, and 24-hour durations. This process followed the same reasoning and use as described in the other AWA PMP studies. These analyses demonstrated that the maximum 12-hour persisting dew point climatology used in HMRs 51 and 55A were outdated and more importantly did not adequately represent the atmospheric moisture available in extreme rainfall storm environments. The updated climatology more accurately represents the atmospheric moisture fueling storms by using average maximum dew point values observed over durations specific to each storm's rainfall duration. The maximum average dew point values replace the maximum 12-hour persisting dew point values which often missed or underestimated the atmospheric moisture available and hence led to inaccurate maximization calculations.

6.2 HYSPLIT Trajectory Model

The HYSPLIT trajectory model developed by the NOAA Air Resources Laboratory (Draxler and Rolph 2003, 2010) was used during the analysis of each of the rainfall events included on the short storm list when available (1948-present). Use of a trajectory model provides increased confidence for determining moisture inflow vectors and storm representative dew points. The HYSPLIT model trajectories have been used to analyze the moisture inflow vectors in other PMP studies completed by AWA over the past several years. During these analyses, the model trajectory results were verified and the utility explicitly evaluated (e.g. Tomlinson et al. 2006-2011, Kappel et al. 2012-2013).

Instead of subjectively determining the moisture inflow trajectory, the HYSPLIT model interface was used to determine the trajectory of the atmospheric moisture inflow, both location and altitude, for various levels in the atmosphere associated with the storm's rainfall production. The HYSPLIT model was run for trajectories at several levels of the lower atmosphere to capture the moisture source for each storm event.

These included 700mb (approximately 10,000 feet), 850mb (approximately 5,000 feet), and storm center location surface elevation. For the majority of the analyses a combination of all three levels was determined to be most appropriate for use in evaluation of the upwind moisture source location. It is important to note that the resulting HYSPLIT model trajectories are only used as a general guide of where to evaluate the moisture source for storms in space and time. The final determination of the storm representative dew point and its location is determined following the standard procedures used by AWA in previous PMP studies and as outlined in the HMRs and WMO manuals. Appendix F of this report contains each of the HYSPLIT trajectories analyzed as part of this study for each storm. As an example, Figure 6.0 shows the HYSPLIT trajectory model results used to analyze the inflow vector for the Council Grove, KS, July 1951 storm (AWA 38).

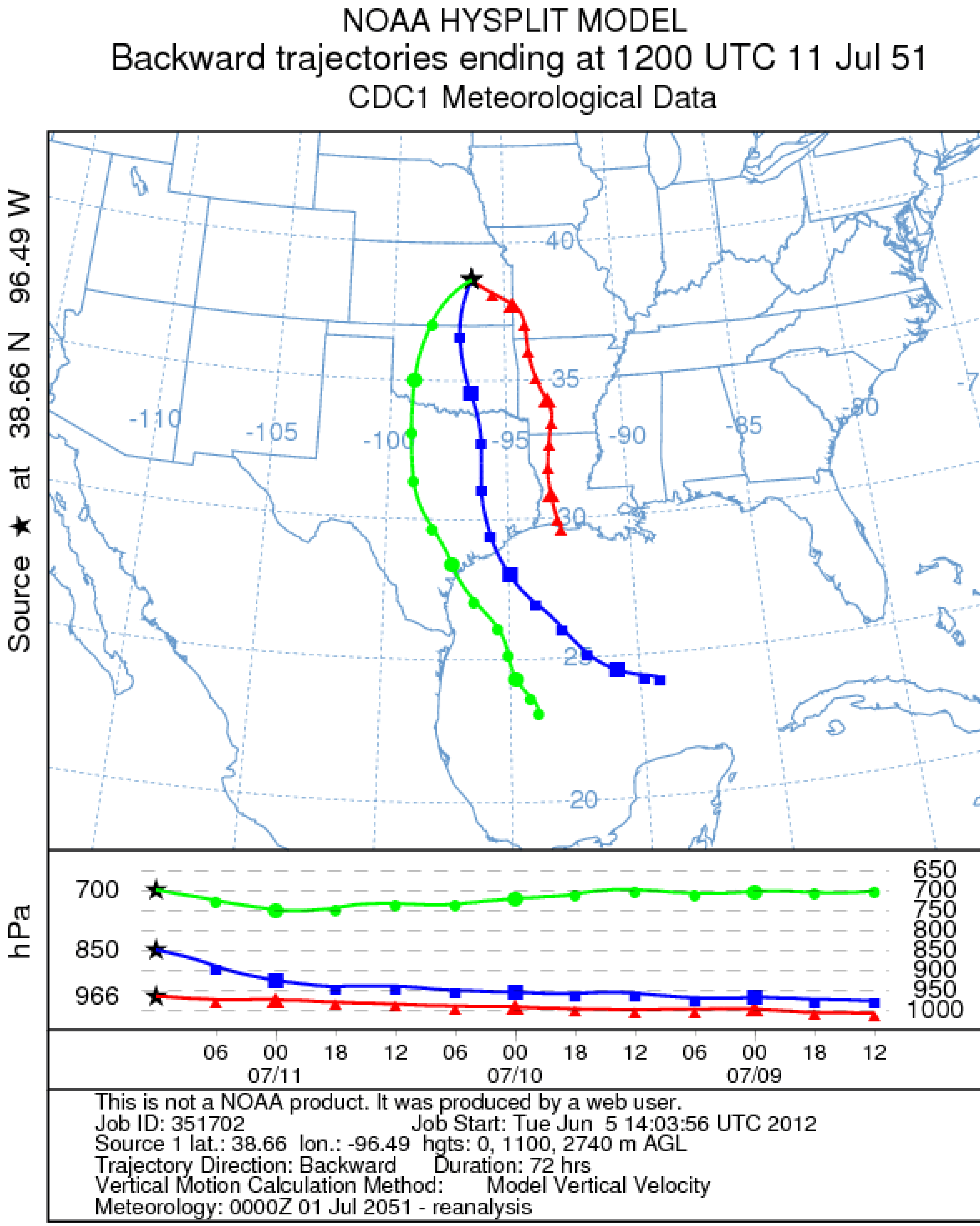

Figure 6.0 HYSPLIT trajectory model results for Council Grove, KS, July 1951 storm (AWA 18).

6.3 Use of Grid Points to Spatially Distribute PMP Values

To appropriately distribute rainfall values spatially and temporally across the large ANO basin, a series of grid points were used. The grid consisted of 22 locations, one of which was the ANO site location. In addition, the overall grid was extended outside of the basin boundaries over bordering regions (see Figure 1.3). This grid design ensured that no extrapolation of adjusted rainfall values were required for any location within the basin.

All appropriate storm rainfall values were maximized and transpositioned to each of the 22 grid points as appropriate (Appendix F lists the grid point(s) where each storm was transpositioned). Depth-Area (DA) curves for each duration (6-hours to 72-hours) and for area sizes from 10- through 100,000-square miles were plotted for each grid point and envelop curves constructed. Using results from the DA analyses, Depth-Duration (DD) curves were constructed for each grid point (see Section 9 for details). Results from the DD analysis were input into GIS where the values for each duration and area size at each grid point were spatially analyzed. The final PMP maps derived using the grid point methodologies are provided in Appendix A.

Having the contoured PMP maps to analyze on a regional basis proved to be a very valuable asset compared to having only rainfall values at a single location. The ability to look at the relationships among grid points at various spatial and temporal scales as a whole proved very insightful and was of great importance in deriving the final PMP values across the large ANO basin.

7. Storm Maximization

Storm maximization is the process of increasing rainfall associated with an observed extreme storm under the potential condition that additional atmospheric moisture could have been available to the storm for rainfall production. Maximization is accomplished by increasing surface dew points to some climatological maximum and calculating the enhanced rainfall amounts that could potentially be produced. An additional consideration is usually applied that selects the climatological maximum dew point for a date two weeks towards the warm season from the date that the storm actually occurred. This procedure assumes that the storm could have occurred with the same storm dynamics two weeks earlier or later in the year when maximum dew points (and hence moisture levels) could be higher. A more detailed discussion of this procedure and example calculations are provided in Appendix C.

7.1 Use of Dew Point Temperatures for Storm Maximization

HMR and WMO procedures for storm maximization use a representative storm dew point as the parameter to represent available moisture to a storm. Prior to the mid-1980s, maps of maximum dew point values from the *Climatic Atlas of the United States* (1968) were the source for maximum dew point values. HMR 55A published in 1988 updated maximum dew point values for a portion of United States from the Continental Divide eastward into the central plains. The regional PMP study for Michigan and Wisconsin produced return frequency maps using the L-moments method. The Review Committee for that study included representatives from NWS, FERC, Bureau of Reclamation, and others. They agreed that the 50-year return frequency values were appropriate for use in PMP calculations. HMR 57 was published in 1994 and HMR 59 in 1999. These more recent NWS publications also updated the maximum dew point climatology, but used maximum observed dew points instead of return frequency values. For the Nebraska statewide study, the Review Committee and FERC Board of Consultants agreed that the 100-year return frequency maximum dew point climatology maps were appropriate because this added a layer of conservatism over the use of 50-year return period values. This has subsequently been employed in all AWA PMP studies. This study is again using the 100-year return frequency climatology with the data updated through the first half of 2013 (Figure 7.0).

Observed storm rainfall amounts are maximized using the ratio of precipitable water for the maximum dew point to precipitable water for the storm representative dew point, assuming a vertically saturated atmosphere. This procedure was followed in this study using the updated maximum dew point climatology developed and described in Section 6. A more detailed discussion, along with examples of this procedure, is provided in Appendices C and D.

For storm maximization, average dew point values for the appropriate duration which was most representative of the actual rainfall accumulation period for an individual storm (6-, 12-, or 24-hour) was used to determine the storm representative dew point. To determine which time frame was most appropriate, the total rainfall amount was analyzed. The duration (6-, 12- or 24-hour) closest to when approximately 90% of the rainfall had accumulated was used to determine the duration used, i.e. 6-hour, 12-hour, or 24-hour.

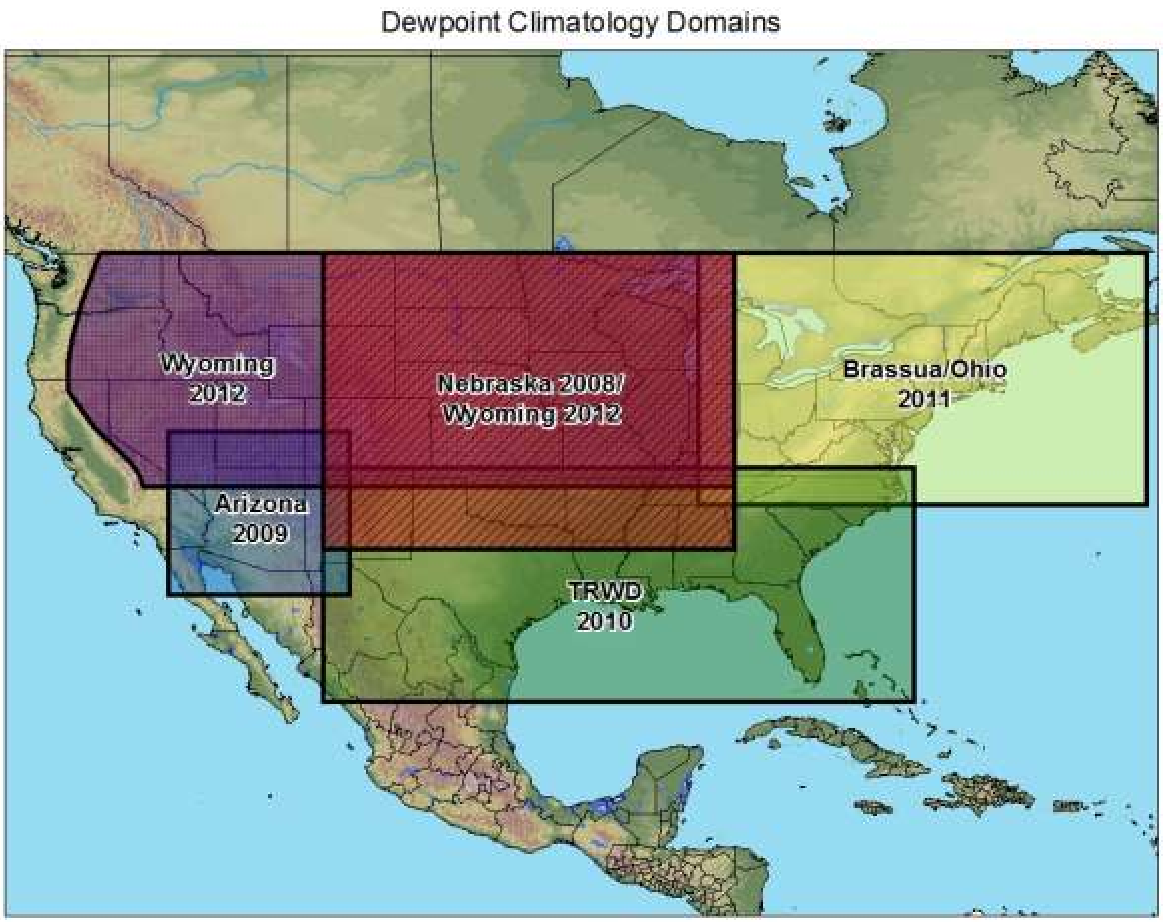

Figure 7.0 Dew point climatology development dates and regions.

7.1.1 Rationale for Using Maximum Average Dew Point Climatology

In previous storm analyses performed by the NWS and the USACE, a 12-hour persisting dew point was used for both the storm representative and maximum dew points. The 12-hour persisting dew point is the value equaled or exceeded at all observations during the 12-hour period (e.g. WMO 1986). However, as was established in previous and ongoing AWA PMP studies, this dew point methodology tends to underestimate the storm representative dew point value associated with the rainfall event.

An excellent example of this, from the Nebraska statewide PMP study but relevant for the storm types that affect the ANO basin, is illustrated by the David City, NE 1963 storm. During this extreme storm event, a narrow tongue of moisture was advected into the region by strong southeasterly flow during a short time period. Most of the rain with this event (approximately 15 inches) accumulated in less than 6 hours (Figure 7.1). For this storm, hourly dew point data were collected from several locations near the rainfall event. These included Omaha, NE; Des Moines, IA; Topeka, KS; and Kansas City, MO. Following standard procedures for determining storm representative dew point location, it was determined that Topeka, KS and Kansas City, MO were the two stations that best represented the air mass that produced the extreme rainfall. Using hourly dew point data for these two stations clearly showed that use of 6-hour average dew point values better represented the atmospheric moisture available to the storm event than did use of 12-hour persisting dew point values. The 6-hour average dew point representing the moisture in the air mass associated with the rainfall was 71.5°F at Kansas City, MO and 71°F at Topeka, KS. Using these dew point values, a 1,000 mb 6-hour average dew point of 73.5°F was determined for Kansas City, MO and a dew point of 73°F was determined for Topeka, KS. Using the NWS approach, the 12-hour persisting dew point is 63°F (65°F at 1,000 mb) at Kansas City, MO and 66°F (68°F at 1,000 mb) at Topeka, KS for an average 1,000 mb adjusted value of 66.5°F (Table 7.0).

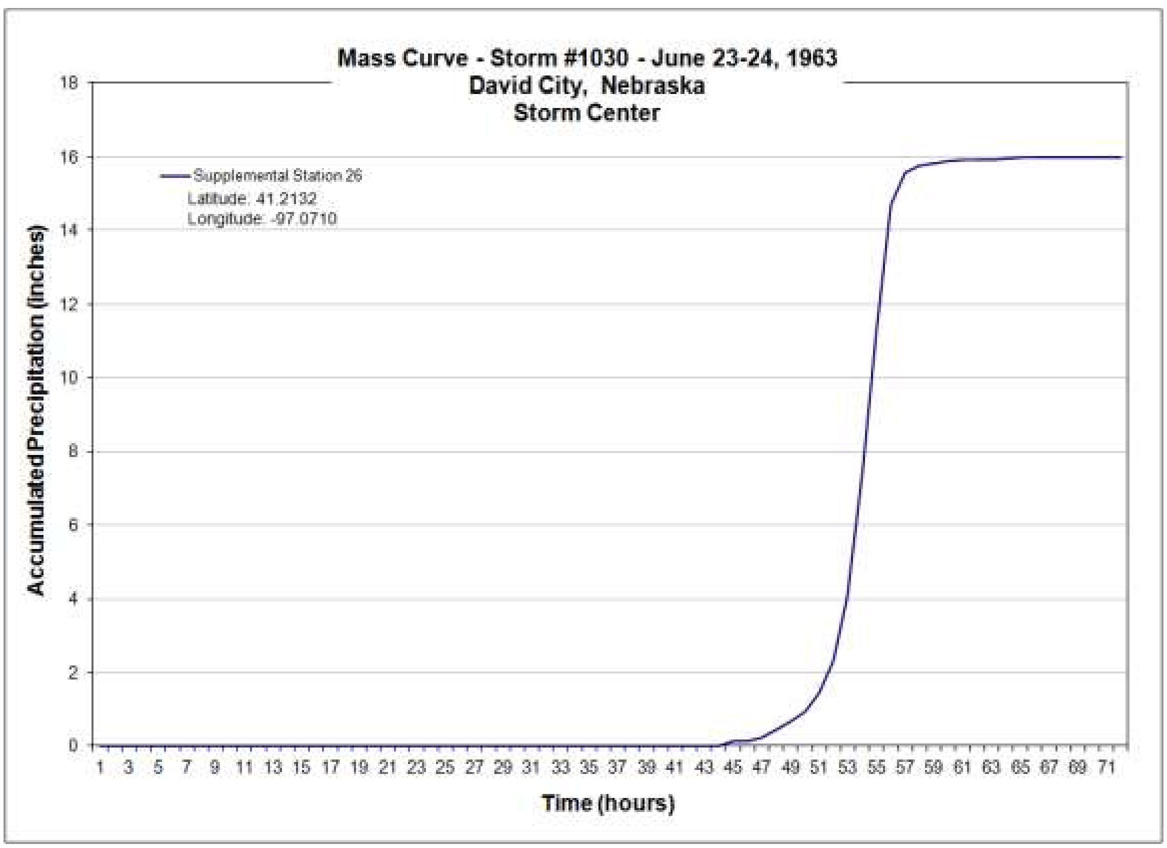

Figure 7.1 Mass Curve as analyzed by SPAS for David City, NE 1963 storm event

Table 7.0 Comparison of 6-hour average storm representative dew point vs. 12-hour persisting storm representative dew point for David City, NE 1963

Observed Dew Point Values for David City, NE 1963																								
Kansas City, MO																								
Hour	00Z	01Z	02Z	03Z	04Z	05Z	06Z	07Z	08Z	09Z	10Z	11Z	12Z	13Z	14Z	15Z	16Z	17Z	18Z	19Z	20Z	21Z	22Z	23Z
Dew Point	58	61	62	62	63	63	*63*	64	66	68	69	**71**	**72**	**72**	**72**	**71**	**71**	69	68	67	67	67	67	67
												Air Mass Supplying Rainfall Event												
12-Hour Persisting Td 63 (65 reduced to 1000mb)							***12 Hour Persisting Td Timeframe***																	
6-Hour Average Td 71.5 (73.5 reduced to 1000mb)												**6 Hour Average Td timeframe**												
Topeka, KS																								
Hour	00Z	01Z	02Z	03Z	04Z	05Z	06Z	07Z	08Z	09Z	10Z	11Z	12Z	13Z	14Z	15Z	16Z	17Z	18Z	19Z	20Z	21Z	22Z	23Z
Dew Point	61	62	64	65	65	65	*66*	66	67	68	69	**72**	**71**	**71**	**71**	**70**	**70**	70	69	70	69	68	66	69
												Air Mass Supplying Rainfall Event												
12-Hour Persisting Td 66 (68 reduced to 1000mb)							***12 Hour Persisting Td Timeframe***																	
6-Hour Average Td 71 (73 reduced to 1000mb)												**6 Hour Average Td timeframe**												

The 12-hour persisting dew point analysis included dew point values from a six hour period not associated with the rainfall. The hourly dew point value that provides the 12-hour persisting dew point occurred outside of the rainfall period after adjustment for advection time from the dew point observing station(s) to the storm location.

7.1.2 Rationale for Adjusting HMR 51 Persisting Dew Point Values

In some cases, storms on the short storm list previously analyzed in the USACE Storm Studies and used in NWS HMRs, an adjustment factor was applied to provide consistency in storm maximization while utilizing the updated dew point climatology. The adjustment factor was determined using the same procedure used in the EPRI and other AWA PMP studies.

Results from the dew point analyses showed consistent results for MCS type storms for differences between the older method for determining 12-hour persisting storm representative dew points and the approach using average storm representative dew points. The following discussion from the EPRI report addresses these differences:

The average difference between dew points for the synoptic storms was five degrees less than that for the MCS storms. This may be attributed to the greater homogeneity of inflow moisture associated with the synoptic events. With most of the modern MCS storms, limited-area, short-duration pockets of relatively moist air were found within the inflow moisture at one or two locations. The analyses may indicate that for MCS events, bubbles of extremely moist air interact with storm catalysts to create extreme rainfall events of short duration. A warm humid air mass over a broad area with small moisture gradients more aptly describes the synoptic inflow moisture. Several stations within the air mass may have the same or similar dew points. Much smaller variations in dew points along the inflow moisture vector are expected.

Large spatial and temporal variations in moisture associated with MCS-type storms are not represented well with 12-hour persisting dew points, especially when only two observations a day are available. Average dew point values, temporally consistent with the duration of the storm event provide a much improved description of the inflow moisture available for conversion to precipitation. The more homogeneous moist air *masses associated with synoptic storms result in smaller differences between average and persisting values.*

This analysis has provided correlations between 12-hour persisting storm dew points and average storm dew points for both MCS and synoptic storms. Despite the small sample size, the consistent results tend to support the reliability of the analysis. However, the small sample size has been considered in making recommendations for adjusting the old storm representative dew points for use in determining PMP estimations. The eight degree difference for MCS-type storms has been decreased to five degrees to provide a conservative adjustment. A similar consideration is made for synoptic-type storms. The three-degree difference is decreased to two degrees to provide a conservative adjustment. The adjusted representative storm dew points are used with the new maximum average dew point climatology to maximize storms.

Similar analyses were completed in the Nebraska statewide PMP study, the Ohio statewide PMP study, and the Wyoming statewide PMP study. These analyses investigated additional modern storms. The results of these analyses of MCS storm data provided an average difference of 7°F between the average and 12-hour persisting dew points. For synoptic storms, the average difference was 2°F. Results of the more recent analyses were very consistent with the EPRI study. This again validated the process of adjusting the maximum 12-hour persisting dew points in order to achieve compliance with using the maximum average dew point climatology.

8. Storm Transpositioning

Extreme rain events that have occurred over geographically and climatically similar regions surrounding a study area are a very important part of the historical evidence on which PMP estimates for a drainage basin are based. Study locations usually have a limited period of record for rainfall data collected within the basin boundaries and hence have a limited number of extreme storms that have been observed over the basin. Storms observed regionally with a similar meteorology and topography are analyzed and adjusted to provide information describing the storm rainfall as if the storm had occurred over the study basin. Transfer of a storm from where it occurred to a location that is meteorologically and topographically similar is called *storm transpositioning*. The underlying assumption is that storms transposed to the study area could occur over the basin under similar meteorological conditions. To properly relocate such storms, it is necessary to address issues of similarity as they relate to topography and meteorological conditions and make appropriate adjustments.

The area considered to contain storms which were potentially transpositionable to one or more grid points analyzed as part of this study extended from the Continental Divide of the Rocky Mountains south of 48°N east through the first upslopes on the west side of the Appalachians, south the southern Plains to approximately 50 miles north of the Gulf of Mexico (see Section 4.1). This region was considered meteorologically homogenous to one or more locations within the overall ANO basin. Further analysis of storm patterns on both a temporal and spatial scale within non-orographic regions of the basin revealed that only storms that occurred within a +/- 1,000 feet of elevation of a particular location possessed similar enough storm dynamics to be transpositionable to that location. Further, the limits of transpositionability were refined for specific storms after all adjustments were applied based on meteorological judgment and fit with other similar storms in the region.

8.1 Storm Transposition Calculations

The procedure for in-place storm maximization has been discussed (see Section 7.0). The same maps used for deriving maximum dew points were used in the storm transpositioning procedure. The procedure for deriving the climatological maximum dew points for use in the calculating the transposition maximization ratio uses the information derived during the calculation of the in-place maximization factor. The wind inflow vector connecting the storm location with the storm representative dew point location was transpositioned to each grid point. The value of the maximum dew point at that upwind location provided the transpositioned maximum dew point value used to compute the transposition adjustment factor for relocating the storm to the appropriate grid point and basin centroid. Figure 8.0 shows an example inflow vector map and transpositioned vector to grid point 2 for the Albany, TX, August, 1978 (AWA 18) storm. The primary effect of storm transpositioning was to adjust storm rainfall amounts to account for enhanced (or reduced) atmospheric moisture made available to the storm at the transposed location versus the original location. A more detailed discussion of this procedure and example calculations are provided in Appendix D. The inflow vector map and data used to calculate the transposition factor for each storm are included in Appendix F.

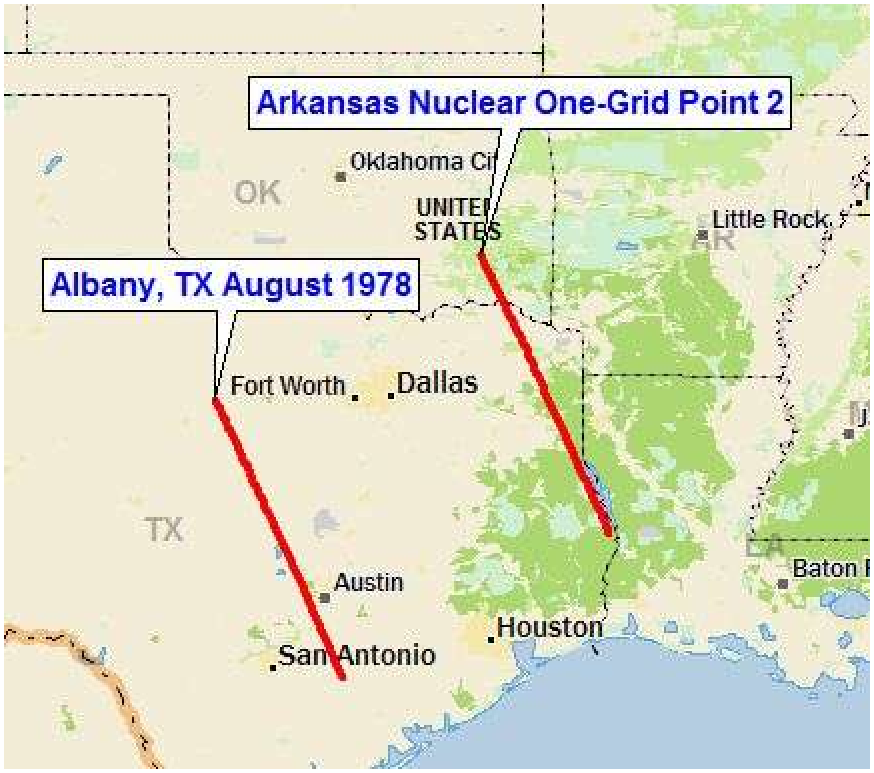

Figure 8.0 An example of inflow wind vector transpositioning for Albany, TX, August, 1978 storm (AWA 18). The storm representative dew point location is 260 miles south/southeast of the storm location.

8.2 Storm Spreadsheet Development Process

AWA has developed an Excel spreadsheet for each storm on the PMP and LIP short storm lists which incorporates relevant storm information, automatically calculates appropriate adjustment factors, and computes the adjusted rainfall DAD table. These storm spreadsheets used the observed storm DADs, storm representative dew points, maximum dew points (both in-place and transposition), storm elevation, and transposition location elevation information either as published in the USACE Storm Studies reports, HMR 51 tables, or as developed during AWA SPAS storm analyses. This information was entered into individual storm spreadsheets, one for each short list storm for each appropriate grid point. Using the storm center location and inflow vector, the in-place maximum dew point was determined. The same inflow vector was then moved to each appropriate grid point to determine the transpositioned maximum dew point value and total adjustment factor for that storm at each location. This information was entered into the storm spreadsheet to calculate the in-place maximization factor, the transposition factor, and finally the total adjustment factor. This total adjustment factor was applied to the storm DAD table values to provide the final adjusted DAD table for the maximized and transpositioned storm rainfall values at each location.

Once all the storms were adjusted to each appropriate grid point, DA and DD plots were constructed for each location for analysis and envelopment. This ensured spatial and temporal continuity for each grid point location. The resulting analysis results were subsequently plotted and contoured within GIS to produce the final basin-wide PMP maps. Appendix F includes the storm spreadsheets developed for each storm transpositioned to a specific grid point. Figure 8.1 displays an example storm spreadsheet for the Warner Park, TN, May, 2010 storm (AWA 2) at the basin centroid. The information in Appendix F allows a user the opportunity to explicitly evaluate, verify, and recalculate the values derived in this study, if so desired.

Storm Name:	SPAS 1208, Warner Park, TN	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	5/1-3/2010	
AWA Analysis Date:	12/19/2013	

Temporal Transposition Date	15-May	
	Lat	Long
Storm Center Location	36.06 N	86.91 W
Storm Rep Dew Point Location	31.50 N	90.00 W
Transposition Dew Point Location	38.16 N	95.94 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 360	miles
Grid Point Elevation	350	feet
Storm Center Elevation	600	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place storm elevation is	600	which subtracts	0.15	inches of precipitable water at	75.0 F	
The in-place storm elevation is	600	which subtracts	0.16	inches of precipitable water at	76.5 F	
The transposition storm elevation at	350	which subtracts	0.25	inches of precipitable water at	75.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.25	inches of precipitable water at	75.0 F	

The in-place maximization factor is	1.08
The transposition/elevation factor is	0.90
The barrier adjustment factor is	1.00
The total adjustment factor is	0.96

Notes: Storm representative Td value was based on 12-hr surface dewpoint values between on May 1 along with Hysplit backward trajectory. Values were selected in region where temperature did not vary more than a degree over a large area. Used an average of KJAN, KMCB, KHBG, and KASD.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	4.4	15.0	17.3	18.0	18.1	19.0	19.2	19.4	-
100 sq miles	3.7	13.2	15.9	16.5	16.6	18.3	18.5	18.7	-
200 sq miles	3.4	12.2	15.0	15.6	15.8	17.8	18.1	18.3	-
500 sq miles	2.8	10.6	13.5	14.3	14.6	16.8	17.4	17.7	-
1000 sq miles	2.3	9.0	12.6	13.3	13.5	16.4	16.9	17.1	-
2000 sq miles	1.8	7.4	11.1	12.0	12.6	15.7	16.1	16.4	-
5000 sq miles	1.4	5.2	9.2	10.3	10.9	14.1	14.8	15.0	-
10000 sq miles	1.0	3.8	7.4	8.4	8.6	12.2	13.0	13.1	-
20000 sq miles	0.7	2.9	5.4	6.3	7.2	10.2	11.0	11.2	-

Adjusted Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	4.3	14.4	16.7	17.3	17.4	18.3	18.4	18.7	-
100 sq miles	3.6	12.7	15.3	15.9	16.0	17.6	17.8	18.0	-
200 sq miles	3.3	11.7	14.4	15.0	15.2	17.1	17.4	17.6	-
500 sq miles	2.7	10.2	13.0	13.8	14.1	16.2	16.8	17.0	-
1000 sq miles	2.2	8.7	12.1	12.8	13.0	15.8	16.2	16.4	-
2000 sq miles	1.7	7.1	10.7	11.5	12.2	15.1	15.5	15.8	-
5000 sq miles	1.3	5.0	8.9	9.9	10.5	13.6	14.2	14.4	-
10000 sq miles	1.0	3.6	7.1	8.1	8.3	11.8	12.5	12.6	-
20000 sq miles	0.6	2.8	5.2	6.1	6.9	9.9	10.6	10.7	-

Storm or Storm Center Name	**SPAS 1208, Warner Park, TN**	
Storm Date(s)	5/1-3/2010	
Storm Type	Synoptic	
Storm Location	36.06 N	86.91 W
Storm Center Elevation	600	
Precipitation Total & Duration (10 sq mi)	19.71 inches in 60 hours	
Storm Representative Td	75.0 F	12
Storm Representative Td Location	31.50 N	90.00 W
In-place Maximum Td	76.5 F	
Moisture Inflow Vector	SSW @ 360	
In-place Maximization Factor	**1.08**	
Temporal Transposition (Date)	15-May	
Transposition Td Location	38.16 N	95.94 W
Transposition Maximum Td	75.0 F	
Transposition Adjustment Factor	**0.90**	
Grid point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**0.96**	

Figure 8.1 Example of the storm spreadsheet for the Warner Park, TN, May 2010 storm (AWA 2) transpositioned to grid point 1.

9. Development of PMP Values for the ANO Basin

Storm maximization and transposition provide an indication of the maximum amount of rainfall that a particular storm could have produced at any location within the region analyzed for the ANO basin. Use of these values alone does not ensure that PMP values are provided for all area sizes and durations since some of the maximized and transpositioned values could be less than the PMP. By enveloping the rainfall amounts from all the major storms, rainfall values indicative of the PMP magnitude are produced (e.g. WMO, 1986, 2009). The standard process for deriving DAD values for all grid point was used in the project.

9.1 Envelopment Procedures and DAD Derivation

Enveloping is a process for selecting the largest value from a set of data. This technique provides continuous smooth curves based on the largest rainfall values from the set of maximized and transpositioned storm rainfall values. The largest rainfall amounts provide guidance for drawing the curves.

During the enveloping process, values which are not consistent (are either high or low) are re-evaluated to insure reliability. High values are enveloped unless an explanation can be provided to justify undercutting the value. No undercutting of rainfall values was done in this study. Low values are also re-evaluated for reliability and then enveloped to maintain consistency with surrounding values. This enveloping procedure addresses the possibility that for certain area sizes and durations, no significantly large storms have been observed that provide large enough values after being maximized and transposed to represent PMP at an area size and/or duration. The result of this procedure is a set of smooth curves that maintain continuity among temporal periods and areal sizes.

The envelopment process was used in PMP determination for this study, following the same procedures used for envelopment in the derivation of PMP in the HMRs, the WMO PMP Manual, and previous AWA PMP studies. Once the total storm adjusted rainfall values for the appropriate storms at each grid point were determined, they were plotted on individual DA charts for each duration for analysis. Envelopment was applied to each DA curve for each duration. The DA envelopment curves were drawn to provide continuity in space. Figure 9.0 is an example of an DA chart with the envelopment curve for the 72-hour duration at the ANO grid point 1.

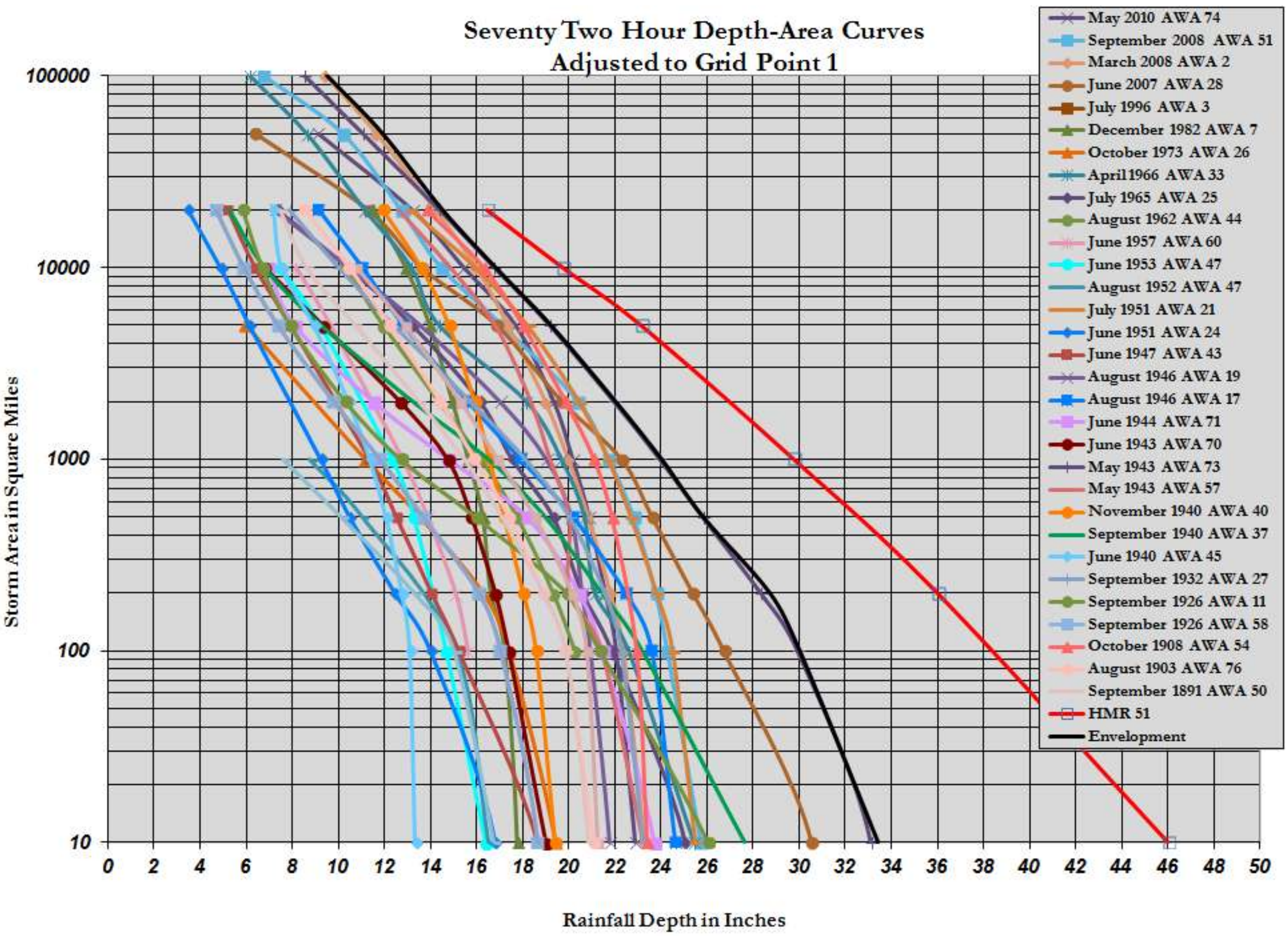

Figure 9.0 72-hour DA curves for ANO grid point 1.

The second application of the envelopment process was used with the DD curves at each location. Curves for each of the area sizes were constructed using results from the DA analysis at each grid point. The DD curves were drawn to produce smooth curves that provide continuity in time among all durations. Figure 9.1 gives an example of the DD curves for grid point 1.

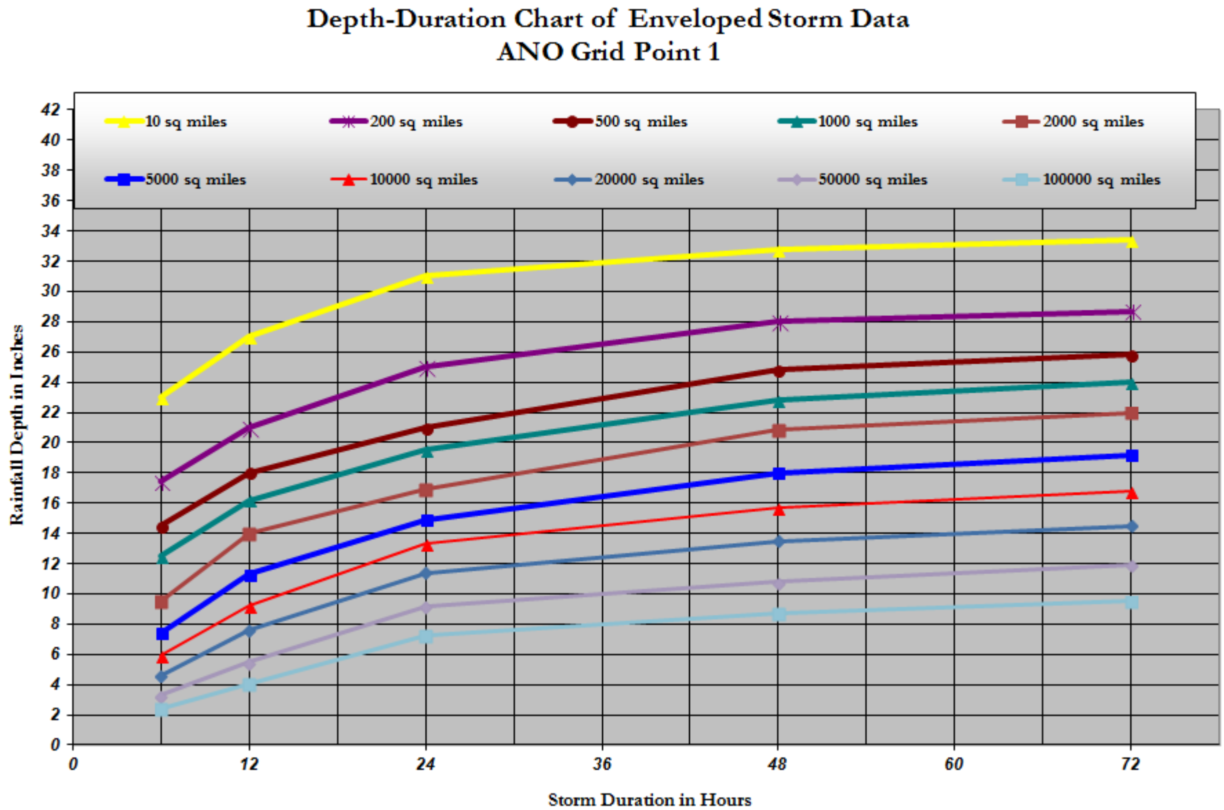

Figure 9.1 DD curves for ANO grid point 1.

The final set of DD curves for all durations at each grid point defines the initial set of PMP values. The envelopment of the adjusted storms together with the curve smoothing process insured that all storm data were included and that the resulting set of PMP values provides rainfall values that are consistent spatially and temporally at each location. These are the values that were then plotted and contoured in GIS to begin the process of manual smoothing. Several smoothing iterations were completed to provide spatial and temporal continuity of the PMP values across all grid points. The final version of this process produced the gridded PMP values.

10. Storm Dimensions

10.1 PMP Design Storm Parameters

Storm isohyetal patterns for 10 storms evaluated with SPAS were evaluated during a previous PMP study and compared to HMR 52 procedures and data over the ANO basin. Each of these storms were representative of the PMP storm type used in the PMP development. The SPAS storm analysis results were used to develop guidance for the hydrologist regarding the PMP design storm's preferred isohyetal orientation and range of movement (direction and speed) following the same approach as the overall development of the PMP, i.e. a storm based, data driven approach. This was required because of the large size of the ANO basin. The stationary PMP design storm as given in HMR 52 may not be as conservative or as meteorologically consistent as would occur in an actual PMP storm environment. Instead, the PMP storm isohyetal pattern would exhibit a preferred orientation based on the storm type(s) that would potentially produce the PMP rainfall over the basin. Further, those storm type(s) would exhibit some amount of movement during the PMF analysis period. This movement would be directly related to the storm dynamics and general meteorological synoptic pattern occurring with the PMP rainfall.

AWA analyzed the hourly gridded rainfall from the 10 SPAS storm events in Table 10.0 to derive these PMP design storm parameters. This procedure allowed for continuity in the overall PMP development by following a storm based, data driven approach to arrive at quantifiable results specific for the ANO basin.

Table 10.0 List of SPAS storms used in development of storm orientation and movement parameters.

Storm Name	State	AWA Storm Number	Lat	Lon	Year	Month	Day	Maximum Rainfall in Inches	Precipitation Source
ALLEY SPRING	MO	3	37.160	-91.450	2008	3	17	15.10	SPAS 1242
AURORA COLLEGE	IL	10	41.458	-88.070	1996	7	16	18.13	SPAS 1286
BIG RAPIDS	MI	12	43.613	-85.313	1986	9	9	13.42	SPAS 1206
DUBUQUE	IA	1	42.440	90.750	2011	7	27	15.14	SPAS 1220
EDGERTON	MO	26	40.413	-95.513	1965	7	18	20.76	SPAS 1183
FALL RIVER	KS	5	37.630	-96.050	2007	6	30	25.50	SPAS 1228
HOKAH	MN	6	43.813	-91.363	2007	8	18	18.32	SPAS 1048
HOLLY	CO	27	37.713	-102.404	1965	6	16	19.18	SPAS 1293
WARNER PARK	TN	2	36.061	-86.906	2010	4	30	19.71	SPAS 1208
WOOSTER	OH	24	40.915	-81.973	1969	7	4	14.95	SPAS 1209

10.2 Storm Orientation

Storm orientation is an important storm characteristic when considering the placement of an isohyetal pattern over a basin. The orientations of the 10 storm events in Table 10.0 were evaluated to determine a preferred storm orientation for a design PMP storm pattern over the basin. The shape of each storm's total storm isohyetal pattern was examined to determine the orientation of the major axis. Storm orientations are described by an angle of 180° to 359°, where 180° is equivalent to south-to-north and 270° is equivalent to west-to-east orientation. Results of these investigations showed that the orientation parameters as given in HMR 52 Figure 8 are appropriate for use in the ANO basin.

10.3 Storm Movement Analysis

Storm movement for the 10 SPAS storm events were analyzed to determine a maximum and minimum speed of movement and range of directions of storm movement that could be expected for PMP storms. SPAS hourly rainfall grids were accumulated in 12-hour increments and 24-hour increments through the total storm duration and used in the analysis. The rainfall storm center for each set of 12-hour and 24-hour grids were used to get the distance and direction of movement. An elliptical with a ratio of 2.5 was centered over each storm center (lat/lon), and the orientation for each 12-hour and 24-hour pattern were determined. For example, the Warner Park, TN, May 2010 storm (AWA 2) had five 12-hour increments. The ellipse used to determine the orientation for the fourth 12-hour increment is shown in Figure 10.0. This process was repeated for each 12-hour and 24-hour hour increment.

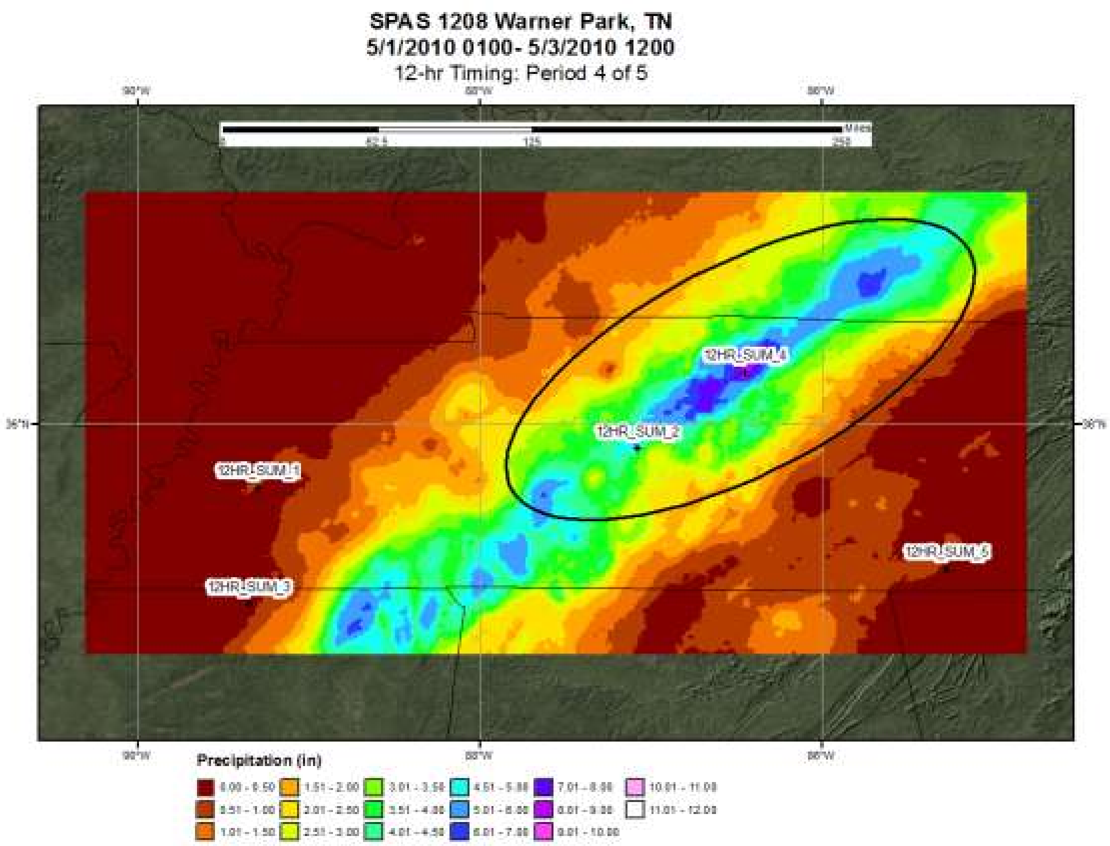

Figure 10.0 Example for Warner Park, TN, May, 2010 storm (AWA 2) showing elliptical used to determine orientation of the fourth 12-hour increment.

The rainfall storm centers for each 12-hour and 24-hour increment were used to calculate an average storm center movement (in miles) for each increment. This was done using least squares linear regression, the slope of the line is the direction of the storm movement and the length of the line represents the storm movement speed. For example, the Warner Park, TN, May 2010 storm (AWA 2) is shown below. This analysis results in a total storm center movement distance to the east-northeast of 175 miles during the fourth 12-hour increment (Figure 10.1).

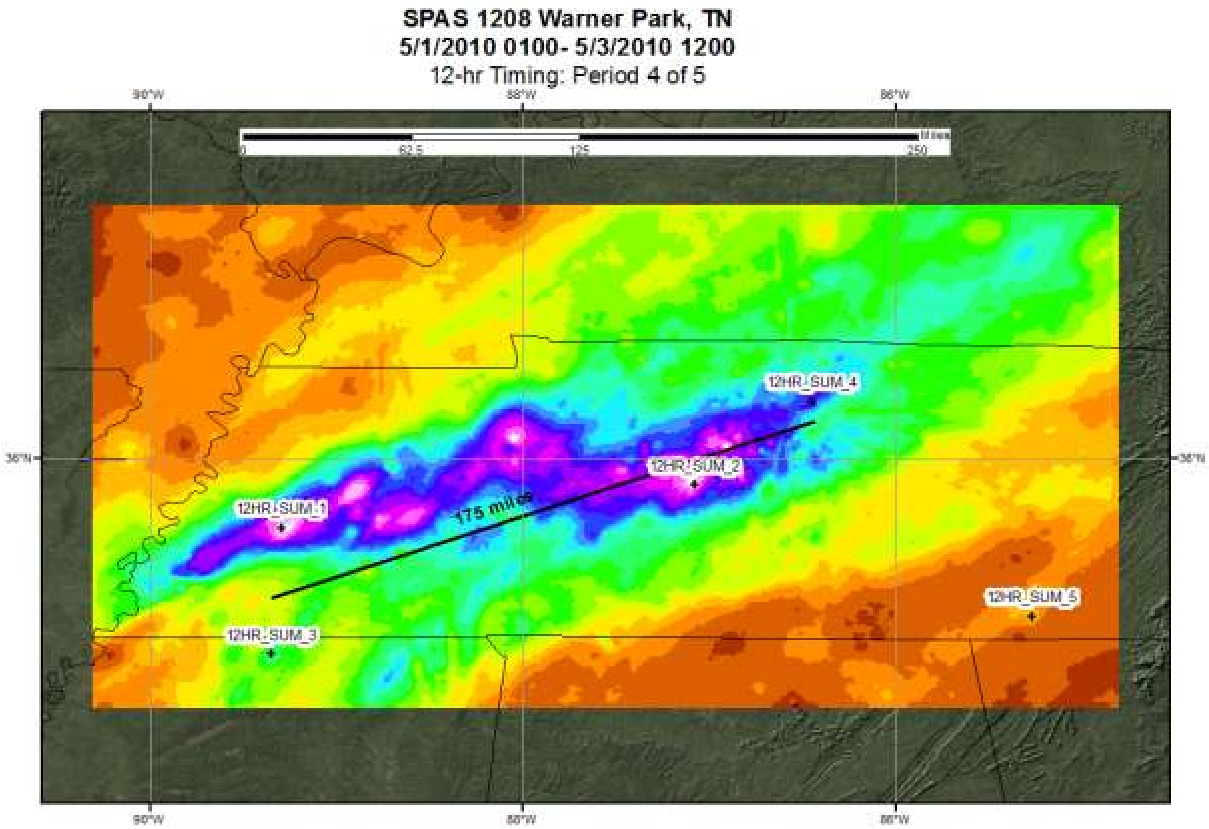

Figure 10.1 Example for Warner Park, TN, May, 2010 storm (AWA 2). Storm movement between each point at each 12-hour increment was calculated based on regression line and storm center points.

The 12-hour and 24-hour distances that a storm center moved were calculated and the direction of movement was determined using the storm centers for each 12-hour and 24-hour increment. The largest distance between to storm center locations for the 12-hour and 24-hour increments was measured and the line between these points was used to determine the orientation. For example, the Warner Park, TN, May 2010 storm (AWA 2) had three 24-hour increments, the greatest storm center movement was between the first and second storm center. The distance and direction of this line was 165 miles with an orientation of 255° (Figure 10.2).

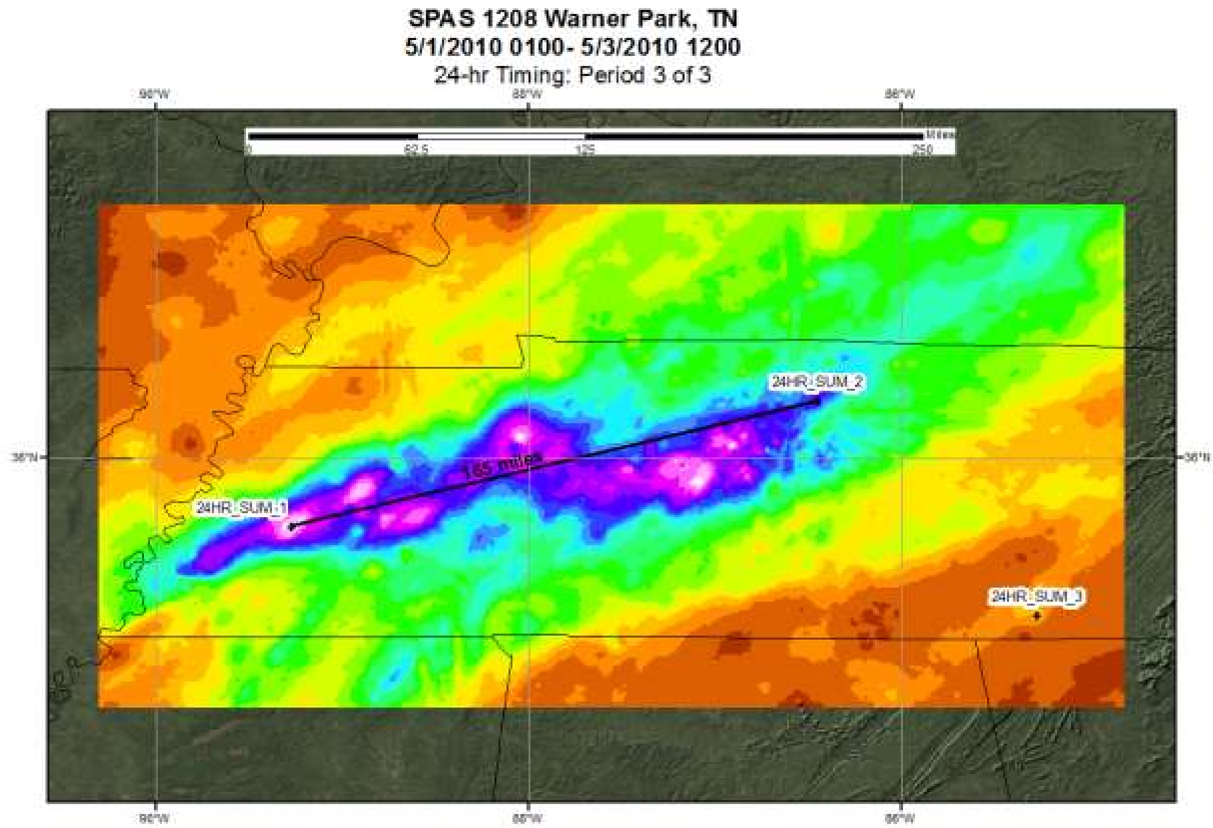

Figure 10.2 Example for Warner Park, TN, May, 2010 storm (AWA 2), 24-hour longest storm center movement and orientation.

The average storm center movement, by ordinary least squares regression, and maximum 12-hour and 24-hour distance and orientation were analyzed to determine the most appropriate range storm movement. The 24-hour movement was used for PMP/PMF determination. This analysis led to the following recommendations for PMP design storm movement of the all-season and cool-season PMP isohyetal patterns across the basin.

PMP Design Storm Isohyetal Movement and Orientation Recommendation

The maximum amount a storm can be moved in a 24-hour period is 200 miles and the minimum amount is 20 miles. The orientation of the isohyetal pattern should follow the guidance produced in HMR 52 and will vary from west to east and north to south across the ANO basin.

11. Local Intense Precipitation (LIP)

AWA completed an analysis to derive the 1-hour 1-square mile Local Intense Precipitation (LIP) for the ANO site location. This analysis followed the storm-based approach as used in the overall PMP development and as given in HMRs 51 and 52. The storm-based approach utilizes observed rainfall data from rainfall events which have occurred over the site and in regions where storms are considered to be transpositionable to the ANO site location. These rainfall data are maximized in-place following standard maximization procedures, then transpositioned to the ANO location. The transpositioning process accounts for differences in moisture and elevation between the original storm location and the ANO site. The process produces a total adjustment factor that is applied to the original rainfall data for each storm. The result represents the maximum rainfall each storm could have produced at the site had all factors leading to the rainfall been ideal and maximized. Information is included in this section detailing the storms used, how they were analyzed, and how the LIP values were derived. Information on each individual storm event evaluated is included in Appendix G, with the dew point climatologies used to maximize the storms provided in Appendix B.

11.1 Development of LIP Values

The PMP values provided in HMR 51 for the ANO site provide values starting with the 6-hour duration and the 10-square mile area size. There are no explicit values provided at the 1-hour duration and/or 1-square mile area size. HMR 52 provides information to derive the 1-hour 1-and 10-square mile values based on HMR 51 6-hour 10-square mile storm analyzed values. Unfortunately, the most recent storm evaluated in HMR 51 occurred in 1972. In addition, because HMR 51 covers a large domain, generalization and conservatism were employed in the development of the respective PMP and LIP values. This resulted in LIP values which were influenced by storms not appropriate for the ANO site location (e.g. Smethport, PA July 1942) and therefore are not reliable values for the ANO site.

The site-specific LIP analysis performed during this study for the ANO site corrected many of the issues in the HMRs by explicitly evaluating storms which are directly transpositionable to the ANO site. In addition, the understanding of the meteorology of these events has advanced significantly since HMR 51 was published. These corrections and the updated storm database were employed in this calculation. In addition, the results and data from numerous SPAS storm analyses used in the PMP development in this study and several others in the region were used extensively in this analysis.

11.2 LIP Storm List

The initial step in the development of the LIP values was to identify a set of storms which represent rainfall events that are LIP-type local storm events. This included storms where extreme heavy rainfall accumulated over short durations and small area sizes. These include observed rainfall amounts associated with MCS and individual thunderstorms. This procedure is similar to what is described in HMR 52 Section 6.

AWA evaluated all storms used in previous PMP studies in the region considered transpositionable to the ANO location to develop a list of the storms needed for proper LIP evaluation and determination. This resulted in 23 events being evaluated (Table 11.0 and Figure 11.0). Fourteen of these storms were previously analyzed in HMRs 33 and 51 by the NWS and USACE. The remaining nine were analyzed using SPAS.

Table 11.0 Storms used in the 1-hour 1-square mile Local Intense Precipitation analysis.

Storm Name	State	AWA Storm Number	Lat	Lon	Year	Month	Day	Max Rainfall	Precipitation Source	ANO Total Adjustment Factor	ANO 1-hour 1mi^2 PMP
WARNER PARK	TN	2	36.0611	-86.9056	2010	4	30	19.71	SPAS 1208	1.18	5.40
LARTO LAKE	LA	4	31.220	-92.130	2008	9	1	23.31	SPAS 1182	1.15	7.07
FALL RIVER	KS	5	37.6300	-96.0500	2007	6	30	25.50	SPAS 1228	1.23	5.76
ALBANY	TX	18	32.7260	-99.3500	1978	8	3	32.50	SPAS 1179	1.26	15.36
ENID	OK	21	36.3805	-97.8683	1973	10	10	19.45	SPAS 1034	1.20	8.88
WOOSTER	OH	24	40.9146	-81.9729	1969	7	4	14.95	SPAS 1209	1.30	6.01
GLADEWATER	TX	25	32.5365	-94.9427	1966	4	27	25.33	SPAS 1181	1.24	3.62
EDGERTON	MO	26	40.4125	-95.5125	1965	7	18	20.76	SPAS 1183	1.27	4.67
COLLEGE HILL	OH	30	40.0854	-81.6479	1963	6	3	19.39	SPAS 1226	1.84	4.67
CAMP POLK	LA	81	31.067	-93.200	1953	4	23	21.10	LMV 5-3	0.97	4.97
HARRISONBURG DAM	LA	79	31.767	-91.817	1953	5	11	25.40	LMV 5-4	1.02	6.01
KELSO	MO	37	37.1906	-89.5495	1952	8	11	13.00	UMV 3-30	1.27	10.57
HOLT	MO	40	39.4528	-94.3422	1947	6	18	17.60	MR 8-20	1.18	14.16
COLLINSVILLE	IL	42	38.6717	-89.9800	1946	8	12	18.70	MR 7-2B	1.19	4.57
MOUNDS	OK	44	35.8770	-96.0610	1943	5	16	17.00	SW 2-21	1.39	14.14
SILVER LAKE	TX	45	32.6700	-95.5960	1943	6	5	16.50	SW 3-3	1.15	10.45
HALLETT	OK	52	36.2000	-96.6000	1940	9	2	24.00	SW 2-18	1.17	13.78
ENGLE	TX	83	29.681	-97.009	1940	6	29	22.70	GM 5-11	1.22	8.59
BEBE	TX	84	29.332	-97.682	1936	6	30	21.00	GM 5-6	1.11	9.95
NEOSHO FALLS	KS	61	38.0820	-95.7010	1926	9	12	14.00	SW 2-1	1.34	11.49
THRALL	TX	77	30.591	-97.297	1921	9	9	39.70	GM 4-12	1.14	16.34
BONAPARTE	IA	70	40.7667	-91.7500	1905	6	10	12.10	UMV 2-5	1.29	8.26

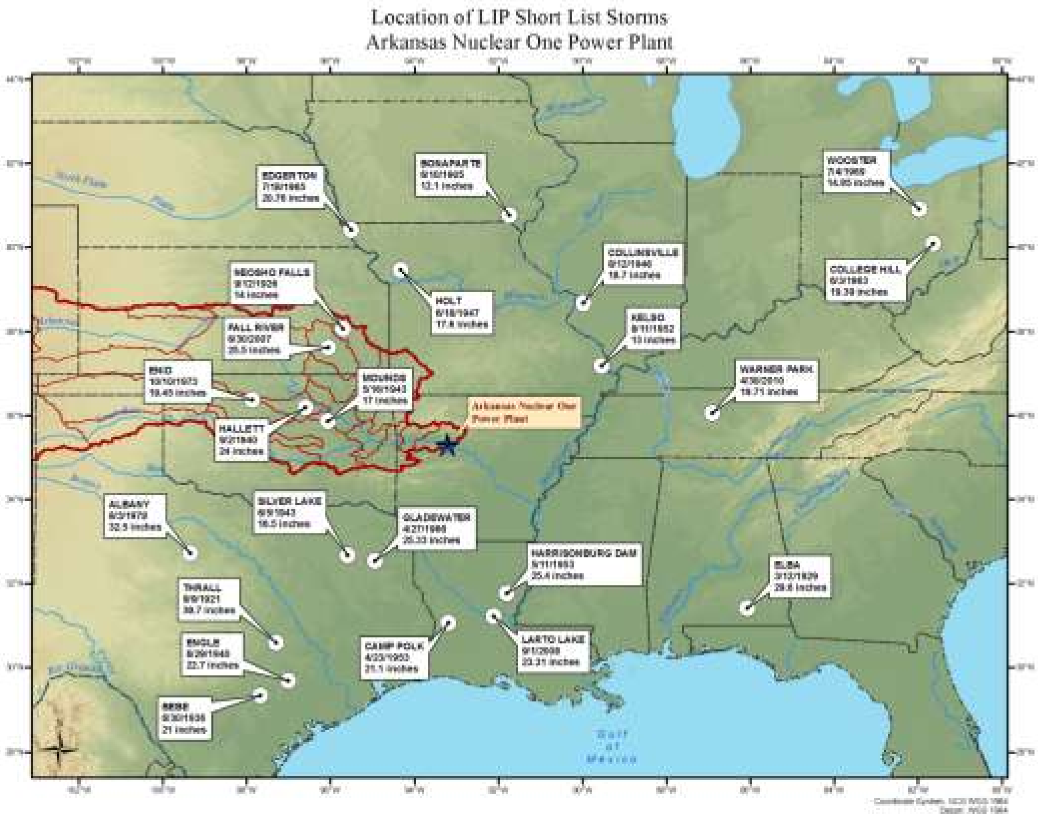

Figure 11.0 Storms used in the LIP calculations in relation to the ANO site location.

11.3 LIP Storm Calculation Process

Most of the 14 storms analyzed by the NWS/USACE did not contain explicit 1-hour 1-square mile rainfall data. This is the result of the lack of hourly recording information available during the original analyses. To correct for this, information presented in HMR 52, Section 6 was utilized. This information provided ratios which allowed for the computation of the 1-hour 1-square mile value to be derived from the 6-hour 10-square mile PMP value (HMR 52 Figure 23). Although these ratios were derived to apply to the HMR 51 PMP values, they are implicitly relevant for use in this calculation because both processes are using the same data set and following the storm-based approach, i.e. it is only a scaling variation that is occurring. No inherent change or adjustment to the data is taking place that would result in a different data set or storm type. For the Bonaparte, IA June 1905 and Holt, MO June 1947 storm events analyzed by the NWS/USACE, explicit 1-hour data was available and therefore no ratio application was required.

The nine storms analyzed using SPAS allowed for explicit hourly rainfall to be evaluated with a spatial resolution of 1/3rd square mile. This provided data for the storm rainfall 1-hour 1-square mile area sizes to be explicitly evaluated.

Once all the storms were identified and their 1-hour 1-square mile values derived, the final step in the process was to maximize each storm specific to the ANO location. This was a two-step process. First, the in-place maximization factor was calculated. This provides a value that is applied to the observed storm values which represents what the storm rainfall would have been had the atmospheric conditions and moisture been at maximum levels when the storm occurred. Next, the resulting in-place maximized values for each storm was adjusted as if the storm had occurred over the ANO site. To accomplish this, the transposition calculation process was followed to adjust the storm from its original location to the ANO site. The transposition calculation adjusts for differences in available moisture both in the horizontal (north/south and east/west directions) and vertical (differences in elevation) at the site versus the original storm location. All the calculations and resulting values for each storm used in the LIP analysis are provided in Appendix G.

After the maximization and transposition factors were calculated for each of the storms, the results were applied to the maximum 1-hour value for each storm to calculate the maximized 1-hour 1-square mile values. The largest of these values results in the site-specific LIP for the ANO site (see Table 11.0 for all resulting values). After adjustments were applied, the Thrall, TX September 1921 storm (AWA 77) had the highest 1-hour rainfall, with four other storms providing slightly smaller values and support for this value. Note that use of the Thrall, TX storm at the ANO site is beyond the transposition limits noted by the NWS. Therefore, AWA"s judgment to use this storm at the site produces LIP values that are higher than would be calculated had Thrall, TX not be transpositioned. However, this transposition limits of the storm, as well as the meteorology which led to the rainfall, were deemed similar enough during this analysis to allow it to be transpositioned.

For final application of the LIP hydrology, this value is then required to be split into sub-hourly increments of 5-, 15-, 30-minutes. Updated evaluations of the appropriate amount of rainfall to assign to each increment for the site based on storm data would have been ideal. However, a lack of sub-hourly PMP-type storm data from the 14 storms analyzed by the NWS/USACE prevented an updated evaluation from being completed. Therefore, it is recommended that the ratios derived in HMR 52 be applied at the ANO site (HMR 52 Figures 36-38). Table 11.1 shows the result of applying these ratios to the maximized Thrall, TX September 1921 (AWA 77) rainfall.

Table 11.1 Site specific 1-hour 1-square mile LIP values at the ANO site.

Time (min)	ANO PMP Depth (in) at 1-hour 1-square mile
60	16.3
30	12.2
15	8.4
5	5.4

12. Results

The following are the main conclusions from this study:

- HMR 51 and 55A PMP values are outdated. This study provided updated PMP values to replace HMR 51 and 55A PMP values.
- HMR 52 PMP design storm parameters were based on a set of storms that were not specifically transpositionable to this basin. This study provided updated PMP design storm movement guidance based on storms transpositionable to this basin and taking into consideration the large size of this basin.
- The most recent storm used to derive PMP values in HMR 51 occurred in 1972. This study updated the storm database to include storms through 2013.
- HMRs 51 and 52 did not use computer based technologies in the storm analyses procedures. This study used computer technology and GIS to more accurately analyze storm rainfall patterns and implement the spatially distributed PMP values.
- HMRs 51, 52, and 55A did not have weather radar to help spatially distribute rainfall among rain gauge locations. SPAS storm analyses incorporates this information when available to provide the most advanced spatial representation of rainfall storm patterns possible.
- Understanding of meteorological processes, interactions, and storm patterns have advanced greatly since the publication of HMRs 51 and 55A. Satellite and radar technology have greatly added to the understanding of storm patterns over the last 40 years. This study incorporated the state-of-the-science understanding and technology associated with analyzing extreme rainfall events.
- HMRs 51 and 52 provide generalized and smoothed LIP values over a large geographic domain that covers the United States east of the 105th meridian. This calculation considered characteristics specific to the site, and produced PMP values that explicitly considered the meteorology of the PMP storm type which would result in the 1-hour 1-square mile area size LIP values.
- The transposition limits of the Smethport, PA July 1942, which produced the 4- and 6-hour world record rainfall, were not allowed to influence the LIP values at the ANO site. The refined transposition limits used in this calculation result in lower LIP values compared to HMR 52 for locations where the Smethport storm apparently influenced PMP values in HMR 51. Smoothing of the PMP/LIP isolines in HMRs 51 and 52 necessarily had to encompass the Smethport maximized in-place rainfall far beyond its explicit transposition limits. Note, Section 3.2.4 of HMR 51 states that they "slightly undercut" the maximized 6-, 12-, and 24-hour values by up to 7% to avoid "excessive envelopment of all other data in a large region surrounding the Smethport location." This over envelopment effect extended well beyond the intended transposition limits of the Smethport storm because the PMP/LIP isolines required smoothing and fitting over surrounding regions.

- Each storm's inflow vector was re-evaluated and combined with an updated set of dew point climatologies and when necessary, updated storm representative dew point values were used for the in-place maximization and transposition factors. The HYSPLIT trajectory model (Draxler and Rolph 2003, Draxler and Rolph 2010) was used to evaluate moisture inflow vectors for storms on the short storm list. Trajectory models were not available in HMR studies. Use of HYSPLIT allowed for a high degree of confidence when evaluating moisture inflow vectors and storm representative dew points.
- Several new storms have been analyzed and included in this LIP analysis that were not included in HMRs 33, 51, and 52. This provided a higher level of confidence in the final PMP values. Further, this allowed for a refined set of values that better represent the LIP estimates at the site. This expanded the data set used to derive LIP includes a large number of recent storms where weather radar data were available.
- The calculation provided adjustments for storm elevation to the nearest 100 feet of elevation, whereas HMRs 51 and 52 made no explicit adjustment for elevation. This adjustment depends on the elevation of the historic storm's maximum rainfall location and therefore varies from storm to storm.
- Storms analyzed by the NWS/USACE which occurred prior to 1948 and used 12-hour persisting dew points in the storm maximization process were adjusted so that the updated dew point climatology could be utilized consistently. For thunderstorms and MCC storm events 7°F was added to the NWS/USACE storm representative dew point. This was done to adjust for using average dew point values for varying durations vs. 12-hour persisting dew point values. Recent evaluations of 12-hour persisting storm representative dew points showed those used in HMR 51 underestimated the storm representative dew point values.

12.1 PMP Values

This PMP study has produced PMP values for use in computing the PMF using HMR 52 procedures with modifications to account for the large size of the ANO basin. This includes updated quantification of the PMP design storm movement across the basin. Values for all durations and area sizes provided in HMRs 51 and 55A, as well as for additional area sizes out to 100,000 square miles have been computed using the procedures described in this report.

The study provides PMP values for use in computing the PMF at any location within the basin. Values for all durations up to 72 hours and areal sizes up to 100,000 square miles have been computed in gridded GIS format. Note, HMR 51 standard area sizes extend only to 20,000 square miles and HMR 55A only extends to 5,000 square miles. Appendix A contains the PMP maps produced in this study.

The study was designed to retain as much continuity as possible with the methodology used in HMRs 51 and 55A, as well as previous AWA studies, while incorporating improvements based on changes in technology, meteorological understanding, and availability of updated data. In addition, special consideration was given to the size of the ANO basin, especially relating to the PMP design storm movement.

Full SPAS storm rainfall analyses were completed for one storm not analyzed in the HMRs or the previous AWA studies. The study continued the use of surface dew point data to quantify moisture inflow to storms. However, instead of using the 12-hour persisting value as in HMR 51, an average dew point value for a duration (6-, 12-, or 24-hours) consistent with the storm precipitation was used. This approach provides a more representative parameterization of the moisture available to the storm.

An updated dew point climatology was developed during previous AWA studies and was used in this study. This allows for average dew point values and maximum average dew point climatology maps at the 100-year return frequency level for 6-, 12-, and 24-hour durations to be used for storm maximization and transposition. Storms were maximized and transpositioned to a set of 22 grid points. This covered the entire basin and provided a margin for boundary conditions (see Figure 1.4).

12.2 Comparison of the PMP Values with HMR 51 PMP

A comparison was made at various area sizes and durations to determine the difference between results of PMP values versus HMR 51 values at each grid point where HMR 51 PMP values were available for direct comparison. Tables 12.0-12.4 provide the percent reductions from HMR 51 PMP values throughout the basin at each area size and duration analyzed for all grid points.

Table 12.0 Percent difference between PMP values at each grid point at the 6-hour duration vs HMR 51 PMP values. Negative values represent reductions from HMR 51. Only grid points with HMR 51 values are included in the comparisons.

Arkansas Nuclear One Grid Points 6-hr PMP						
Grid Point	10 sqmi	200 sqmi	1,000 sqmi	5,000 sqmi	10,000 sqmi	20,000 sqmi
1	-26%	-26%	-22%	-23%	-19%	-14%
2	-21%	-17%	-19%	-22%	-19%	-14%
3	-20%	-20%	-19%	-19%	-18%	-20%
4	-19%	-19%	-21%	-13%	-11%	-12%
5	-22%	-18%	-19%	-30%	-34%	-31%
8	-26%	-20%	-20%	-20%	-20%	-21%
9	-26%	-17%	-19%	-20%	-20%	-18%
10	-26%	-17%	-17%	-17%	-16%	-15%
11	-24%	-20%	-19%	-15%	-14%	-12%
12	-20%	-17%	-19%	-29%	-26%	-26%
16	-25%	-17%	-17%	-18%	-18%	-14%
17	-24%	-16%	-14%	-14%	-14%	-13%
18	-23%	-20%	-17%	-15%	-16%	-13%
19	-19%	-19%	-19%	-30%	-32%	-33%
20	-21%	-22%	-27%	-32%	-33%	-40%

Table 12.1 Percent difference between PMP values at each grid point at the 12-hour duration vs HMR 51 PMP values. Negative values represent reductions from HMR 51. Only grid points with HMR 51 values are included in the comparisons.

Arkansas Nuclear One Grid Points 12-hr PMP						
Grid Point	10 sqmi	200 sqmi	1,000 sqmi	5,000 sqmi	10,000 sqmi	20,000 sqmi
1	-27%	-25%	-22%	-15%	-13%	-17%
2	-22%	-18%	-23%	-16%	-13%	-17%
3	-20%	-13%	-24%	-19%	-17%	-23%
4	-16%	-7%	-18%	-9%	-10%	-16%
5	-23%	-15%	-22%	-27%	-28%	-26%
8	-23%	-21%	-23%	-21%	-18%	-20%
9	-23%	-21%	-21%	-16%	-13%	-15%
10	-22%	-20%	-19%	-12%	-12%	-14%
11	-22%	-21%	-18%	-12%	-18%	-24%
12	-24%	-24%	-25%	-19%	-22%	-27%
16	-21%	-19%	-19%	-16%	-14%	-16%
17	-20%	-17%	-16%	-15%	-15%	-16%
18	-22%	-19%	-17%	-12%	-14%	-20%
19	-24%	-24%	-25%	-20%	-27%	-34%
20	-28%	-23%	-32%	-25%	-34%	-45%

Table 12.2 Percent difference between PMP values at each grid point at the 24-hour duration vs HMR 51 PMP values. Negative values represent reductions from HMR 51. Only grid points with HMR 51 values are included in the comparisons.

Arkansas Nuclear One Grid Points 24-hr PMP						
Grid Point	10 sqmi	200 sqmi	1,000 sqmi	5,000 sqmi	10,000 sqmi	20,000 sqmi
1	-27%	-20%	-18%	-11%	-12%	-12%
2	-25%	-22%	-26%	-19%	-15%	-13%
3	-18%	-12%	-23%	-22%	-20%	-18%
4	-13%	-5%	-14%	-12%	-7%	-5%
5	-24%	-13%	-21%	-13%	-11%	-10%
8	-23%	-18%	-22%	-18%	-12%	-10%
9	-25%	-19%	-22%	-15%	-7%	-4%
10	-20%	-14%	-19%	-10%	-4%	1%
11	-20%	-17%	-17%	-12%	-11%	-8%
12	-21%	-22%	-20%	-12%	-12%	-8%
16	-23%	-16%	-19%	-11%	-8%	-1%
17	-22%	-17%	-16%	-13%	-7%	-2%
18	-23%	-16%	-20%	-16%	-13%	-12%
19	-21%	-22%	-21%	-14%	-28%	-24%
20	-21%	-23%	-22%	-15%	-34%	-29%

Table 12.3 Percent difference between PMP values at each grid point at the 48-hour duration vs HMR 51 PMP values. Negative values represent reductions from HMR 51. Only grid points with HMR 51 values are included in the comparisons.

Arkansas Nuclear One Grid Points 48-hr PMP						
Grid Point	10 sqmi	200 sqmi	1,000 sqmi	5,000 sqmi	10,000 sqmi	20,000 sqmi
1	-25%	-17%	-18%	-13%	-9%	-5%
2	-25%	-16%	-20%	-16%	-13%	-8%
3	-22%	-12%	-16%	-16%	-11%	-4%
4	-17%	-7%	-10%	-8%	-1%	7%
5	-27%	-18%	-21%	-20%	-20%	-19%
8	-28%	-18%	-16%	-14%	-11%	-9%
9	-26%	-17%	-17%	-11%	-7%	-5%
10	-27%	-16%	-16%	-11%	-7%	-4%
11	-25%	-17%	-19%	-13%	-8%	-7%
12	-27%	-16%	-24%	-23%	-23%	-21%
16	-26%	-14%	-16%	-10%	-6%	-4%
17	-26%	-14%	-13%	-8%	-5%	-3%
18	-25%	-13%	-22%	-12%	-7%	-6%
19	-23%	-11%	-25%	-25%	-22%	-26%
20	-21%	-9%	-24%	-25%	-23%	-34%

Table 12.4 Percent difference between PMP values at each grid point at the 72-hour duration vs HMR 51 PMP values. Negative values represent reductions from HMR 51. Only grid points with HMR 51 values are included in the comparisons.

Arkansas Nuclear One Grid Points 72-hr PMP						
Grid Point	10 sqmi	200 sqmi	1,000 sqmi	5,000 sqmi	10,000 sqmi	20,000 sqmi
1	-27%	-20%	-19%	-17%	-15%	-13%
2	-28%	-22%	-23%	-20%	-17%	-15%
3	-26%	-19%	-20%	-19%	-18%	-16%
4	-20%	-12%	-14%	-11%	-6%	-5%
5	-27%	-18%	-21%	-18%	-19%	-25%
8	-29%	-19%	-18%	-16%	-15%	-14%
9	-28%	-19%	-18%	-12%	-10%	-8%
10	-29%	-17%	-17%	-11%	-8%	-8%
11	-27%	-15%	-14%	-9%	-8%	-9%
12	-27%	-17%	-23%	-26%	-27%	-26%
16	-28%	-15%	-17%	-11%	-9%	-9%
17	-28%	-16%	-15%	-6%	-4%	-5%
18	-27%	-16%	-19%	-7%	-3%	-4%
19	-25%	-14%	-25%	-16%	-23%	-17%
20	-23%	-11%	-21%	-20%	-32%	-32%

12.3 Reasons for Reductions of PMP versus HMR 51

This PMP study provided differences in PMP values from those presented in HMR 51. This study explicitly addressed elevation, whereas detailed terrain effects were not evaluated in HMR 51. All HMR 51 storms on both the PMP and LIP short storm lists were re-evaluated to determine the updated storm representative dew point and maximized using an updated dew point climatology.

Since the study followed the same basic storm rainfall adjustment procedures as HMR 51, it would be useful to understand the cause of the differences in the PMP values. Detailed working papers are not available for HMR 51, so explicit differences in calculations and procedures cannot be evaluated. However, the following issues were treated differently in the two studies:

1. HMR 51 provides generalized and smoothed PMP values over a large geographic domain covering the United States east of the 105th meridian. Specific characteristics unique to individual basins, such as ANO, were not addressed. This study considered characteristics specific to the basin, and produced PMP values explicitly considered the meteorology of the PMP storm type which would results in the PMF for the basin.

2. Each storm's inflow vector was re-evaluated and combined with an updated set of dew point climatology data and when necessary, updated storm representative dew point values were used for the in-place maximization and computation of the total

adjustment factors. The HYSPLIT trajectory model was used to evaluate and verify moisture inflow vectors for storms on the short storm list. Trajectory models were not available in previous HMR studies. The use of HYSPLIT allowed for a high degree of confidence when evaluating moisture inflow vectors and storm representative dew points.

3. Several new storms have been analyzed and included in this PMP study that were not included in HMRs 51 and 55A. This provided a higher level of confidence in the final PMP and LIP values. Further, this allowed for a refined set of values that better represent the PMP values, as the data set used to derive PMP has been expanded to include a larger set of more recent storms.

4. The site-specific PMP study provided adjustments for storm elevation to the nearest 100 feet of elevation, whereas HMR 51 made no explicit adjustment for elevation for PMP value over the basin. This adjustment depends on the elevation of the historic storm's maximum rainfall location and therefore varies from storm to storm. Further, the average basin elevation for each grid point was evaluated in this study using GIS, providing a much more accurate representation and calculation to account for loss of available moisture up to that elevation.

5. SPAS was used in conjunction with NEXRAD data (when available) to evaluate the spatial and temporal distribution of rainfall. Use of NEXRAD data generally produced higher point rainfall amounts than were observed using only rain gauge observations and provides objective spatial distributions of storm rainfall for locations among rain gauges. SPAS results provided storm DADs, total storm precipitation patterns, and mass curves for the newly analyzed storms. Using these technologies, significant improvements of the storm rainfall analyses were achieved.

6. Previously analyzed storm events that occurred prior to 1948 that used 12-hour persisting dew points were adjusted using storm representative dew point adjustments of 2°F for synoptic type storm events and 7°F for MCS type storm events. This was done to adjust for using average dew point values for varying durations vs. 12-hour persisting dew point values. Recent evaluations of 12-hour persisting storm representative dew points show those used in HMRs 51 and 55A underestimated the storm representative values. An updated set of maximum dew point climatology maps were produced. These maps have higher maximum dew point values than those used in HMR studies and therefore compensate to some extent for the higher storm representative dew points.

7. HMRs 51 and 52 provide generalized and smoothed LIP values over a large geographic domain that covers the United States east of the 105th meridian. Specific characteristics unique to the ANO site were not addressed. This calculation considered characteristics specific to the site, and produced PMP

values that explicitly considered the meteorology of the PMP storm type which would result in the 1-hour 1- square mile area size LIP values.

8. The transposition limits of the Smethport, PA July 1942, which produced the 4- and 6-hour world record rainfall, were not allowed to influence the LIP values at the ANO site. The refined transposition limits used in this calculation result in lower LIP values compared to HMR 52 for locations where the Smethport storm apparently influenced PMP values in HMR 51. Smoothing of the PMP/LIP isolines in HMRs 51 and 52 necessarily had to encompass the Smethport maximized in-place rainfall far beyond its explicit transposition limits. Note, Section 3.2.4 of HMR 51 states that they "slightly undercut" the maximized 6-, 12-, and 24-hour values by up to 7% to avoid "excessive envelopment of all other data in a large region surrounding the Smethport location." This over envelopment effect extended well beyond the intended transposition limits of the Smethport storm because the PMP/LIP isolines required smoothing and fitting over surrounding regions.

13. Sensitivity Analysis

In the process of deriving site-specific PMP values, various assumptions were made and explicit procedures were adopted for use. Additionally, various parameters and derived values are used in the calculations. It is of interest to assess the sensitivity of PMP values to assumptions that were made and to the variability of parameter values.

13.1 Assumptions

13.1.1 Saturated Storm Atmospheres

The atmospheric air masses that provide moisture to both the historic storm and the PMP storm are assumed to be saturated through the entire depth of the atmosphere and to contain the maximum moisture possible based on the surface dew point. This assumes moist pseudo-adiabatic temperature profiles for both the historic storm and the PMP storm. Limited evaluation of this assumption in the EPRI Michigan/Wisconsin Regional PMP study (Tomlinson, 1993) and the Blenheim Gilboa study (Tomlinson et al. 2008) indicated that historic storm atmospheric profiles are generally not entirely saturated and contain somewhat less precipitable water than is assumed in the PMP procedure. It follows that the PMP storm (if it were to occur) would also have somewhat less precipitable water available than the assumed saturated PMP atmosphere would contain. What is used in the PMP procedure is the *ratio* of precipitable water associated with each storm. If the precipitable water values for each storm are both slightly overestimated, the ratio of these values will be essentially unchanged. For example, consider the case where instead of a historic storm with a storm representative dew point of 70^{o}F degrees having 2.25 inches of precipitable water assuming a saturated atmosphere, it actually had 90% of that value or about 2.02 inches. The PMP procedure assumes the same type of storm with similar atmospheric characteristics for the maximized storm but with a higher dew point, say 76^{o}F degrees. The maximized storm, having similar atmospheric conditions, would have about 2.69 inches of precipitable water instead of the 2.99 inches associated with a saturated atmosphere with a dew point of 76^{o}F degrees. The maximization factor computed using the assumed saturated atmospheric values would be 2.99/2.25 = 1.33. If both storms were about 90% saturated instead, the maximization factor would be 2.69/2.02 = 1.33. Therefore potential inaccuracy of assuming saturated atmospheres (whereas the atmospheres may be somewhat less than saturated) should have a minimal impact on storm maximization and subsequent PMP calculations.

13.1.2 Maximum Storm Efficiency

The assumption is made that if a sufficient period of record is available for rainfall observations, at least a few storms would have been observed that attained or came close to attaining the maximum storm efficiency possible in nature for converting atmospheric moisture to rainfall for regions with similar climates and topography. The further assumption is made that if additional atmospheric moisture had been available, the storm would have maintained the same efficiency for converting atmospheric moisture to rainfall. The ratio of the maximized rainfall amounts to the actual rainfall amounts would be the same as the ratio of the precipitable water in the atmosphere associated with each storm.

There are two issues to be considered. First is the assumption that a storm has occurred that has rainfall efficiency close to the maximum possible. Unfortunately, state-of-the-science in meteorology does not support a theoretical evaluation of storm efficiency for use in PMP evaluation. However, if the period of record is considered (generally over 100 years), along with the extended geographic region with transpositionable storms, it is accepted that there should have been at least one storm with dynamics that approach the maximum efficiency for rainfall production.

The other issue is the assumption that storm efficiency does not change if additional atmospheric moisture is available. Storm dynamics could potentially become more efficient or possibly less efficient depending on the interaction of cloud microphysical processes with the storm dynamics. Offsetting effects could indeed lead to the storm efficiency remaining essentially unchanged. For the present, the assumption of no change in storm efficiency is accepted, mirroring the HMR and WMO assumptions.

13.2 Parameters

13.2.1 Storm Representative Dew Point and Maximum Dew Point

The in-place maximization factor depends on the determination of storm representative dew points, along with maximum historical dew point values. The magnitude of the maximization factor varies depending on the values used for the storm representative dew point and the maximum dew point. Holding all other variables constant, the maximization factor is smaller for higher storm representative dew points as well as for lower maximum dew point values. Likewise, larger maximization factors result from the use of lower storm representative dew points and/or higher maximum dew points. The magnitude of the change in the maximization factor varies depending on the dew point values. For the range of dew point values used in most PMP studies, the maximization factor for a particular storm will change about 5% for every 1^{o}F difference between the storm representative and maximum dew point values. The same sensitivity applies to the transposition factor, with ~ 5% change for every 1^{o}F change in either the in-place maximum dew point or the transposition maximum dew point[2].

For example, consider the following case:

Storm representative dew point: 75^{o}F Precipitable water: 2.85 "

[2] Note that the amount of moisture per degree of dew point temp is not linear, but this 5% formula fits within the range of dew points used in this analysis.

Maximum dew point: 79°F Precipitable water: 3.44"
Maximization factor = 3.44"/2.85" = 1.21

If the storm representative dew point were 74°F with precipitable water of 2.73",
Maximization Factor = 3.44"/2.73" = 1.26 (an increase of approximately 4%)

If the maximum dew point were 78°F with precipitable water of 3.29",
Maximization Factor = 3.29"/2.85" = 1.15 (a decrease of approximately 5%)

13.2.2 Sensitivity of the Elevation Adjustment Factor

Variations in elevation associated with topographic features remove atmospheric moisture from an air mass as it moves over the terrain. When storms are transpositioned, the elevation of the storm center location is used to compute the amount of atmospheric moisture depleted from the storm atmosphere during the in-place moisture maximization process. The absolute amount of moisture depletion is somewhat dependent on the dew point values, but is primarily dependent on the elevation at the original storm location compared to the elevation of the basin centroid and each grid point. The elevation adjustment is slightly less than 1% for every 100 feet of elevation change between the original storm location and the study basin elevation.

For example, consider the following case:

Maximum dew point:	79°F
Elevation:	1,000 '
Precipitable water between 1000-mb and the top of the atmosphere:	3.44"
Precipitable water between 1000-mb and 1,000':	0.28"

Elevation Adjustment Factor = (3.44"-0.28")/3.44" = 0.92 (approximately 1% per 100 feet)

If the elevation were 2,000', the precipitable water between
1000mb and 2,000' is 0.55"
Elevation Adjustment Factor = (3.44"-0.55")/3.44" = 0.84 (approximately 1% per 100 feet)

14. Recommendations for Application

14.1 PMP and LIP Applications

PMP values have been computed that provide maximum rainfall amounts for use in computing the PMF at any location within the ANO basin. The study addressed several issues that could potentially affect the magnitude of the PMP storm over basin as compared with HMRs 51 and 55A and the LIP storm over the ANO site location.

Analysis of moisture availability for previously analyzed storms and analysis of recent extreme storms with up to date state-of-the-science techniques resulted in PMP values which replace HMRs 51 and 55A and LIP values which replace those in HMR 52. These represent the most current PMP values that should be used together with the procedures in HMR 52 and updated PMP design storm parameters to provide PMP rainfall at any location within the basin.

HMR 52 uses a procedure for locating the largest amounts of rainfall associated with the PMP storm, such that the largest volume of rain falls within the watershed boundaries. Because the ANO basin is much larger than the largest HMR 52 design storm, updated parameters in addition to HMR 52 were evaluated. This included storm movement recommendations for the PMP design storm.

14.2 Discussion on the Spatial Limits of the PMP Values

The grid system used in this study was designed such that no regions within the basin required extrapolation of storm data but allowed for interpolation between rainfall values at grid point or the use of the gridded data within GIS. The grid extended beyond the geographic boundaries of the basin. The emphasis was to provide the most reliable and consistent analysis within the geographic region. PMP maps are provided to allow for PMP values to be extracted for any location in basin. As an option, a user who has GIS software can use the gridded data to explicitly determine PMP values at any location within the basin.

For each of the storms analyzed, appropriate transposition grid points were defined (see Appendix F). After all the storms were analyzed, the largest rainfall values were determined for each grid point for each duration and area size. These largest values were enveloped to insure both spatial and temporal continuity.

Once the enveloped values were finalized, lines of constant PMP values were drawn using GIS interpolation software for each duration and area size. These iso-PMP lines were extended beyond the basin boundary such that PMP values could be interpolated at all locations within the basin. Hence, the reason that some iso-PMP lines extend beyond the basin boundary is to allow for gradients to be determined between lines for all locations within the ANO basin.

For regions outside of the basin where extrapolation would be required, the gradient is uncertain. There are probably regions where the extended lines provide reasonable PMP values while for other regions, PMP values are less reliable. This study provides PMP values only for locations within the ANO basin.

14.3 Climate Change Assumptions

AWA recognizes that the climate is in a constant state of change. However, the current scientific consensus and understanding cannot agree how climate is changing and more importantly what those changes will be for the region. Therefore, one cannot say whether the region will be wetter or drier, warmer or colder and/or experience more or less extreme rainfall events with any quantitative and statistically significant certainty. Further, most projects of this type have a projected life between 30 to 50 years before they are redeveloped. In general, most projected changes that *may* occur within the Earth's climate system would be unlikely to significantly affect the project's hydrology beyond the bounds of the PMP and/or LIP values derived as part of this project during its useful life. Based on these discussions, it is apparent that the current practice of PMP determination should *not* be modified in an attempt to address potential changes associated with climate change. This study has continued the practice of assuming no climate change, as climate trends are not considered when preparing PMP estimates (WMO, Section 1.1.1).

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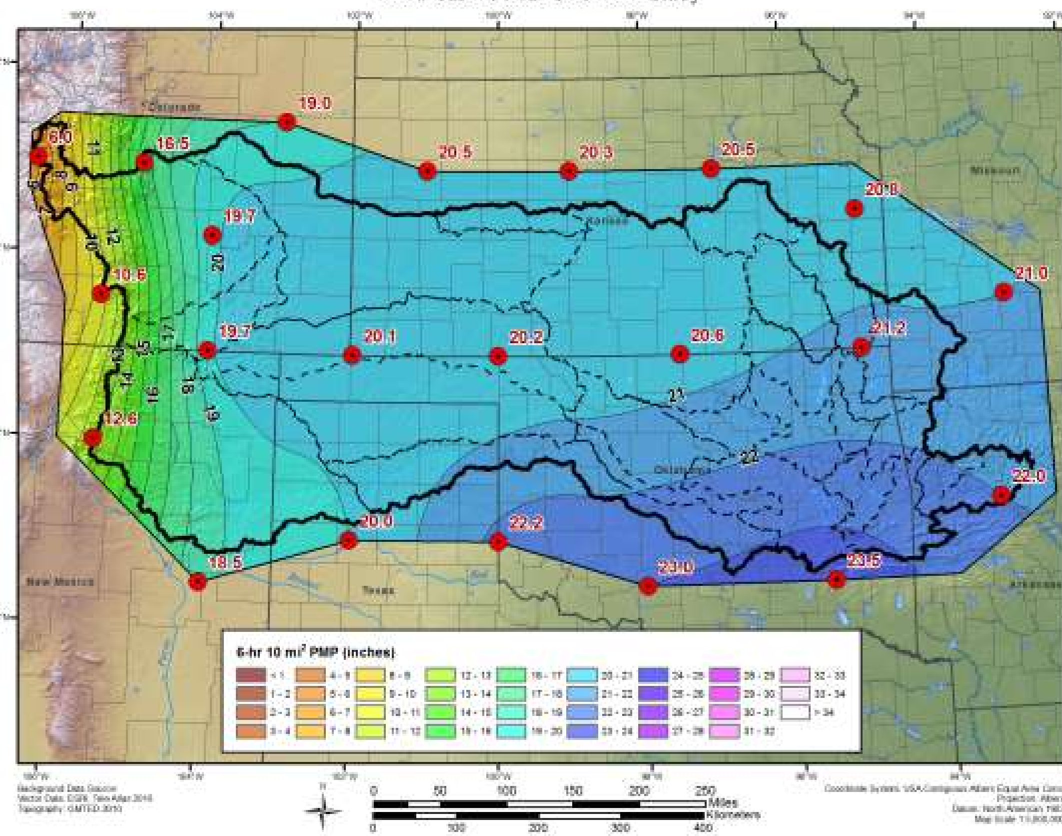
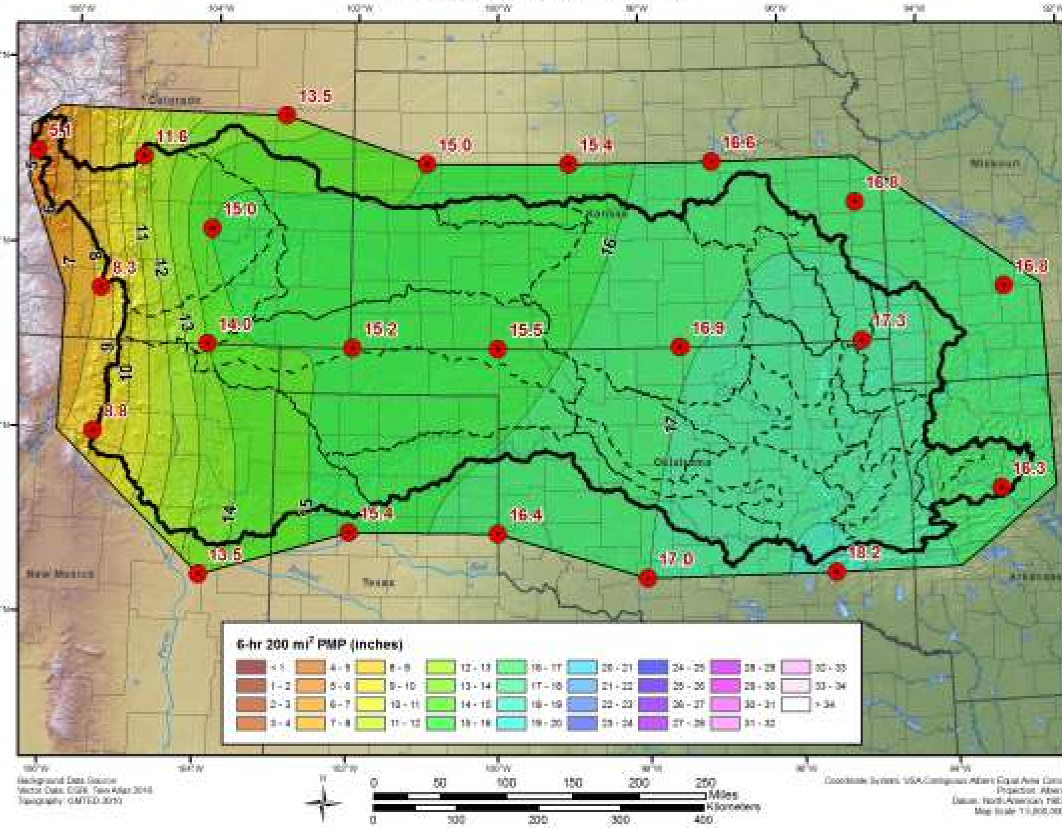
Appendix A

ANO Probable Maximum Precipitation Maps

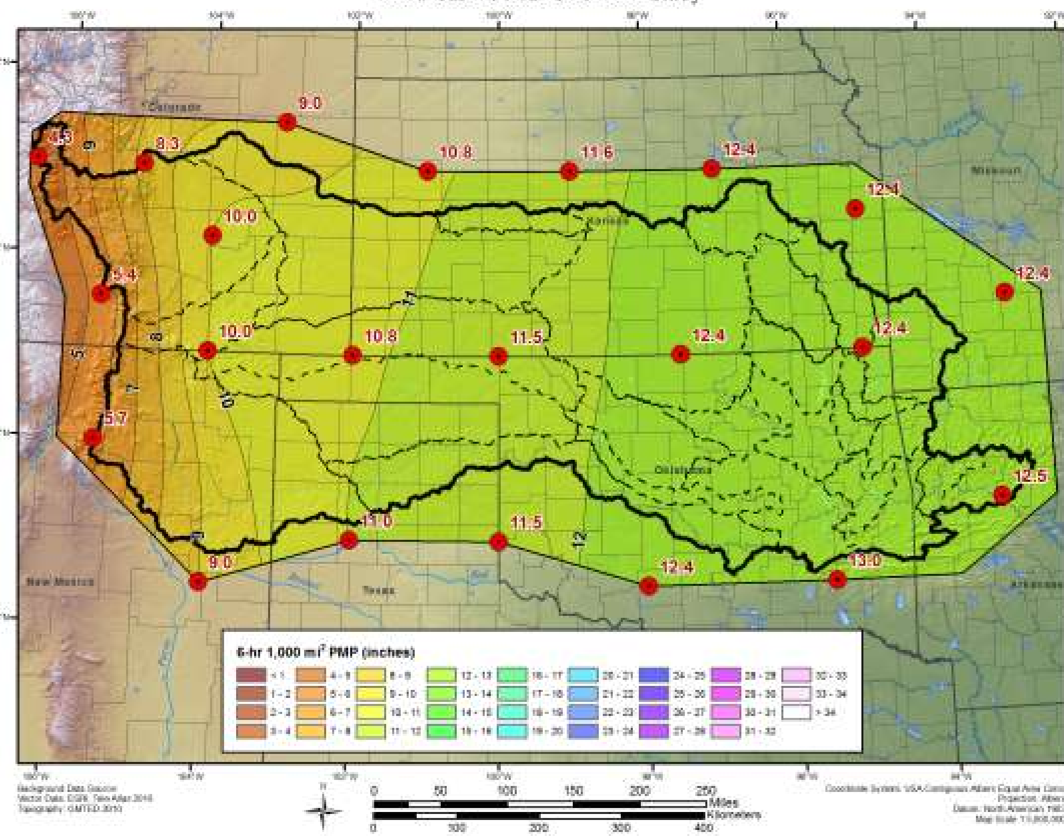
All-Season PMP - 6-hour 10 mi^2 (inches)
Arkansas Nuclear One PMP Study



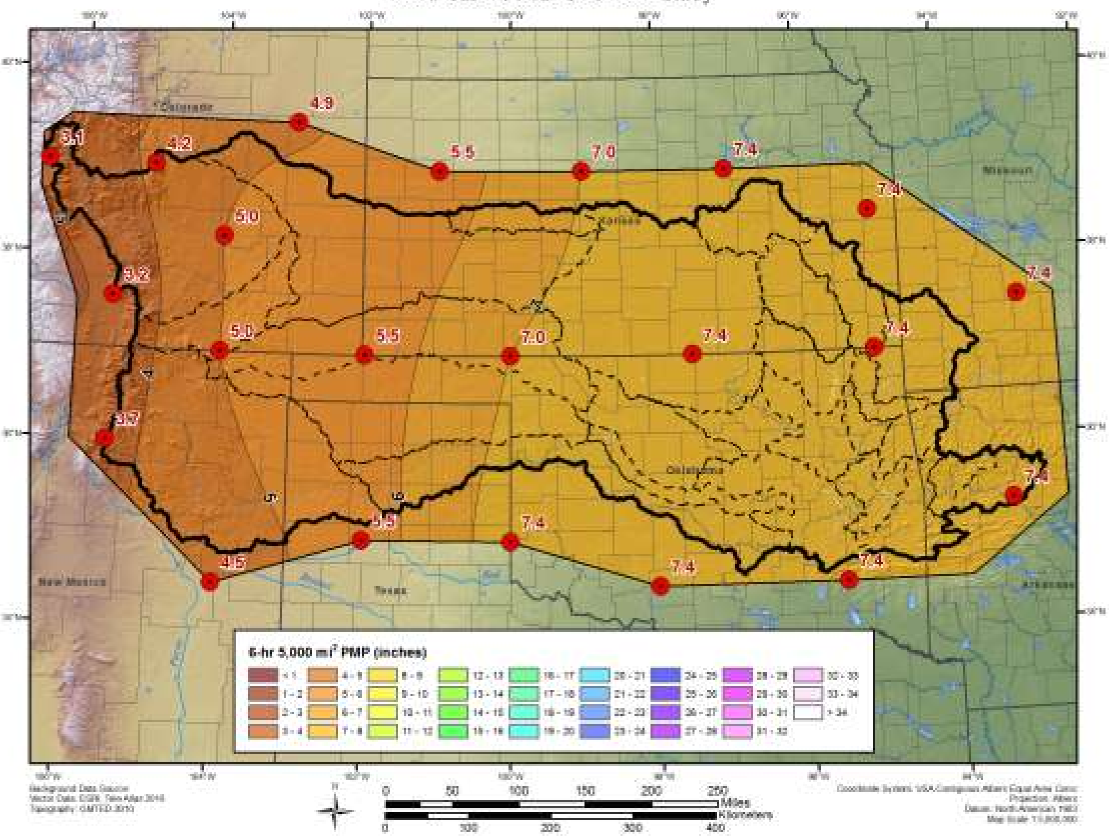
All-Season PMP - 6-hour 200 mi² (inches)
Arkansas Nuclear One PMP Study



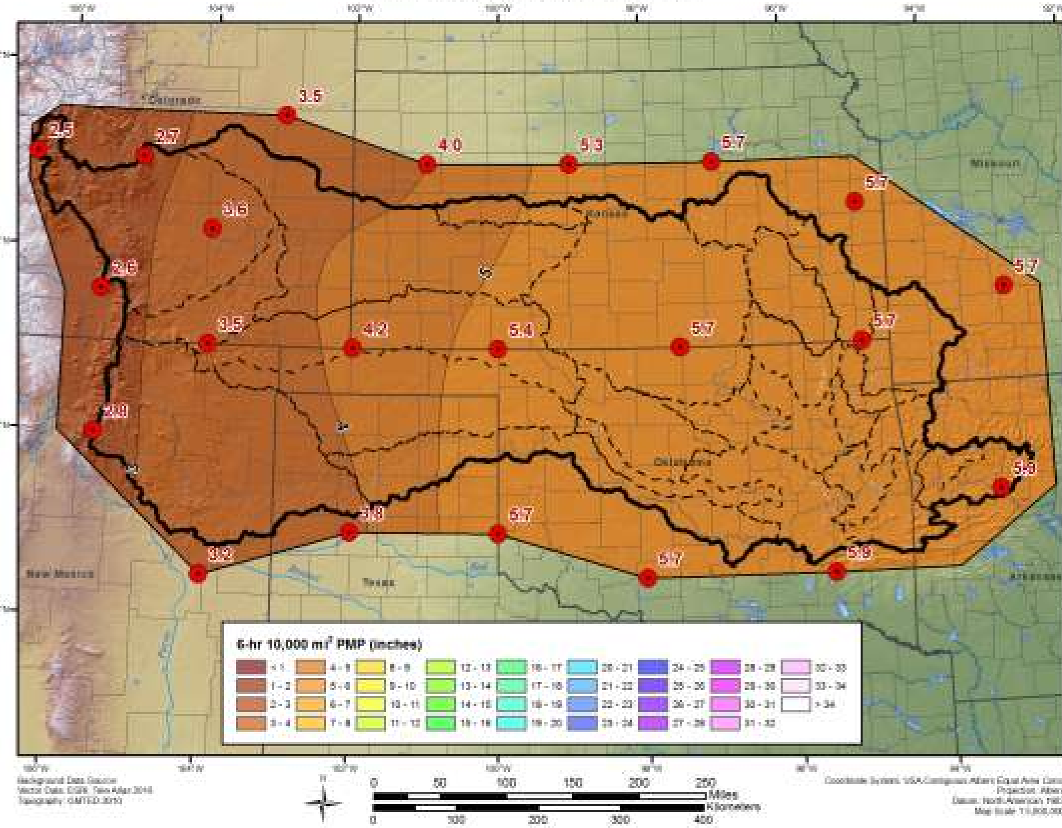
All-Season PMP - 6-hour 1,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



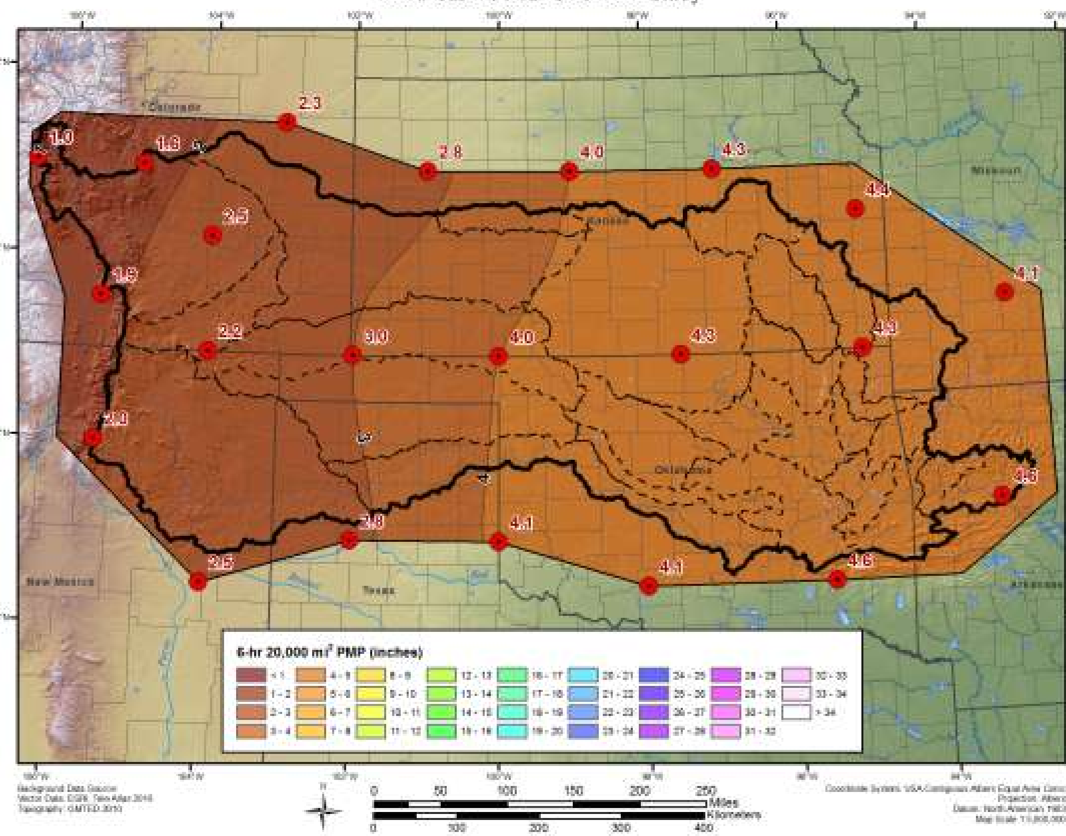
All-Season PMP - 6-hour 5,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



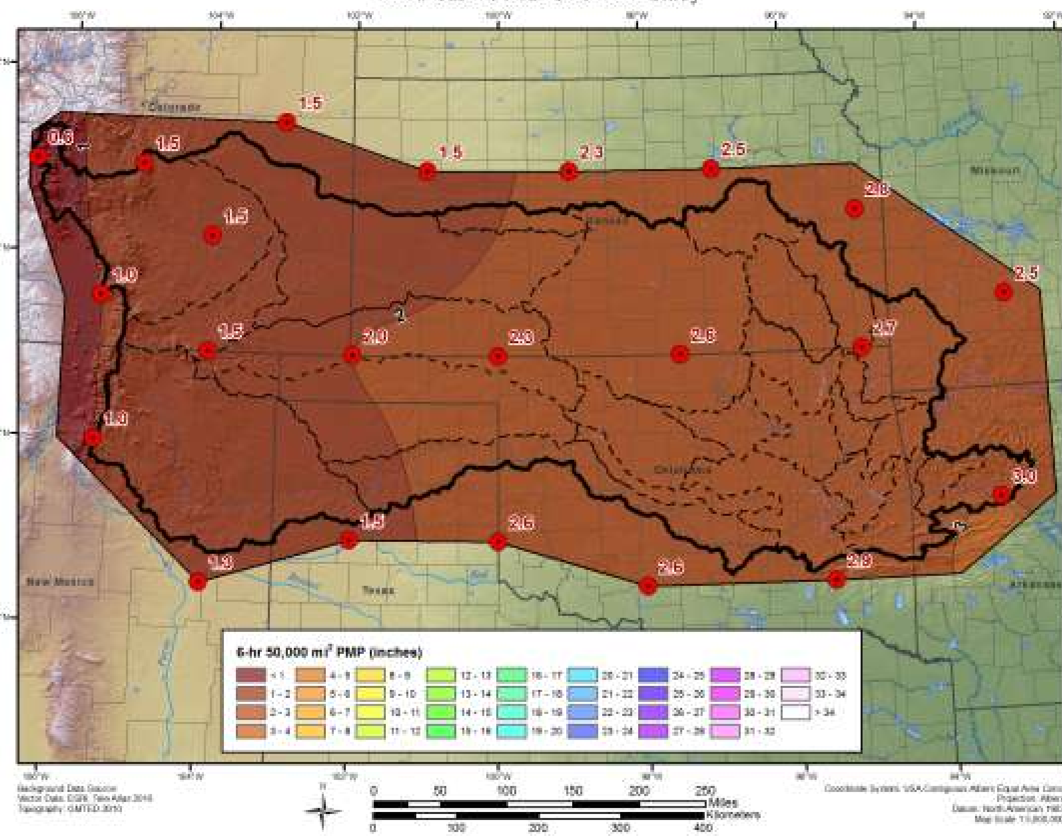
All-Season PMP - 6-hour 10,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



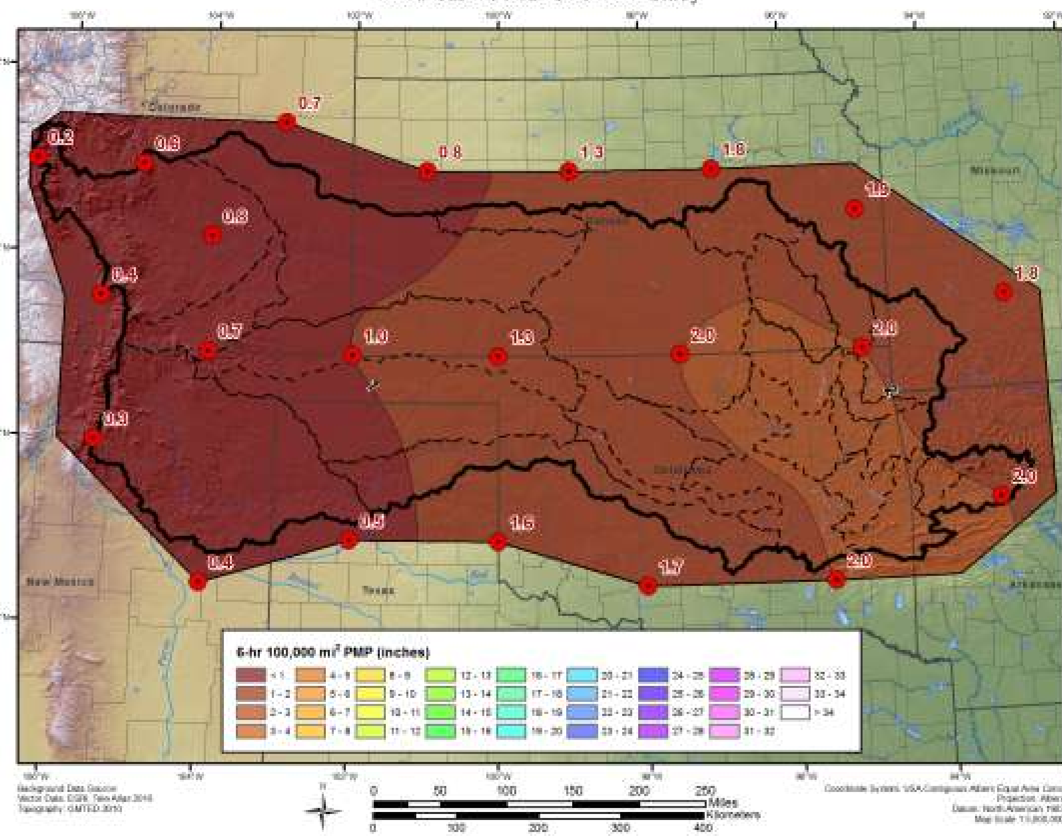
All-Season PMP - 6-hour 20,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



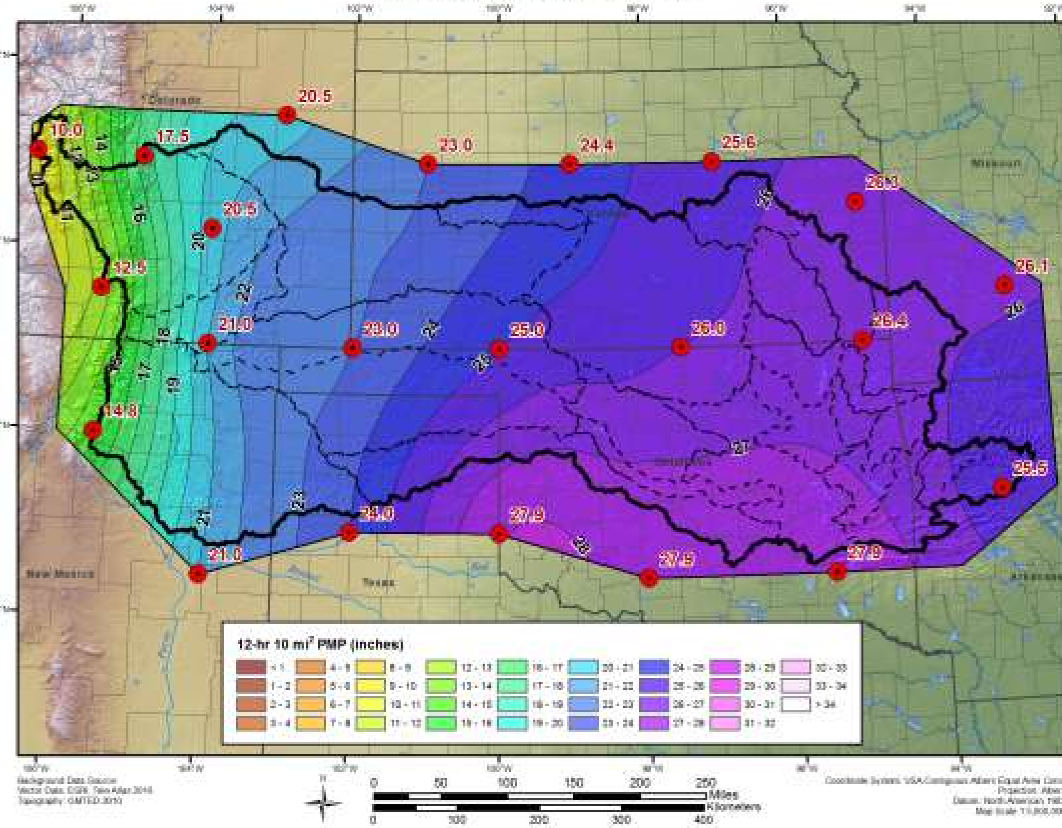
All-Season PMP - 6-hour 50,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



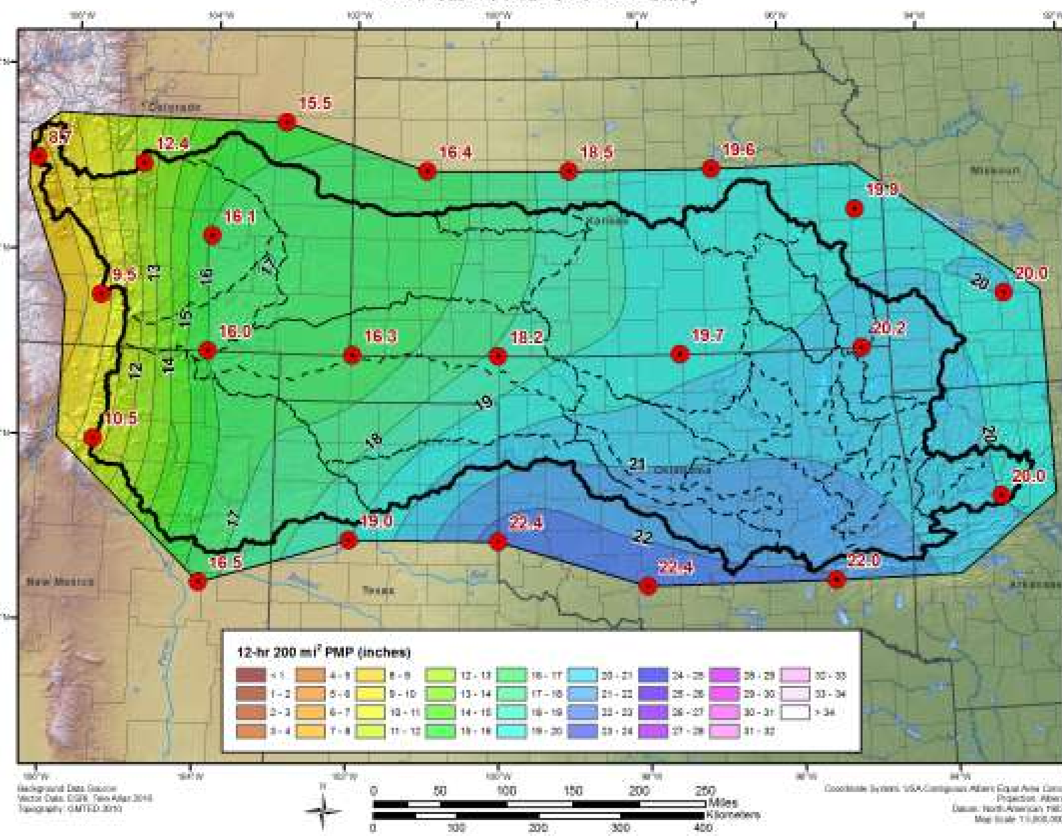
All-Season PMP - 6-hour 100,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



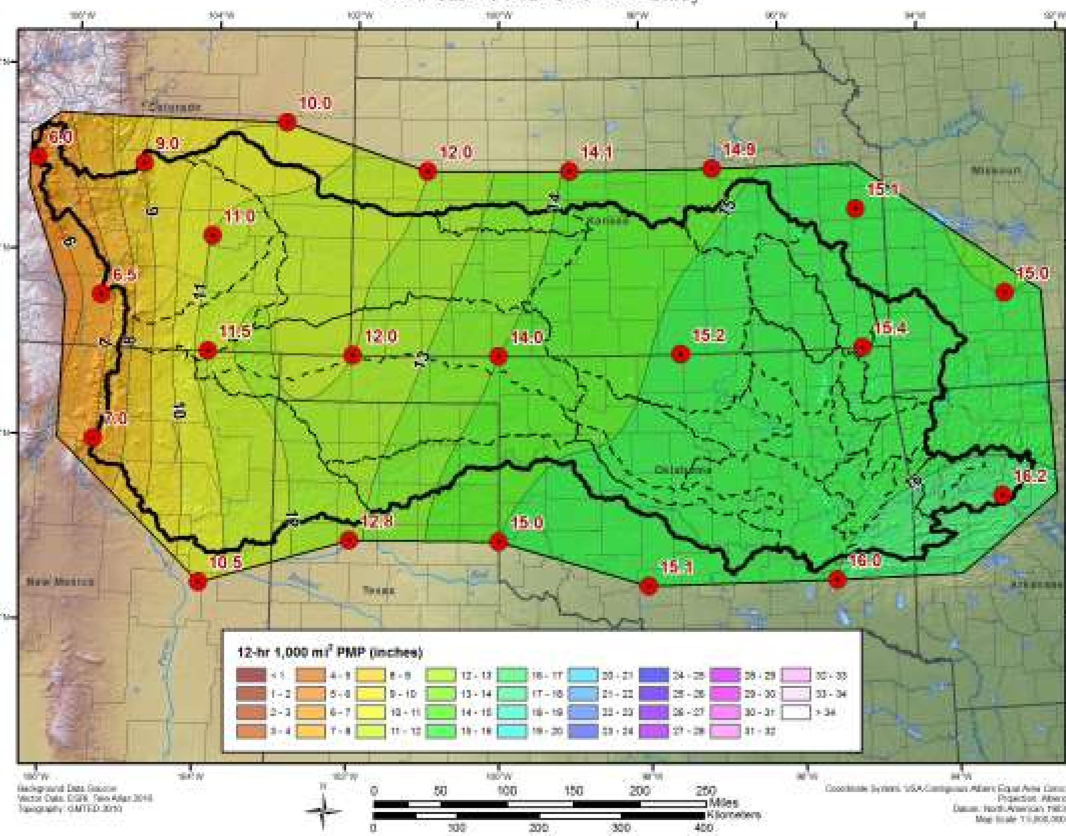
All-Season PMP - 12-hour 10 mi² (inches)
Arkansas Nuclear One PMP Study



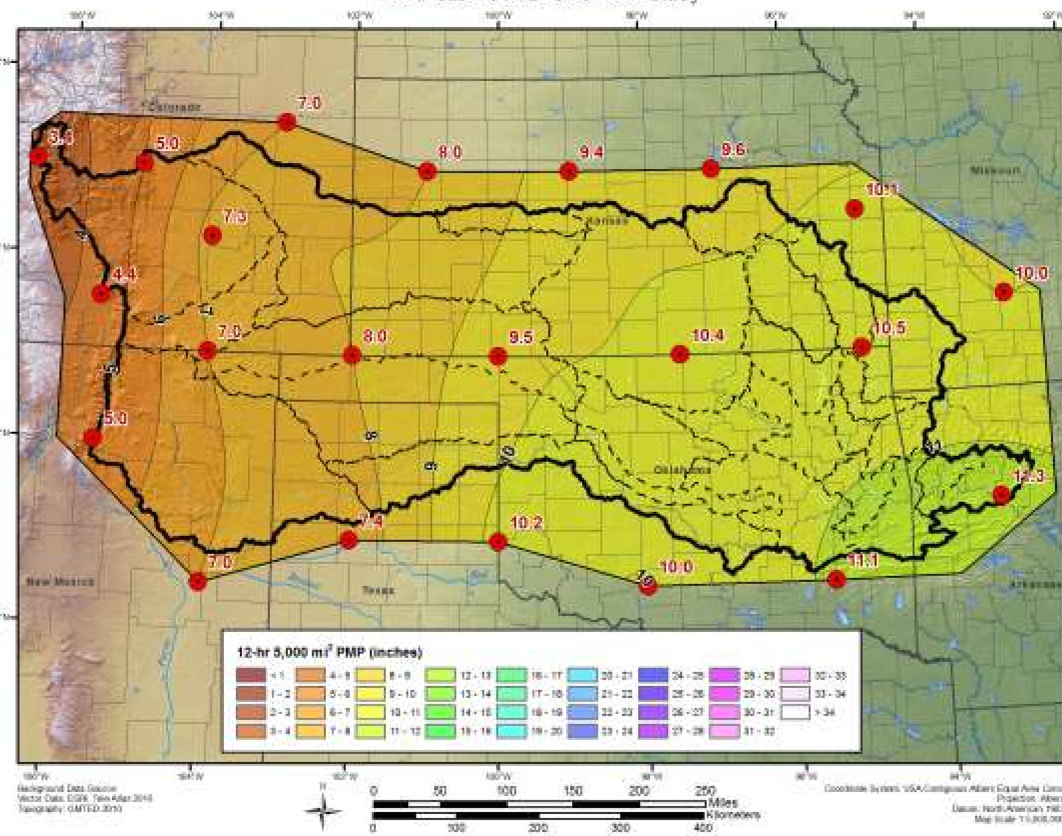
All-Season PMP - 12-hour 200 mi^2 (inches)
Arkansas Nuclear One PMP Study



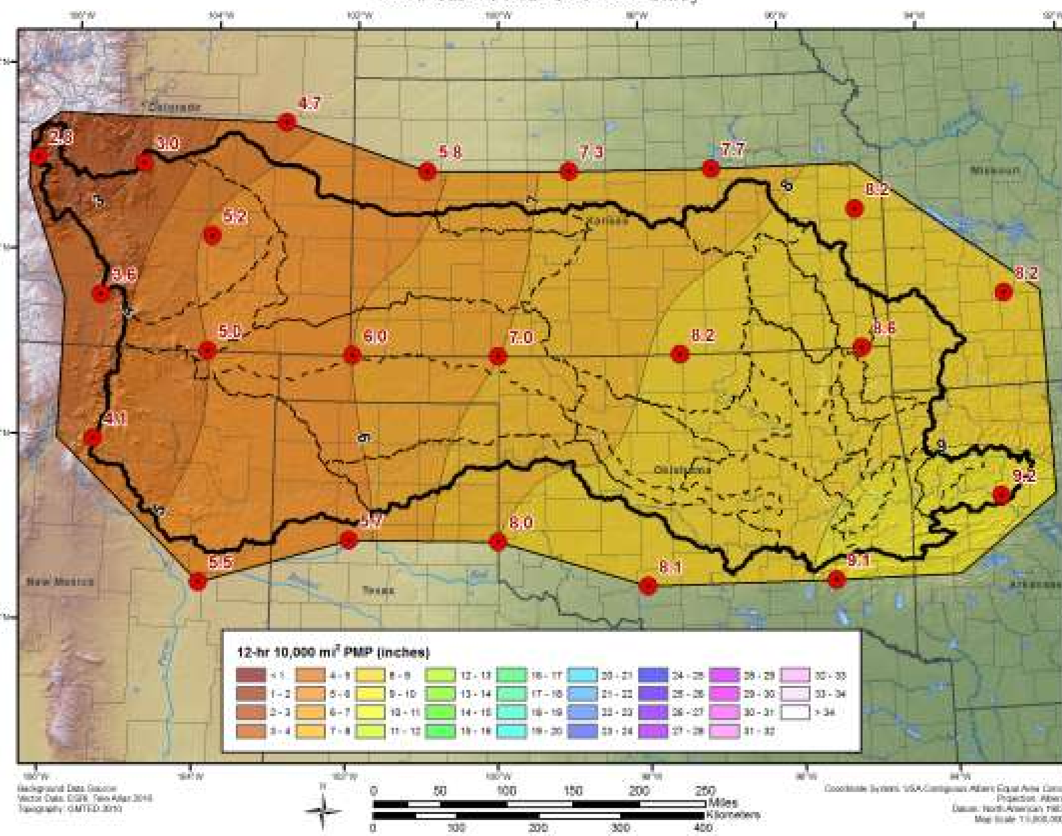
All-Season PMP - 12-hour 1,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



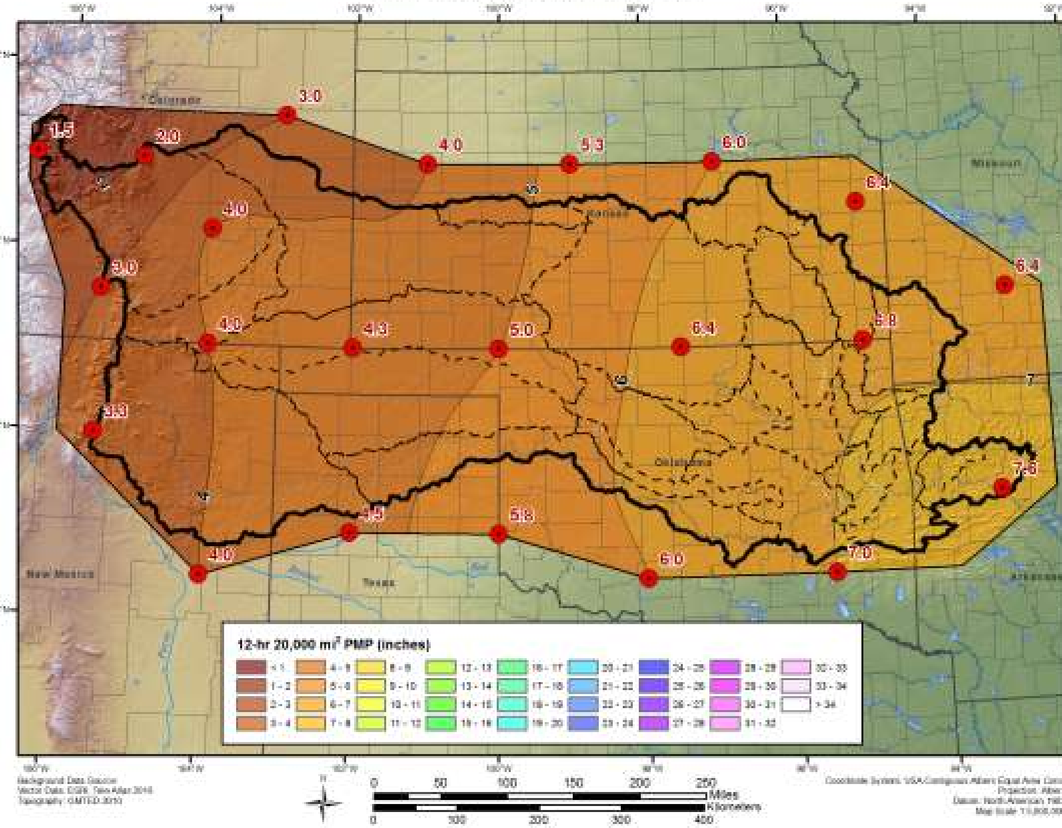
All-Season PMP - 12-hour 5,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



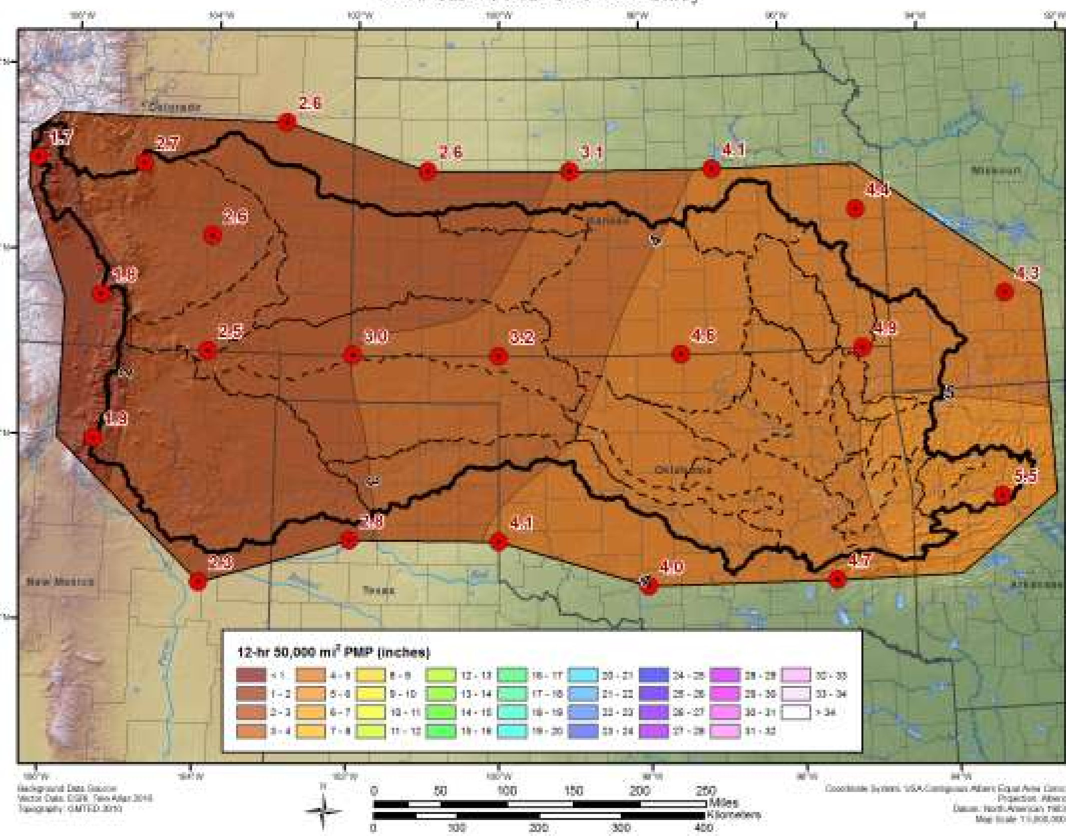
All-Season PMP - 12-hour 10,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



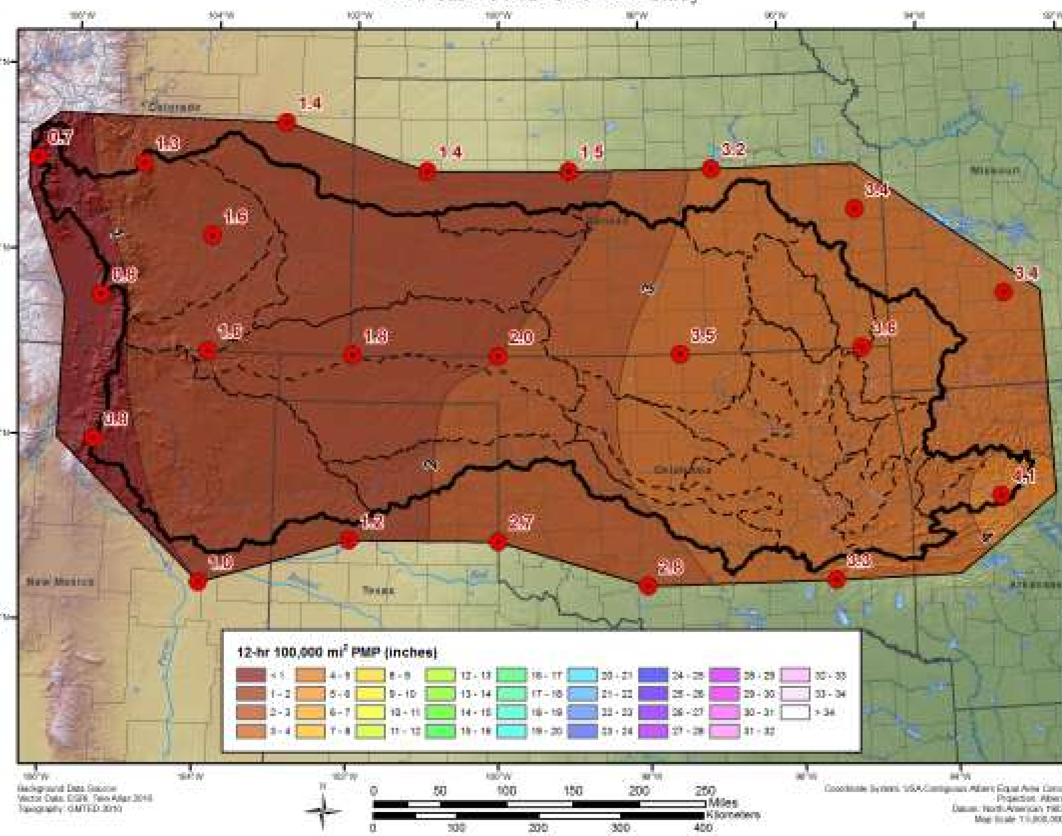
All-Season PMP - 12-hour 20,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



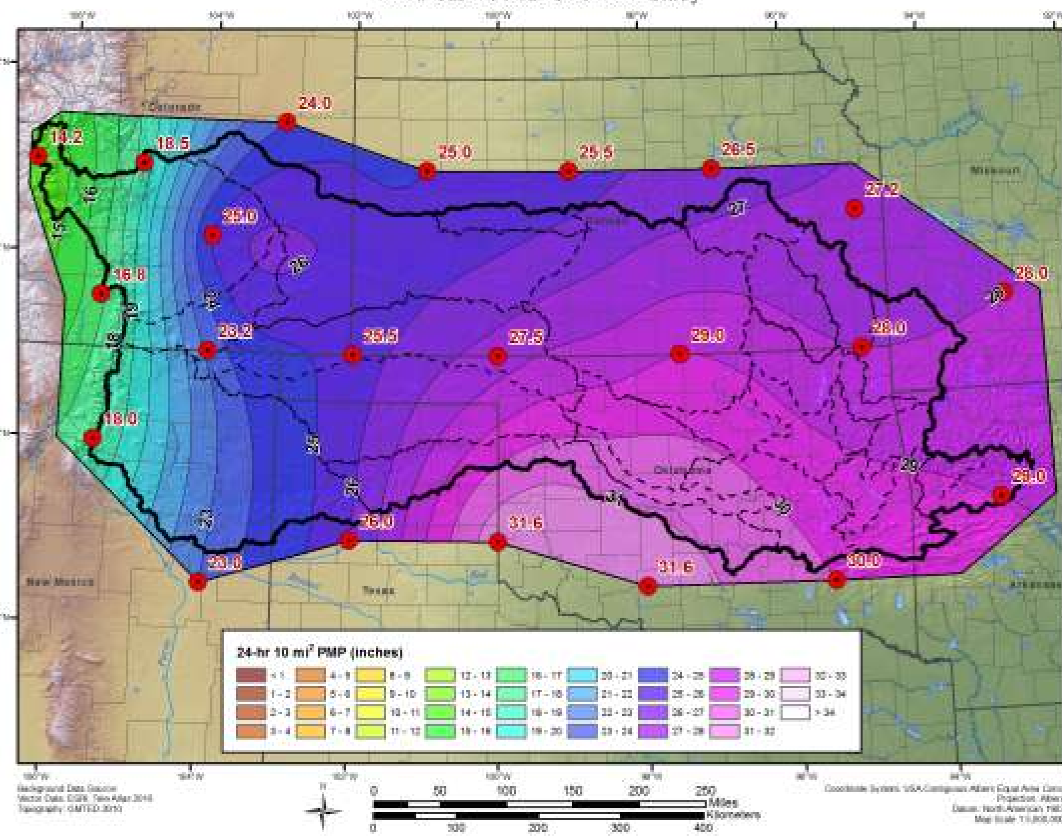
All-Season PMP - 12-hour 50,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



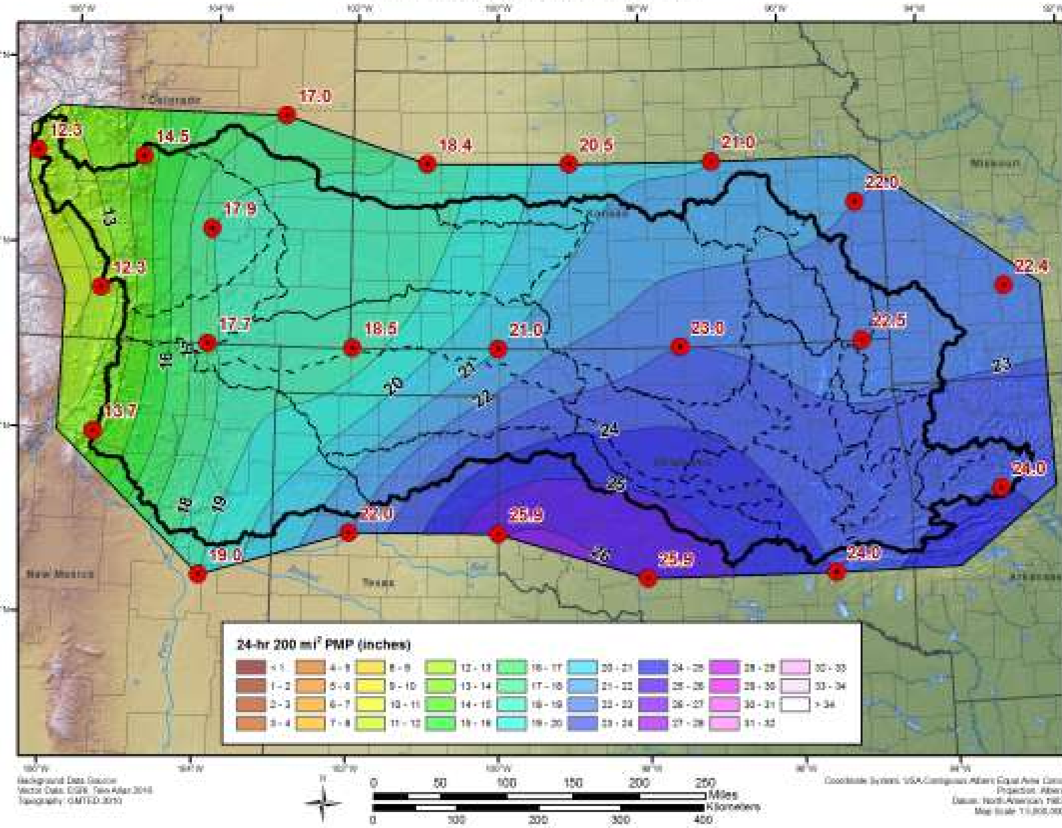
All-Season PMP - 12-hour 100,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



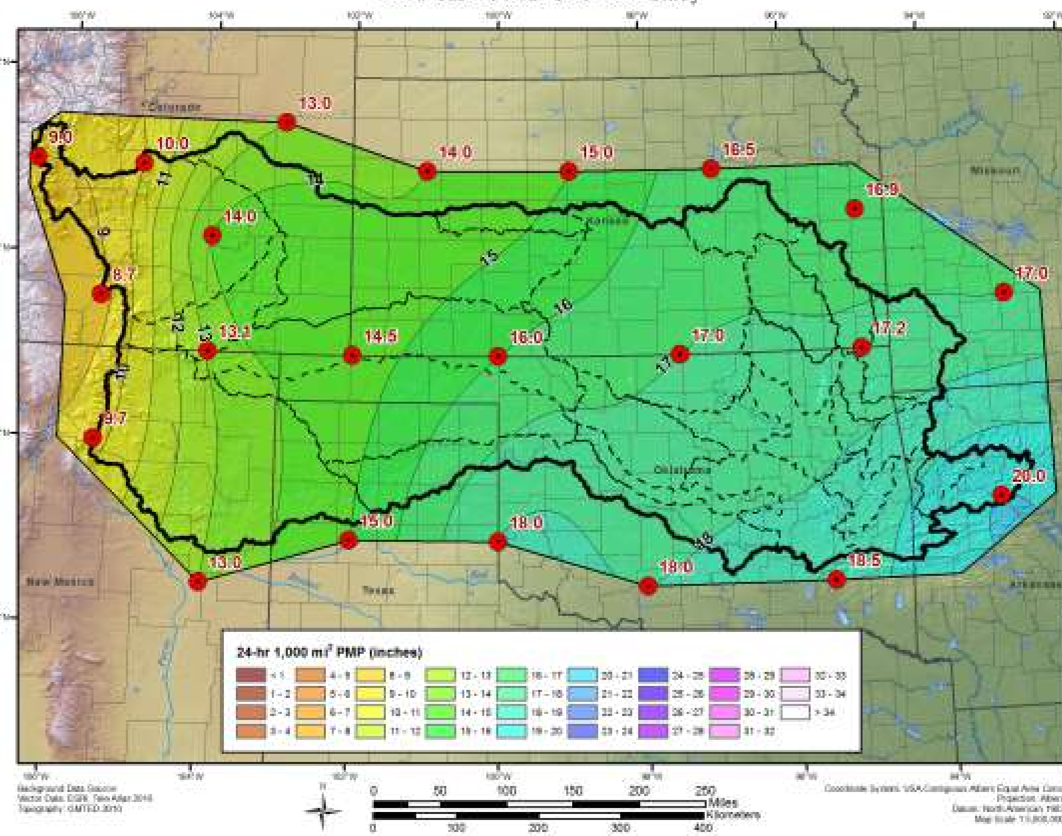
All-Season PMP - 24-hour 10 mi^2 (inches)
Arkansas Nuclear One PMP Study



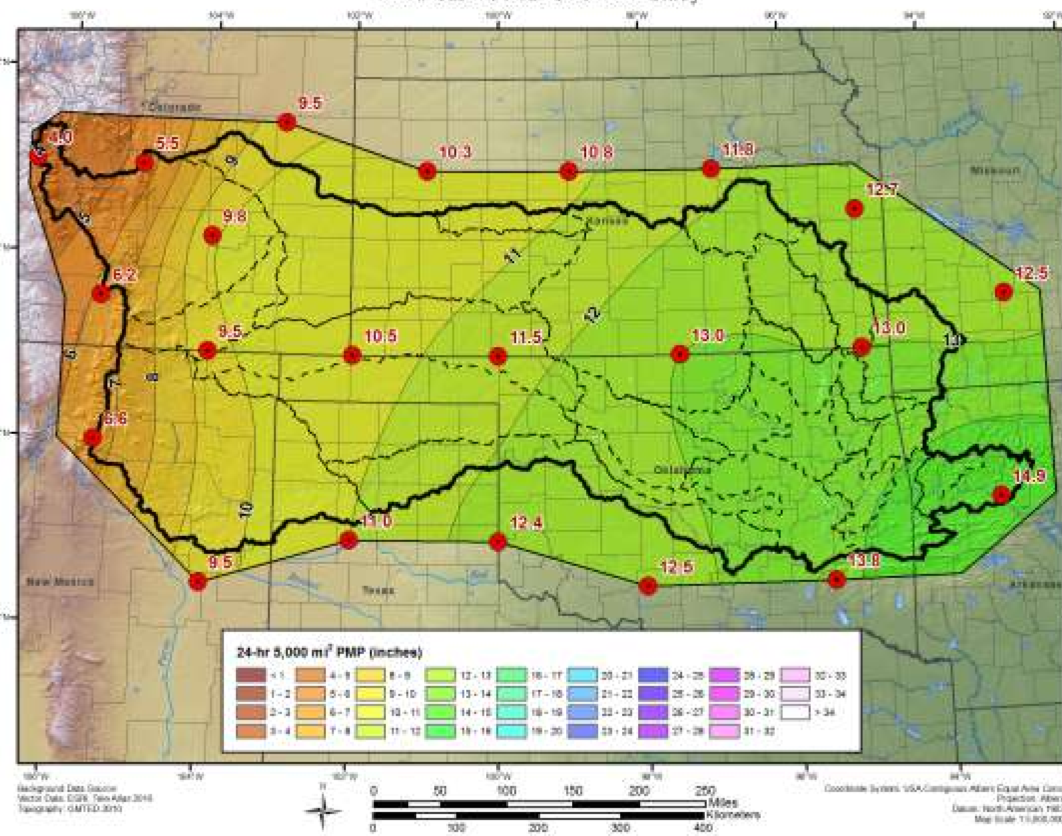
All-Season PMP - 24-hour 200 mi^2 (inches)
Arkansas Nuclear One PMP Study



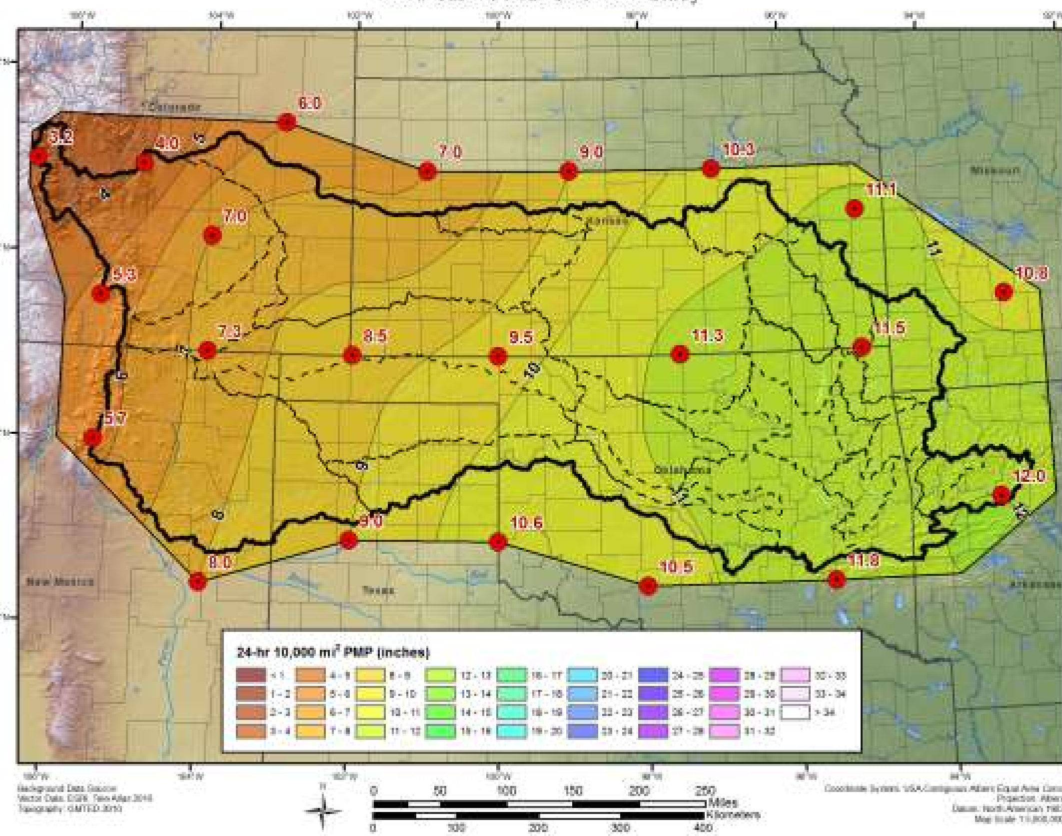
All-Season PMP - 24-hour 1,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 24-hour 5,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 24-hour 10,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 24-hour 20,000 mi^2 (inches)
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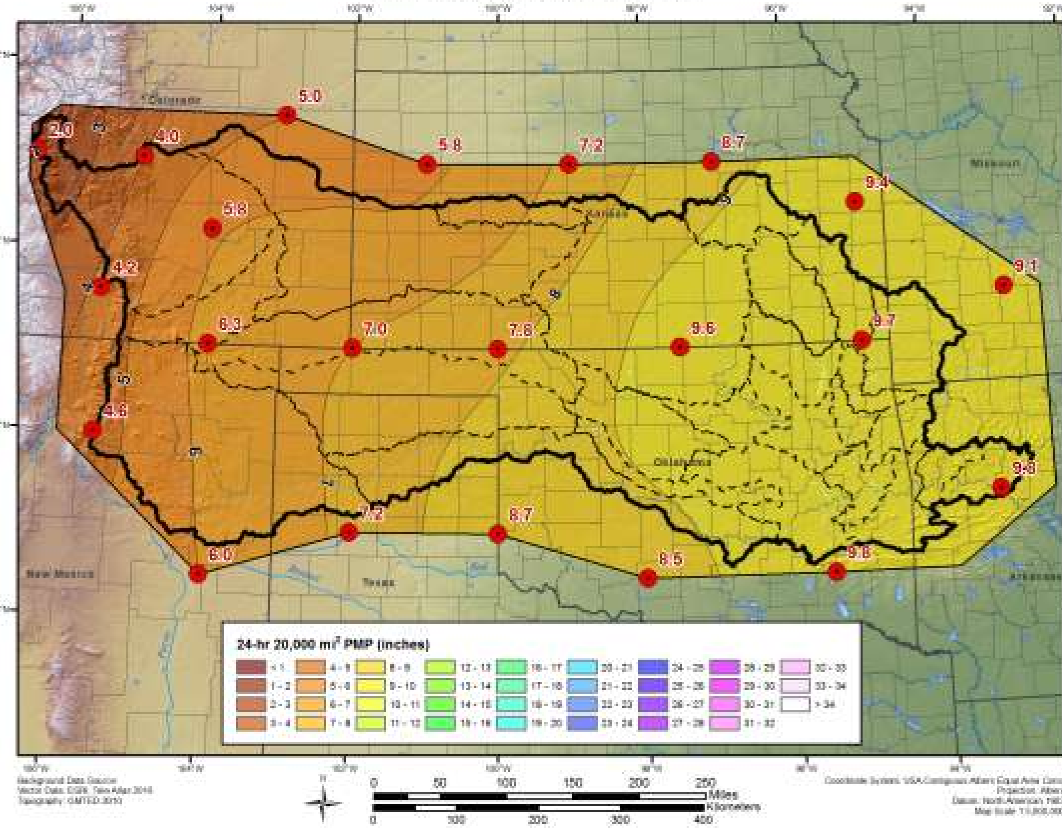
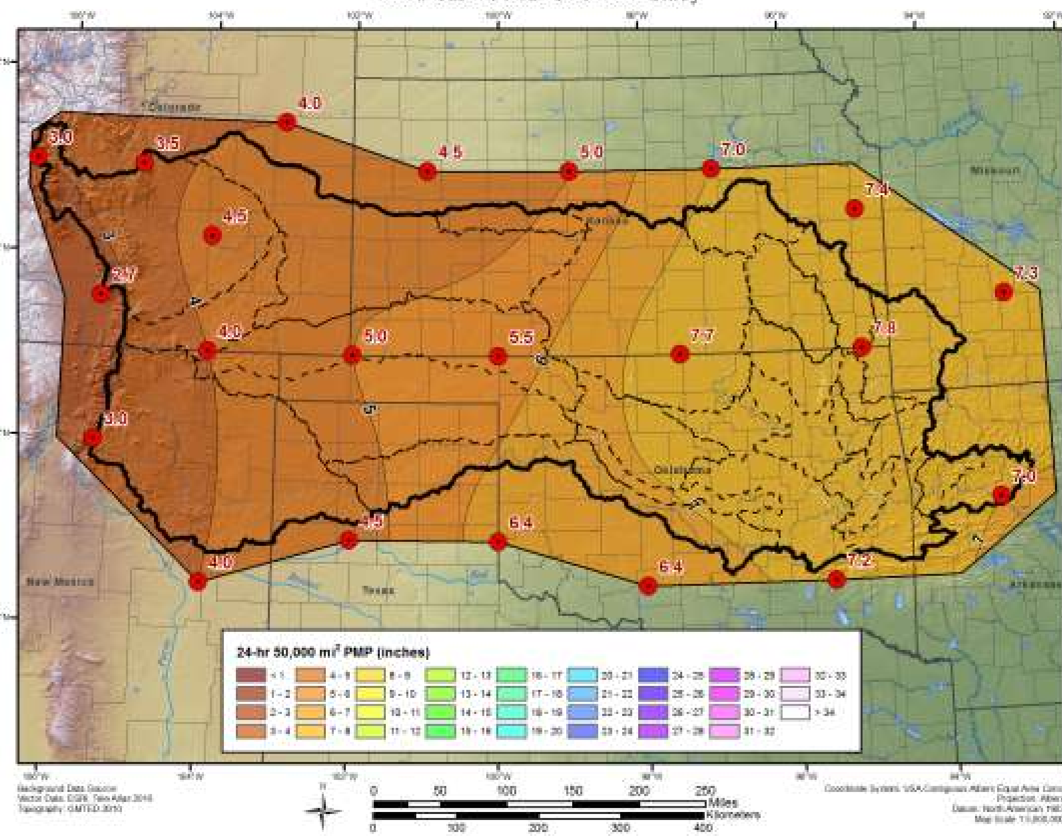
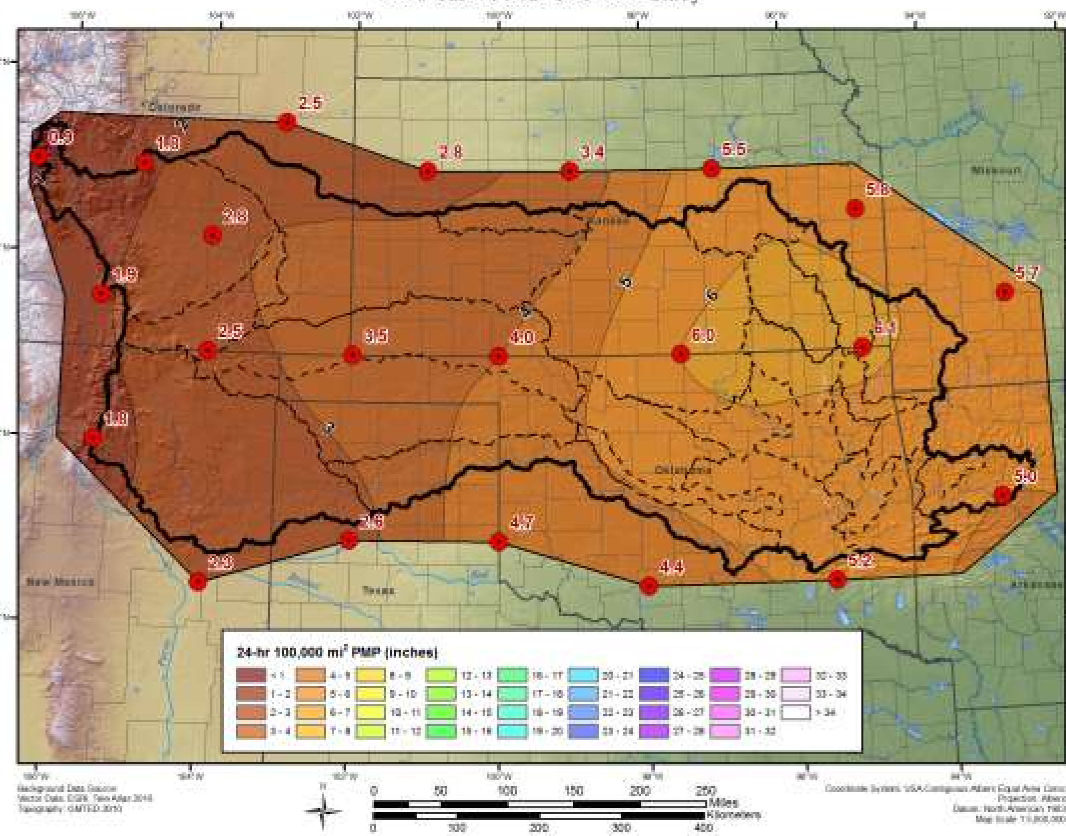


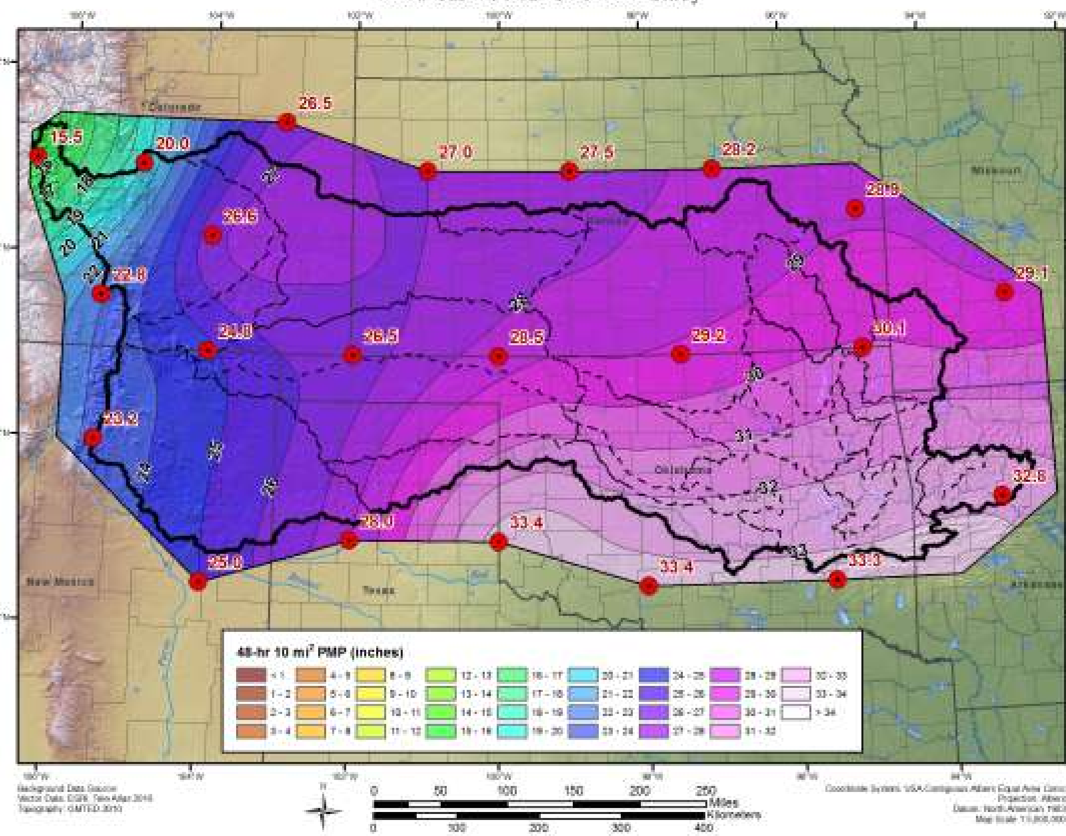
All-Season PMP - 24-hour 50,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 24-hour 100,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 48-hour 10 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 48-hour 200 mi^2 (inches)
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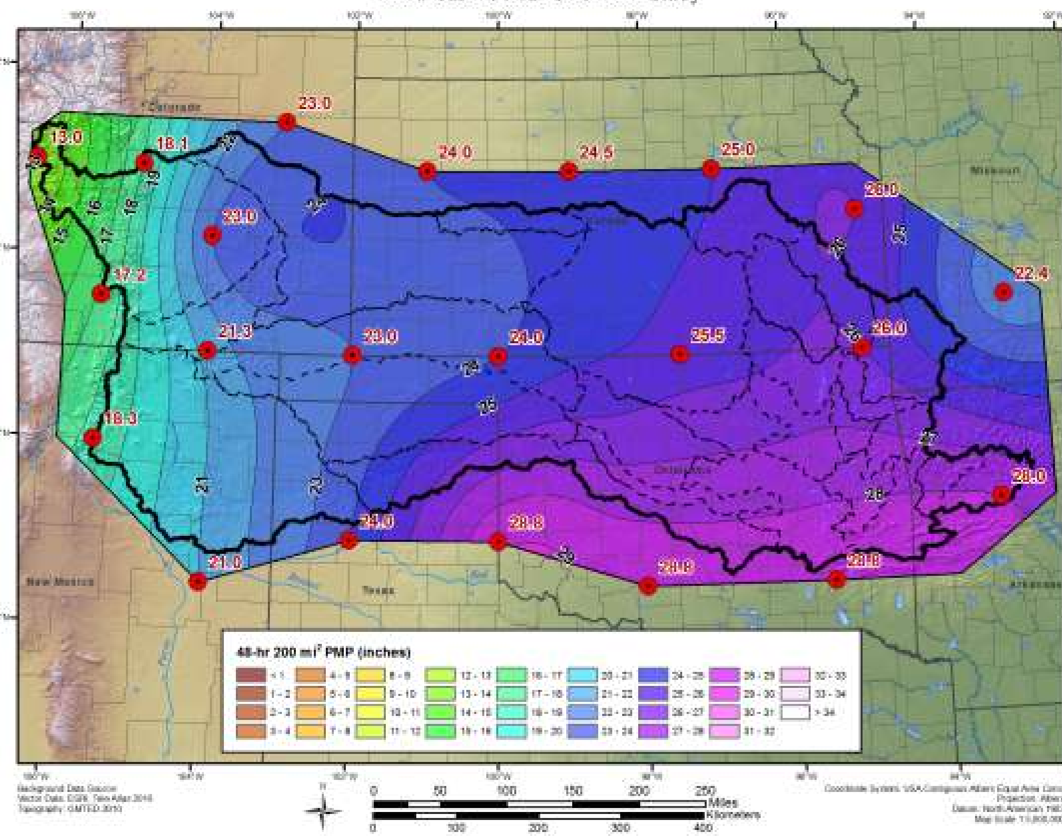
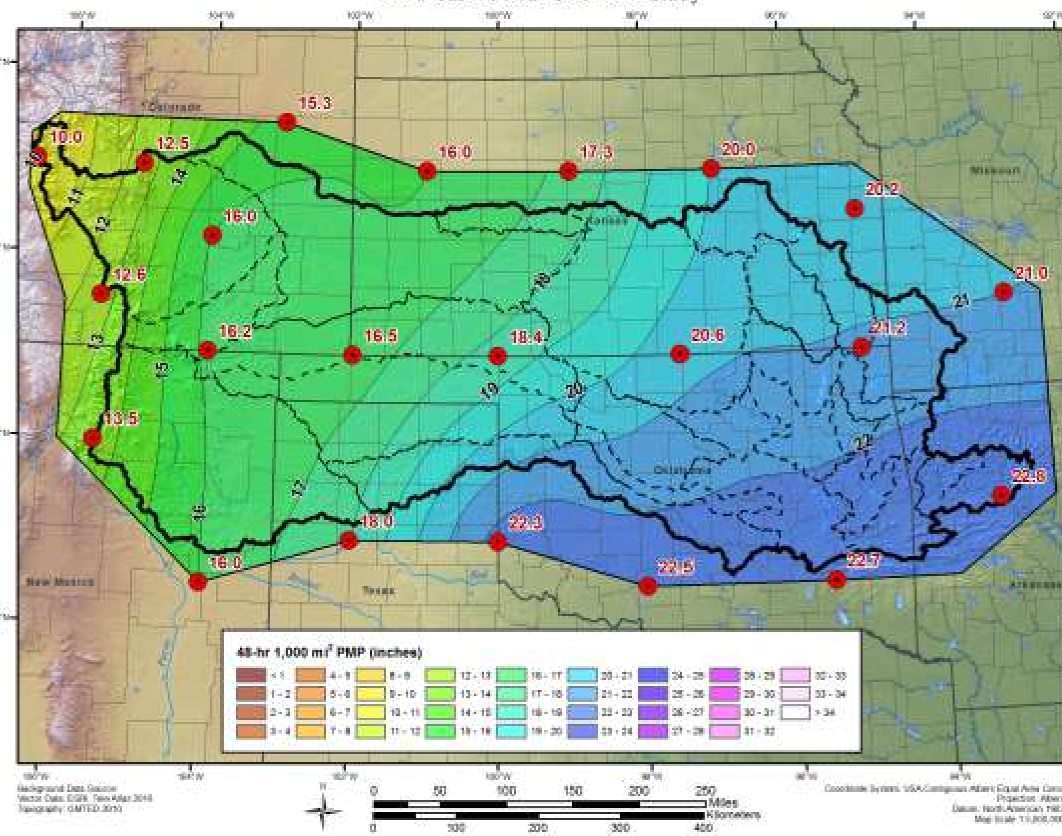


All-Season PMP - 48-hour 1,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 48-hour 5,000 mi^2 (inches)
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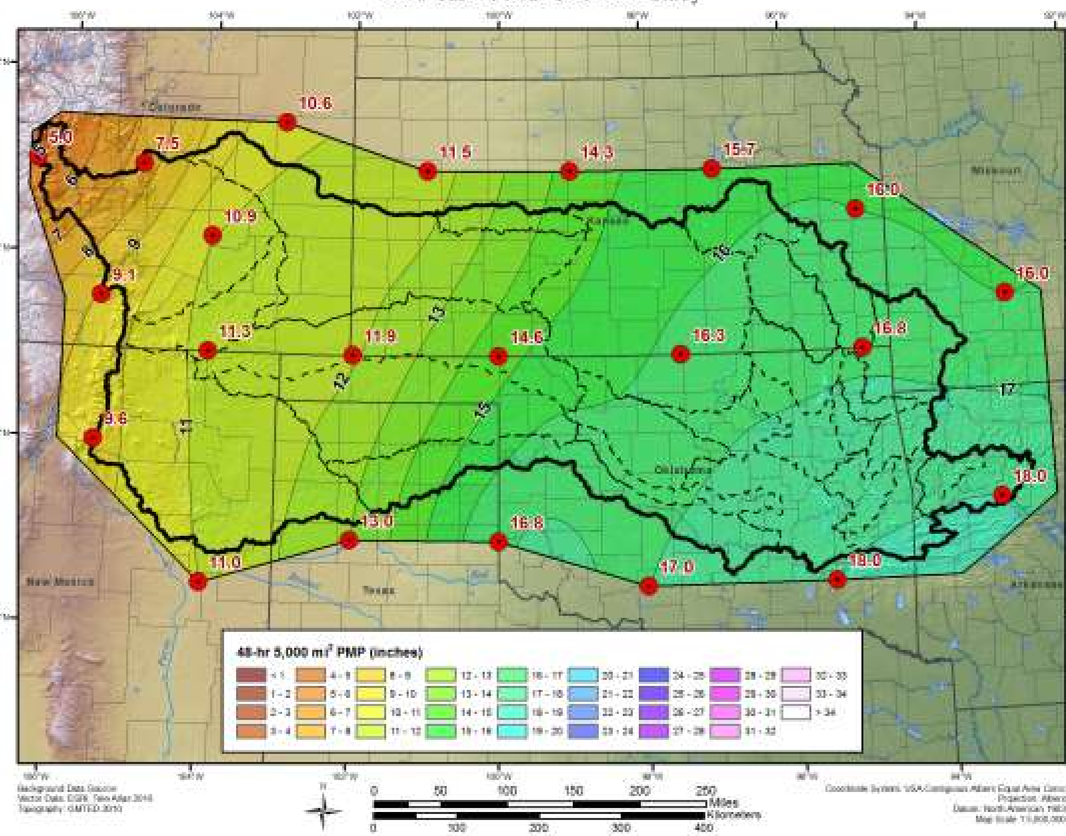

All-Season PMP - 48-hour 10,000 mi^2 (inches)
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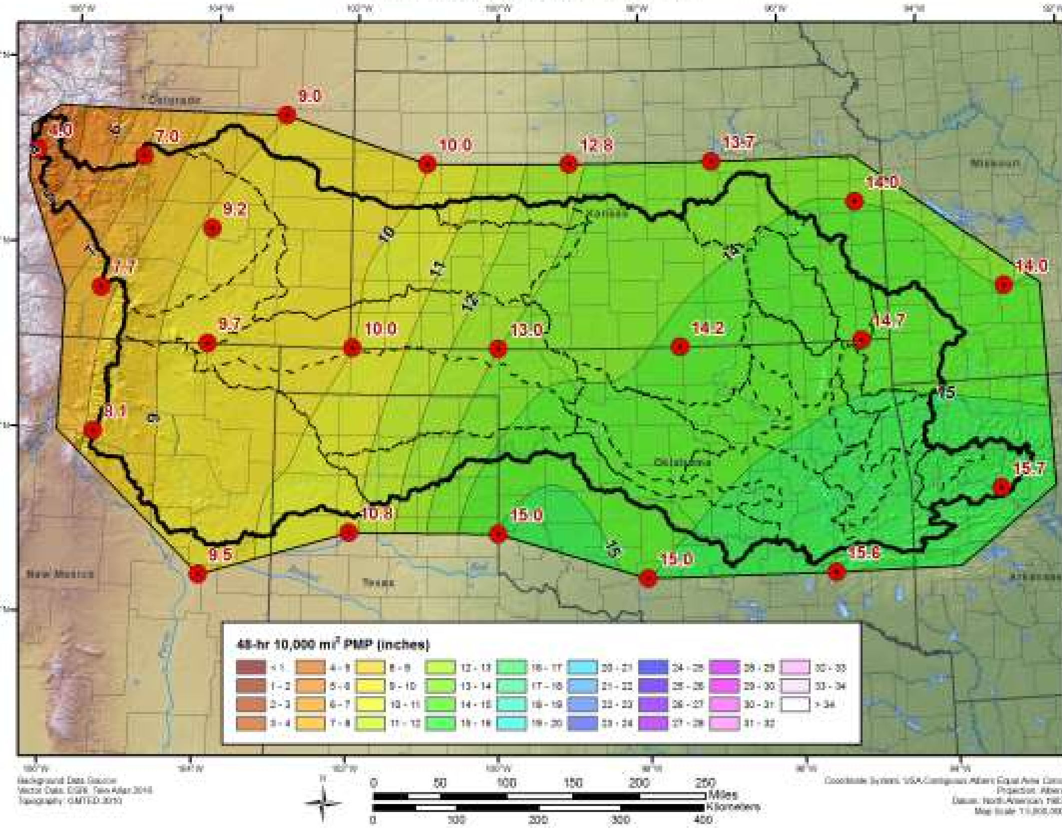

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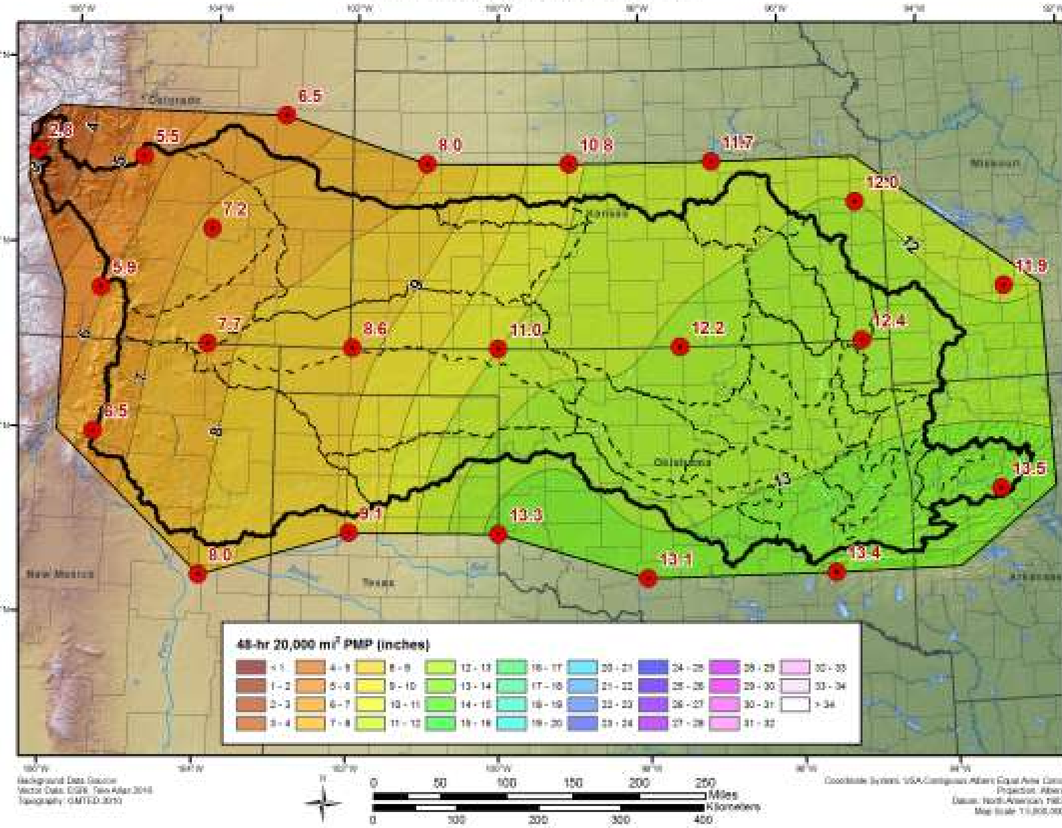

All-Season PMP - 48-hour 50,000 mi² (inches)
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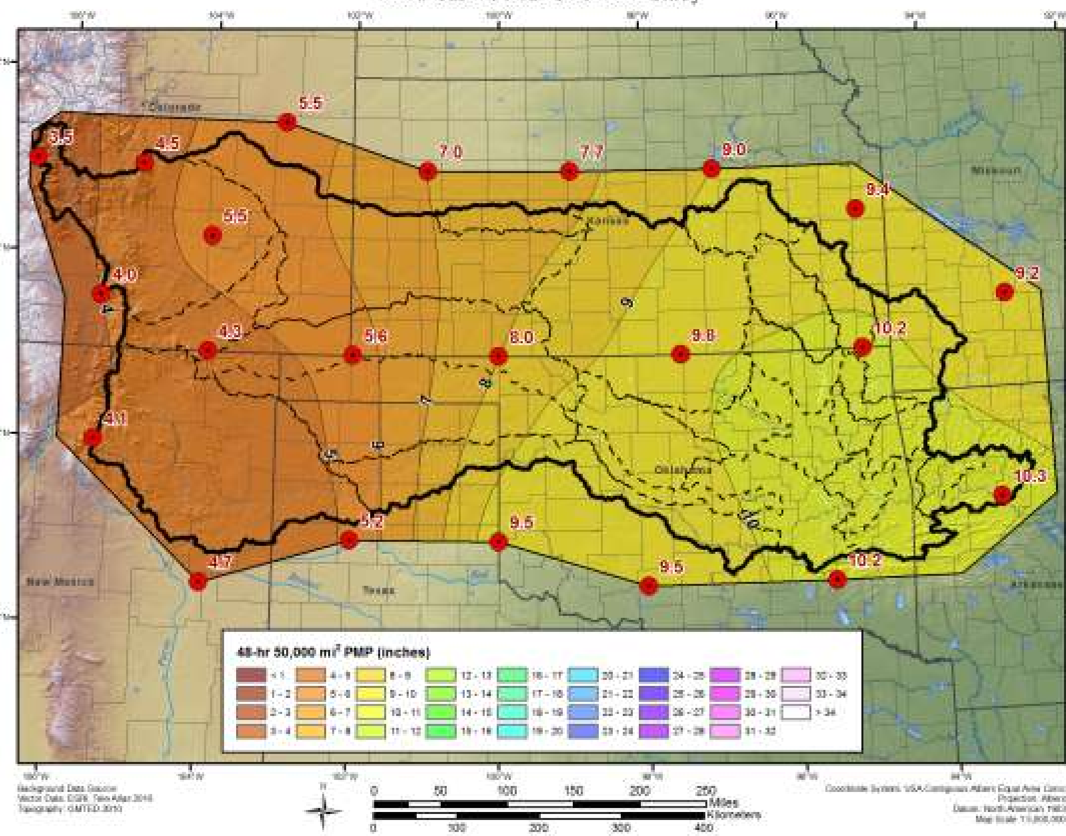

All-Season PMP - 48-hour 100,000 mi^2 (inches)
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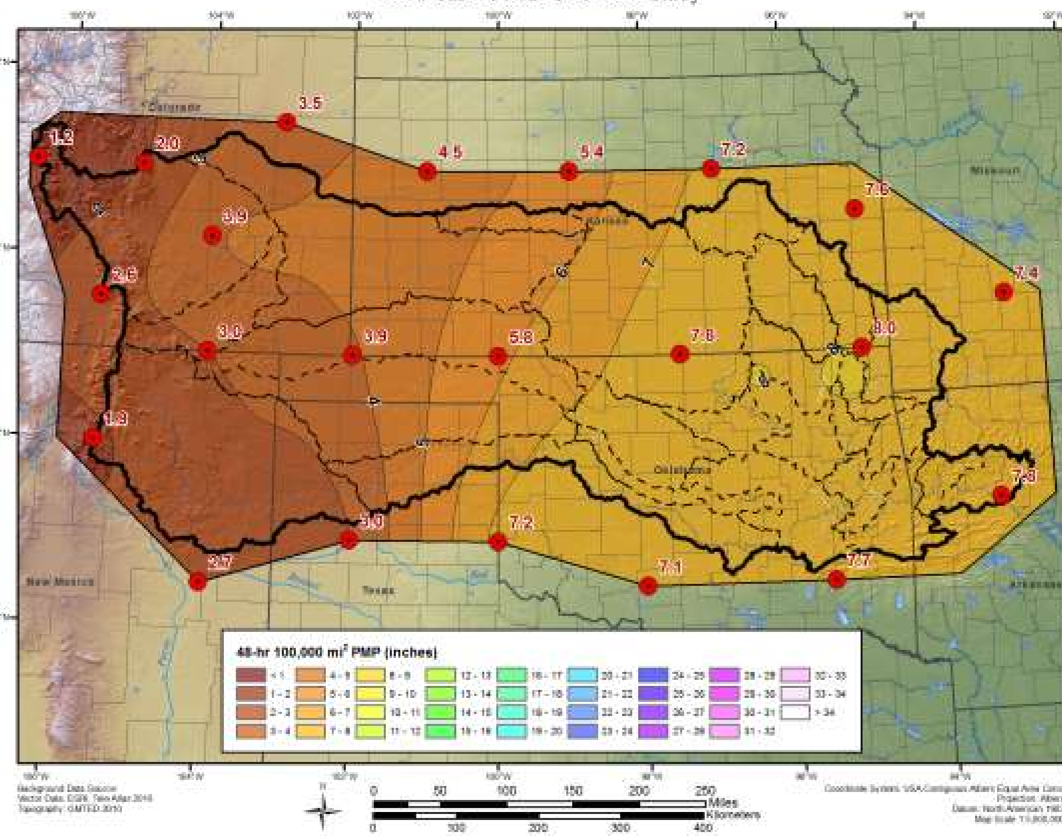
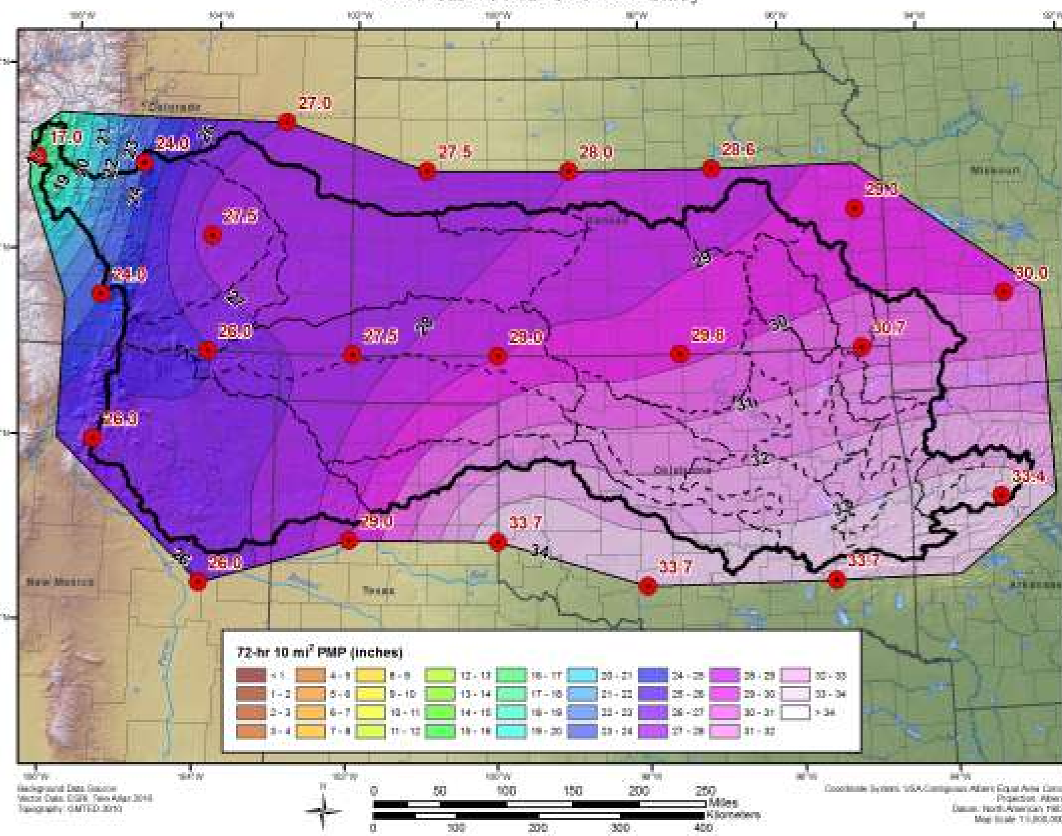


All-Season PMP - 72-hour 10 mi² (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 72-hour 200 mi^2 (inches)
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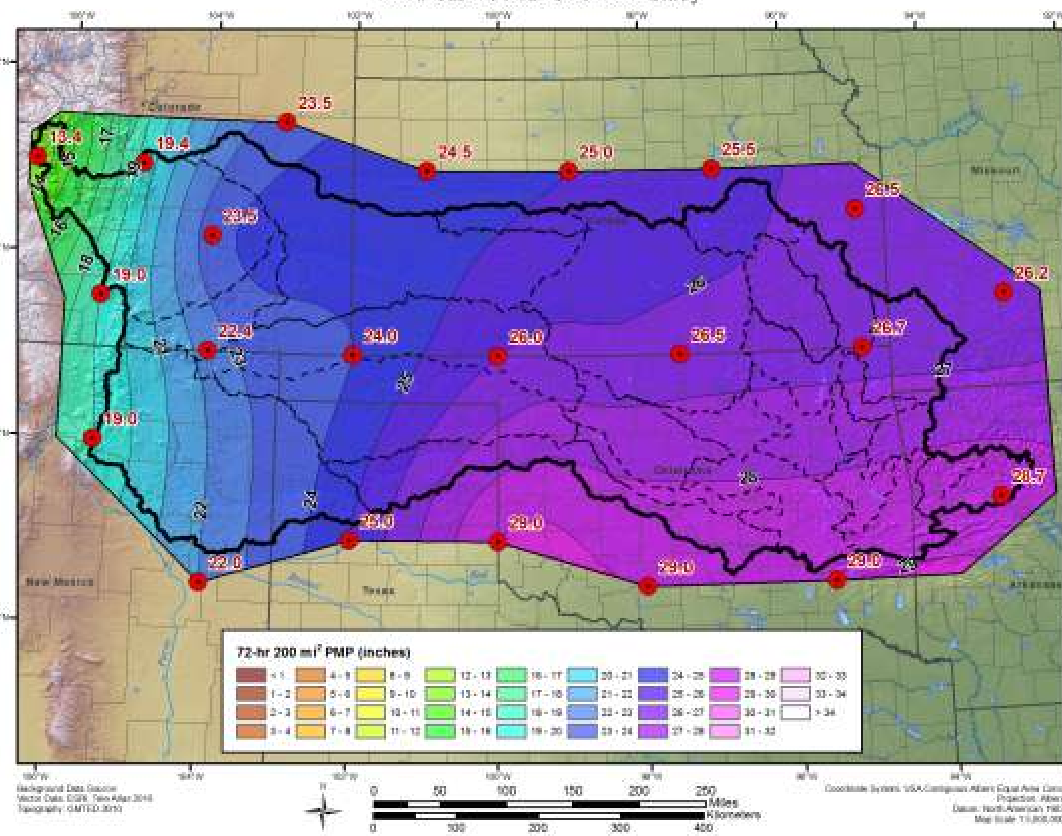

All-Season PMP - 72-hour 1,000 mi^2 (inches)
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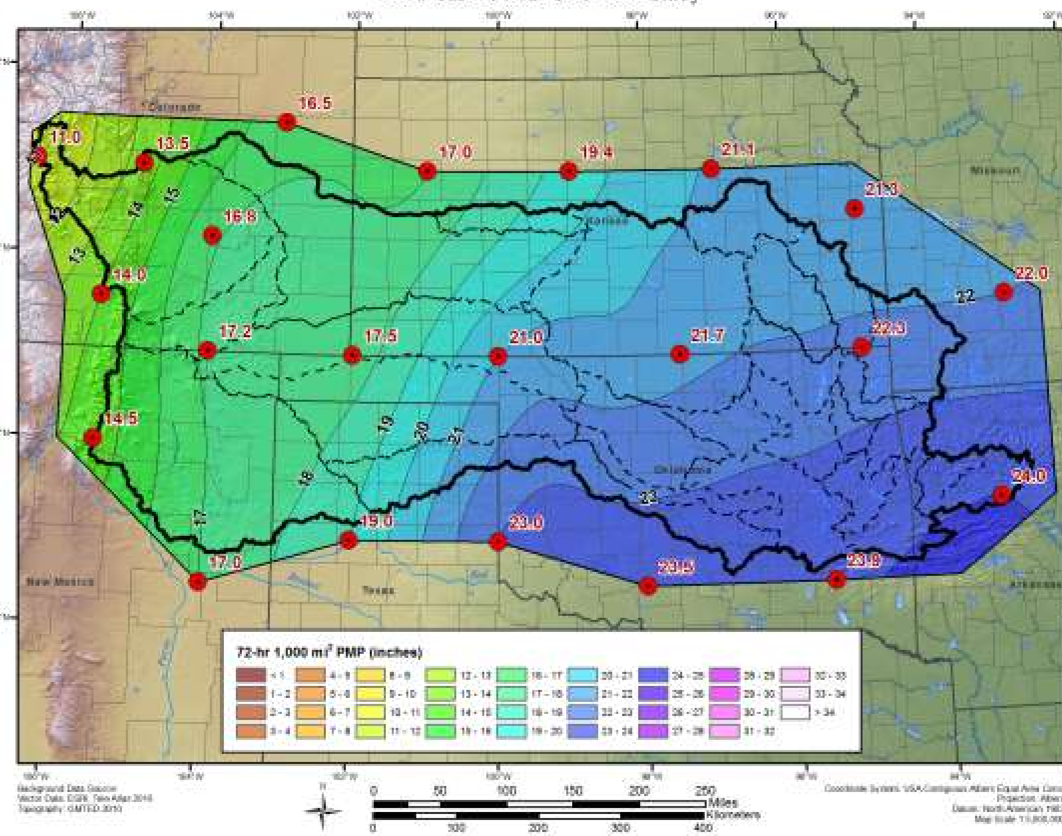
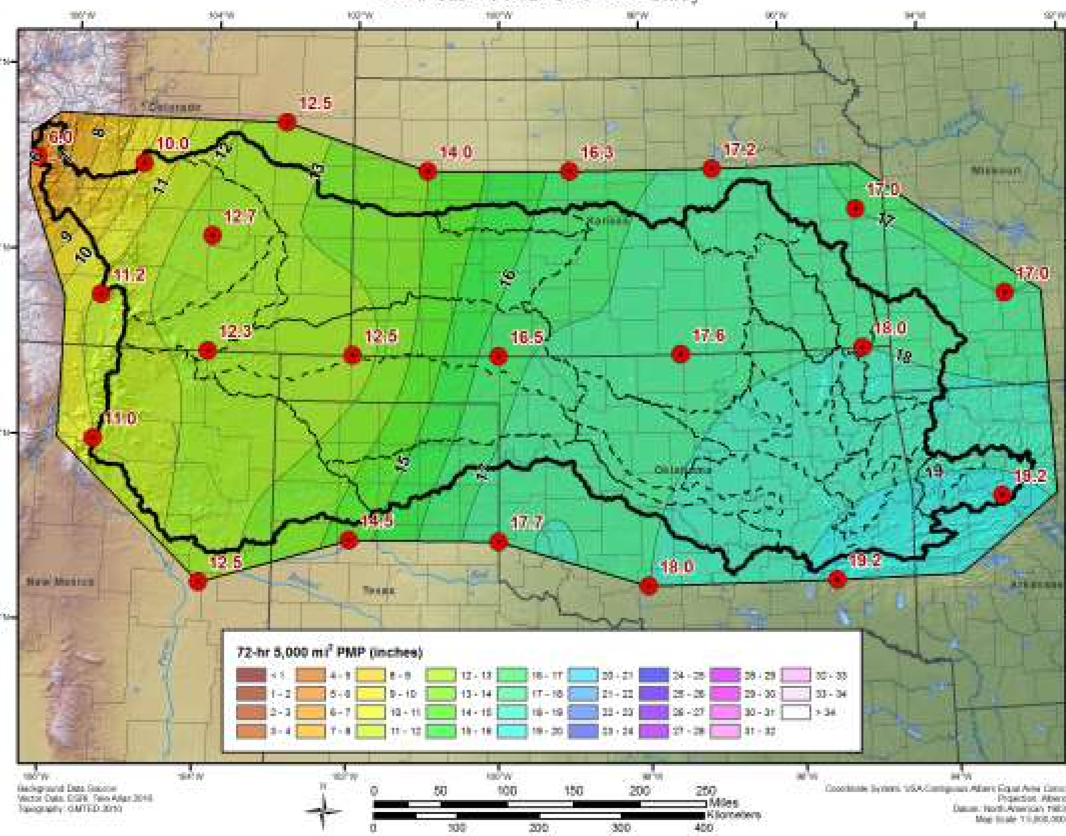
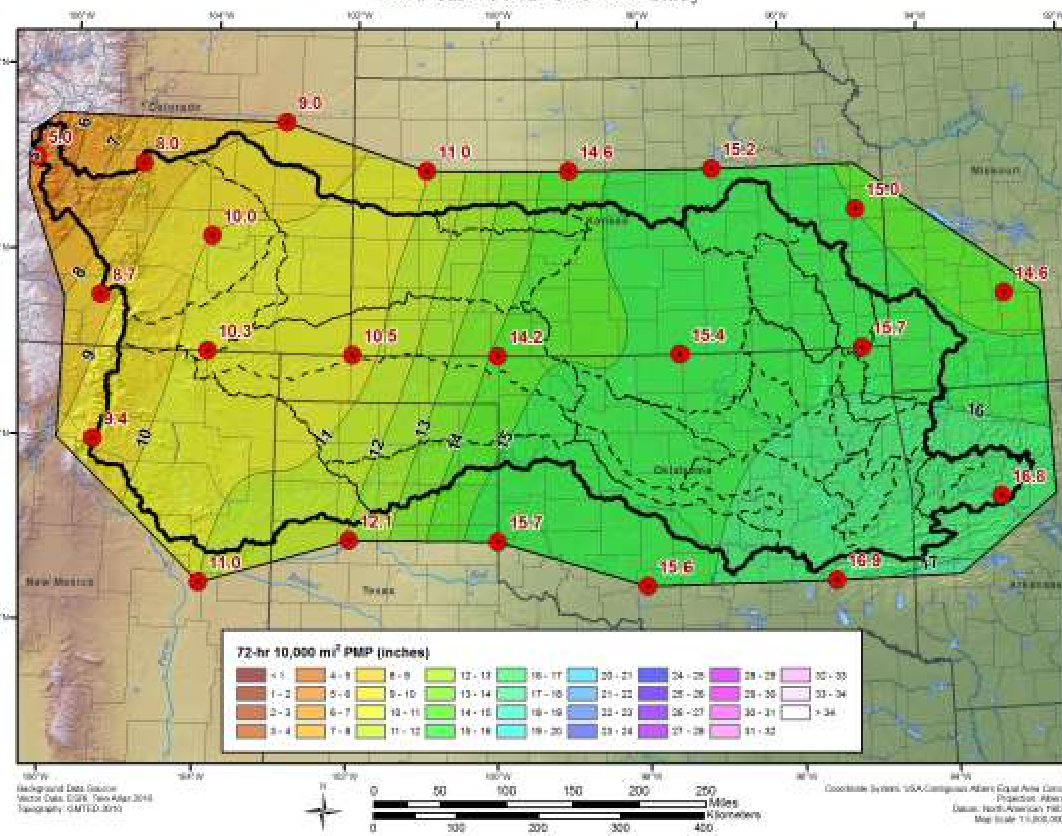


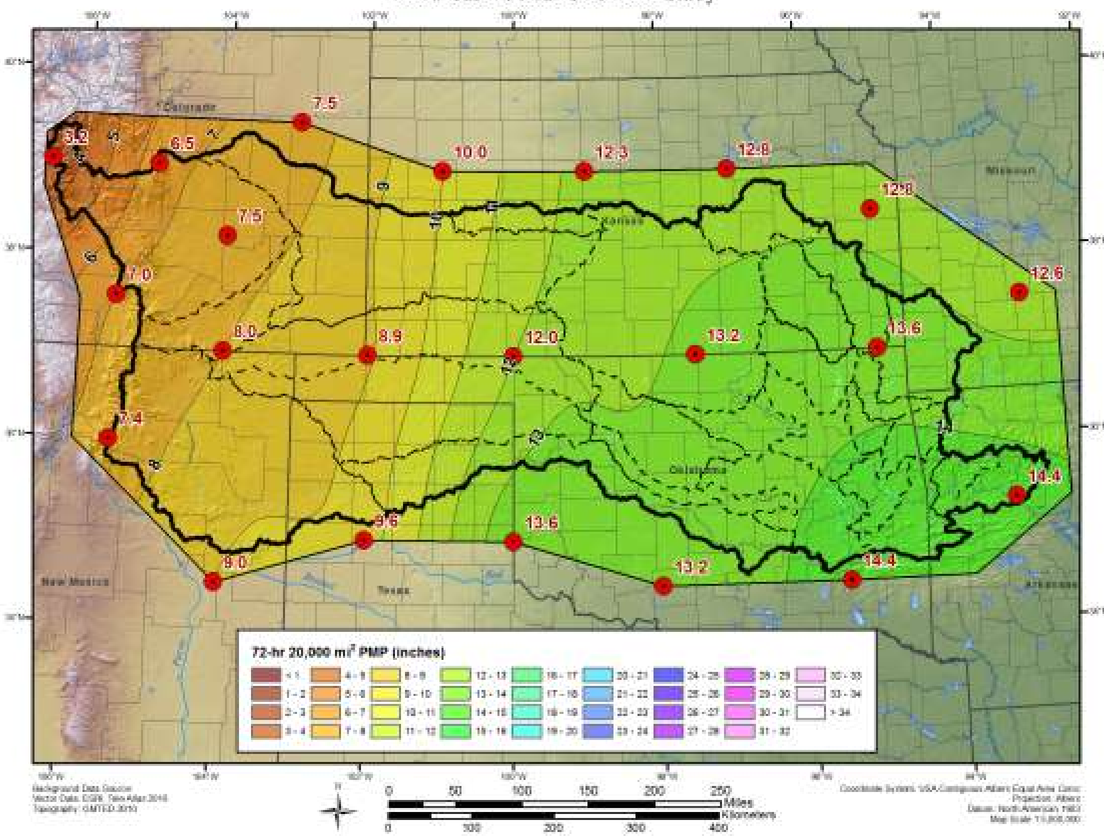
All-Season PMP - 72-hour 5,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



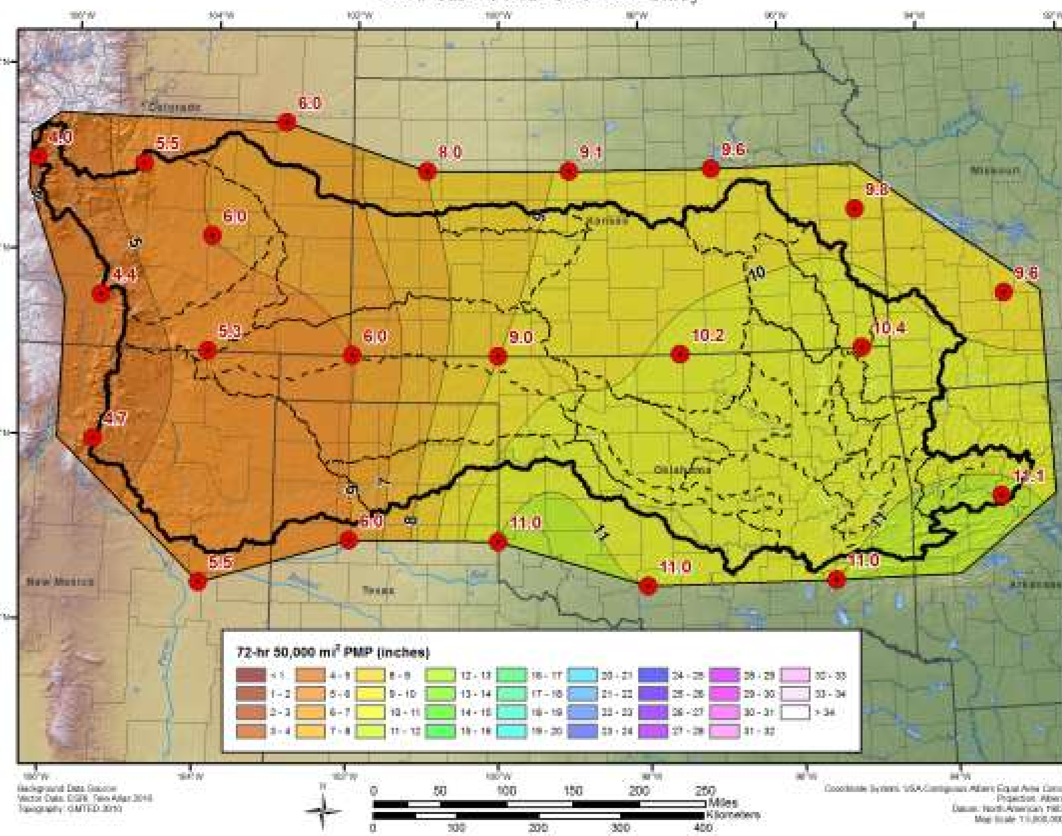
All-Season PMP - 72-hour 10,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



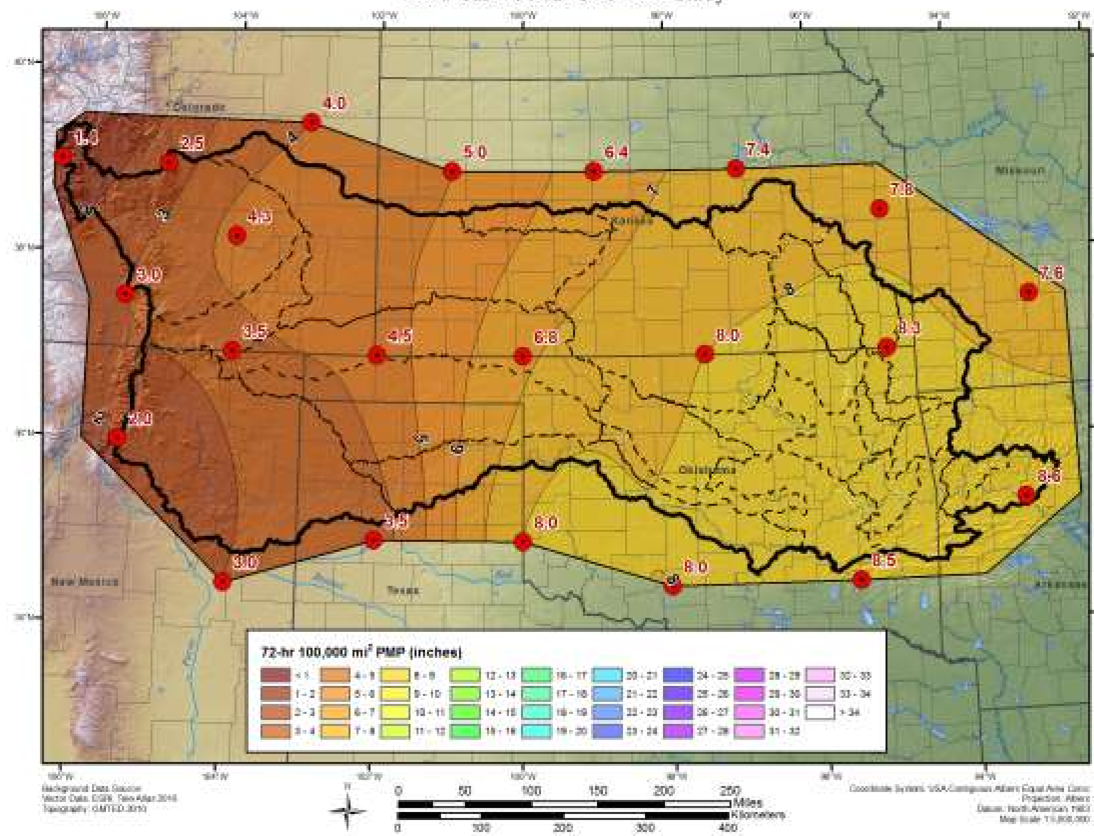
All-Season PMP - 72-hour 20,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



All-Season PMP - 72-hour 50,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



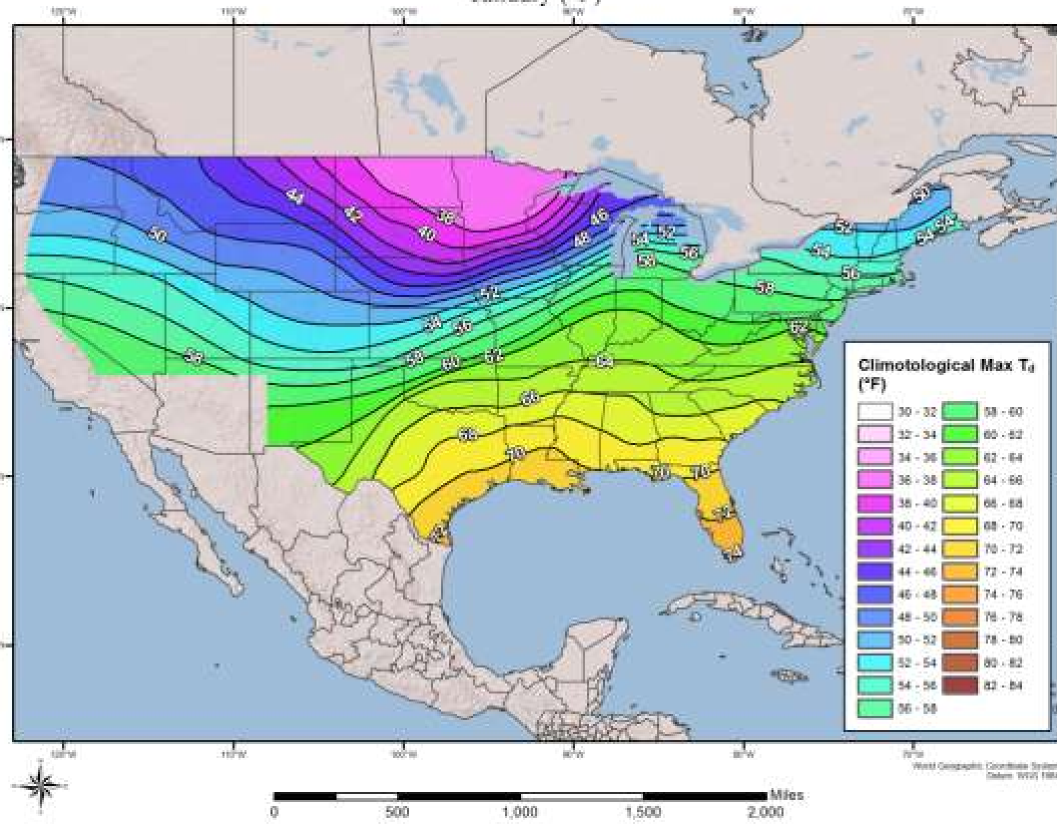
All-Season PMP - 72-hour 100,000 mi^2 (inches)
Arkansas Nuclear One PMP Study



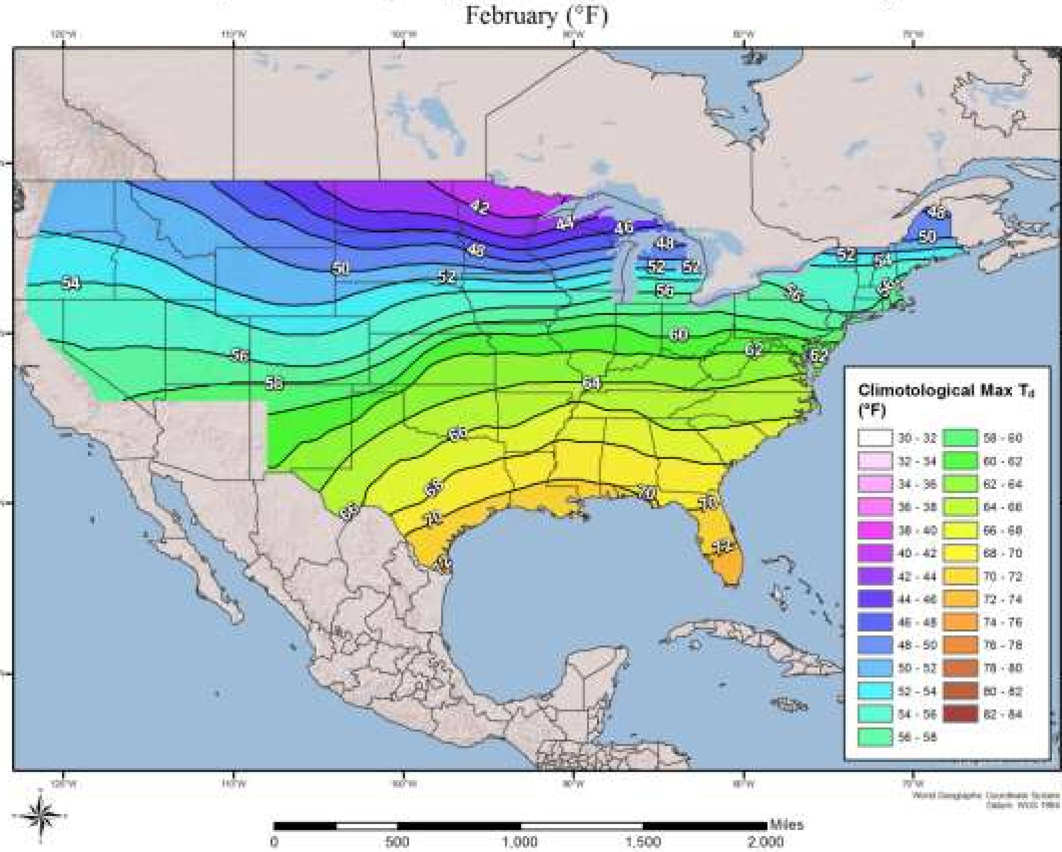
Appendix B

100-year Return Frequency Maximum Average Dew Point Climatology Maps Used in the Storm Maximization and Transposition Calculations

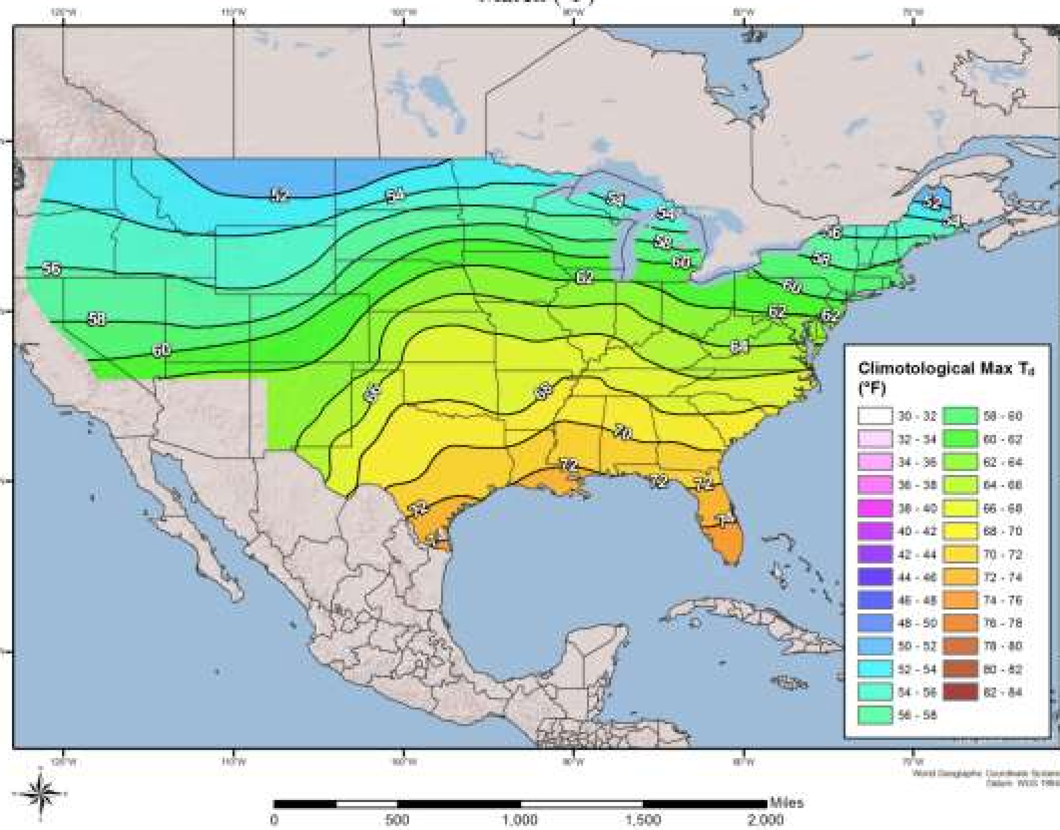
6-hour Monthly Dew Point Climatology
January (°F)



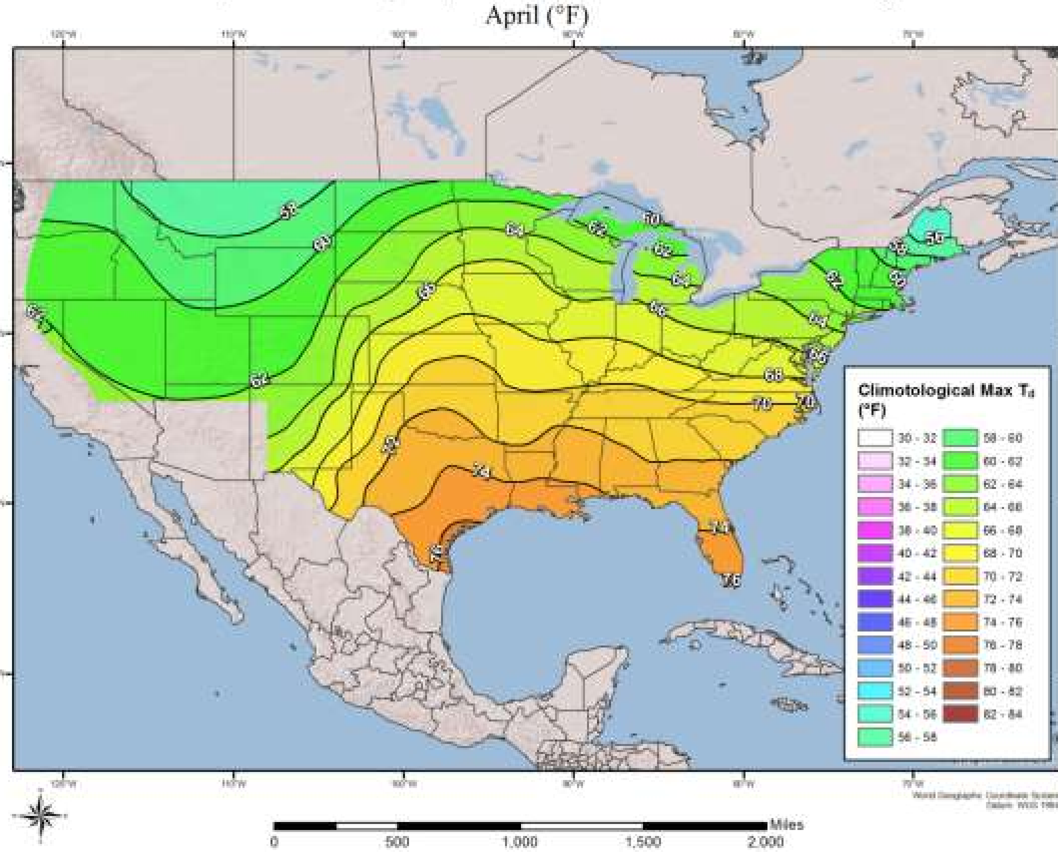
100-year Return Frequency 6-hour Maximum Dew Point Climatology
February (°F)



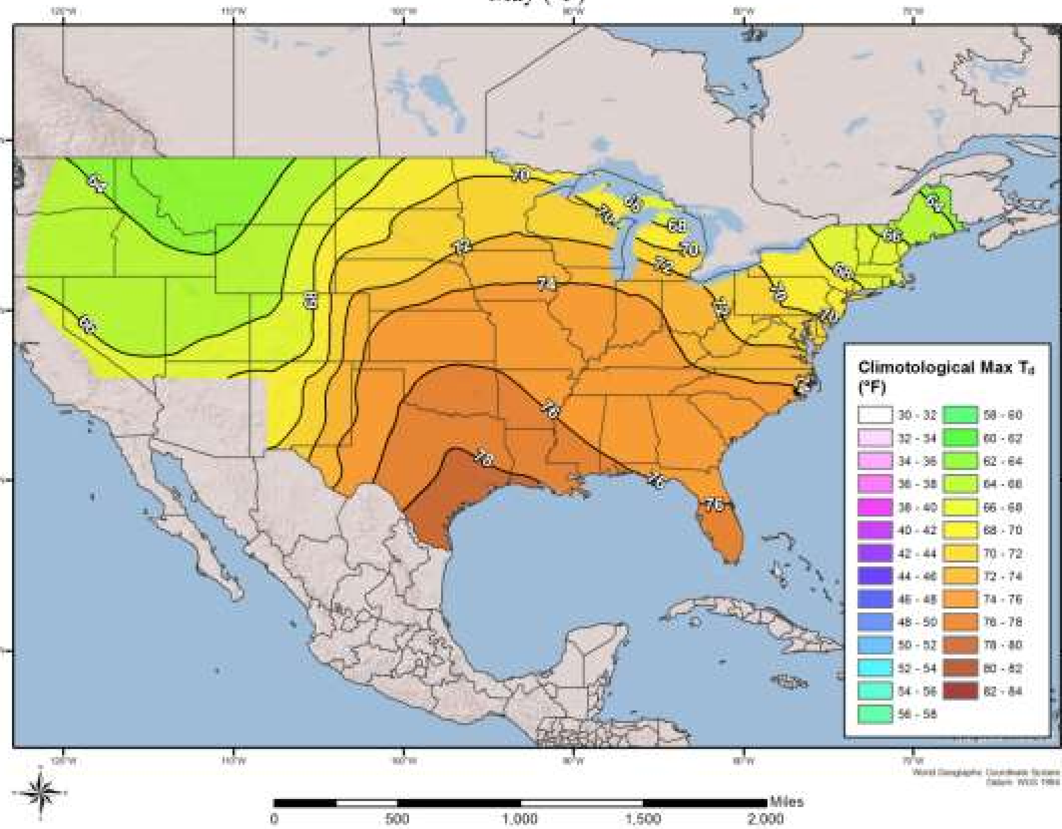
100-year Return Frequency 6-hour Maximum Dew Point Climatology
March (°F)



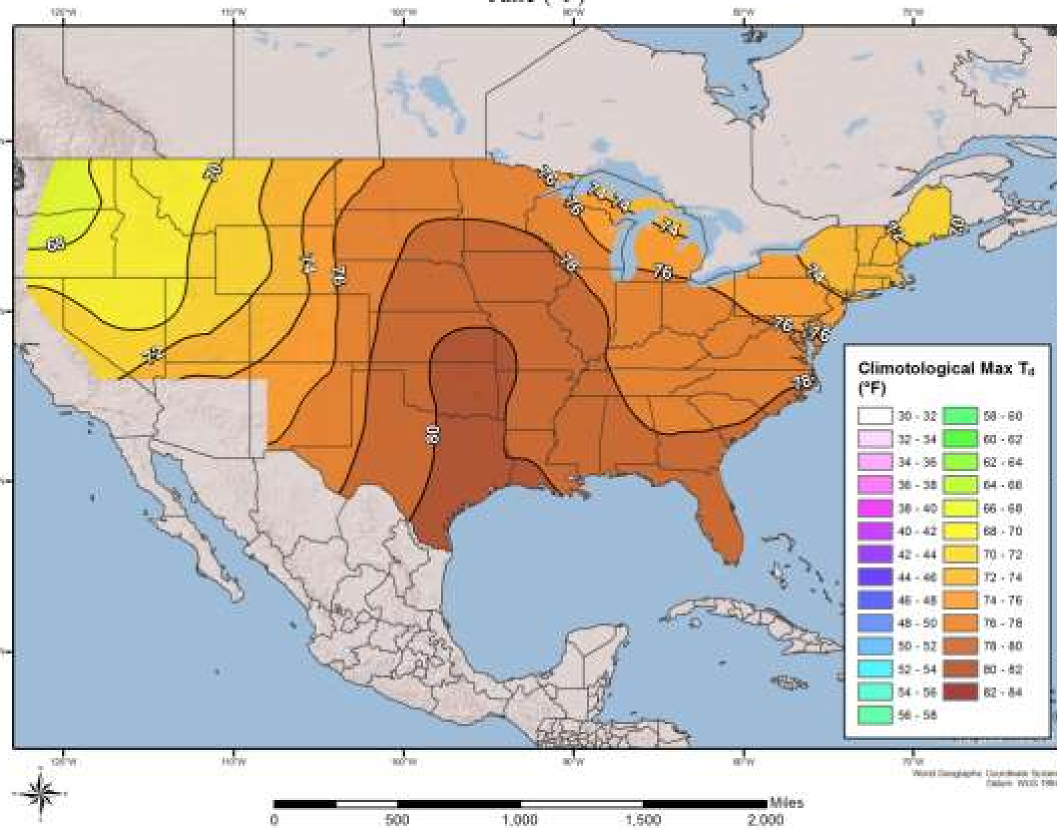
100-year Return Frequency 6-hour Maximum Dew Point Climatology
April (°F)



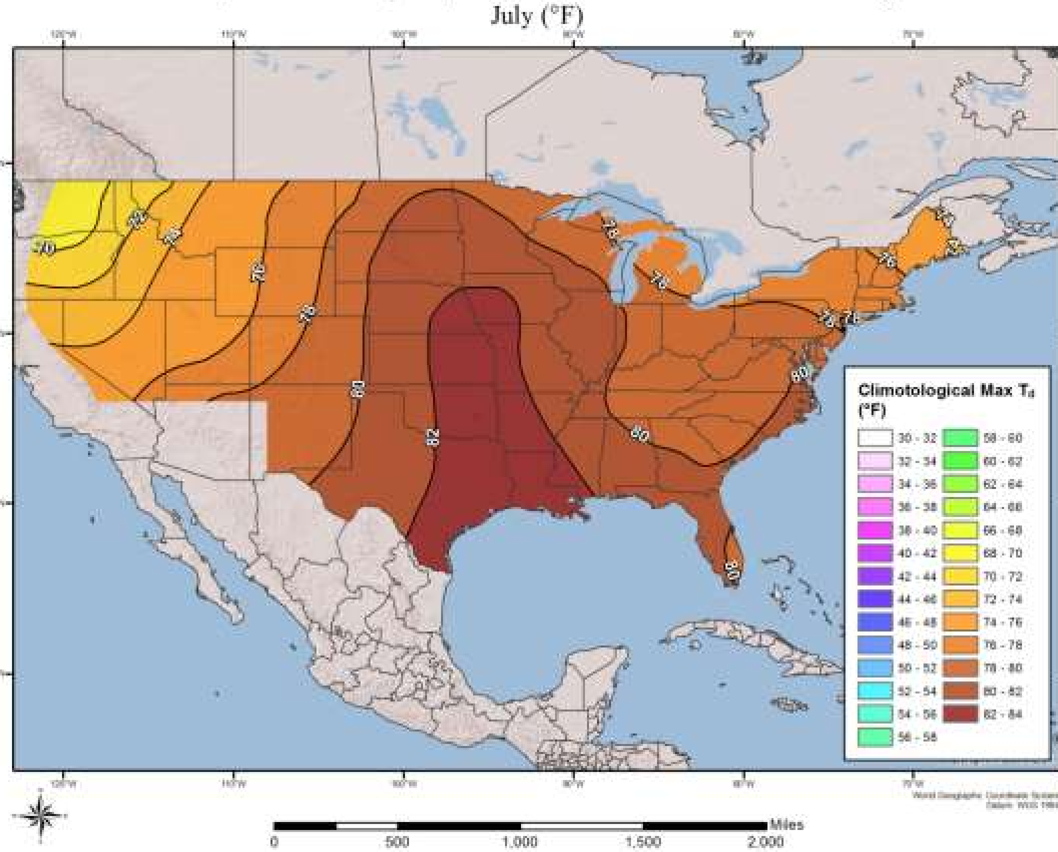
100-year Return Frequency 6-hour Maximum Dew Point Climatology
May (°F)



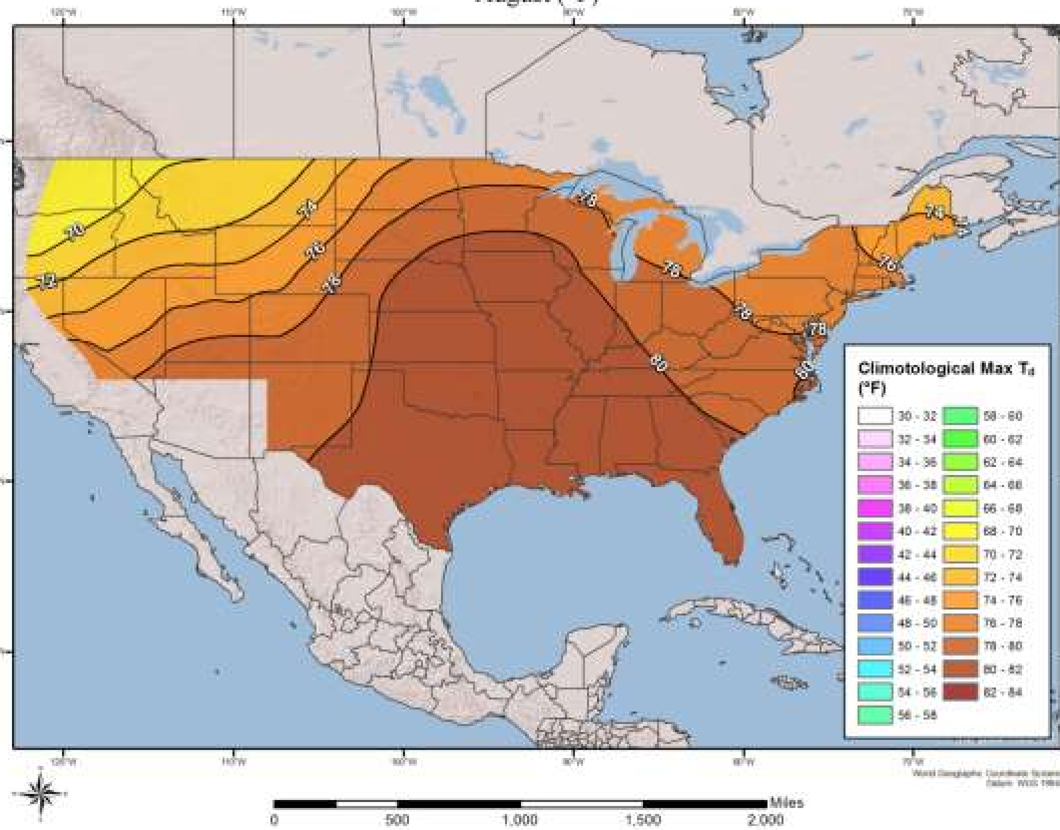
100-year Return Frequency 6-hour Maximum Dew Point Climatology
June (°F)



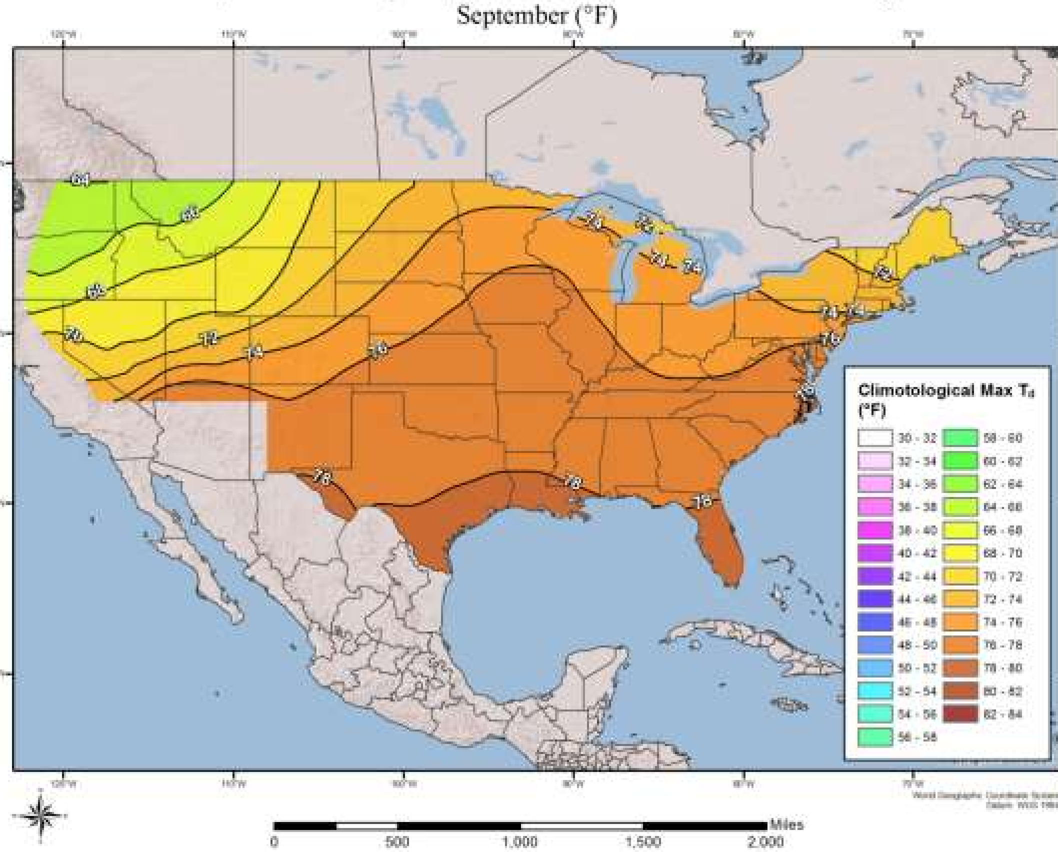
100-year Return Frequency 6-hour Maximum Dew Point Climatology
July (°F)



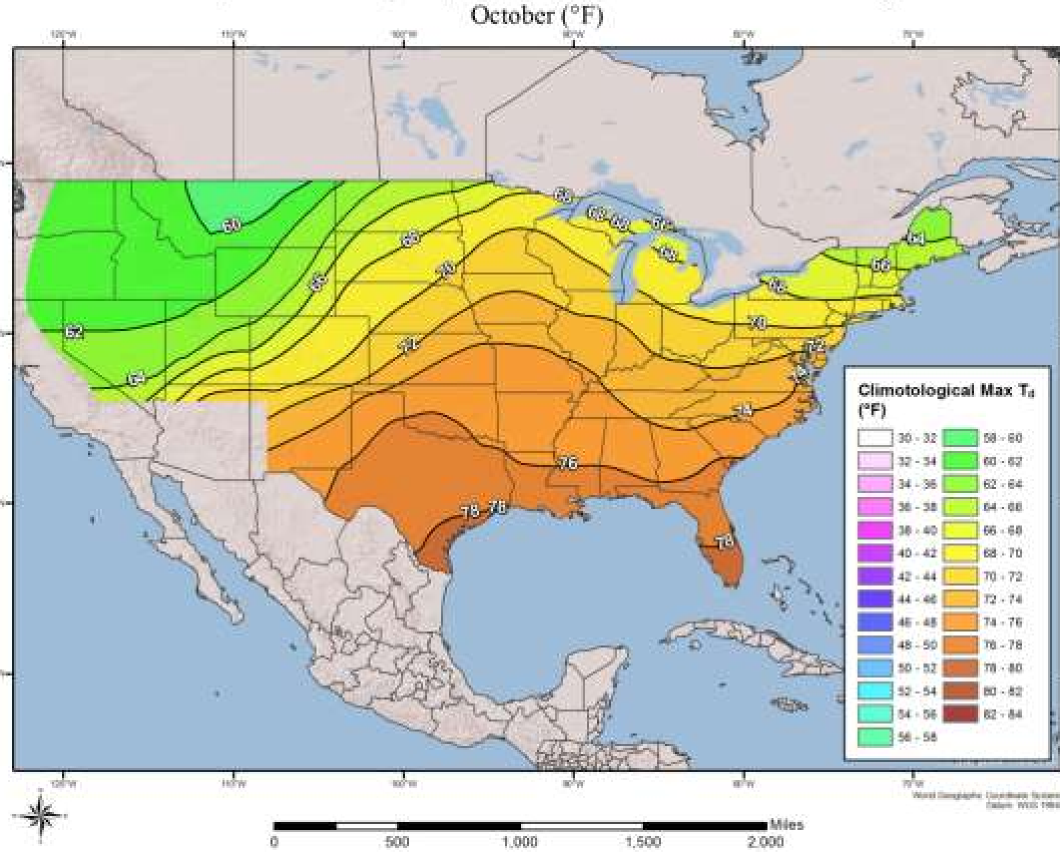
100-year Return Frequency 6-hour Maximum Dew Point Climatology
August (°F)



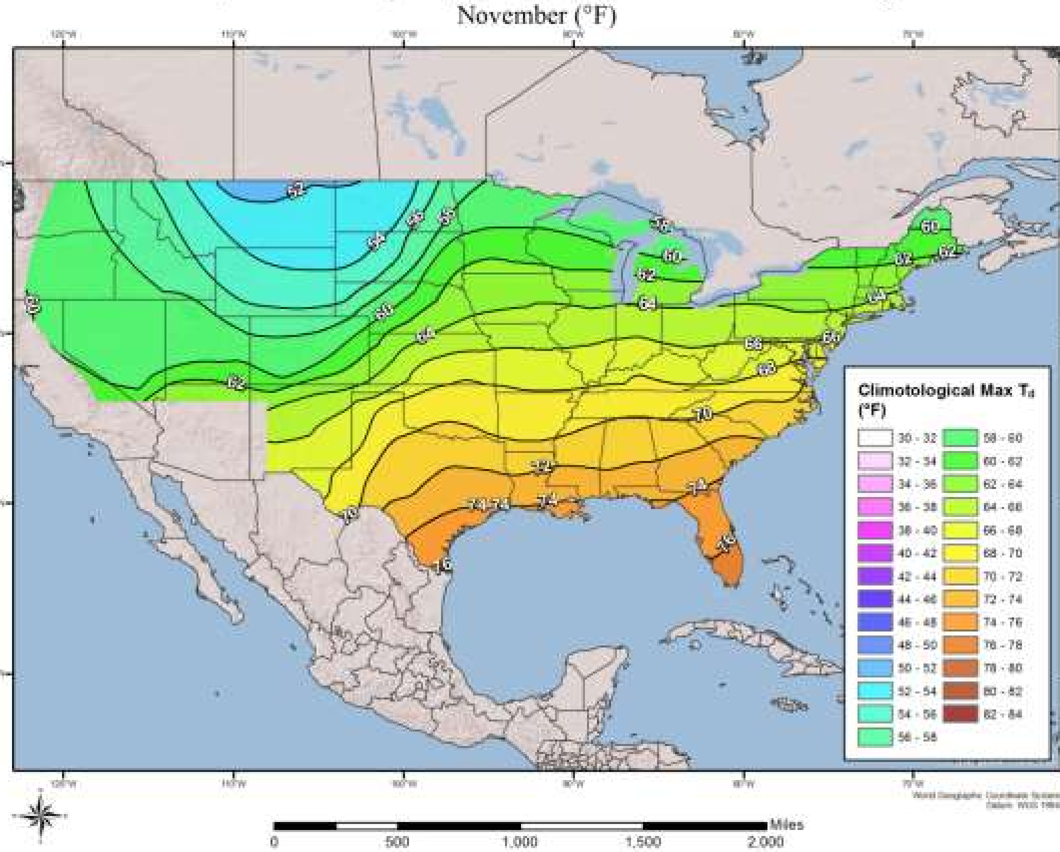
100-year Return Frequency 6-hour Maximum Dew Point Climatology
September (°F)



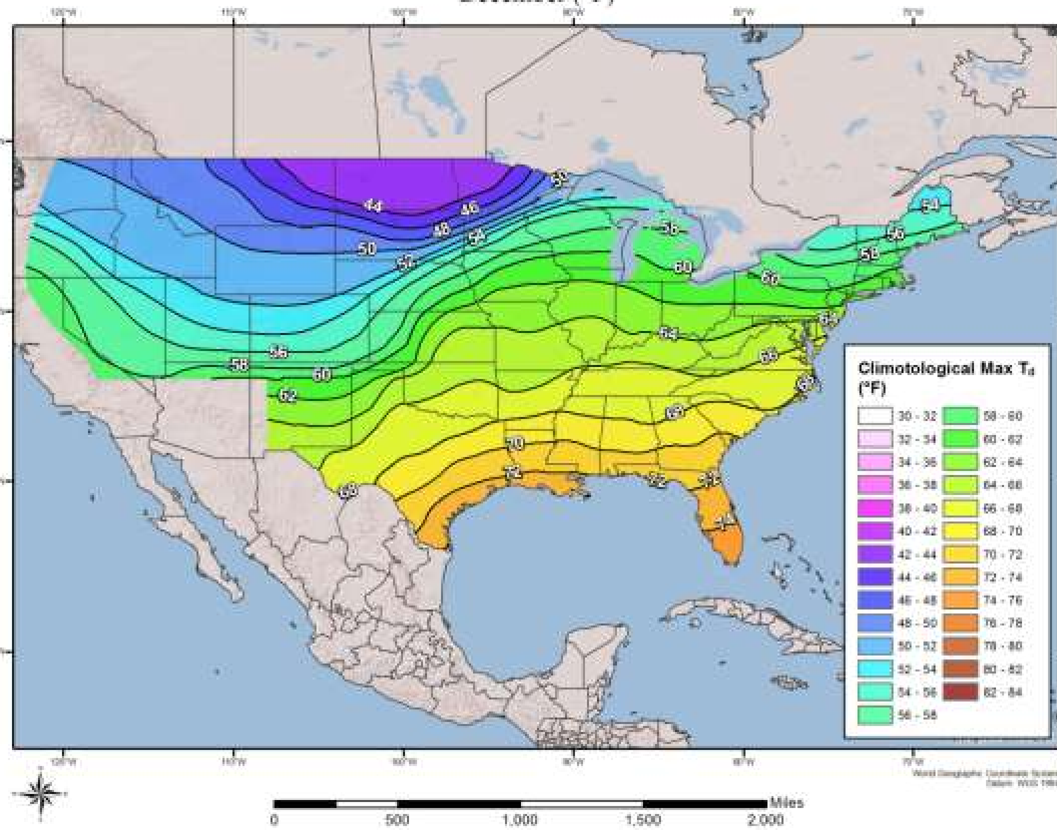
100-year Return Frequency 6-hour Maximum Dew Point Climatology
October (°F)



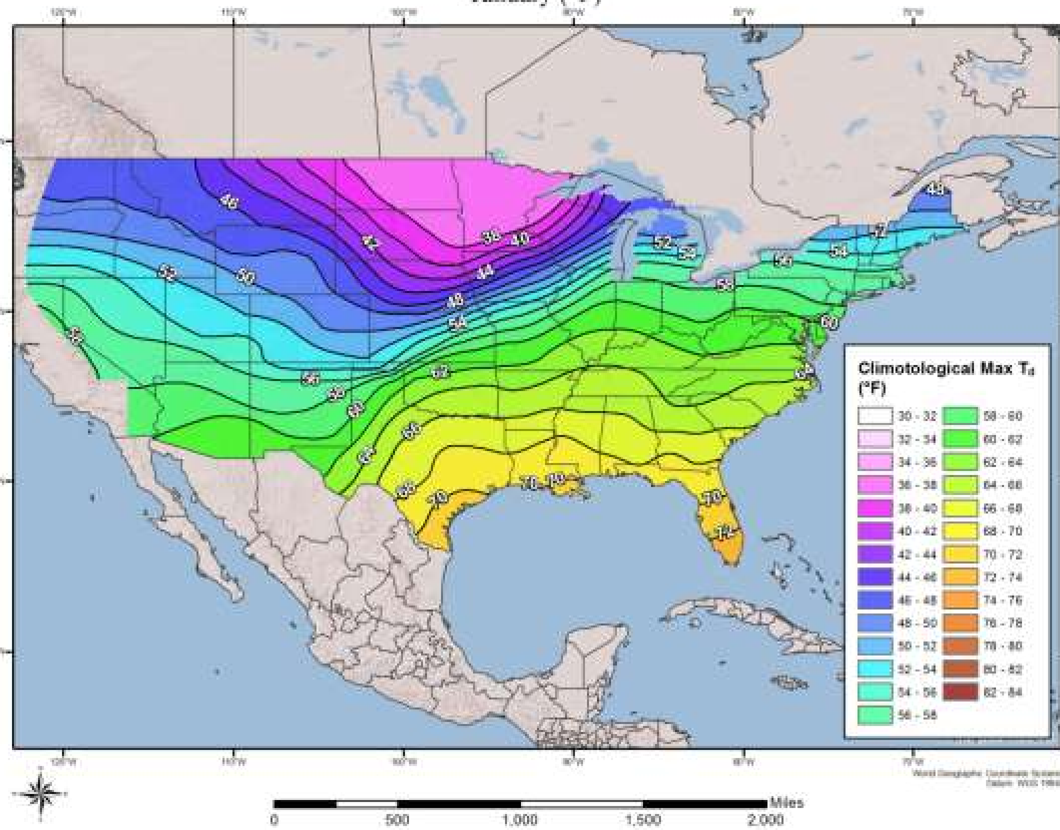
100-year Return Frequency 6-hour Maximum Dew Point Climatology
November (°F)



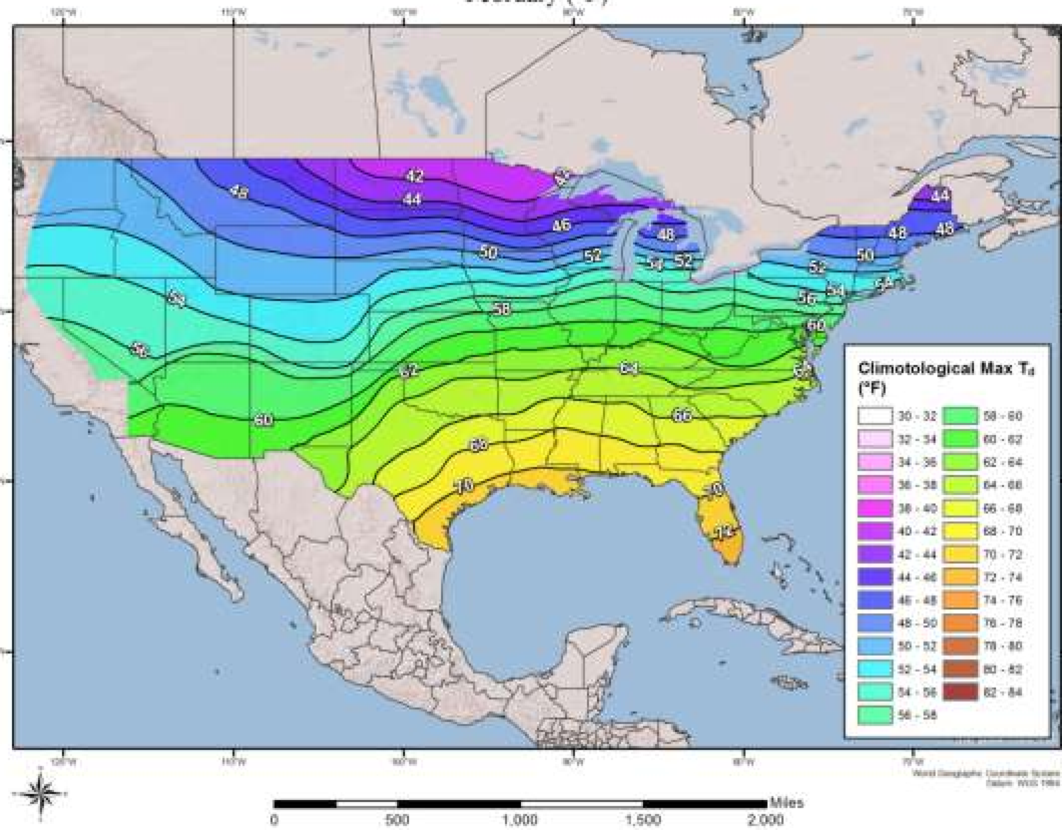
100-year Return Frequency 6-hour Maximum Dew Point Climatology
December (°F)



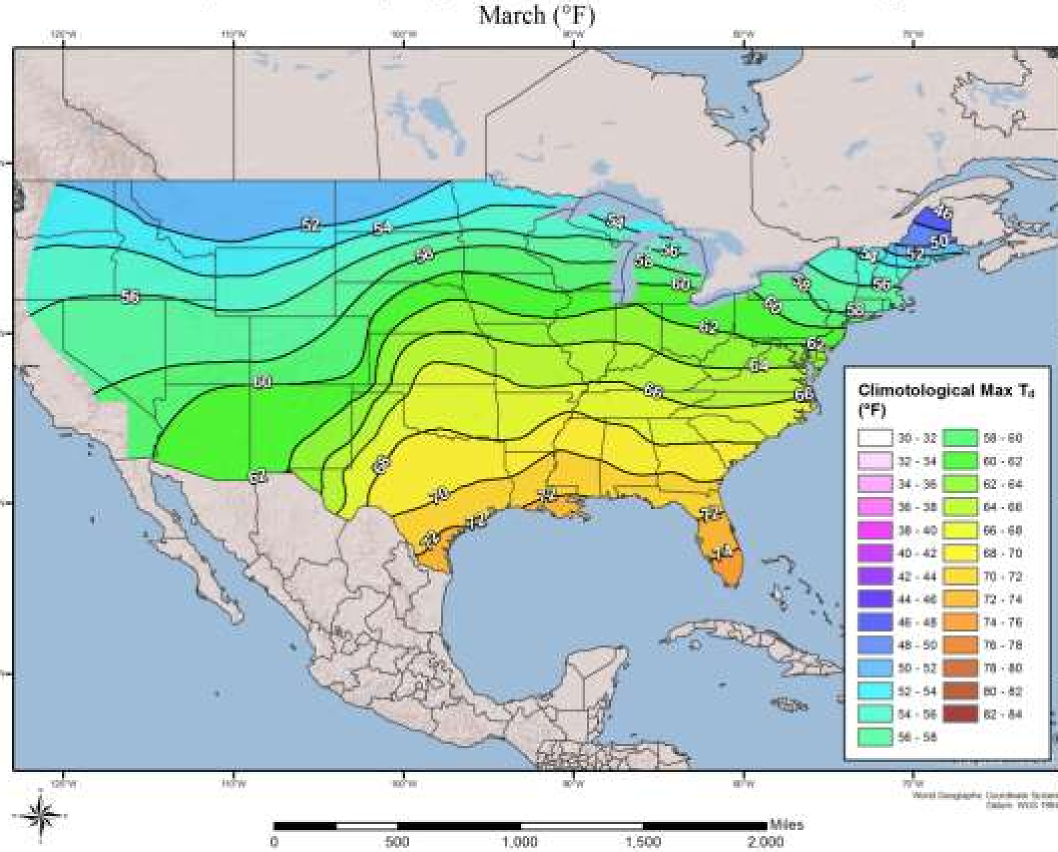
100-year Return Frequency 12-hour Maximum Dew Point Climatology
January (°F)



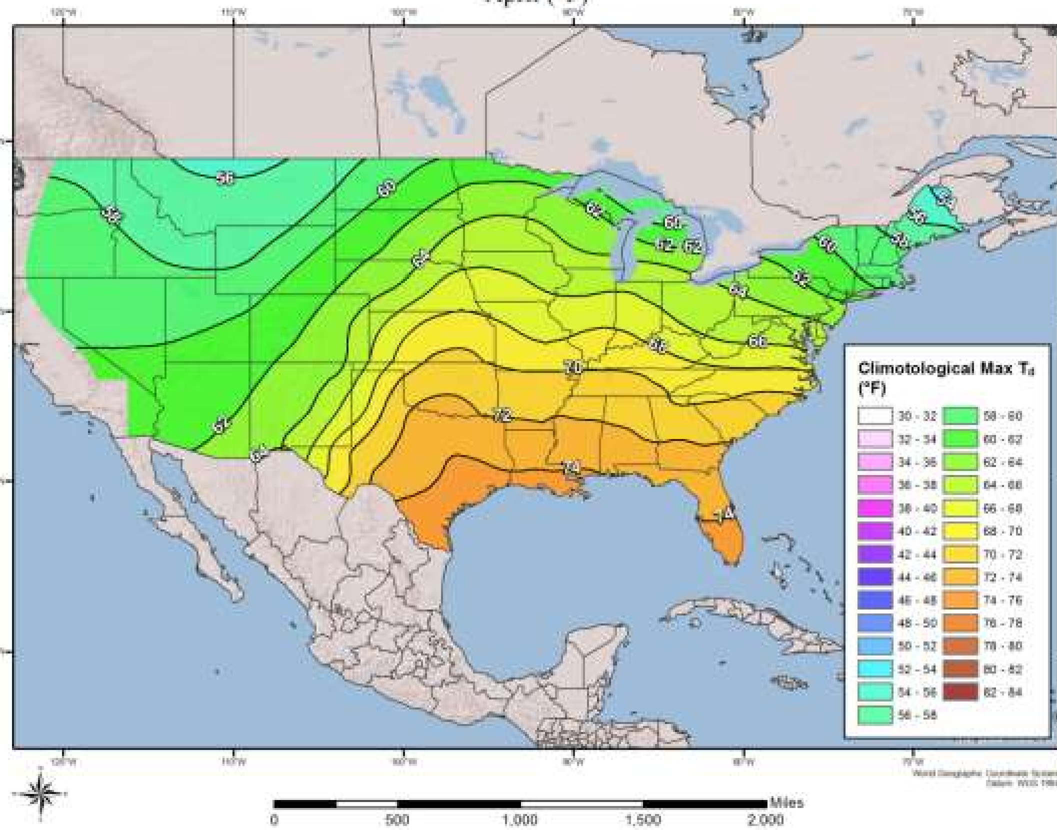
100-year Return Frequency 12-hour Maximum Dew Point Climatology
February (°F)



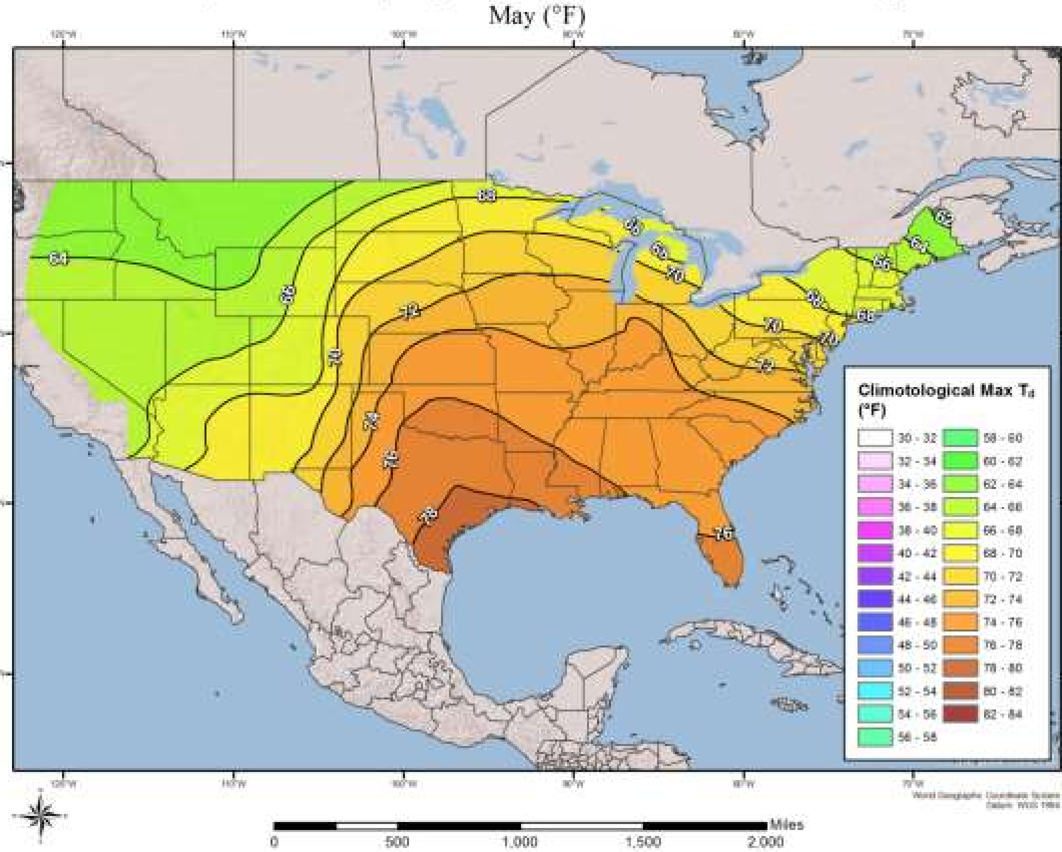
100-year Return Frequency 12-hour Maximum Dew Point Climatology
March (°F)



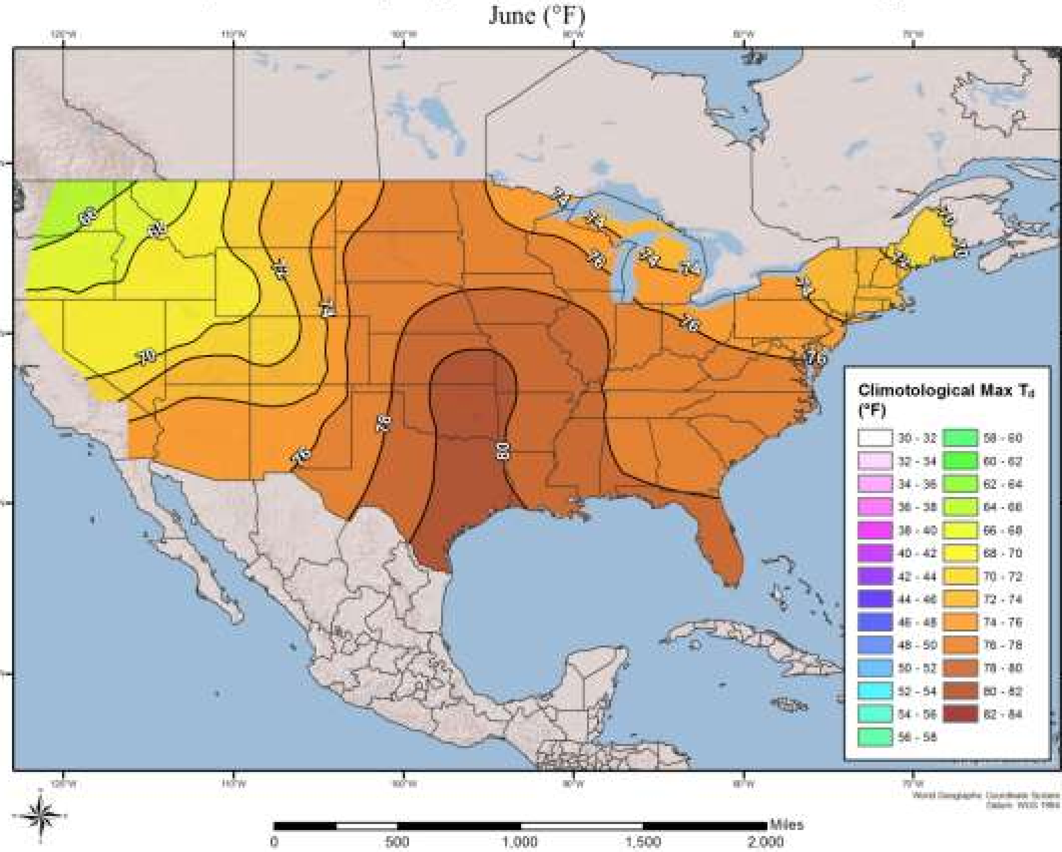
100-year Return Frequency 12-hour Maximum Dew Point Climatology
April (°F)



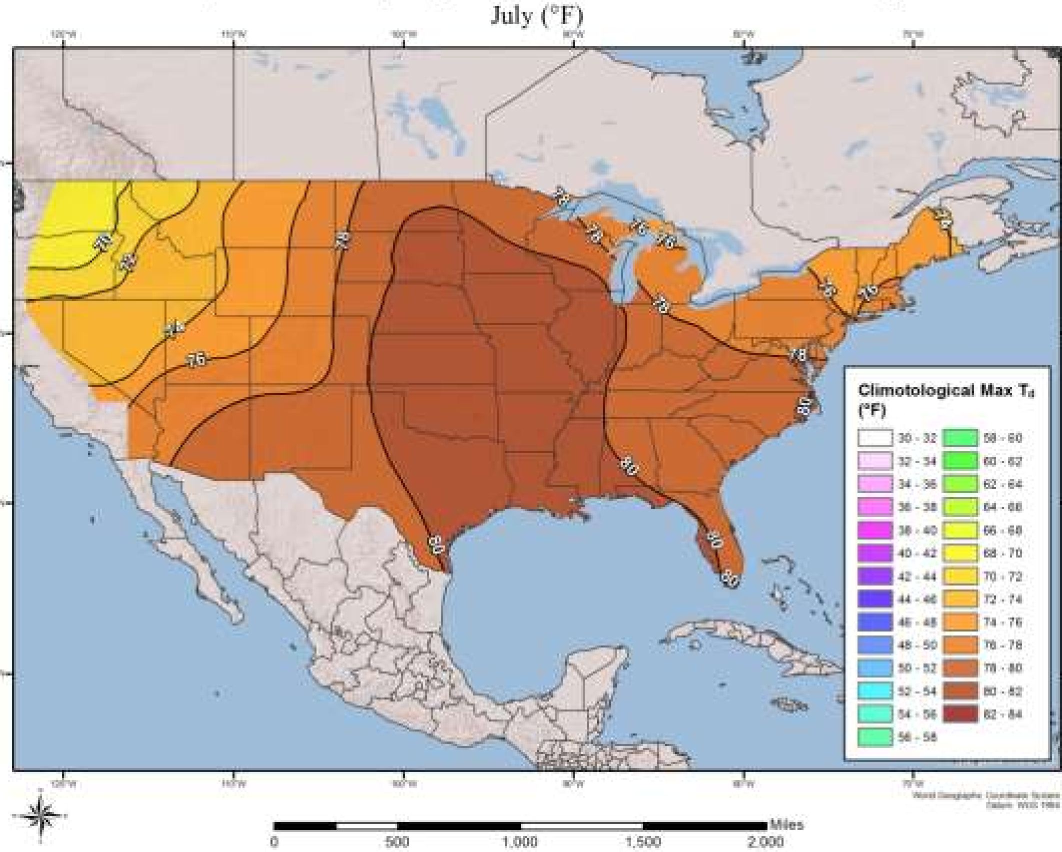
100-year Return Frequency 12-hour Maximum Dew Point Climatology
May (°F)



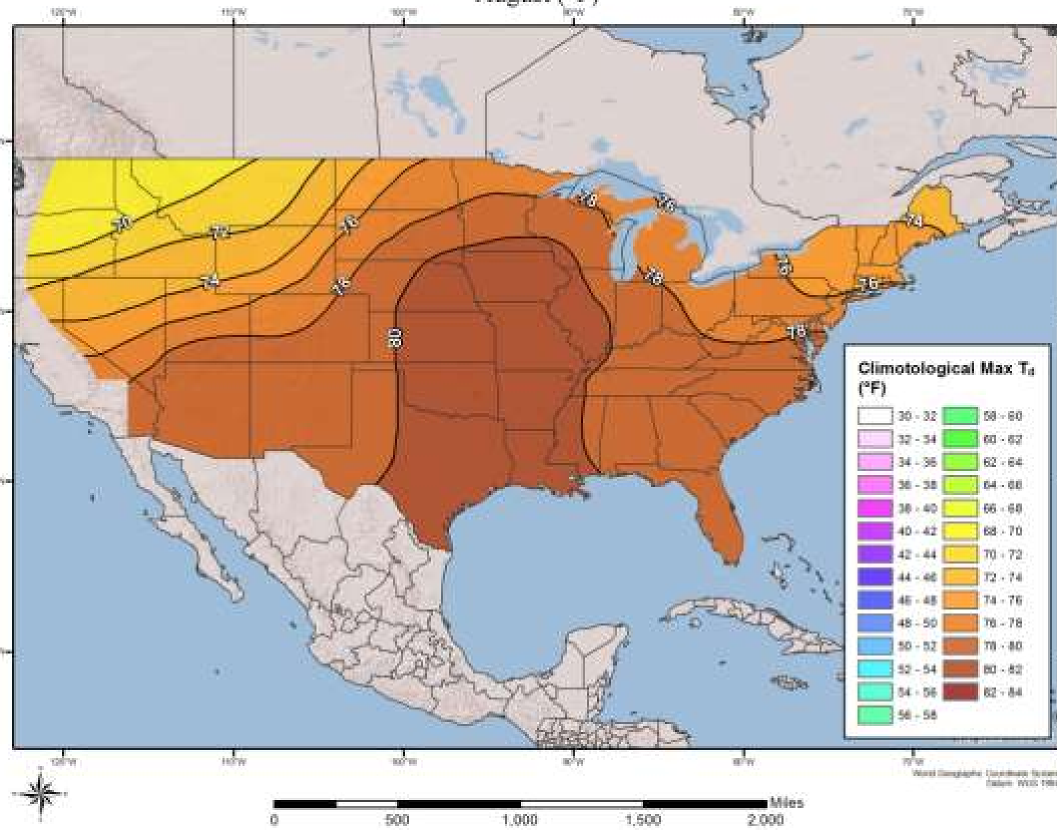
100-year Return Frequency 12-hour Maximum Dew Point Climatology
June (°F)



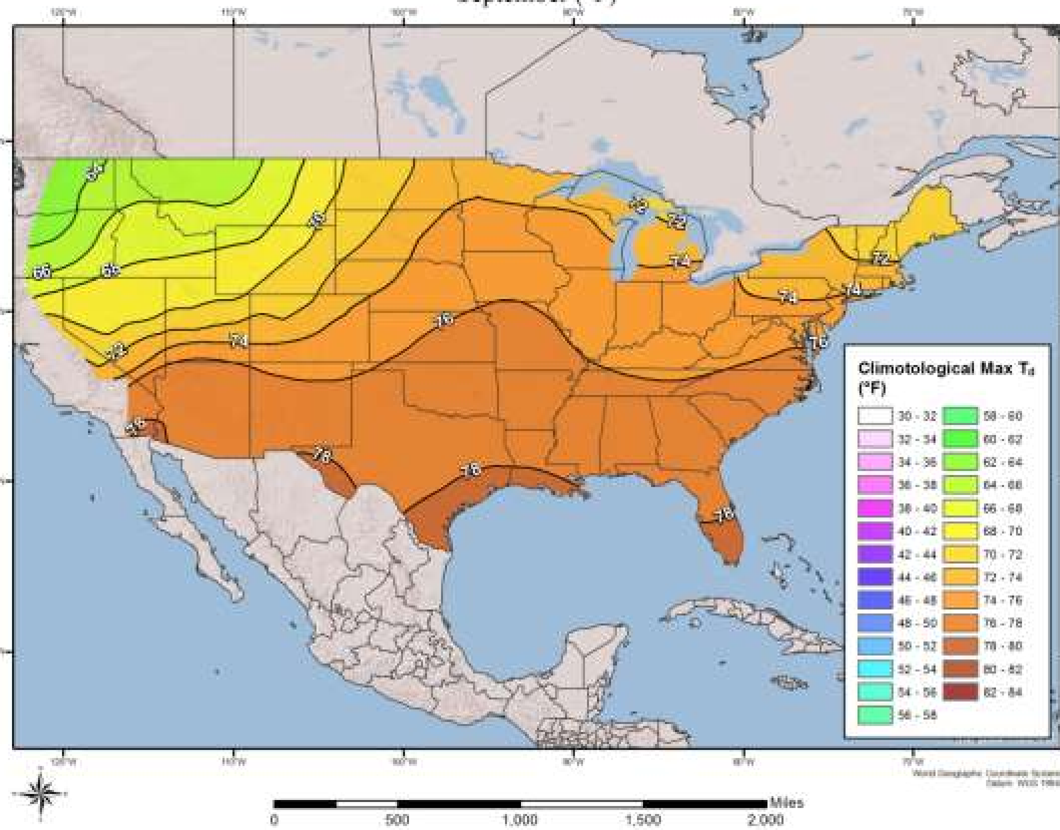
100-year Return Frequency 12-hour Maximum Dew Point Climatology
July (°F)



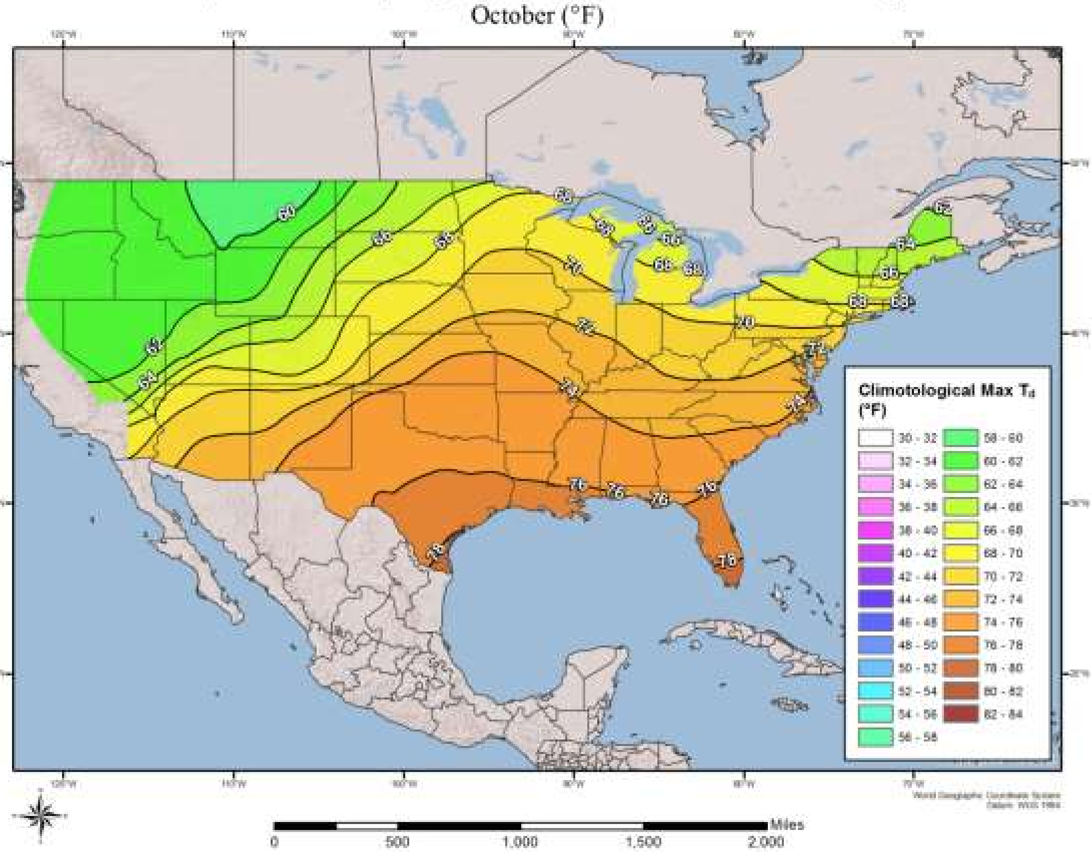
100-year Return Frequency 12-hour Maximum Dew Point Climatology
August (°F)



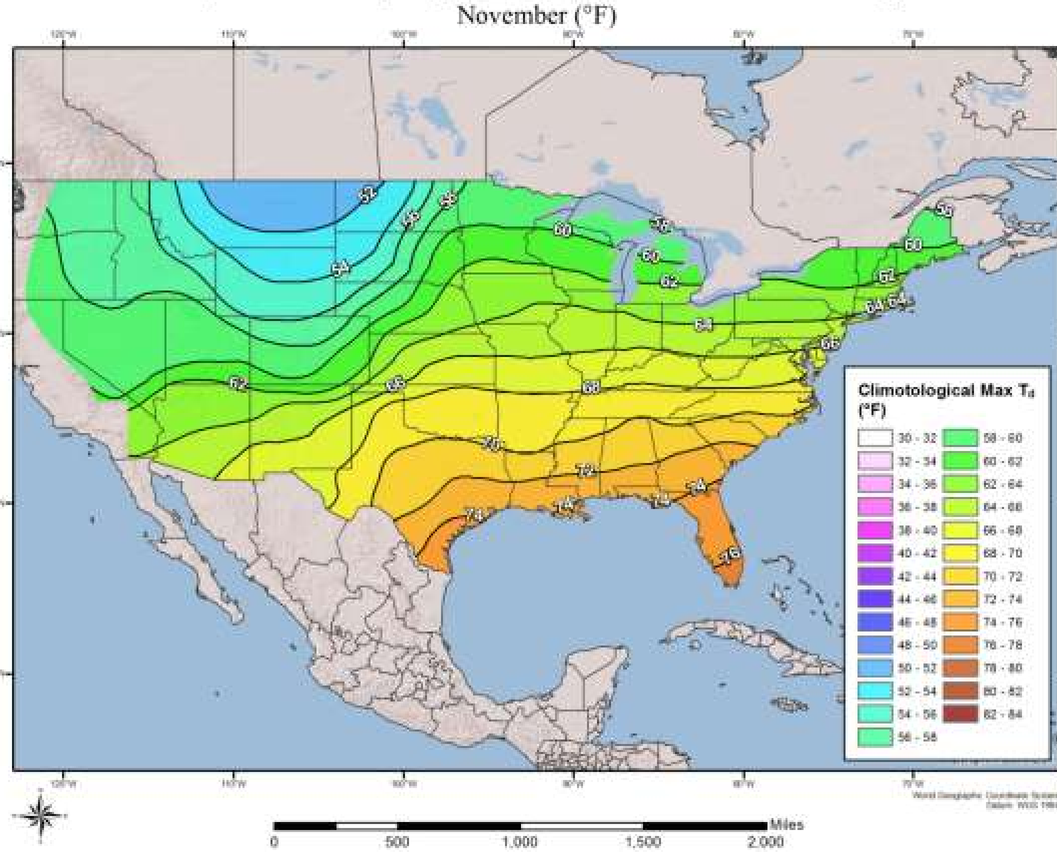
100-year Return Frequency 12-hour Maximum Dew Point Climatology
September (°F)



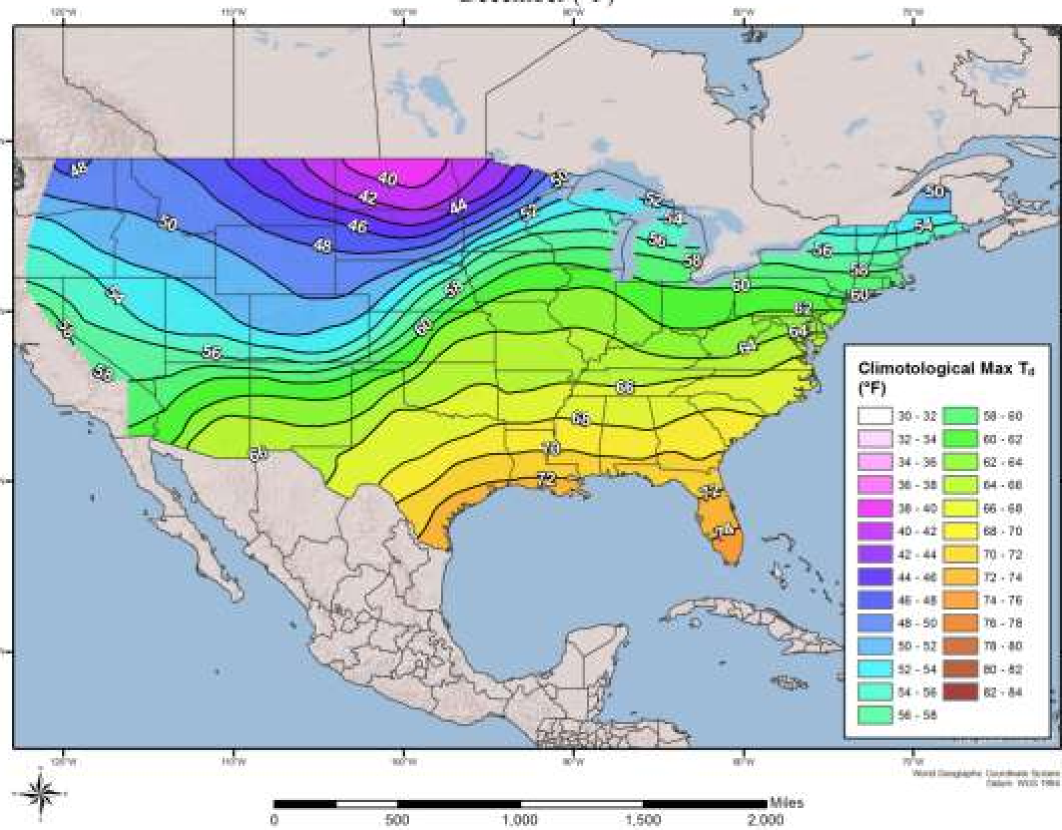
100-year Return Frequency 12-hour Maximum Dew Point Climatology
October (°F)



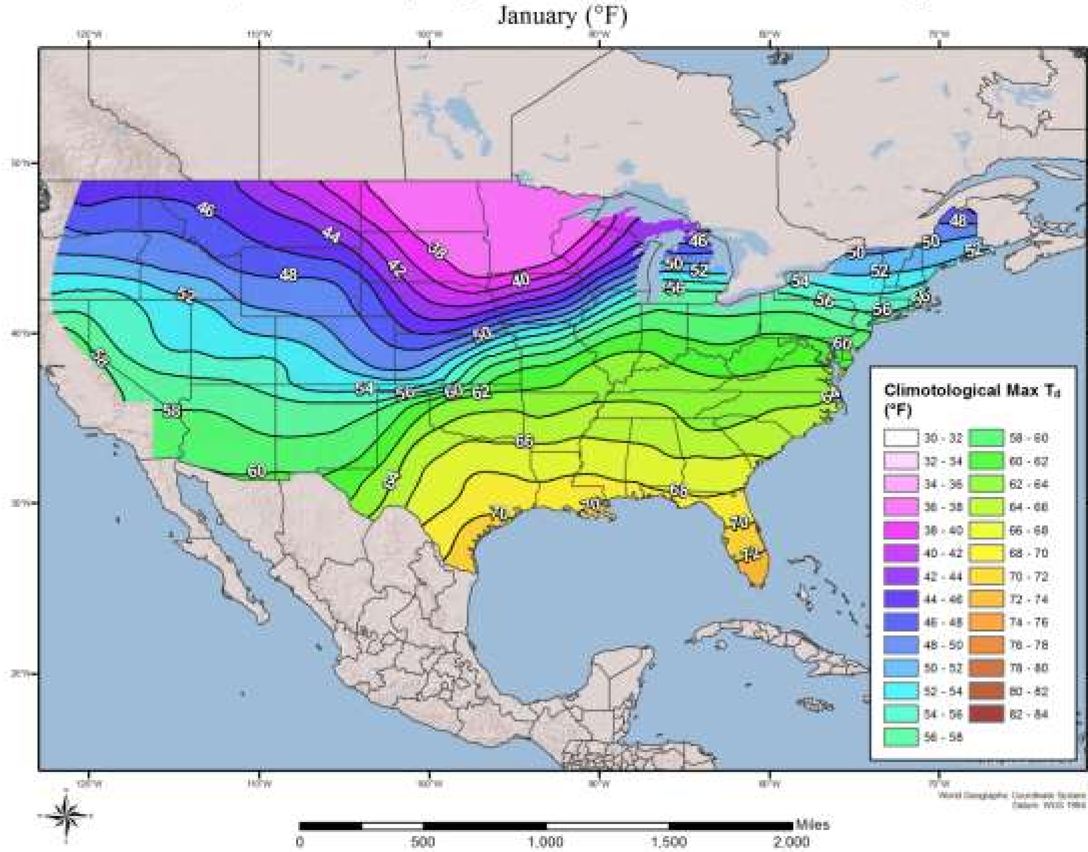
100-year Return Frequency 12-hour Maximum Dew Point Climatology
November (°F)



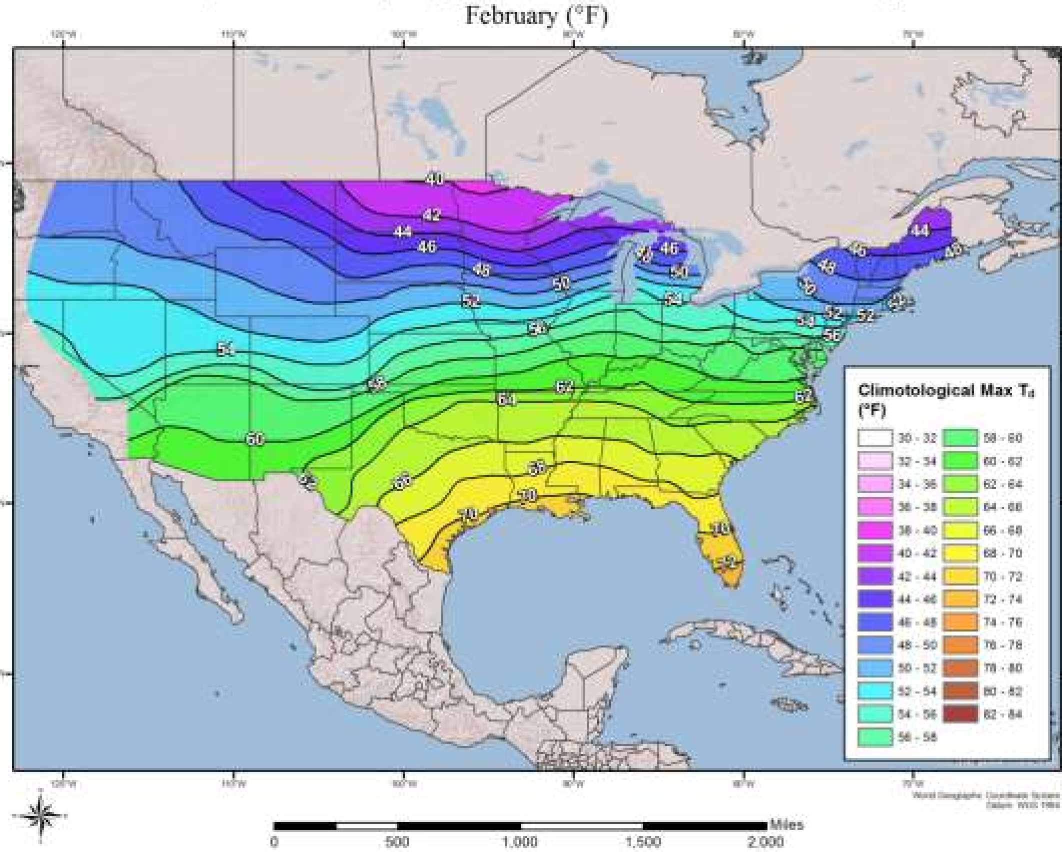
100-year Return Frequency 12-hour Maximum Dew Point Climatology
December (°F)



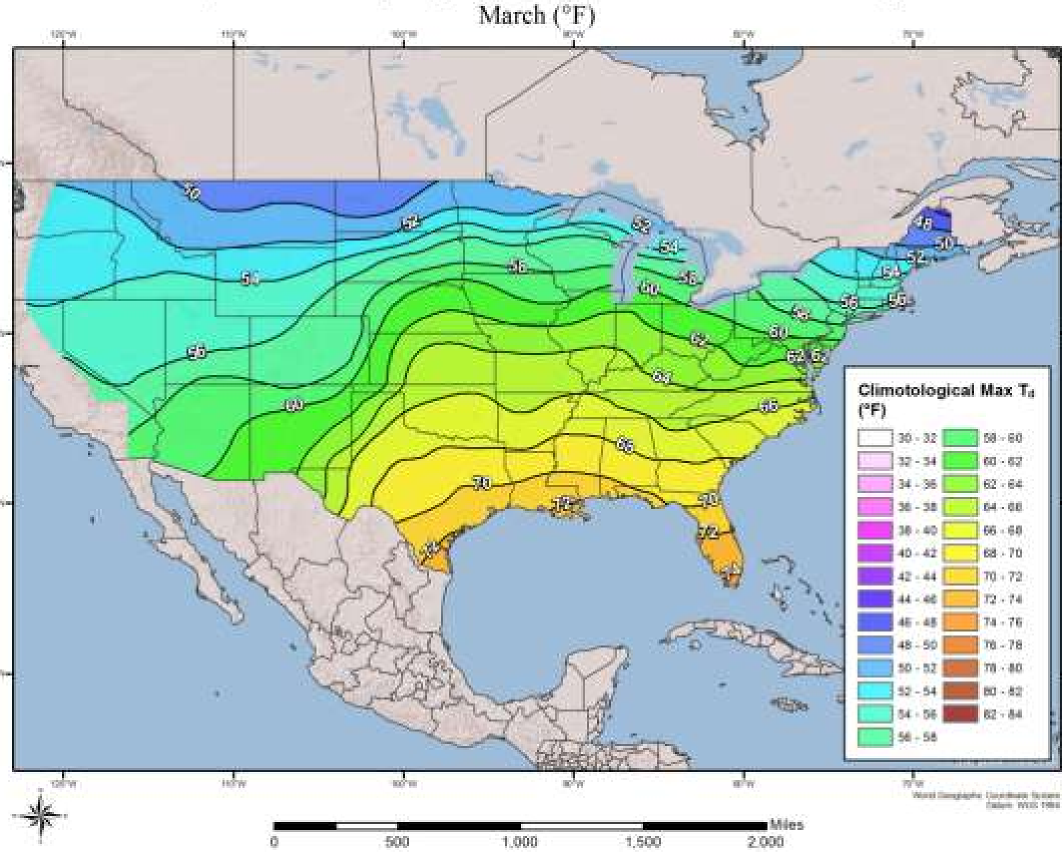
100-year Return Frequency 24-hour Maximum Dew Point Climatology
January (°F)



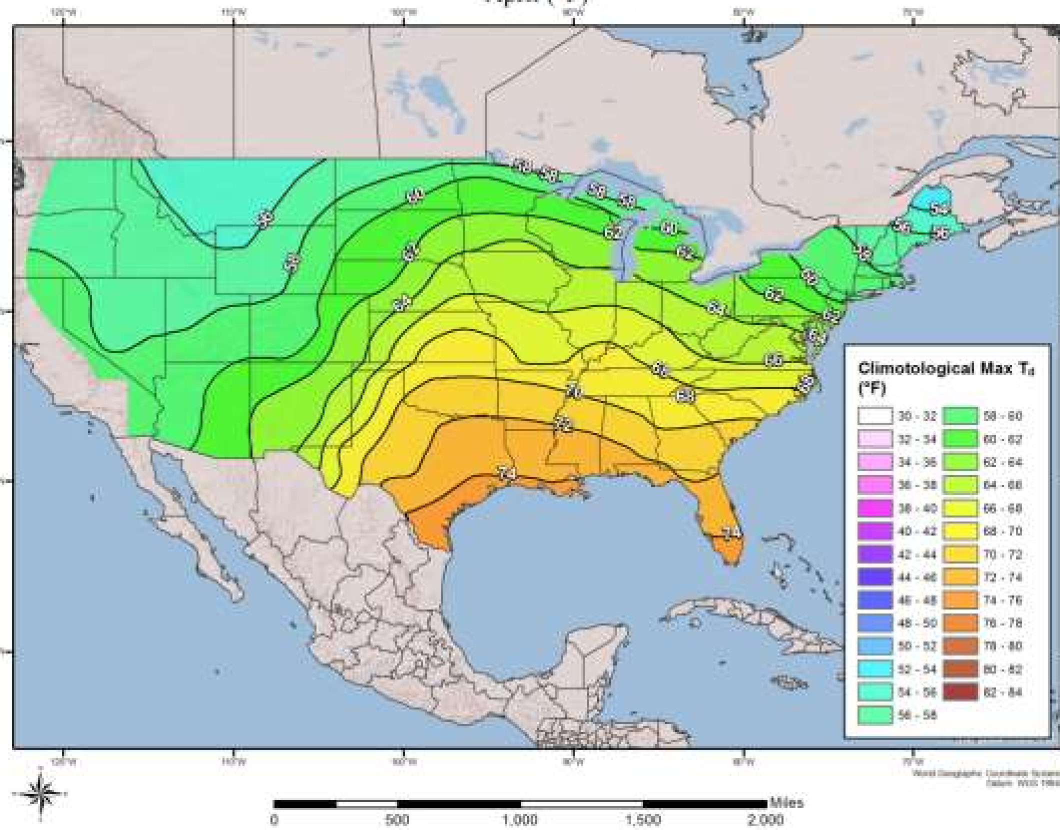
100-year Return Frequency 24-hour Maximum Dew Point Climatology
February (°F)



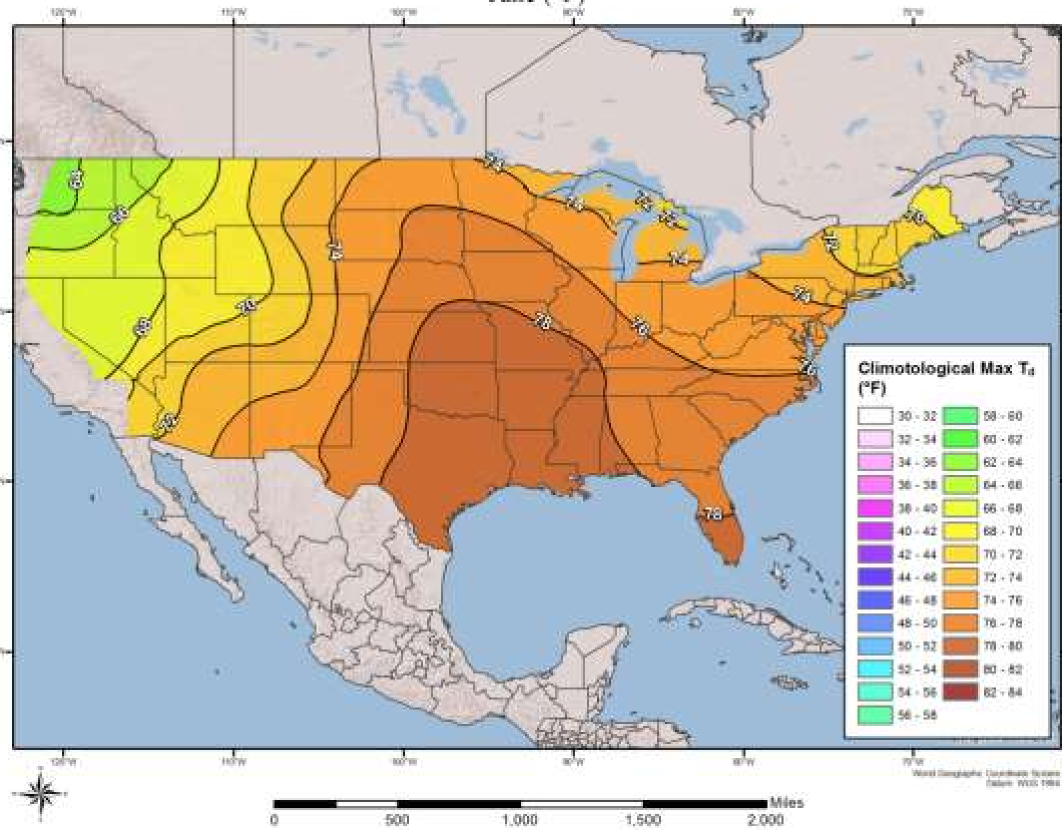
100-year Return Frequency 24-hour Maximum Dew Point Climatology
March (°F)



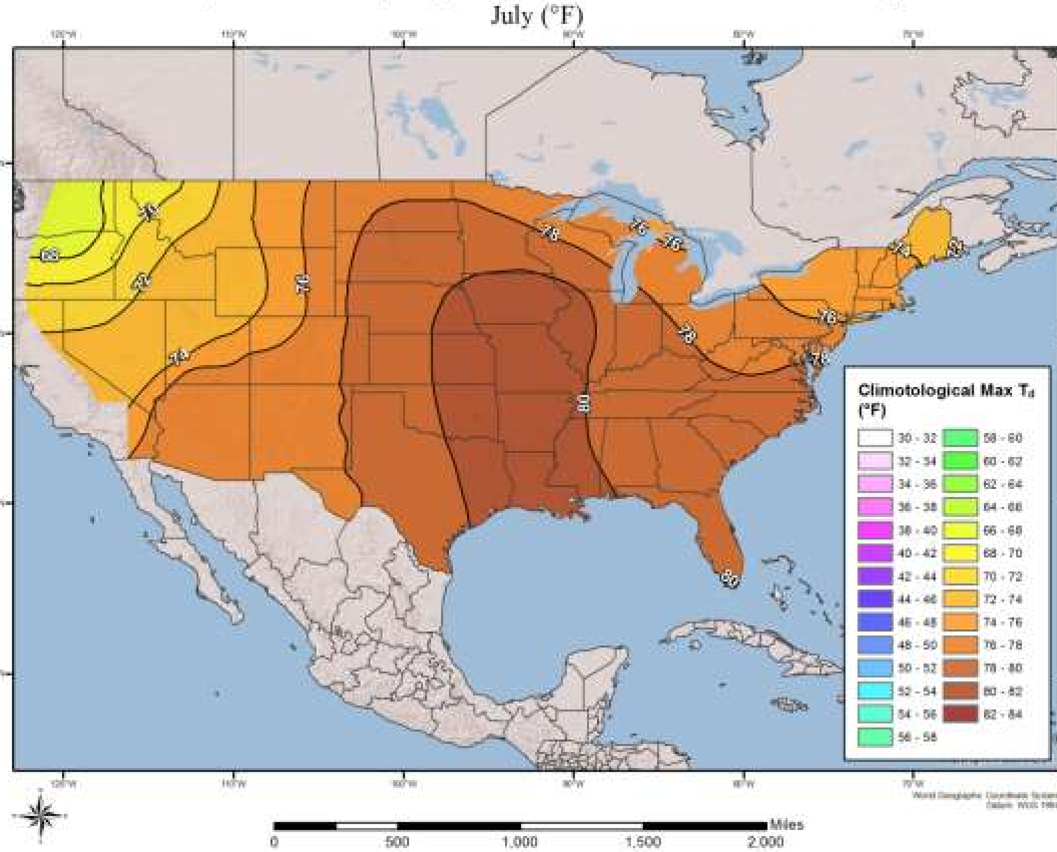
100-year Return Frequency 24-hour Maximum Dew Point Climatology
April (°F)



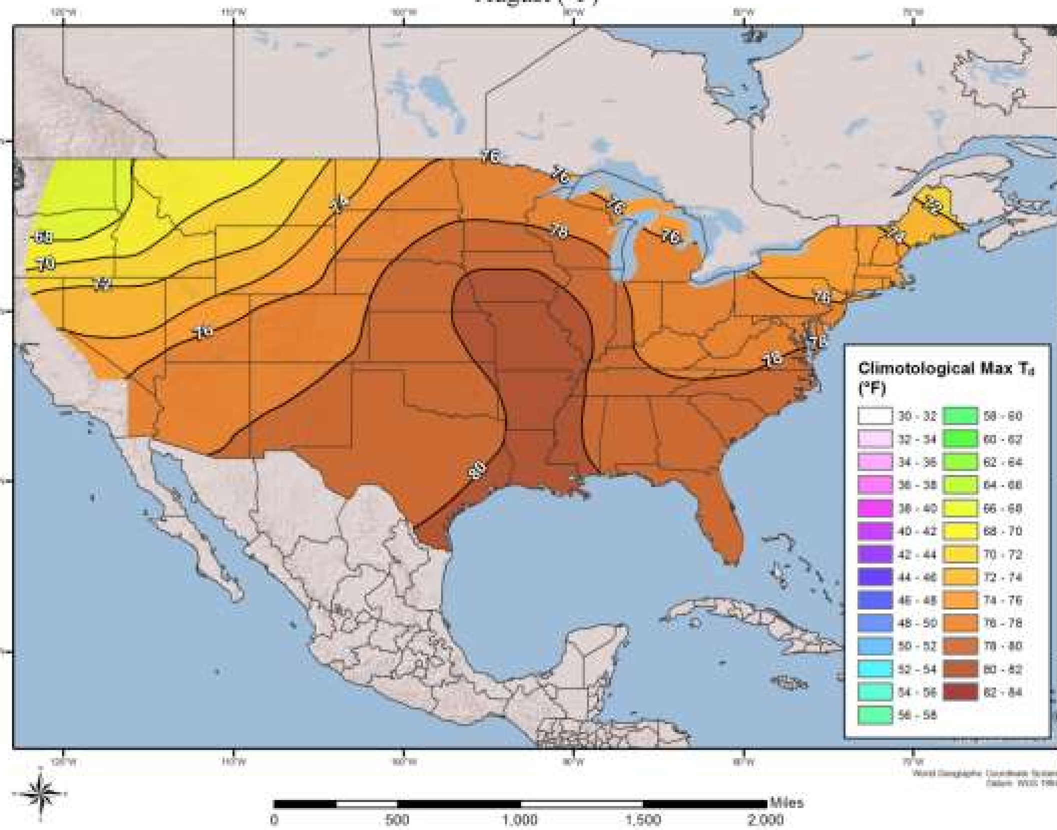
100-year Return Frequency 24-hour Maximum Dew Point Climatology
June (°F)



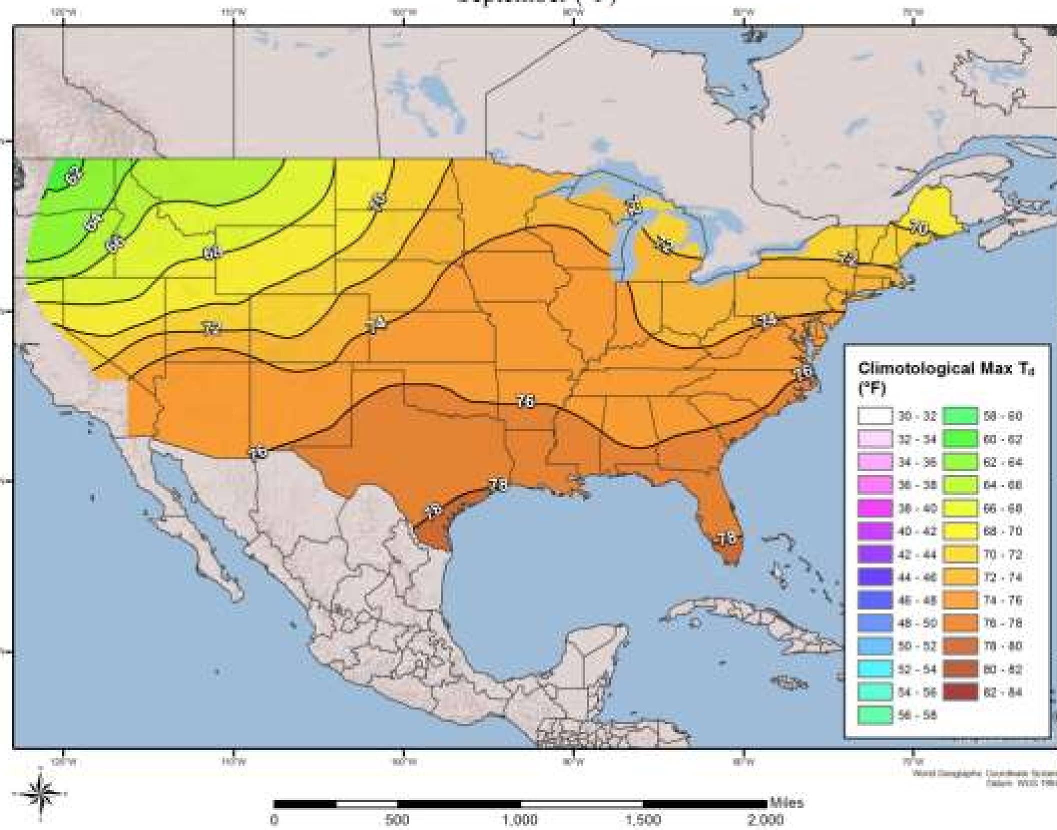
100-year Return Frequency 24-hour Maximum Dew Point Climatology
July (°F)



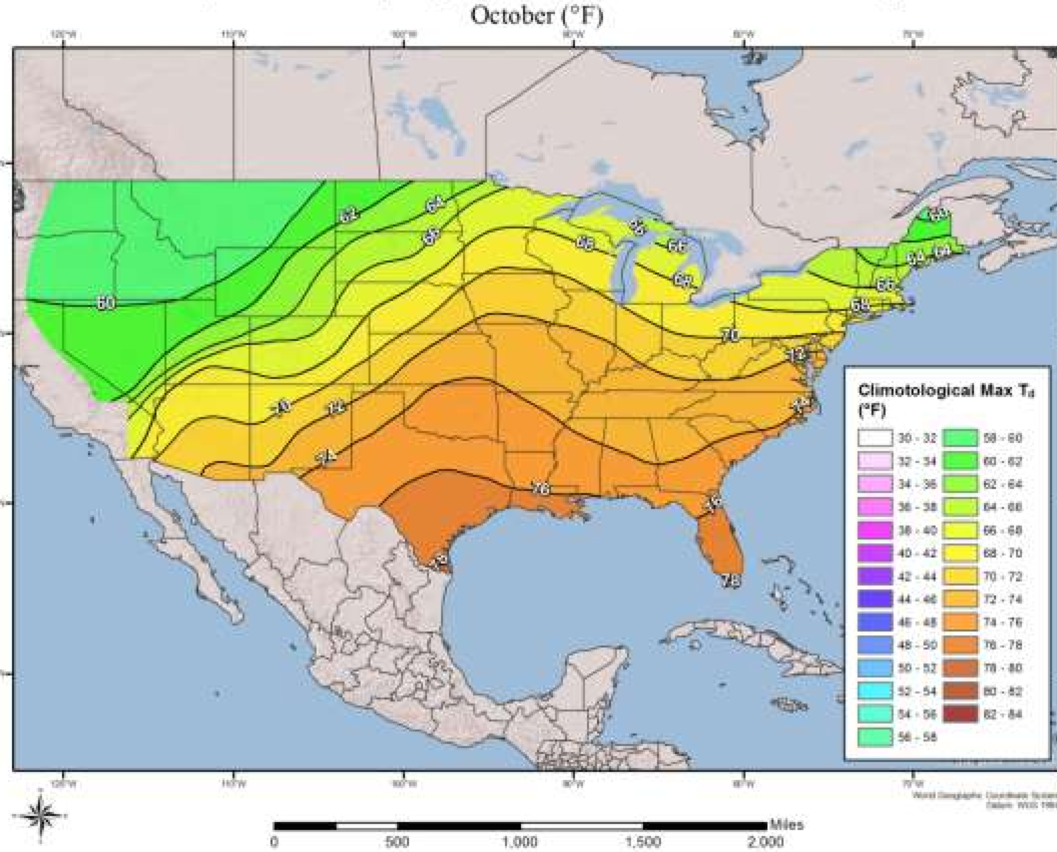
100-year Return Frequency 24-hour Maximum Dew Point Climatology
August (°F)



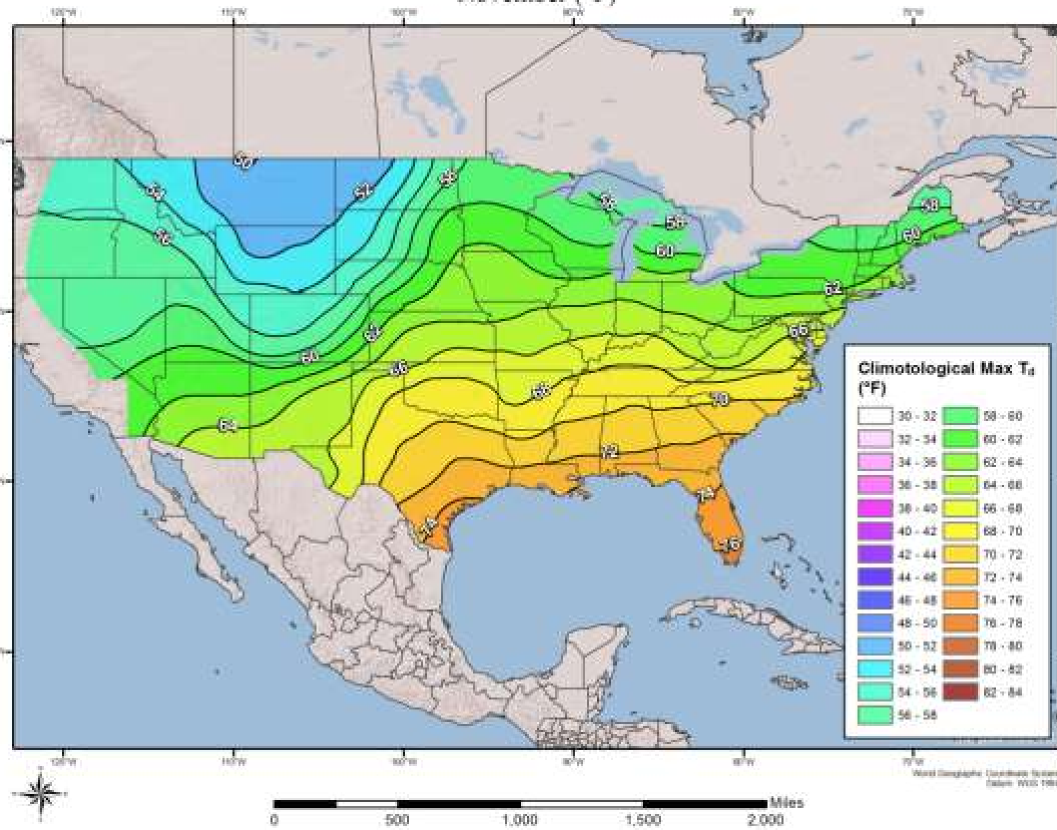
100-year Return Frequency 24-hour Maximum Dew Point Climatology
September (°F)



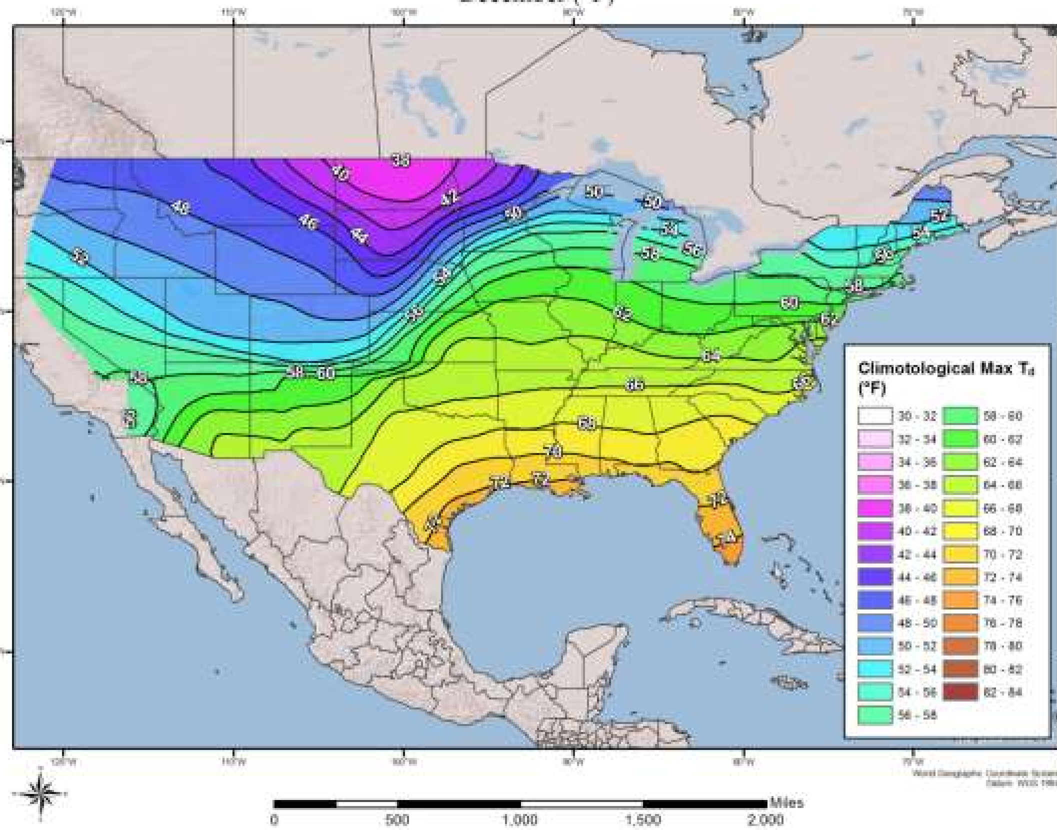
100-year Return Frequency 24-hour Maximum Dew Point Climatology
October (°F)



100-year Return Frequency 24-hour Maximum Dew Point Climatology
November (°F)



100-year Return Frequency 24-hour Maximum Dew Point Climatology
December (°F)



Appendix C

Procedure for using Dew Point Temperatures for Storm Maximization and Transposition

Maximum dew point temperatures (hereafter referred to as dew points) have historically been used for two primary purposes in the PMP computation process:

1. Increase the observed rainfall amounts to a maximum value based on a potential increase in atmospheric moisture available to the storm.
2. Adjust the available atmospheric moisture to account for any increases or decreases associated with the maximized storm potentially occurring at another location within the transposition limits for that storm.

HMR and WMO procedures for storm maximization use a representative storm dew point as the parameter to represent available moisture to a storm. Prior to the mid-1980s, maps of maximum dew point values from the *Climatic Atlas of the United States*, Environmental Data Services, Department of Commerce (1968), were the source for maximum dew point values. HMR 55 published in 1984 updated maximum dew point values for a portion of the United States from the Continental Divide eastward into the central plains. A regional PMP study for Michigan and Wisconsin produced return frequency maps using the L-moments method (Tomlinson 1993). The Review Committee for that study included representatives from NWS, FERC, Bureau of Reclamation, and others. They agreed that the 50-year return frequency values were appropriate for use in PMP calculations. HMR 57 was published in 1994 and HMR 59 in 1999. These latest NWS publications also update the maximum dew point climatology but use maximum observed dew points instead of return frequency values. For this study, the 100-year return frequency dew point climatology maps were appropriate because this added a layer of conservatism and the extra 17 years of data available since the EPRI and Nebraska studies allow the 100-year return frequency to be more reliable. Storm precipitation amounts are maximized using the ratio of precipitable water for the maximum observed dew point to precipitable water for the storm representative dew point, assuming a vertically saturated atmosphere. This procedure was followed in this study using the updated maximum dew point climatology developed during recent and ongoing PMP studies. The climatological maximum 100-year return frequency maps for the 6-, 12-, and 24-hour durations are giving in Appendix B.

The procedure for determining a storm representative dew point begins with the determination of the inflow wind vector (direction and magnitude) for the air mass that contains the atmospheric moisture available to the storm. Beginning and ending times of the rainfall event at locations of the most extreme rainfall amounts are determined using rainfall mass curves from those locations.

The storm inflow wind vector is determined using available wind data. The inflow wind vector has historically been determined using winds reported by weather stations, together with upper air winds, when available. Recently, re-analyzed weather model data representing various atmospheric parameters including wind direction and speed in the atmosphere have become available for use from the HYSPLIT trajectory model and the North American Reanalysis Project (Kalnay et al 1996). These analyses are available back to 1948. Use of these wind fields in the lower portion of the atmosphere provides much improved reliability in the determination of the storm inflow wind vectors. The program is available through an online interface through the Air Resources Laboratory section of NOAA. Users are able to enter in specific parameters that then produce a trajectory from a starting point going backwards (or forwards) for a specified amount of time. Users can define variables such as the starting point (using latitude and longitude or a map interface), the date and time to start the trajectory, the length of time to run the trajectory, and the pressure level at which to delineate the inflow vector. Figure C.0 shows example inflow vectors generated by HYSPLIT at three levels: 700mb, 850mb, and surface for an example storm event. The data generated from the HYSPLIT runs is then used in conjunction with standard methods to help delineate the source region of the air mass responsible for the storm precipitation. Also, this serves as another tool to determine from which weather stations to derive hourly dew point data for storm representative dew point analysis.

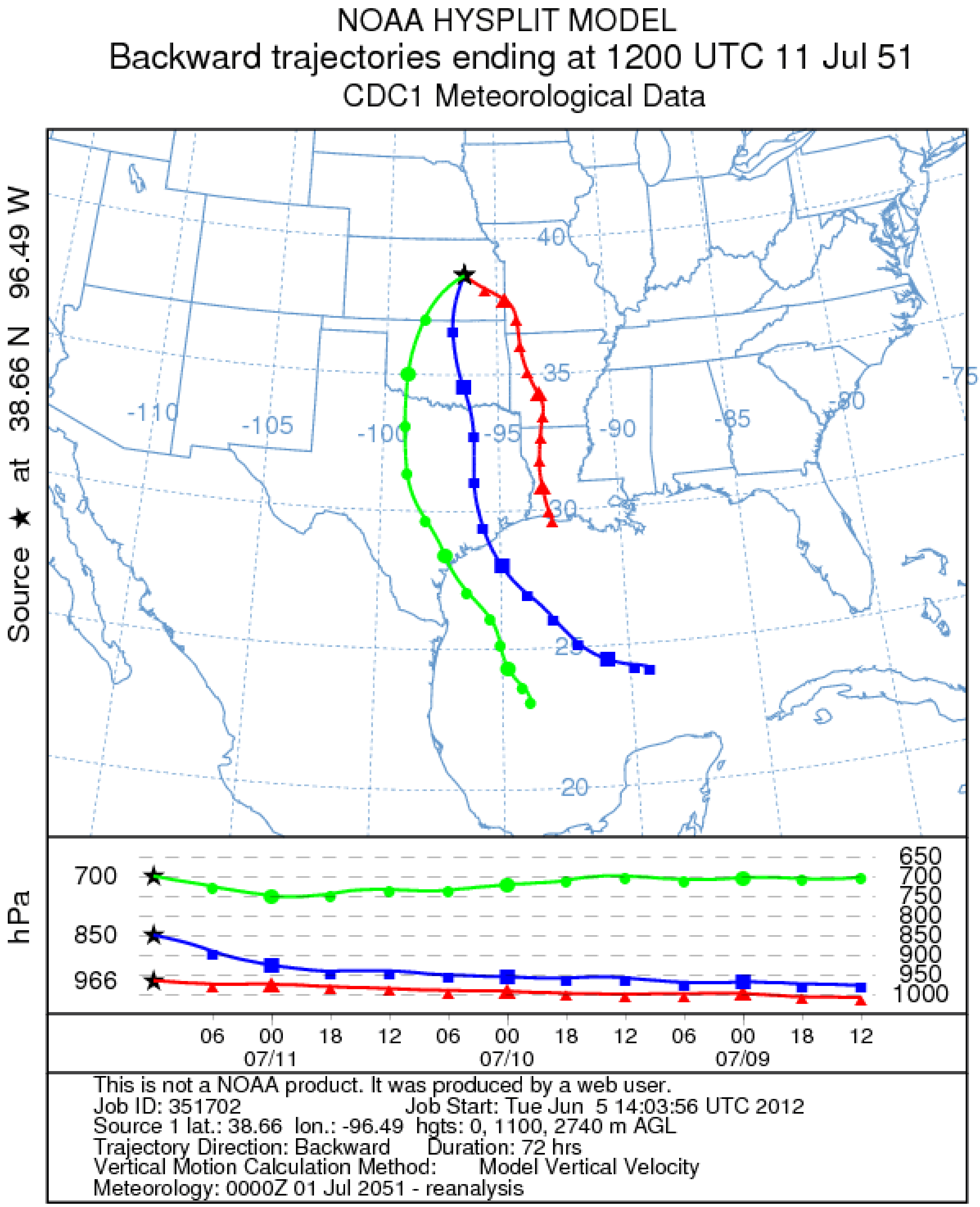


Figure C.0 HYSPLIT trajectory model results for Council Grove, KS, July 1951 storm (AWA 18).

The inflow wind vector is followed upwind until a location is reached that is outside of the storm rainfall. The nearest weather stations that report dew point values are identified. At least two stations are desired but a single station with reliable dew points observations can be used. The time period used to identify the appropriate dew point values is determined by computing the time required for the air mass to be transported from the location of the weather station(s) to the location of maximum rainfall. The start time of the extreme rainfall is then adjusted back in time to account for transit time from the dew point observing station(s) to the maximum rainfall location.

For example, consider the following case:

1. Rainfall begins at 11:00am and ends at 6:00pm the following day at the location of maximum rainfall,
2. The storm representative dew point location (the location of the weather stations observing the dew points) is 100 miles from the maximum rainfall location in the direction of the inflow wind vector, and
3. The inflow wind speed is 20 mph.

The transit time for the air mass from the weather stations to the maximum rainfall location is five hours (100 miles divided by 20 mph). The time to begin using the dew point observations is five hours before the rainfall began (11:00am minus 5 hours = 6:00am) and the time to stop using the dew point observations is five hours before the rainfall ended (6:00pm minus 5 hours = 1:00pm the following day). Dew point observations taken between these times are used to determine the storm representative average 24-hour 1000mb dew point value. The storm representative dew point location can come from a single location if only one station is used or from a location between the reporting weather stations if more than one station is used. The vector connecting this location and the location of maximum rainfall becomes the wind inflow vector used for storm transpositioning.

The storm representative dew point determined from the hourly dew point observations needs to be corrected to the 1000mb level. The elevation of the storm representative dew point location is used in this correction. The correction factor of 2.4°F per 1,000 feet of elevation is used. This is the same correction factor used in the *Climatic Atlas of the United States* (Environmental Data Services, Department of Commerce, 1968). For example, a storm representative dew point of 72°F at a station location with an elevation of 800 feet above sea level is corrected with a factor of 800 X 2.4 /1000 = 1.9°F. The dew point value corrected to 1000mb (sea level) is 72°F + 1.9°F = 74°F after rounding.

The procedure that computes the in-place maximized rainfall for a storm provides an estimate of the maximum amount of rainfall that could have been produced by the same storm at the same location if the maximum amount of atmospheric moisture had been available. This procedure requires that a maximum value for the storm representative dew point be determined. The maximum dew point value is selected at the same location where the storm dew point was determined using a maximum dew point climatology. The maximum dew point values must be corrected to 1000mb. The precipitable water in the atmosphere is determined using the storm representative and maximum dew point values. Precipitable water is defined in this study as the total amount of moisture in a column of the atmosphere from sea level to 30,000 feet assuming a vertically saturated atmosphere. Values of atmospheric precipitable water are determined using the moist pseudo-adiabatic assumption, i.e. assume that for the given 1000mb dew point value, the atmosphere holds the maximum amount of moisture possible. The ratio of the precipitable water associated with the maximum 1000mb dew point to the precipitable water associated with the 1000-mb storm representative dew point is the maximization factor.

For example, consider the following case:

1000mb storm representative dew point:	72°F
1000mb maximum dew point:	76°F
Precipitable water associated with a 1000mb dew point of 72°F:	2.47"
Precipitable water associated with a 1000mb dew point of 76°F:	2.99"

Maximization factor: PW(76°F)/PW(72°F) = 2.99"/2.47" = 1.21

For transpositioning, the storm inflow vector (determined by connecting the storm representative dew point location with the location of maximum rainfall) is moved to the basin location being studied. The new location of the upwind end of the vector is determined. The maximum dew point associated with that location is then selected using the same maximum dew point climatology map used for in-place maximization. The transpositioning factor is the ratio of the precipitable water associated with the maximum 1000mb dew point value at the transpositioned location to the precipitable water associated with the maximum 1000mb dew point for the storm representative dew point location.

An example is provided.

1000mb maximum dew point at the storm representative dew point location:	76°F
1000mb maximum dew point at the transpositioned location:	74°F
Precipitable water associated with a 1000mb dew point of 76°F:	2.99"
Precipitable water associated with a 1000mb dew point of 74°F:	2.73"

Transposition factor: PW(74°F)/PW(76°F) = 2.73"/2.99" = 0.91

Appendix D

Procedure for Deriving PMP Values from Storm Depth-Area-Duration (DAD) Analyses

Although PMP rainfall amounts are theoretical values, there currently is no theoretical method for determining the values. The accepted procedure for determining PMP values begins with the identification of the largest identified historic observed rainfall amounts in the region and applies the following procedures:

1. Increase the rainfall amounts to some maximized value (in-place maximization),
2. Adjust the "maximized" rainfall amounts to the potential situation where the historic storm occurs over the basin being studied (transposition),
3. Adjust the "maximized transpositioned" rainfall amounts for elevation changes or intervening topographic barriers which could potentially affect the storm moisture and subsequently the rainfall amounts for the "maximized transpositioned" storm (barrier adjustment).

The procedure begins with the Depth-Area-Duration (DAD) analysis from the largest of the identified storms that have occurred over regions that are climatologically and topographically similar to the area being studied. Identification of the largest rainfall events is relatively straight forward and is accomplished by identifying the largest station rainfall amounts and correlating the dates among adjacent stations to identify the areal extent of the heavy rainfall and the storm period. The DAD for each storm is computed using isohyetal analyses for each hour during the storm and determining the largest rainfall totals for each duration of interest over each area size of interest. HMR 51 uses temporal periods of 6-, 12-, 24-, 48- and 72- hours. Standard area sizes of 10-, 200-, 1,000-, 5,000-, 10,000- and 20,000-square miles area used. Other durations and area sizes can also be used in the DAD analysis as desired. In this study, area sizes of 50,000- and 100,000-square miles were analyzed in addition to the standard area sizes.

The US Army Corps of Engineers, the Bureau of Reclamation and the National Weather Service have performed storm studies and produced DADs for many storms. This study reviewed additional weather station data to identify extreme rainfall storms that had not been identified and studied previously. The new storms identified primarily occurred since the publication of HMRs 51 and 55A, but additional storms that occurred prior to HMR publication were also identified. DADs that had been previously developed are used in this report. Newly identified storms are analyzed in this study, and DADs are developed for these storms. These DADs quantify the rainfall associated with each storm event, providing the largest rainfall amounts for each of the durations and area sizes used in this study.

Identification of storms that can be transpositioned to the ANO basin is largely based on subjective judgments. For a storm to be transpositionable, it should have occurred over a region that is climatologically and topographically similar to the basin being studied. Storms generally should not be transpositioned across significant topographic features or into different climate regions. The largest rainfall events identified in the storm search generally occurred over locations closer to the Gulf of Mexico with moisture moving in from the south and north. These storms occurred in similar meteorological, climatological, and topographical settings. Therefore, it is assumed that the same moisture sources and dynamics that produced these events could have produced a similar storm over the basin.

Maximization of the storm DADs involves deriving the in-place and transposition factors to adjust the observed rainfall to look like it would have occurred had the storm been located over the basin. This accounts for the three factors which could affect a particular storm as it's moved from its original location to the ANO basin; the storm could have been some amount bigger in-place had more moisture been available, the storm would have had more or less moisture available to it versus where it originally occurred based on it being moved toward or away from its moisture source, and the storm would have occurred at a lower or higher elevation than its original location.

For this study, all computations associated with historic storms are computed at the 1000mb level (approximately sea level). The elevation of the location where the largest rainfall was observed is used as the storm elevation. An adjustment is applied to the storm moisture to account for the elevation of the storm above sea level. For example, if the maximum rainfall occurred at an elevation of 500 feet, the total atmospheric moisture (500 to 30,000 feet) is decreased by the amount of moisture associated with the storm representative dew point between sea level and 500 feet. The adjustment factor uses precipitable water contained in the moisture maximized atmosphere above the storm elevation, i.e., the moisture contained in the entire depth of the moisture maximized atmosphere, minus the moisture contained in the moisture maximized atmosphere below the storm elevation. An adjustment was made to account for the storm's elevation (either higher or lower than the particular grid point basin centroid elevation) and the amount of precipitable water that would be available, more if the elevation was lower and less if the elevation was higher. This elevation adjustment factor is determined by computing the ratio of precipitable water in the moisture maximized atmosphere above the elevation to the precipitable water in the entire depth of the moisture maximized atmosphere.

The equations for the computation of the in-place maximization factor, transposition and elevation adjustment factors are as follows:

In-place maximization factor =
(storm representative maximum dew point PW – in-place storm elevation maximum dew point PW) / (storm representative dew point PW – in-place storm elevation representative dew point PW)

Transpositioned/elevation to basin factor =
(transpositioned maximum dew point PW – average basin elevation maximum dew point PW)/(storm representative maximum dew point PW – in-place storm elevation representative dew point PW)

Multiplication of these terms leads to a simplified computation where all the required adjustments are combined in a single equation.

Total adjustment factor =
(in-place max factor) * (transpositioned/elevation to basin factor) * (barrier/elevation adjustment factor)

The total adjustment factor modifies the storm DAD by a factor using two computed values:

1) The maximum atmospheric moisture available to a historic storm if it were to occur over the study basin. This air mass is assumed to contain the maximum amount of atmospheric moisture for the basin location and is adjusted for elevation upwind of the basin and within the basin.

2) The atmospheric moisture available for the historic storm at the location and elevation where it occurred.

The total adjustment factor is applied as a linear multiplier for all rainfall amounts in the storm DAD.

As an example, the DAD from the Warner Park, TN SPAS 1208 AWA Storm Number 2W storm center is maximized, transpositioned, and elevation/barrier adjusted to the basin centroid. The following are values for the parameters used in computing the adjustments:

Storm representative Td:	75.0° F
In-place maximum Td:	76.5° F
Transpositioned maximum Td:	74.0° F
Storm elevation:	600'
Average basin elevation:	1,150’
Total atmospheric precipitable water for 75.0° F:	2.85"
Total atmospheric precipitable water for 76.5° F:	3.07"
Total atmospheric precipitable water for 74.0° F:	2.73"
Adjustment for storm elevation, 1000mb to 600' at 75.0°F:	0.15"
Adjustment for storm elevation, 1000mb to 600' at 76.5°F:	0.16"
Adjustment for ave basin elevation, 1000mb to 1,150' at 74.0°F:	0.28"
Adjustment for inflow barrier elevation, 1000mb to 1150' at 74.0°F:	0.28"

Total adjustment factor =
(in-place max factor) * (transpositioned to basin factor) * (elevation/barrier adjustment factor)

= ((3.07" - 0.16") / (2.85" - 0.15")) * ((2.73" - 0.28") / (3.07" - 0.16")) * ((2.73" - 0.28") / (2.73" - 0.28")) = (1.08) * (0.84) * (1.00) = 0.91

To explicitly show how each adjustment factor (in-place maximization, transposition and elevation/barrier adjustment) affects the total adjustment, separate computation are provided.

<u>In-place maximization factor</u>

Storm representative dew point:	75.0° F
In-place maximum dew point:	76.5° F
Storm atmospheric precipitable water for 75.0° F:	2.85"
Maximum atmospheric precipitable water for 76.5° F:	3.07"
Adjustment for storm elevation, 1000mb to 600' at 75.0°F:	0.15"
Adjustment for storm elevation, 1000mb to 600' at 76.5°F:	0.16"

In-place maximization factor =
(storm representative maximum dew point PW – in place storm elevation maximum PW)/(storm representative dew point PW – in place storm elevation maximum dew point PW)

= (3.07"- 0.16) / (2.85" - 0.15")
= 2.91" / 2.70"
= 1.08

<u>Transposition factor</u>

In-place maximum dew point	76.5° F
Transpositioned maximum dew point	74.0° F
Maximum atmospheric precipitable water for 82.0° F:	3.07"
Maximum atmospheric precipitable water for 80.5° F:	2.73"
Adjustment for storm elevation, 1000mb to 600' at 76.0°F:	0.16"
Adjustment for storm elevation, 1000mb to 1,150' at 74.0°F:	0.28"

Transposition factor =
(transpositioned maximum dew point PW – basin elevation maximum dew point PW)/(storm representative maximum dew point PW – in place storm elevation maximum dew point PW)

= (2.73" - 0.28") / (3.07" - 0.16")
= 2.45" / 2.91"
= 0.84

<u>Moisture inflow barrier adjustment factor</u>

For this study there were no intervening barriers that would deplete moisture before reaching any of the grid points or basin centroid. Therefore, in all cases this factor was equal to 1.00.

Total adjustment factor = (In-Place maximization) X (Transposition) X (Barrier Adjustment/Storm elevation)

$$= 1.08 * 0.84 * 1.00$$
$$= 0.91$$

This is the same total adjustment computed earlier (within round-off error) using the single equation to compute the total adjustment factor.

Since these procedures involve linear multiplication, Excel spreadsheets can be used to incorporate the storm DAD and apply the factors to compute the total adjusted DAD. Each storm spreadsheet and all the data used for the calculations are presented for the PMP storms in Appendix F and the LIP storm list in Appendix G

Once the total adjustment factors are applied to all of the storms being considered, rainfall amounts from largest storms are plotted on a log-linear plot with rainfall depth plotted on the linear scale and area size plotted on the log scale. A separate graph is constructed for each duration period, e.g. 6-hour, 12-hour, etc. The graphs provide curves of the transpositioned maximized adjusted storm rainfall amounts for all area sizes. These DA curves represent the maximum rainfall potential based on standard procedure modifications of the largest observed historic storms in the region surrounding the basins. An enveloping curve is drawn using the largest rainfall values. All of the plotted rainfall amounts either lie on the enveloping curve or below it. The exception is in the case where there is reason to suspect that a value is larger than is reasonable and that rainfall value may be undercut, i.e. the envelop curve should be drawn beneath the value. Undercutting should rarely be done and each case needs to be justified. No undercutting was done in this study. In general, the enveloping curve should provide a smooth transition among the maximum rainfall values for various area sizes. This process of enveloping DA plots provides continuity in space for the rainfall amounts among various area sizes.

After enveloping curves are completed for each of the duration periods, DD curves are plotted on a linear-linear graph, with duration on one axis and depth on the other. Since there is only a single curve for each area size from the enveloped DA plots, all of DA curves can be plotted as a family of curves on a single graph. Enveloping of curves is completed for each area size. The enveloping curve should provide a smooth transition among the maximum rainfall values for various durations. This procedure of enveloping DD plots provides continuity in time for the rainfall amounts among various durations.

The final envelopment curves provide the maximum rainfall amounts that represent PMP values for each particular grid point. Rainfall amounts for each area size and each duration are taken from the curves and used to construct the PMP DAD table.

Appendix E

Storm Precipitation Analysis System (SPAS) Description

INTRODUCTION

The Storm Precipitation Analysis System (SPAS) is grounded on years of scientific research with a demonstrated reliability in hundreds of post-storm precipitation analyses. It has evolved into a trusted hydrometeorological tool that provides accurate precipitation data at a high spatial and temporal resolution for use in a variety of sensitive hydrologic applications (Faulkner et al 2004, Tomlinson et al 2003-2012). Applied Weather Associates, LLC and METSTAT, Inc. initially developed SPAS in 2002 for use in producing Depth-Area-Duration values for Probable Maximum Precipitator (PMP) analyses. SPAS utilizes precipitation gauge data, "basemaps" and radar data (when available) to produce gridded precipitation at time intervals as short as 5-minutes, at spatial scales as fine as 1 km^2 and in a variety of customizable formats. To date (April 2012) SPAS has been used to analyze over 230 storm centers across all types of terrain, among highly varied meteorological settings and some occurring over 100-years ago.

SPAS output has many applications including, but not limited to: hydrologic model calibration/validation, flood event reconstruction, storm water runoff analysis, forensic cases and PMP studies. Detailed SPAS-computed precipitation data allow hydrologists to accurately model runoff from basins, particularly when the precipitation is unevenly distributed over the drainage basin or when rain gauge data is limited or not available. The increased spatial and temporal accuracy of precipitation estimates has eliminated the need for commonly made assumptions about precipitation characteristics (such as uniform precipitation over a watershed), thereby greatly improving the precision and reliability of hydrologic analyses.

In order to instill consistency in SPAS analyses, many of the core methods have remained consistent from beginning. However, SPAS is constantly evolving and improving through new scientific advancements and as new data and improvements are incorporated. This write-up describes the current inter-workings of SPAS, but the reader should realize SPAS can be customized on a case-by-case basis to account for special circumstances; these adaptations are documented and included in the deliverables. The over arching goal of SPAS is to combine the strengths of rain gauge data and radar data (when available) to provide sound, reliable and accurate spatial precipitation data.

Hourly precipitation observations are generally limited to a small number of locations, with many basins lacking observational precipitation data entirely. Meanwhile Next Generation Radar (NEXRAD) data provides valuable spatial and temporal information over data-sparse basins, it has historically lacked reliability for determining precipitation rates and reliable quantitative precipitation estimates (QPE). The improved reliability in SPAS is made possible by hourly calibration of the NEXRAD radar-precipitation relationship, combined with local hourly bias adjustments to force consistency between the final result and "ground truth" precipitation measurements. If NEXRAD radar data is available (generally for storm events since the mid-1990's), precipitation at temporal scales as frequent as 5-minutes is available, otherwise the precipitation data is available hourly. A summary of the general SPAS processes are shown in flow chart in Figure E.0.

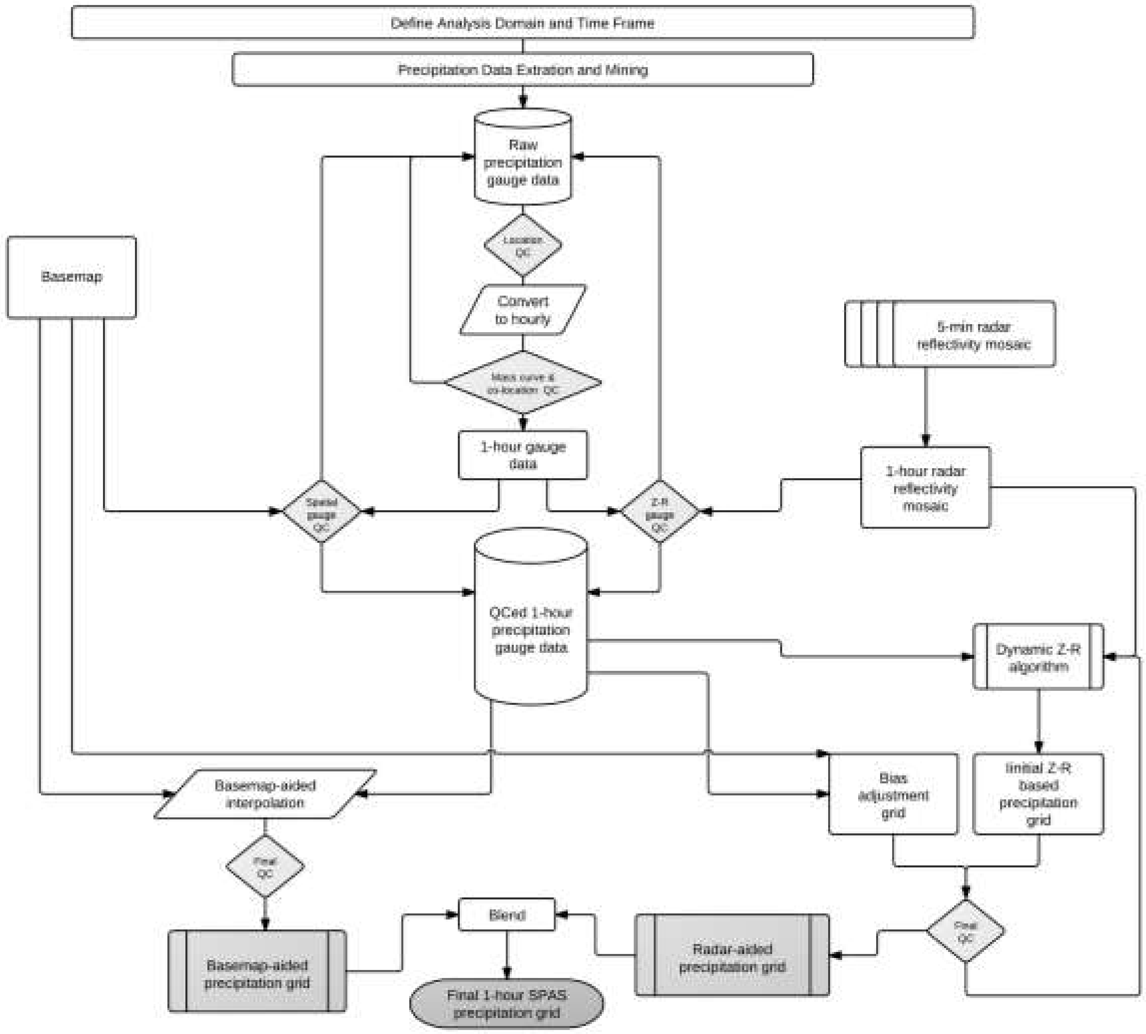


Figure E.0 SPAS flow chart.

SETUP

Prior to a SPAS analysis careful definition of the storm analysis domain and time frame to be analyzed is established. Several considerations are made to ensure the domain (longitude-latitude box) and time frame are sufficient for the given application.

SPAS Analysis Domain

For PMP applications it is important to establish an analysis domain that completely encompasses a storm center, meanwhile hydrologic modeling applications are more concerned about a specific basin, watershed or catchment. If radar data is available, then it is also important to establish an area large enough to encompass enough stations (minimum of ~30) to adequately derive reliable radar-precipitation intensity relationships (discussed later). The domain is defined by evaluating existing documentation on the storm as well as plotting and evaluating initial precipitation gauge data on a map. The analysis domain is defined to include as many hourly recording gauges as possible given their importance in timing. The domain must include enough of a buffer to accurately model the nested domain of interest. The domain is defined as a longitude-latitude (upper left and lower right corner) rectangular region.

SPAS Analysis Time Frame

Ideally, the analysis time frame, also referred to as the Storm Precipitation Period (SPP), will extend from a dry period through the target wet period then back into another dry period. This is to ensure that total storm precipitation amounts can be confidently associated with the storm in question and not contaminated by adjacent wet periods. If this is not possible, a reasonable time period is selected that is bounded by relatively lighter precipitation. The time frame of the hourly data must be sufficient to capture the full range of daily gauge observational periods in order for the daily observations to be disaggregated into estimated incremental hourly values (discussed later). For example, if a daily gauge takes observations at 8:00 AM, then the hourly data must be available from 8:00 AM the day prior. Given the configuration of SPAS, the minimum SPP is 72 hours and aligns midnight to midnight.

The core precipitation period (CPP) is a sub-set of the SPP and represents the time period with the most precipitation and the greatest number of reporting gauges. The CPP represents the time period of interest and where our confidence in the results is highest.

DATA

The foundation of a SPAS analysis is the "ground truth" precipitation measurements. In fact, the level of effort involved in "data mining" and quality control represent over half of the total level of effort needed to conduct a complete storm analysis. SPAS operates with three primary data sets: precipitation gauge data, a "basemap" and, if available, radar data. Table E.0 conveys the variety of precipitation gauges usable by SPAS. For each gauge, the following elements are gathered, entered and archived into to SPAS database:

- Station ID
- Station name
- Station type (H=hourly, D=Daily, S=Supplemental, etc.)
- Longitude in decimal degrees
- Latitude in decimal degrees
- Elevation in feet above MSL
- Observed precipitation
- Observation times
- Source
- If unofficial, the measurement equipment and/or method is also noted.

Based on the SPP and analysis domain, hourly and daily precipitation gauge data are extracted from our in-house database as well as the Meteorological Assimilation Data Ingest System (MADIS). Our in-house database is contains data dating back to the late 1800s, while the MADIS system (described below) contains archived data back to 2002.

Hourly Precipitation Data

Our hourly precipitation database is largely comprised of data from NCDC TD-3240, but also precipitation data from other mesnonets and meteorological networks (e.g. ALERT, Flood Control Districts, etc.) that we have collected and archived as part of previous studies. Meanwhile, MADIS provides data from a large number of networks across the U.S., including NOAA's HADS (Hydrometeorological Automated Data System), numerous mesonets, the Citizen Weather Observers Program (CWOP), departments of transportation, etc. (see http://madis.noaa.gov/mesonet_providers.html for a list of providers). Although our automatic data extraction is fast, cost-effective and efficient, it never captures all of the available precipitation data for a storm event. For this reason, a thorough "data mining" effort is undertaken to acquire all available data from sources such as U.S. Geological Survey (USGS), Remote Automated Weather Stations (RAWS), Community Collaborative Rain, Hail & Snow Network (CoCoRaHS), National Atmospheric Deposition Program (NADP), Clean Air Status and Trends Network (CASTNET), local observer networks, Climate Reference Network (CRN), Global Summary of the Day (GSD) and Soil Climate Analysis Network (SCAN). Unofficial hourly precipitation are gathered to give guidance on either timing or magnitude in areas otherwise void of precipitation data. The WeatherUnderground and MesoWest, two of the largest weather databases on the Internet, contain a good deal of official data, but also unofficial gauges.

Table E.0 Different precipitation gauge types used by SPAS.

Precipitation Gauge Type	Description
Hourly	Hourly gauges with complete, or nearly complete, incremental hourly precipitation data.
Hourly estimated	Hourly gauges with some estimated hourly values, but otherwise reliable.
Hourly pseudo	Hourly gauges with reliable temporal precipitation data, but the magnitude is questionable in relation to co-located daily or supplemental gauge.
Daily	Daily gauge with complete data and known observation times.

Daily estimated	Daily gauges with some or all estimated data.
Supplemental	Gauges with unknown or irregular observation times, but reliable total storm precipitation data. (E.g. public reports, storms reports, “Bucket surveys”, etc.)
Supplemental estimated	Gauges with estimated total storm precipitation values based on other information (e.g. newspaper articles, stream flow discharge, inferences from nearby gauges, pre-existing total storm isohyetal maps, etc.)

Daily Precipitation Data

Our daily database is largely based on NCDC’s TD-3206 (pre-1948) and TD-3200 (1948 through present) as well as SNOTEL data from NRCS. Since the late 1990s, the CoCoRaHS network of more than 15,000 observes in the U.S. has become a very important daily precipitation source. Other daily data is gathered from similar, but smaller gauge networks, for instance the High Spatial Density Precipitation Network in Minnesota.

As part of the daily data extraction process, the time of observation, as indicted in database (if available), accompanies each measured precipitation value. Accurate observation times are necessary for SPAS to disaggregate the daily precipitation into estimated incremental values (discussed later). Knowing the observation time also allows SPAS to maintain precipitation amounts within given time bounds, thereby retaining known precipitation intensities. Given the importance of observation times, efforts are taken to insure the observation times are accurate. Hardcopy reports of “Climatological Data,” scanned observational forms (available on-line) and/or gauge metadata forms have proven to be valuable and accurate resources for validating observation times. Furthermore, erroneous observation times are identified in the mass-curve quality-control procedure (discussed later) and can be corrected at that point in the process.

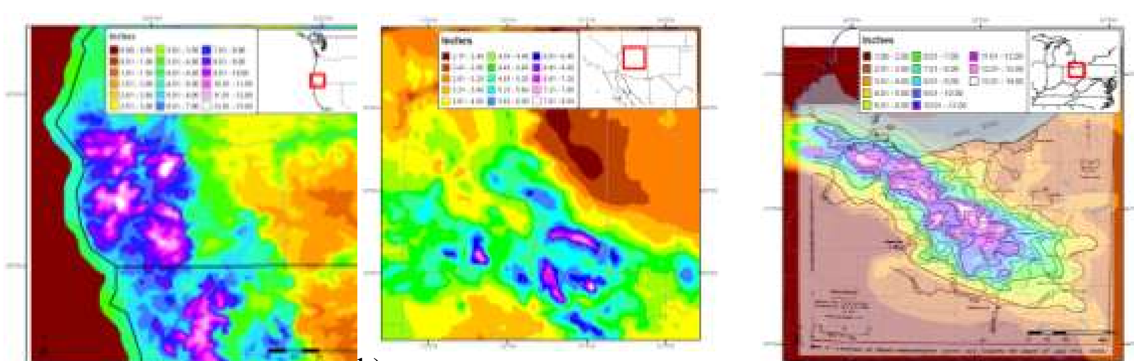
Supplemental Precipitation Gauge Data

For gauges with unknown or irregular observation times, the gauge is considered a “supplemental” gauge. A supplemental gauge can either be added to the storm database with a storm total and the associated SPP as the temporal bounds or as a gauge with the known, but irregular observation times and associated precipitation amounts. For instance, if all that is known is 3” fell between 0800-0900, then that information can be entered. Gauges or reports with nothing more than a storm total are often abundant, but in order to use them, it is important the precipitation is only from the storm period in question. Therefore, it is ideal to have the analysis time frame bounded by dry periods.

Perhaps the most important source of data, if available, is from "bucket surveys," which provide comprehensive lists of precipitation measurements collected during a post-storm field exercise. Although some bucket survey amounts are not from conventional precipitation gauges, they provide important information, especially in areas lacking data. Particularly for PMP-storm analysis applications, it is customary to accept extreme, but valid non-measured precipitation values in order to capture the highest precipitation values.

Basemap

"Basemaps" are independent grids of spatially distributed weather or climate variables that are used to govern the spatial patterns of the hourly precipitation. The basemap also governs the spatial resolution of the final SPAS grids, unless radar data is available/used to govern the spatial resolution. Note that a base map is not required as the hourly precipitation patterns can be based on a station characteristics and an inverse distance weighting technique (discussed later). Basemaps in complex terrain are often based on the PRISM mean monthly precipitation (Figure E.1a) or Hydrometeorological Design Studies Center precipitation frequency grids (Figure E.1b) given they resolve orographic enhancement areas and micro-climates at a spatial resolution of 30-seconds (about 800 m). Basemaps of this nature in flat terrain are not as effective given the small terrain forced precipitation gradients. Therefore, basemaps for SPAS analyses in flat terrain are often developed from pre-existing (hand-drawn) isohyetal patterns (Figure E.1c), composite radar imagery or a blend of both.



a) b) c)

Figure E.1 Sample SPAS "basemaps:" (a) A pre-existing (USGS) isohyetal pattern across flat terrain (SPAS 1209), (b) PRISM mean monthly (October) precipitation (SPAS 1192) and (c) A 100-year 24-hour precipitation grid from NOAA Atlas 14 (SPAS 1138).

Radar Data

For storms occurring since approximately the mid-1990's, weather radar data is available to supplement the SPAS analysis. A fundamental requirement for high quality radar-estimated precipitation is a high quality radar mosaic, which is a seamless collection of concurrent weather radar data from individual radar sites, however in some cases a single radar is sufficient (i.e. for a small area size storm event such as a thunderstorm). Weather radar data has been in use by meteorologists since the 1960's to estimate precipitation depths, but it was not until the early 1990's that new, more accurate NEXRAD Doppler radar (WSR88D) was placed into service across the United States. Currently efforts are underway to convert the WSR88D radars to dual polarization (DualPol) radar. Today, NEXRAD radar coverage of the contiguous United States is comprised of 159 operational sites and 30 in Canada. Each U.S. radar covers an approximate 285 mile (460 km) radial extent and while Canadian radars have approximately 256 km (138 nautical miles) radial extent over which the radar can detect precipitation. (see Figure E.2) The primary vendor of NEXRAD weather radar data for SPAS is Weather Decision Technologies, Inc. (WDT), who accesses, mosaics, archives and quality-controls NEXRAD radar data from NOAA and Environment Canada. SPAS utilizes Level II NEXRAD radar reflectivity data in units of dBZ, available every 5-minutes in the U.S. and 10-minutes in Canada.

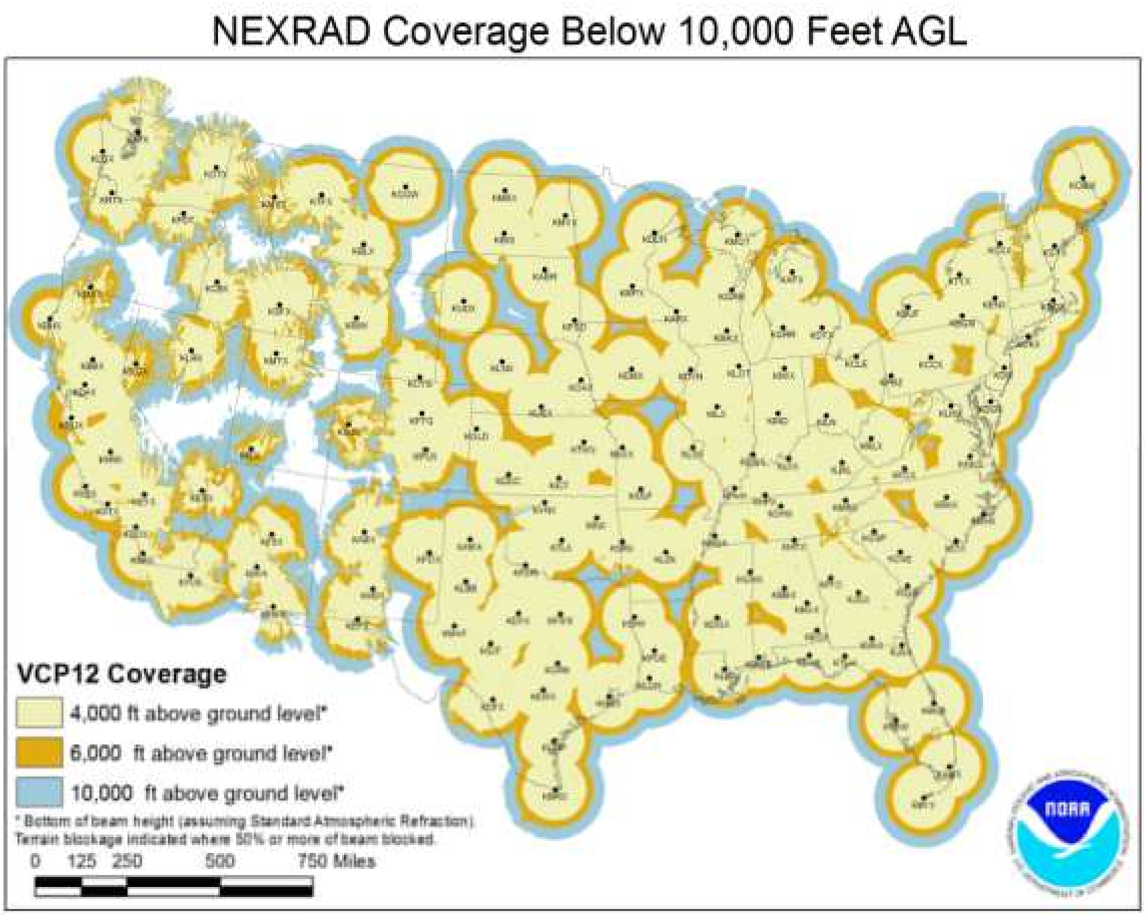


Figure E.2 U.S. radar locations and their radial extents of coverage below 10,000 feet above ground level (AGL). Each U.S. radar covers an approximate 285 mile radial extent over which the radar can detect precipitation.

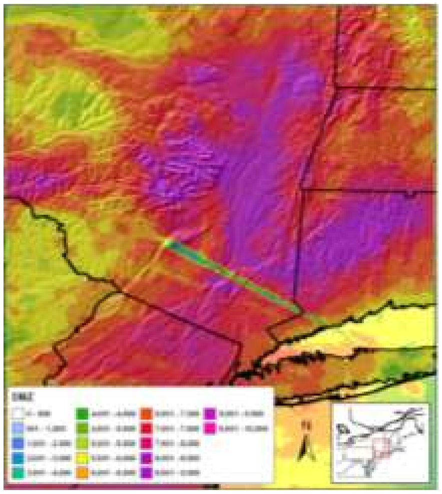
The WDT and National Severe Storms Lab (NSSL) Radar Data Quality Control Algorithm (RDQC) removes non-precipitation artifacts from base Level–II radar data and remaps the data from polar coordinates to a Cartesian (latitude/longitude) grid. Non-precipitation artifacts include ground clutter, bright banding, sea clutter, anomalous propagation, sun strobes, clear air returns, chaff, biological targets, electronic interference and hardware test patterns. The RDQC algorithm uses sophisticated data processing and a Quality Control Neural Network (QCNN) to delineate the precipitation echoes caused by radar artifacts (Lakshmanan and Valente 2004). Beam blockages due to terrain are mitigated by using 30 meter DEM data to compute and then discard data from a radar beam that clears the ground by less than 50 meters and incurs more than 50% power blockage. A clear-air echo removal scheme is applied to radars in clear-air mode when there is no precipitation reported from observation gauges within the vicinity of the radar. In areas of radar coverage overlap, a distance weighting scheme is applied to assign reflectivity to each grid cell, for multiple vertical levels. This scheme is applied to data from the nearest radar that is unblocked by terrain.

Once the data from individual radars have passed through the RDQC, they are merged to create a seamless mosaic for the United States and southern Canada as shown in Figure E.3. A multi-sensor quality control can be applied by post-processing the mosaic to remove any remaining "false echoes". This technique uses observations of infra-red cloud top temperatures by GOES satellite and surface temperature to create a precipitation/no-precipitation mask. Figure 4 shows the impact of WDT's quality control measures. Upon completing all QC, WDT converts the radar data from its native polar coordinate projection (1 degree x 1.0 km) into a longitude-latitude Cartesian grid (based on the WGS84 datum), at a spatial resolution of ~1/3rd-square mile for processing in SPAS.

a) **b)**

Figure E.3 (a) Level-II radar mosaic of CONUS radar with no quality control, (b) WDT quality controlled Level-II radar mosaic.

SPAS conducts further QC on the radar mosaic by infilling areas contaminated by beam blockages. Beam blocked areas are objectively determined by evaluating total storm reflectivity grid which naturally amplifies areas of the SPAS analysis domain suffering from beam blockage as shown in Figure E.4.

a) 

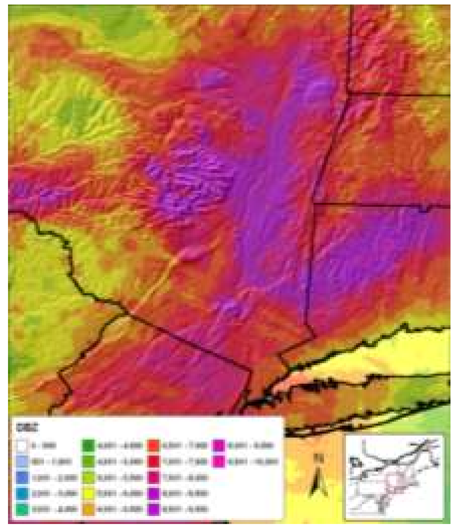
b) 

Figure E.4 Illustration of SPAS-beam blockage infilling where (a) is raw, blocked radar and (b) is filled for a 42-hour storm event.

METHODOLOGY

Daily and Supplemental Precipitation to Hourly

To obtain one hour temporal resolutions and utilize all gauge data, it is necessary to disaggregate the daily and supplemental precipitation observations into estimated hourly amounts. This process has traditionally been accomplished by distributing (temporally) the precipitation at each daily/supplemental gauge in accordance to a single nearby hourly gauge (Thiessen polygon approach). However, this may introduce biases and not correctly represent hourly precipitation at daily/supplemental gauges situated in-between hourly gauges. Instead, SPAS uses a spatial approach by which the estimated hourly precipitation at each daily and supplemental gauge is governed by a distance weighted algorithm of all nearby true hourly gauges.

In order to disaggregate (i.e. distribute) daily/supplemental gauge data into estimate hourly values, the true hourly gauge data is first evaluated and quality controlled using synoptic maps, nearby gauges, orographic effects, gauge history and other documentation on the storm. Any problems with the hourly data are resolved, and when possible/necessary accumulated hourly values are distributed. If an hourly value is missing, the analyst can choose to either estimate it or leave it missing for SPAS to estimate later based on nearby hourly gauges. At this point in the process, pseudo (hourly) gauges can be added to represent precipitation timing in topographically complex locations, areas with limited/no hourly data or to capture localized convention. In order to adequately capture the temporal variations of the precipitation a pseudo hourly gauge is sometimes necessary. A pseudo gauge is created by distributing the precipitation at a co-located daily gauge or by creating a completely new pseudo gauge from other information such as inferences from COOP observation forms, METAR visibility data (if hourly precipitation isn't already available), lightning data, satellite data, or radar data. Often radar data is the best/only choice for creating pseudo hourly gauges, but this is done cautiously given the potential differences (over-shooting of the radar beam equating to erroneous precipitation) between radar data and precipitation. In any case, the pseudo hourly gauge is flagged so SPAS only uses it for timing and not magnitude. Care is taken to ensure hourly pseudo gauges represent justifiably important physical and meteorological characteristics before being incorporated into the SPAS database. Although pseudo gauges provide a very important role, their use is kept to a minimum. The importance of insuring the reliability of every hourly gauge cannot be over emphasized. All of the final hourly gauge data, including pseudos, are included in the hourly SPAS precipitation database.

Using the hourly SPAS precipitation database, each hourly precipitation value is converted into a percentage that represents the incremental hourly precipitation divided by the total SPP precipitation. The GIS-ready x-y-z file is constructed for each hour that contains the latitude (x), longitude(y) and percent of precipitation (z) for a particular hour. Using the GRASS GIS, an inverse-distance-weighting squared (IDW) interpolation technique is applied to each of the hourly files. The result is a continuous grid with percentage values for the entire analysis domain, keeping the grid cells on which the hourly gauge resides faithful to the observed/actual percentage. Since the percentages typically have a high degree of spatial autocorrelation, the spatial interpolation has skill in determining the percentages between gauges, especially since the percentages are somewhat independent of the precipitation magnitude. The end result is a GIS grid for each hour that represents the percentage of the SPP precipitation that fell during that hour.

After the hourly percentage grids are generated and QC'ed for the entire SPP, a program is executed that converts the daily/supplemental gauge data into incremental hourly data. The timing at each of the daily/supplemental gauges is based on (1) the daily/supplemental gauge observation time, (2) daily/supplemental precipitation amount and (3) the series of interpolated hourly percentages extracted from grids (described above).

This procedure is detailed in Figure E.5 below. In this example, a supplemental gauge reported 1.40" of precipitation during the storm event and is located equal distance from the three surrounding hourly recording gauges. The procedure steps are:

Step 1. For each hour, extract the percent of SPP from the hourly gauge-based percentage at the location of the daily/supplemental gauge. In this example, assume these values are the average of all the hourly gauges.

Step 2. Multiply the individual hourly percentages by the total storm precipitation at the daily/supplemental gauge to arrive at estimated hourly precipitation at the daily/supplemental gauge. To make the daily/supplemental accumulated precipitation data faithful to the daily/supplemental observations, it is sometimes necessary to adjust the hourly percentages so they add up to 100% and account for 100% of the daily observed precipitation.

	Hour						
Precipitation	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Hourly station 1	0.02	0.12	0.42	0.50	0.10	0.00	1.16
Hourly station 2	0.01	0.15	0.48	0.62	0.05	0.01	1.32
Hourly station 3	0.00	0.18	0.38	0.55	0.20	0.05	1.36
	Hour						
Percent of total storm precip.	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Hourly station 1	2%	10%	36%	43%	9%	0%	100%
Hourly station 2	1%	11%	36%	47%	4%	1%	100%
Hourly station 3	0%	13%	28%	40%	15%	4%	100%
Average	*1%*	*12%*	*34%*	*44%*	*9%*	*1%*	*100%*
Storm total precipitation at daily gauge				1.40			
	Hour						
Precipitation (estimated)	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Daily station	0.01	0.16	0.47	0.61	0.13	0.02	1.40

Figure E.5 Example of disaggregation of daily precipitation into estimated hourly precipitation based on three (3) surrounding hourly recording gauges.

In cases where the hourly grids do not indicate any precipitation falling during the daily/supplemental gauge observational period, yet the daily/supplemental gauge reported precipitation, the daily/supplemental total precipitation is evenly distributed throughout the hours that make up the observational period; although this does not happen very often, this solution is consistent with NWS procedures. However, the SPAS analyst is notified of these cases in a comprehensive log file, and in most cases they are resolvable, sometimes with a pseudo hourly gauge.

GAUGE QUALITY CONTROL

Exhaustive quality control measures are taken throughout the SPAS analysis. Below are a few of the most significant QC measures taken.

Mass Curve Check

A mass curve-based QC-methodology is used to ensure the timing of precipitation at all gauges is consistent with nearby gauges. SPAS groups each gauge with the nearest four gauges (regardless of type) into a single file. These files are subsequently used in software for graphing and evaluation. Unusual characteristics in the mass curve are investigated and the gauge data corrected, if possible and warranted. See Figure E.6 for an example.

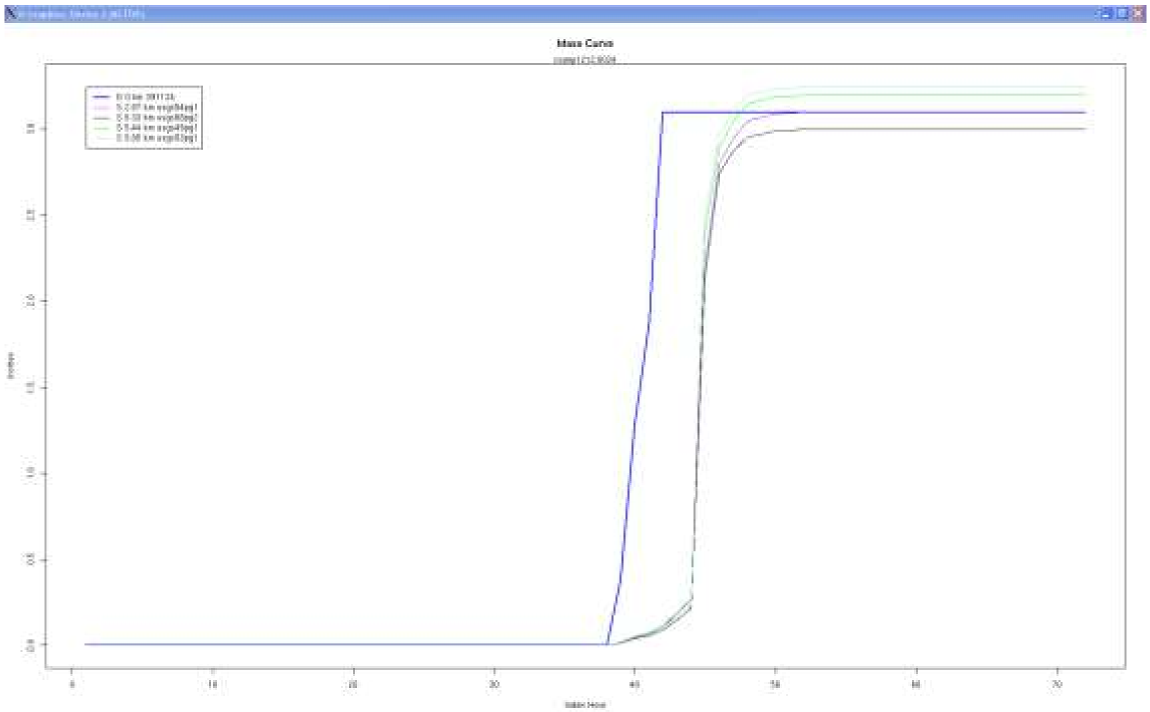


Figure E.6 Sample mass curve plot depicting a precipitation gauge with an erroneous observation time (blue line). X-axis is the SPAS index hour and the y-axis is inches. The statistics in the upper left denote gauge type, distance from target gauge (in km), and gauge ID. In this example, the center gauge (blue line) was found to have an observation error/shift of 1 day.

Gauge Mis-location Check

Although the gauge elevation is not explicitly used in SPAS, it is however used as a means of QCing gauge location. Gauge elevations are compared to a high-resolution 15-second DEM to identify gauges with large differences, which may indicate erroneous longitude and/or latitude values.

Co-located Gauge QC

Care is also taken to establish the most accurate precipitation depths at all co-located gauges. In general, where a co-located gauge pair exists, the highest precipitation is accepted (if accurate). If the hourly gauge reports higher precipitation, then the co-located daily (or supplemental) is removed from the analysis since it would not add anything to the analysis. Often daily (or supplemental) gauges report greater precipitation than a co-located hourly station since hourly tipping bucket gauges tend to suffer from gauge under-catch, particularly during extreme events, due to loss of precipitation during tips. In these cases the daily/supplemental is retained for the magnitude and the hourly used as a pseudo hourly gauge for timing. Large discrepancies between any co-located gauges are investigated and resolved since SPAS can only utilize a single gauge magnitude at each co-located site.

SPATIAL INTERPOLATION

At this point the QCed observed hourly and disaggregated daily/supplemental hourly precipitation data are spatially interpolated into hourly precipitation grids. SPAS has three options for conducting the hourly precipitation interpolation, depending on the terrain and availability of radar data, thereby allowing SPAS to be optimized for any particular storm type or location. Figure E.7 depicts the results of each spatial interpolation methodology based on the same precipitation gauge data.

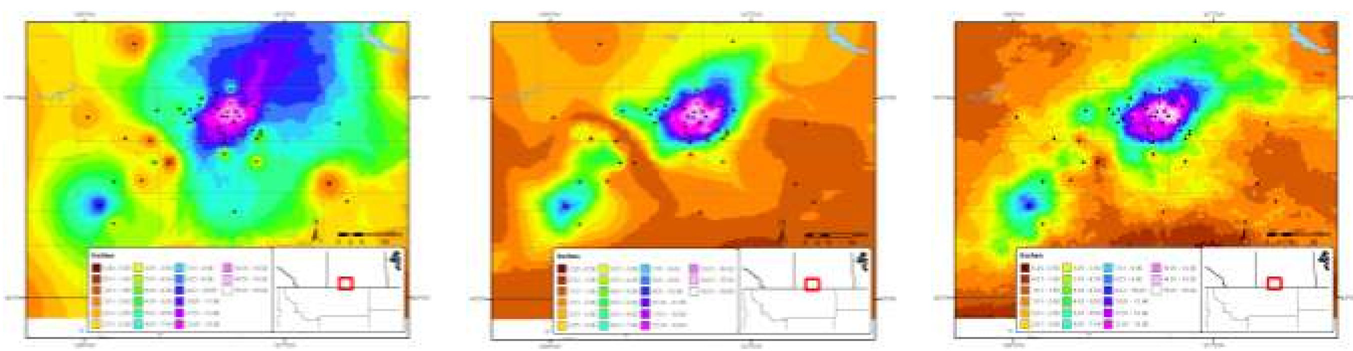


Figure E.7 Depictions of total storm precipitation based on the three SPAS interpolation methodologies for a storm (SPAS 1177, Vanguard, Canada) across flat terrain: (a) no basemap, (b) basemap-aided and (3) radar.

Basic Approach

The basic approach interpolates the hourly precipitation point values to a grid using an inverse distance weighting squared GIS algorithm. This is sometimes the best choice for convective storms over flat terrain when radar data is not available, yet high gauge density instills reliable precipitation patterns. This approach is rarely used.

Basemap Approach

Another option includes the use of a "basemap", also known as a climatologically-aided interpolation (Hunter 2005). As noted before, the spatial patterns of the basemap govern the interpolation between points of hourly precipitation estimates, while the actual hourly precipitation values govern the magnitude. This approach to interpolating point data across complex terrain is widely used. In fact, it was used extensively by the NWS during their storm analysis era from the 1940s through the 1970s.

In application, the hourly precipitation gauge values are first normalized by the corresponding grid cell value of the basemap before being interpolated. The normalization allows information and knowledge from the basemap to be transferred to the spatial distribution of the hourly precipitation. Using an IDW squared algorithm, the normalized hourly precipitation values are interpolated to a grid. The resulting grid is then multiplied by the basemap grid to produce the hourly precipitation grid. This is repeated each hour of the storm.

Radar Approach

The coupling of SPAS with NEXRAD provides the most accurate method of spatially and temporally distributing precipitation. To increase the accuracy of the results however, quality-controlled precipitation observations are used for calibrating the radar reflectivity to rain rate relationship (Z-R relationship) each hour instead of assuming a default Z-R relationship. Also, spatial variability in the Z-R relationship is accounted for through local bias corrections (described later). The radar approach involves several steps, each briefly described below. The radar approach cannot operate alone – either the basic or basemap approach must be completed before radar data can be incorporated.

Z-R Relationship

SPAS derives high quality precipitation estimates by relating quality controlled level–II NEXRAD radar reflectivity radar data with quality-controlled precipitation gauge data in order to calibrate the Z-R (radar reflectivity, Z, and precipitation, R) relationship. Optimizing the Z-R relationship is essential for capturing temporal changes in the Z-R. Most current radar-derived precipitation techniques rely on a constant relationship between radar reflectivity and precipitation rate for a given storm type (e.g. tropical, convective), vertical structure of reflectivity and/or reflectivity magnitudes. This non-linear relationship is described by the Z-R equation below:

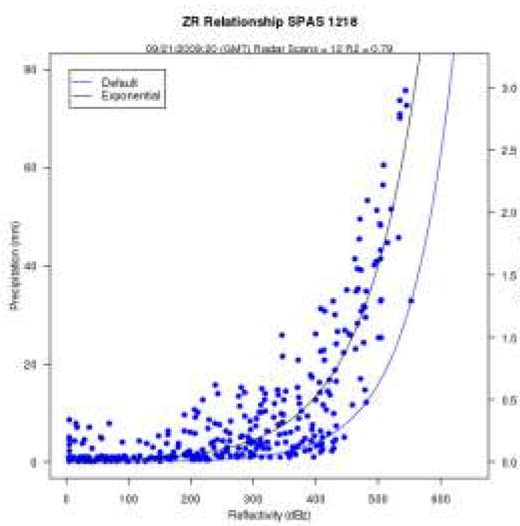


Figure E.8 Example SPAS (denoted as "Exponential") vs. default Z-R relationship (SPAS #1218, Georgia September 2009).

$$Z = A R^b \qquad (1)$$

Where Z is the radar reflectivity (measured in units of dBZ), R is the precipitation (precipitation) rate (millimeters per hour), A is the "multiplicative coefficient" and b is the "power coefficient". Both A and b are directly related to the rain drop size distribution (DSD) and rain drop number distribution (DND) within a cloud (Martner and Dubovskiy 2005). The variability in the results of Z versus R is a direct result of differing DSD, DND and air mass characteristics (Dickens 2003). The DSD and DND are determined by complex interactions of microphysical processes that fluctuate regionally, seasonally, daily, hourly, and even within the same cloud. For these reasons, SPAS calculates an optimized Z-R relationship across the analysis domain each hour based on observed precipitation rates and radar reflectivity (see Figure E.8).

The National Weather Service (NWS) utilizes different default Z-R algorithms, depending on the precipitation-causing event, to estimate precipitation through the use of NEXRAD radar reflectivity data across the United States (see Figure E.90) (Baeck and Smith 1998 and Hunter 1999). A default Z-R relationship of $Z = 300R^{1.4}$ is the primary algorithm used throughout the continental U.S. However, it is widely known that this, compared to unadjusted radar-aided estimates of precipitation, suffers from deficiencies that may lead to significant over or under-estimation of precipitation.

RELATIONSHIP	Optimum for:	Also recommended for:
Marshall-Palmer ($z=200R^{1.6}$)	General stratiform precipitation	
East-Cool Stratiform ($z=130R^{2.0}$)	Winter stratiform precipitation - east of continental divide	Orographic rain - East
West-Cool Stratiform ($z=75R^{2.0}$)	Winter stratiform precipitation - west of continental divide	Orographic rain - West
WSR-88D Convective ($z=300R^{1.4}$)	Summer deep convection	Other non-tropical convection
Rosenfeld Tropical ($z=250R^{1.2}$)	Tropical convective systems	

Figure E.9 Commonly used Z-R algorithms used by the NWS.

Instead of adopting a standard Z-R, SPAS utilizes a least squares fit procedure for optimizing the Z-R relationship each hour of the SPP. The process begins by determining if sufficient (minimum 12) observed hourly precipitation and radar data pairs are available to compute a reliable Z-R. If insufficient (<12) gauge pairs are available, then SPAS adopts the previous hour Z-R relationship, if available, or applies a user-defined default Z-R algorithm from Figure 9. If sufficient data are available, the one hour sum of NEXRAD reflectivity (Z) is related to the 1-hour precipitation at each gauge. A least-squares-fit exponential function using the data points is computed. The resulting best-fit, one hour-based Z-R is subjected to several tests to determine if the Z-R relationship and its resulting precipitation rates are within a certain tolerance based on the R-squared fit measure and difference between the derived and default Z-R precipitation results. Experience has shown the actual Z-R versus the default Z-R can be significantly different (Figure E.10).

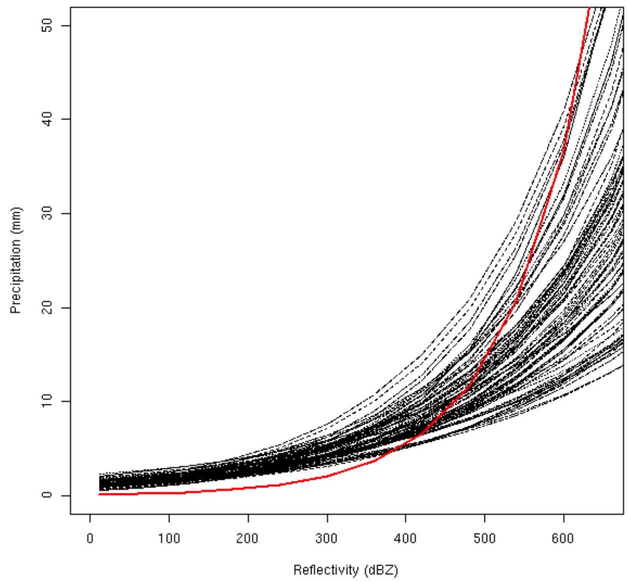


Figure E.10 Comparison of the SPAS optimized hourly Z-R relationships (black lines) versus a default Z=75R2.0 Z-R relationship (red line) for a period of 99 hours for a storm over southern California.

Radar-aided Hourly Precipitation Grids

Once a mathematically optimized hourly Z-R relationship is determined, it is applied to the total hourly Z grid to compute an initial precipitation rate (inches/hour) at each grid cell. To account for spatial differences in the Z-R relationship, SPAS computes residuals, the difference between the initial precipitation analysis (via the Z-R equation) and the actual "ground truth" precipitation (observed – initial analysis), at each gauge. The point residuals, also referred to as local biases, are normalized and interpolated to a residual grid using an inverse distance squared weighting algorithm. A radar-based hourly precipitation grid is created by adding the residual grid to the initial grid; this allows the precipitation at the grid cells for which gauges are "on" to be true and faithful to the gauge measurement. The pre-final radar-aided precipitation grid is subject to some final, visual QC checks to ensure the precipitation patterns are consistent with the terrain; these checks are particularly important in areas of complex terrain where even QCed radar data can be unreliable. The next incremental improvement with SPAS program will come as the NEXRAD radar sites are upgraded to dual-polarimetric capability.

Radar- and Basemap-Aided Hourly Precipitation Grids

At this stage of the radar approach, a radar- and basemap-aided hourly precipitation grid exists for each hour. At locations with precipitation gauges, the grids are equal, however elsewhere the grids can vary for a number of reasons. For instance, the basemap-aided hourly precipitation grid may depict heavy precipitation in an area of complex terrain, blocked by the radar, whereas the radar-aided hourly precipitation grid may suggest little, if any, precipitation fell in the same area. Similarly, the radar-aided hourly precipitation grid may depict an area of heavy precipitation in flat terrain that the basemap-approach missed since the area of heavy precipitation occurred in an area without gauges. SPAS uses an algorithm to compute the hourly precipitation at each pixel given the two results. Areas that are completely blocked from a radar signal are accounted for with the basemap-aided results (discussed earlier). The precipitation in areas with orographically effective terrain and reliable radar data are governed by a blend of the basemap- and radar-aided precipitation. Elsewhere, the radar-aided precipitation is used exclusively. This blended approach has proven effective for resolving precipitation in complex terrain, yet retaining accurate radar-aided precipitation across areas where radar data is reliable. Figure E.11 illustrates the evolution of final precipitation from radar reflectivity in an area of complex terrain in southern California.

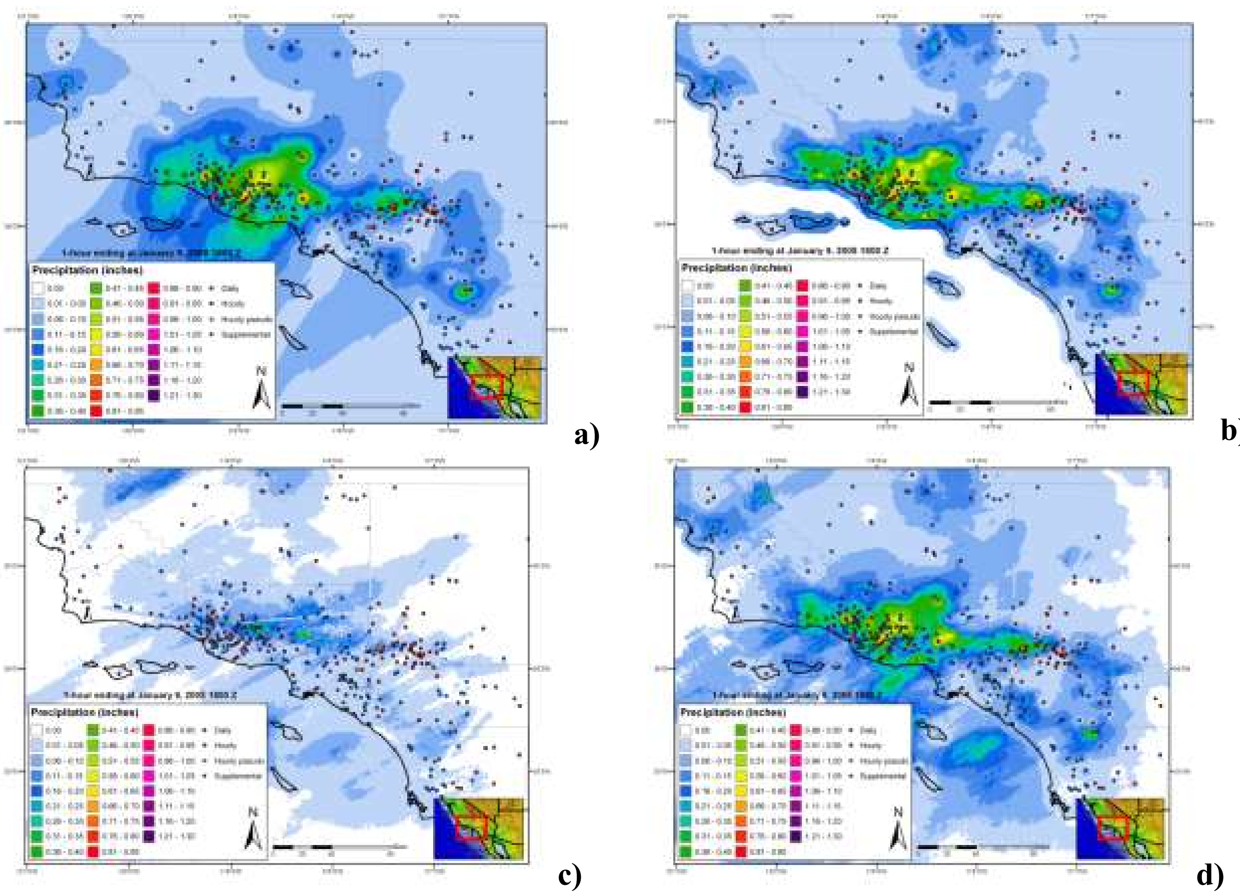


Figure E.11 A series of maps depicting 1-hour of precipitation utilizing (a) inverse distance weighting of gauge precipitation, (b) gauge data together with a climatologically-aided interpolation scheme, (c) default Z-R radar-estimated interpolation (no gauge correction) and (d) SPAS precipitation for a January 2005 storm in southern California, USA.

SPAS versus Gauge Precipitation

Performance measures are computed and evaluated each hour to detect errors and inconsistencies in the analysis. The measures include: hourly Z-R coefficients, observed hourly maximum precipitation, maximum gridded precipitation, hourly bias, hourly mean absolute error (MAE), root mean square error (RMSE), and hourly coefficient of determination (r^2).

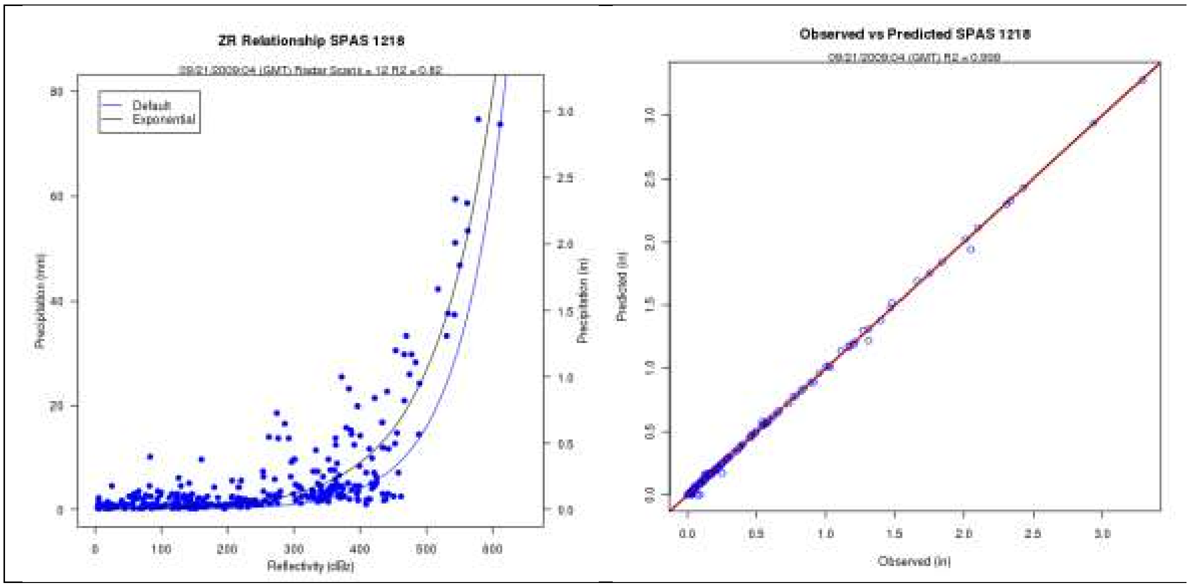


Figure E.12 Z-R plot (a), where the blue line is the SPAS derived Z-R and the black line is the default Z-R, and the (b) associated observed versus SPAS scatter plot at gauge locations.

Comparing SPAS-calculated precipitation (R_{spas}) to observed point precipitation depths at the gauge locations provides an objective measure of the consistency, accuracy and bias. Generally speaking SPAS is usually within 5% of the observed precipitation (see Figure E.12). Less-than-perfect correlations between SPAS precipitation depths and observed precipitation at gauged locations could be the result of any number of issues, including:

- **Point versus area:** A rain gauge observation represents a much smaller area than the area sampled by the radar. The area that the radar is sampling is approximately 1 km^2, whereas a rain gauge only samples approximately $8.0x10^{-9}$ km^2. Furthermore, the radar data represents an average reflectivity (Z) over the grid cell, when in fact the reflectivity can vary across the 1 km^2 grid cell. Therefore, comparing a grid cell radar derived precipitation value to a gauge (point) precipitation depth measured may vary.

- **Precipitation gauge under-catch:** Although we consider gauge data "ground truth," we recognize gauges themselves suffer from inaccuracies. Precipitation gauges, shielded and unshielded, inherently underestimate total precipitation due to local airflow, wind under-catch, wetting, and evaporation. The wind under-catch errors are usually around 5% but can be as large as 40% in high winds (Guo et al 2001, Duchon and Essenberg 2001, Ciach 2003, Tokay et al 2010). Tipping buckets miss a small amount of precipitation during each tip of the bucket due to the bucket travel and tip time. As precipitation intensities increase, the volumetric loss of precipitation due to tipping tends to increase. Smaller tipping buckets can have higher volumetric losses due to higher tip frequencies, but on the other hand capture higher precision timing.

- **Radar Calibration:** NEXRAD radars calibrate reflectivity every volume scan, using an internally generated test. The test determines changes in internal variables such as beam power and path loss of the receiver signal processor since the last off-line calibration. If this value becomes large, it is likely that there is a radar calibration error that will translate into less reliable precipitation estimates. The calibration test is supposed to maintain a reflectivity precision of 1 dBZ. A 1 dBZ error can result in an error of up to 17% in R_{spas} using the default Z-R relationship $Z=300R^{1.4}$. Higher calibration errors will result in higher R_{spas} errors. However, by performing correlations each hour, the calibration issue is minimized in SPAS.

- **Attenuation:** Attenuation is the reduction in power of the radar beams' energy as it travels from the antenna to the target and back. It is caused by the absorption and the scattering of power from the beam by precipitation. Attenuation can result in errors in Z as large as 1 dBZ especially when the radar beam is sampling a large area of heavy precipitation. In some cases, storm precipitation is so intense (>12 inches/hour) that individual storm cells become "opaque" and the radar beam is totally attenuated. Armed with sufficient gauge data however, SPAS will overcome attenuation issues.

- **Range effects:** The curvature of the Earth and radar beam refraction result in the radar beam becoming more elevated above the surface with increasing range. With the increased elevation of the radar beam comes a decrease in Z values due to the radar beam not sampling the main precipitation portion of the cloud (i.e. "over topping" the precipitation and/or cloud altogether). Additionally, as the radar beam gets further from the radar, it naturally samples a larger and larger area, therefore amplifying point versus area differences (described above).

- **Radar Beam Occultation/Ground Clutter:** Radar occultation (beam blockage) results when the radar beam's energy intersects terrain features as depicted in Figure E.13. The result is an increase in radar reflectivity values that can result in higher than normal precipitation estimates. The WDT processing algorithms account for these issues, but SPAS uses GIS spatial interpolation functions to infill areas suffering from poor or no radar coverage.

- **Anomalous Propagation (AP)** - AP is false reflectivity echoes produced by unusual rates of refraction in the atmosphere. WDT algorithms remove most of the AP and false echoes, however in extreme cases the air near the ground may be so cold and dense that a radar beam that starts out moving upward is bent all the way down to the ground. This produces erroneously strong echoes at large distances from the radar. Again, equipped with sufficient gauge data, the SPAS bias corrections will overcome AP issues.

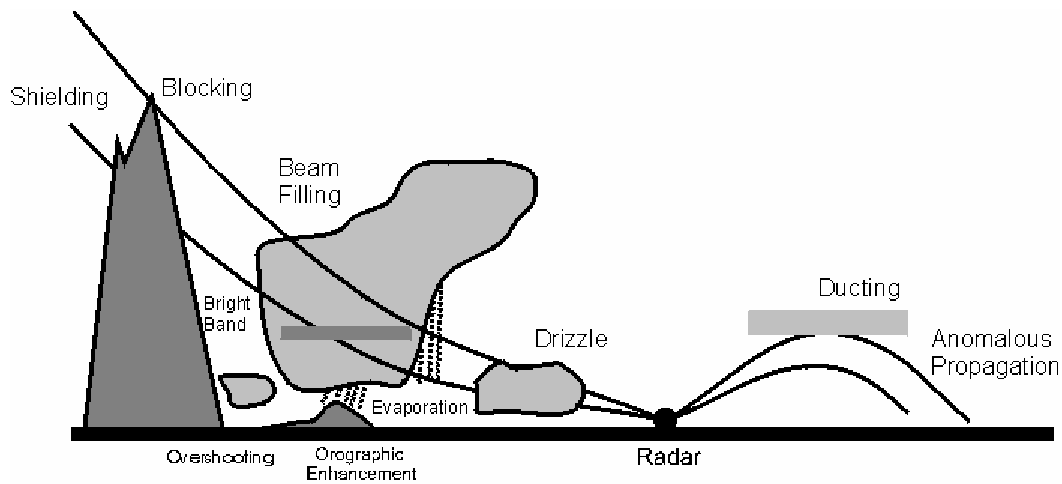


Figure E.13 Depiction of radar artifacts. (Source: Wikipedia)

SPAS is designed to overcome many of these short-comings by carefully using radar data for defining the spatial patterns and relative magnitudes of precipitation, but allowing measured precipitation values ("ground truth") at gauges to govern the magnitude. When absolutely necessary, the observed precipitation values at gauges are nudged up (or down) to force the SPAS results to be consistent with observed gauge values. Nudging gauge precipitation values helps to promote better consistency between the gauge value and the gridcell value, even though these two values sometimes should not be the same since they are sampling different area sizes. For reasons discussed in the "SPAS versus Gauge Precipitation" section, the gauge value and gridcell value can vary. Plus, SPAS is designed to toss observed individual hourly values that are grossly inconsistent with the radar data, hence driving a difference between the gauge and gridcell. In general, when the gauge and gridcell value differ by more than 15% and/or 0.50 inches, and the gauge data has been validated, then it is justified to nudge (artificially increase or decrease) the observed gauge value to "force" SPAS to derive a gridcell value equal to the observed value. Sometimes simply shifting the gauge location to an adjacent gridcell resolves the problems. Regardless, a large gauge versus gridcell difference is a "red flag" and sometimes the result of an erroneous gauge value or a mis-located gauge, but in some cases the difference can only be resolved by nudging the precipitation value.

Before final results are declared, a precipitation intensity check is conducted to ensure the spatial patterns and magnitudes of the maximum storm intensities at 1-, 6-, 12-, etc. hours are consistent with surrounding gauges and published reports. Any erroneous data are corrected and SPAS re-run. Considering all of the QA/QC checks in SPAS, it typically requires 5-15 basemap SPAS runs and, if radar data is available, another 5-15 radar-aided runs, to arrive at the final output.

Test Cases

To check the accuracy of the DAD software, three test cases were evaluated.

"Pyramidville" Storm

The first test was that of a theoretical storm with a pyramid shaped isohyetal pattern. This case was called the Pyramidville storm. It contained 361 hourly stations, each occupying a single grid cell. The configuration of the Pyramidville storm (see Figure E.14) allowed for uncomplicated and accurate calculation of the analytical DA truth independent of the DAD software. The main motivation of this case was to verify that the DAD software was properly computing the area sizes and average depths.

1. Storm center: 39°N 104°W
2. Duration: 10-hours
3. Maximum grid cell precipitation: 1.00”
4. Grid cell resolution: 0.06 sq.-miles (361 total cells)
5. Total storm size: 23.11 sq-miles
6. Distribution of precipitation:
   Hour 1: Storm drops 0.10” at center (area 0.06 sq-miles)
   Hour 2: Storm drops 0.10” over center grid cell AND over one cell width around hour 1 center
   Hours 3-10:
      1. Storm drops 0.10” per hour at previously wet area, plus one cell width around previously wet area
      2. Area analyzed at every 0.10”
      3. Analysis resolution: 15-sec (~.25 square miles)

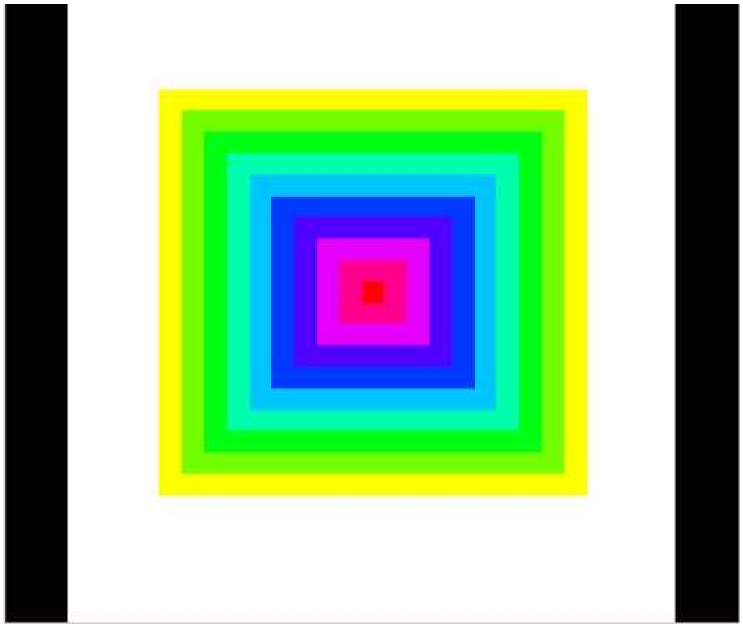


Figure E.14 "Pyramidville" Total precipitation. Center = 1.00", Outside edge = 0.10".

The analytical truth was calculated independent of the DAD software, and then compared to the DAD output. The DAD software results were equal to the truth, thus demonstrating that the DA estimates were properly calculated (Figure E.15).

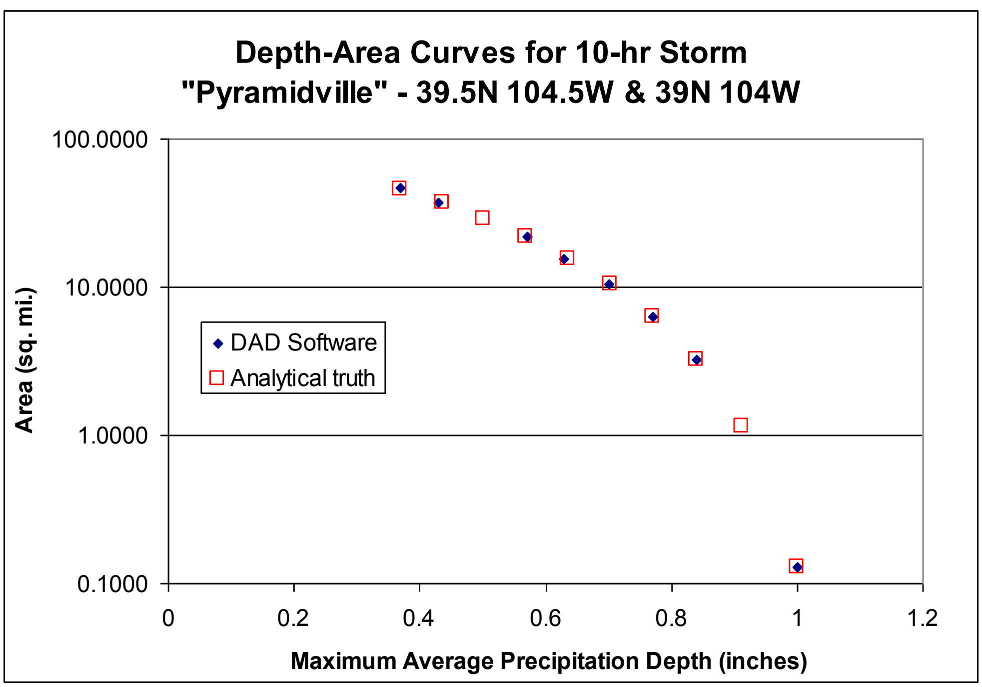


Figure E.15 10-hour DA results for "Pyramidville"; truth vs. output from DAD software.

The Pyramidville storm was then changed such that the mass curve and spatial interpolation methods would be stressed. Test cases included:

- Two-centers, each center with 361 hourly stations
- A single center with 36 hourly stations, 0 daily stations
- A single center with 3 hourly stations and 33 daily stations

As expected, results began shifting from the 'truth,' but minimally and within the expected uncertainty.

Ritter, Iowa Storm, June 7, 1953

Ritter, Iowa was chosen as a test case for a number of reasons. The NWS had completed a storm analysis, with available DAD values for comparison. The storm occurred over relatively flat terrain, so orographics was not an issue. An extensive "bucket survey" provided a great number of additional observations from this event. Of the hundreds of additional reports, about 30 of the most accurate reports were included in the DAD analysis.

The DAD software results are very similar to the NWS DAD values (Table E.1).

Table E.1 The percent difference [(AWA-NWS)/NWS] between the AWA DA results and those published by the NWS for the 1953 Ritter, Iowa storm.

% Difference

	Duration (hours)				
Area (sq.mi.)		6	12	24	total
10		-15%	-7%	2%	2%
100		-7%	-6%	1%	1%
200		2%	0%	9%	9%
1000		-6%	-7%	4%	4%
5000		-13%	-8%	2%	2%
10000		-14%	-6%	0%	0%

Westfield, Massachusetts Storm, August 8, 1955

Westfield, Massachusetts was also chosen as a test case for a number of reasons. It is a probable maximum precipitation (PMP) driver for the northeastern United States. Also, the Westfield storm was analyzed by the NWS and the DAD values are available for comparison. Although this case proved to be more challenging than any of the others, the final results are very similar to those published by the NWS (Table E.2).

Table E.2 The percent difference [(AWA-NWS)/NWS] between the AWA DA results and those published by the NWS for the 1955 Westfield, Massachusetts storm.

% Difference

	Duration (hours)							
Area (sq. mi.)		6	12	24	36	48	60	total
10		2%	3%	0%	1%	-1%	0%	2%
100		-5%	2%	4%	-2%	-6%	-4%	-3%
200		-6%	1%	1%	-4%	-7%	-5%	-5%
1000		-4%	-2%	1%	-6%	-7%	-6%	-3%
5000		3%	2%	-3%	-3%	-5%	-5%	0%
10000		4%	9%	-5%	-4%	-7%	-5%	1%
20000		7%	12%	-6%	-3%	-4%	-3%	3%

The principal components of SPAS are: storm search, data extraction, quality control (QC), conversion of daily precipitation data into estimated hourly data, hourly and total storm precipitation grids/maps and a complete storm-centered DAD analysis.

OUTPUT

Armed with accurate, high-resolution precipitation grids, a variety of customized output can be created (see Figures E.16A-D). Among the most useful outputs are sub-hourly precipitation grids for input into hydrologic models. Sub-hourly (i.e. 5-minute) precipitation grids are created by applying the appropriate optimized hourly Z-R (scaled down to be applicable for instantaneous Z) to each of the individual 5-minute radar scans; 5-minutes is often the native scan rate of the radar in the US. Once the scaled Z-R is applied to each radar scan, the resulting precipitation is summed up. The proportion of each 5-minute precipitation to the total 1-hour radar-aided precipitation is calculated. Each 5-minute proportion (%) is then applied to the quality controlled, bias corrected 1-hour total precipitation (created above) to arrive at the final 5-minute precipitation for each scan. This technique ensures the sum of 5-minute precipitation equals that of the quality controlled, bias corrected 1-hour total precipitation derived initially.

Depth-area-duration (DAD) tables/plots, shown in Figure E.16d, are computed using a highly-computational extension to SPAS. DADs provide an objective three dimensional (magnitude, area size, and duration) perspective of a storms' precipitation. SPAS DADs are computed using the procedures outlined by the NWS Technical Paper 1 (1946).

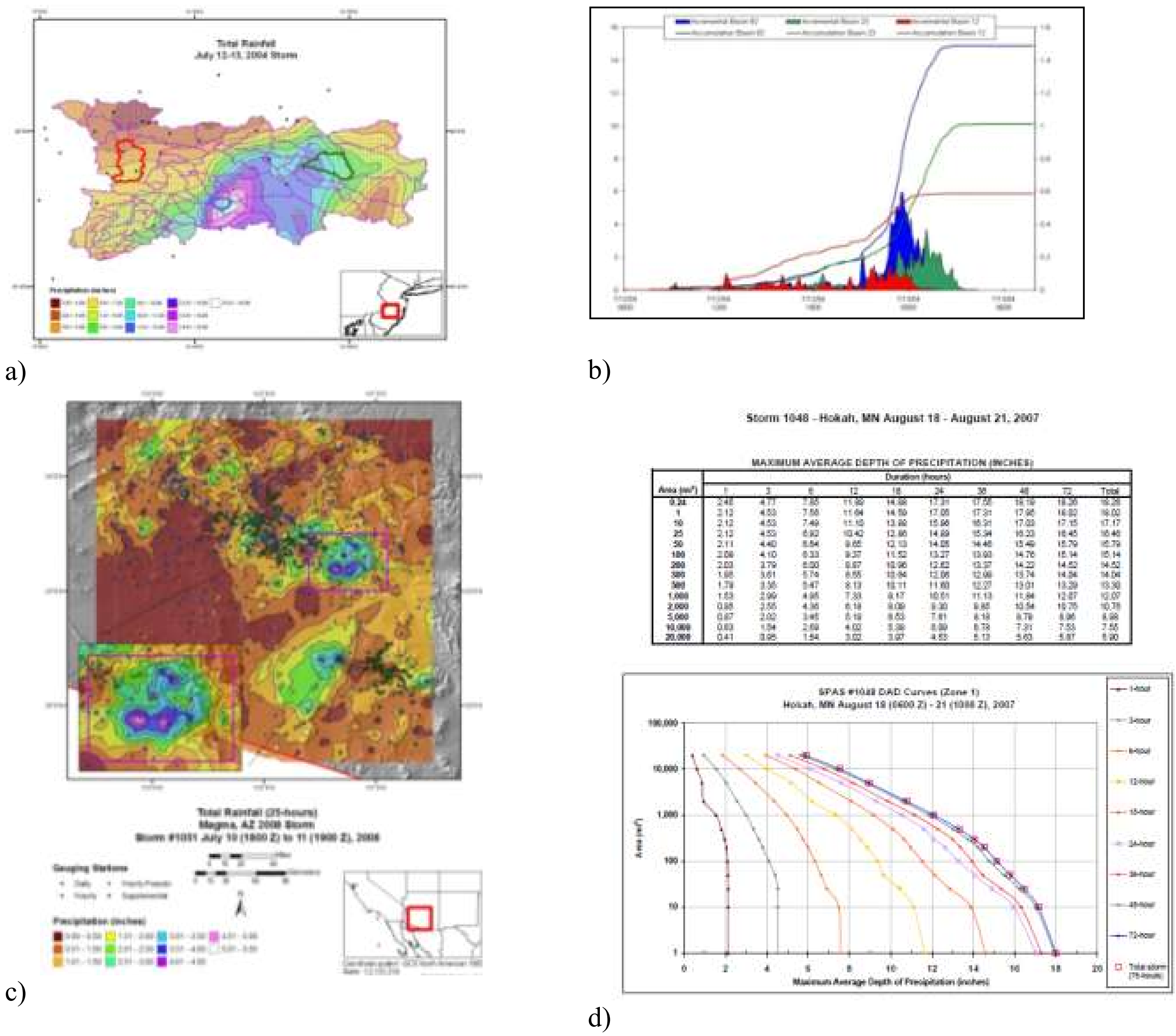


Figure E.16 Various examples of SPAS output, including (a) total storm map and its associated (b) basin average precipitation time series, (c) total storm precipitation map, (d) depth-area-duration (DAD) table and plot, and (e) precipitation gauge catalog with total storm statistics.

SUMMARY

Grounded on years of scientific research with a demonstrated reliability in post-storm analyses, SPAS is a hydro-meteorological tool that provides accurate precipitation analyses for a variety of applications. SPAS has the ability to compute precise and accurate results by using sophisticated timing algorithms, “basemaps”, a variety of precipitation data and most importantly NEXRAD weather radar data (if available). The approach taken by SPAS relies on hourly, daily and supplemental precipitation gauge observations to provide quantification of the precipitation amounts while relying on basemaps and NEXRAD data (if available) to provide the spatial distribution of precipitation between precipitation gauge sites. By determining the most appropriate coefficients for the Z-R equation on an hourly basis, the approach anchors the precipitation amounts to accepted precipitation gauge data while using the NEXRAD data to distribute precipitation between precipitation gauges for each hour of the storm. Hourly Z-R coefficient computations address changes in the cloud microphysics and storm characteristics as the storm evolves. Areas suffering from limited or no radar coverage, are estimated using the spatial patterns and magnitudes of the independently created basemap precipitation grids. Although largely automated, SPAS is flexible enough to allow hydro-meteorologists to make important adjustments and adapt to any storm situation.

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Appendix F

PMP Short Storm List Storm Data

Appendix F:
All Season Short Storm List Storm Analyses

Storm Name	State	AWA Storm Number	Lat	Lon	Year	Month	Day	Maximum Rainfall in Inches	Precipitation Source
BOULDER	CO	86	40.015	-105.268	2013	9	8	20.41	SPAS 1302
CHEYENNE MOUNTAIN	CO	85	38.790	-104.870	2013	9	8	18.89	SPAS 1302
DUBUQUE	IA	1	42.440	90.750	2011	7	27	15.14	SPAS 1220
WARNER PARK	TN	2	36.061	-86.906	2010	4	30	19.71	SPAS 1208
ALLEY SPRING	MO	3	37.160	-91.450	2008	3	17	15.10	SPAS 1242
LARTO LAKE	LA	4	31.220	-92.130	2008	9	1	23.31	SPAS 1182
FALL RIVER	KS	5	37.630	-96.050	2007	6	30	25.50	SPAS 1228
HOKAH	MN	6	43.813	-91.363	2007	8	18	18.32	SPAS 1048
OGALLALA	NE	7	41.125	-101.717	2002	7	6	14.92	SPAS 1033
FORT COLLINS	CO	8	40.548	-105.133	1997	7	28	14.48	SPAS 1230
PAWNEE CREEK	CO	9	40.775	-103.625	1997	7	29	13.58	SPAS 1036
AURORA COLLEGE	IL	10	41.458	-88.070	1996	7	16	18.13	SPAS 1286
MINNEAPOLIS	MN	11	44.889	-93.402	1987	7	23	11.55	SPAS 1210
BIG RAPIDS	MI	12	43.613	-85.313	1986	9	9	13.42	SPAS 1206
CHEYENNE	WY	13	41.354	-104.819	1985	8	1	7.15	SPAS 1213
FOREST CITY	MN	14	45.239	-94.540	1983	6	20	17.00	SPAS 1035
BIG FORK	AR	15	35.871	-92.121	1982	12	1	15.92	SPAS 1219
CLYDE	TX	16	32.479	-99.479	1981	10	10	23.23	SPAS 1184
FRIJOLE CREEK	CO	17	37.096	-104.379	1981	7	3	16.33	SPAS 1247
ALBANY	TX	18	32.726	-99.350	1978	8	3	32.50	SPAS 1179
BIG THOMPSON CANYON	CO	19	40.479	-105.429	1976	7	31	12.52	SPAS 1231
WATERTON RED ROCK	AB	75	49.090	-114.050	1975	6	15	14.46	SPAS 1252
ENID	OK	21	36.381	-97.868	1973	10	10	19.45	SPAS 1034
BAYFIELD	CO	22	37.562	-107.879	1970	9	3	5.95	SPAS 1075
BIG ELK MEADOW	CO	23	40.267	-105.417	1969	5	4	20.01	SPAS 1253
WOOSTER	OH	24	40.915	-81.973	1969	7	4	14.95	SPAS 1209
GLADEWATER	TX	25	32.537	-94.943	1966	4	27	25.33	SPAS 1181
EDGERTON	MO	26	40.413	-95.513	1965	7	18	20.76	SPAS 1183
HOLLY	CO	27	37.713	-102.404	1965	6	16	19.18	SPAS 1293
PLUM CREEK	CO	28	39.188	-104.296	1965	6	15	16.70	SPAS 1293
COLLEGE HILL	OH	30	40.085	-81.648	1963	6	3	19.39	SPAS 1226
DAVID CITY	NE	31	41.213	-97.071	1963	6	24	15.98	SPAS 1030
IDA GROVE	IA	32	42.317	-95.467	1962	8	30	12.85	EPRI
PRAGUE	NE	33	41.358	-96.879	1959	8	1	13.09	SPAS 1031
PARIS WATERWORKS	IN	34	39.050	-87.700	1957	6	27	12.40	HMB-V18
LAKE MALOYA	NM	35	37.009	-104.341	1955	5	19	14.82	SPAS 1251
RITTER	IA	36	43.244	-95.823	1953	6	7	11.00	MR 10-8
KELSO	MO	37	37.191	-89.550	1952	8	11	13.00	UMV 3-30
COUNCIL GROVE	KS	38	38.660	-96.490	1951	7	9	18.50	MR 10-2
DUMONT	IA	39	42.752	-92.976	1951	6	25	12.00	UMV 3-29
HOLT	MO	40	39.453	-94.342	1947	6	18	17.60	MR 8-20
COLE CAMP	MO	41	38.460	-93.203	1946	8	12	19.40	MR 7-2A
COLLINSVILLE	IL	42	38.672	-89.980	1946	8	12	18.70	MR 7-2B
STANTON	NE	43	41.867	-97.050	1944	6	10	17.30	MR 6-15
MOUNDS	OK	44	35.877	-96.061	1943	5	16	17.00	SW 2-21
WARNER	OK	46	35.490	-95.310	1943	5	6	25.00	SW 2-20
SILVER LAKE	TX	45	32.670	-95.596	1943	6	5	16.50	SW 3-3
RANCHO GRANDE	NM	47	34.950	-105.100	1942	8	29	8.00	SW 2-29
HAYWARD	WI	48	46.013	-91.485	1941	8	28	15.00	UMV 1-22
MCCOLLEUM RANCH	NM	49	32.167	-104.733	1941	9	20	21.20	GM 5-19
PRAIRIEVIEW	NM	50	33.117	-103.200	1941	5	20	8.40	GM 5-18
GRANT TOWNSHIP	NE	51	42.240	-96.590	1940	6	3	13.00	MR 4-5
HALLETT	OK	52	36.230	-96.570	1940	9	2	24.00	SW 2-18
HEMPSTEAD	TX	53	30.133	-96.133	1940	11	22	21.10	GM 5-13
INDEX	AR	54	33.547	-94.042	1940	6	30	11.50	LMV 4-25
ELBERT	CO	55	39.238	-104.488	1935	5	30	24.00	SPAS 1295
HALE	CO	56	39.613	-102.263	1935	5	30	18.00	SPAS 1295
CHEYENNE	OK	57	35.610	-99.670	1934	4	3	23.00	SW 2-11
FAIRFIELD	TX	58	31.725	-96.165	1932	8	30	19.50	GM 5-16A
PORTER	NM	59	35.200	-103.283	1930	10	9	9.90	SW 2-6
BOYDEN	IA	60	43.190	-96.010	1926	9	17	24.00	MR 4-24
NEOSHO FALLS	KS	61	38.082	-95.701	1926	9	12	14.00	SW 2-1
PENROSE	CO	62	38.464	-105.070	1921	6	2	12.20	SPAS 1294
MEEK	NM	63	33.683	-105.183	1919	9	15	9.56	GM 5-15B
COOPER	MI	65	42.376	-85.610	1914	8	31	12.60	GL 2-16
CLAYTON	NM	64	36.333	-103.100	1914	4	29	9.60	SW 1-16
WAGON WHEEL	CO	66	37.663	-106.938	1911	10	3	7.88	SPAS 1107
BEAULIEU	MN	67	47.300	-95.900	1909	7	18	10.50	UMV 1-11A
IRONWOOD	MI	68	46.450	-90.183	1909	7	21	13.20	UMV 1-11B
MEEKER	OK	69	35.503	-96.903	1908	10	19	16.23	SW 1-11
BONAPARTE	IA	70	40.767	-91.750	1905	6	10	12.10	UMV 2-5
MEDFORD	WI	71	45.133	-90.333	1905	6	4	11.20	GL 2-12
ROCIADA	NM	72	35.867	-105.333	1904	9	26	7.90	SW 1-6
WOODBURN	IA	73	41.012	-93.599	1903	8	24	15.50	MR 1-10
LAMBERT	MN	75	47.800	-96.000	1897	7	18	8.00	UMV 1-2
GREELEY	NE	76	41.550	-98.533	1896	6	4	12.30	MR 4-3
LARRABEE	IA	77	42.861	-95.545	1891	9	10	13.00	MR 4-2

Appendix F: Table F.1: List of storm used in the All Season PMP development

Boulder, CO, AWA 86

September 8, 2013

Storm Type: Frontal

Grid Point Used: 21-22

Storm Name:	SPAS1302 Boulder, CO Zone 1		
Storm Date:	9/8-18/2013		
AWA Analysis Date:	12/20/2013		

Storm Adjustment for Grid Point 21

Temporal Transposition Date	31-Aug	
	Lat	Long
Storm center location	40.02 N	105.27 W
Storm Rep dew point location	37.00 N	102.5 W
Transposition dewpoint location	37.26 N	104.13 W
Basin location	39.00 N	105.00 W

Moisture Inflow Direction:	SE @ 255	miles
Grid Point Elevation	7,381	feet
Storm Center Elevation	5,330	feet
Storm Rep Analysis Duration	24	feet

The storm representative dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place storm elevation is	5,330	which subtracts	1.19	inches of precipitable water at	76.0 F	
The in-place storm elevation is	5,330	which subtracts	1.21	inches of precipitable water at	76.5 F	
The transposition grid elevation at	7,381	which subtracts	1.59	inches of precipitable water at	77.0 F	
The inflow barrier/grid elevation height is	7,381	which subtracts	1.59	inches of precipitable water at	77.0 F	

The in-place storm maximization factor is	1.03
The transposition/elevation to basin factor is	0.84
The barrier adjustment factor is	1.00
The total adjustment factor is	0.86

Notes: DAD values taken from SPAS 1302 Zone 2. Storm representative dew point value was based on maximum 24-hr Td values between September 11-12, 2013 at KDHT, KCAO, KSPD and KLHX.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	2.5	4.7	6.5	9.2	10.9	12.1	14.3	15.3	15.8	17.6
10 sq miles	2.2	4.3	5.6	7.2	9.2	10.6	12.8	14.3	14.7	16.3
100 sq miles	1.3	2.9	4.3	6.2	7.7	9.3	11.3	12.4	13.2	14.4
200 sq miles	1.1	2.6	4.0	5.8	7.1	8.5	10.6	11.8	12.4	13.5
500 sq miles	0.9	2.1	3.5	4.9	6.1	7.5	9.3	10.3	10.9	11.9
1000 sq miles	0.6	1.7	3.0	3.9	5.1	6.6	8.0	8.7	9.3	9.9
2000 sq miles	0.4	1.3	2.3	3.3	4.1	5.4	6.5	6.9	7.7	8.4
5000 sq miles	0.2	0.6	1.1	1.9	2.4	3.0	4.1	4.5	5.3	5.8
10000 sq miles	0.1	0.4	0.8	1.0	1.2	1.6	2.3	3.5	4.0	4.5
20000 sq miles	-	-	-	-	-	-	-	-	-	-
50000 sq miles	-	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

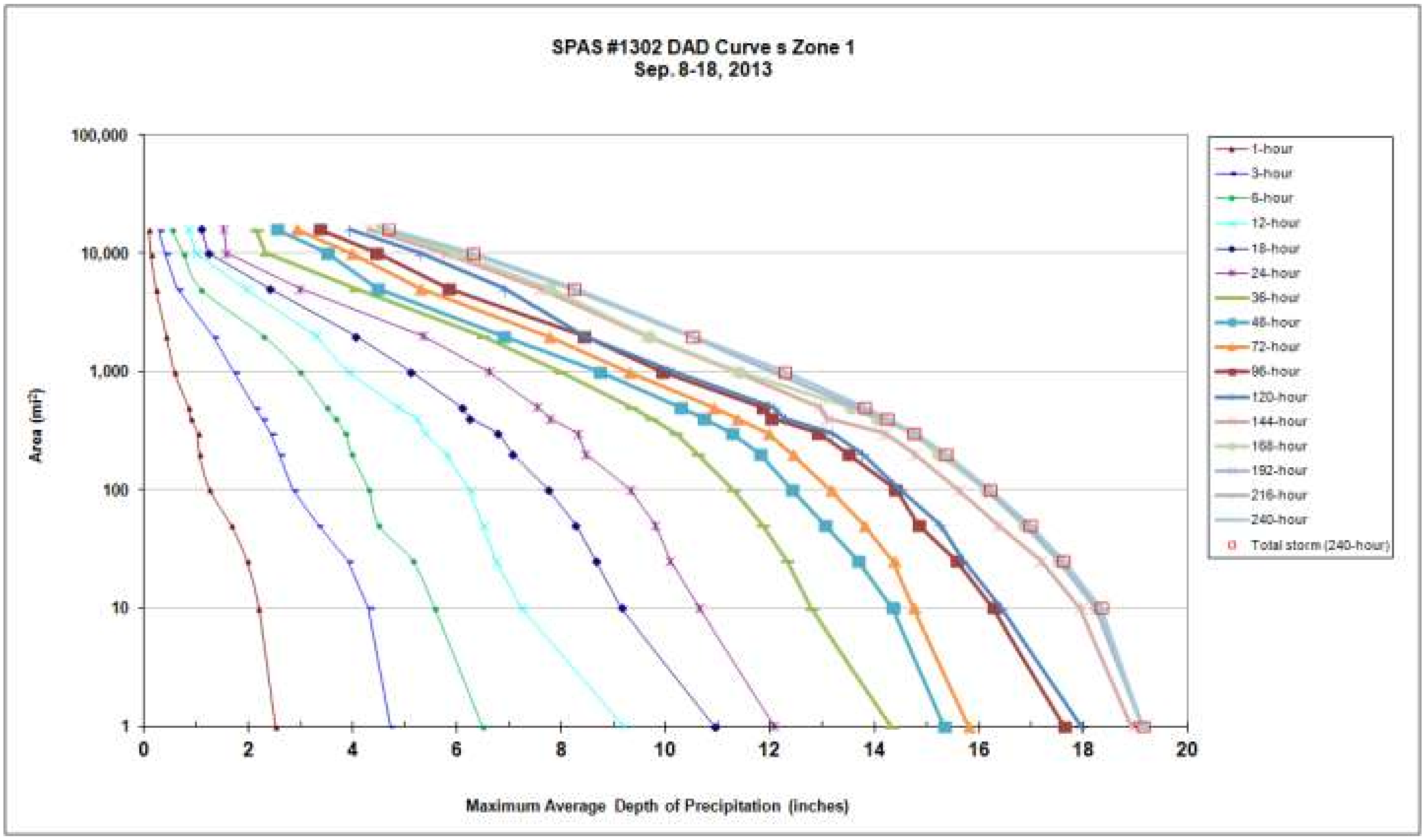
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	2.2	4.1	5.6	7.9	9.4	10.4	12.3	13.2	13.6	15.2
10 sq miles	1.9	3.7	4.8	6.2	7.9	9.2	11.0	12.3	12.7	14.0
100 sq miles	1.1	2.5	3.7	5.4	6.7	8.0	9.7	10.7	11.3	12.4
200 sq miles	0.9	2.2	3.4	5.0	6.1	7.3	9.1	10.2	10.7	11.6
500 sq miles	0.7	1.8	3.0	4.2	5.3	6.5	8.0	8.8	9.4	10.2
1000 sq miles	0.5	1.5	2.6	3.4	4.4	5.7	6.9	7.5	8.0	8.6
2000 sq miles	0.4	1.1	2.0	2.8	3.5	4.6	5.6	5.9	6.7	7.3
5000 sq miles	0.2	0.6	0.9	1.7	2.1	2.6	3.5	3.8	4.6	5.0
10000 sq miles	0.1	0.4	0.6	0.8	1.1	1.4	2.0	3.0	3.4	3.8
20000 sq miles	-	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**SPAS1302 Boulder, CO Zone 1**			
Storm Date(s)	9/8-18/2013			
Storm Type	Synoptic			
Storm Location	40.02 N	105.27 W		
Storm Center Elevation	5,330			
Precipitation Total & Duration	20.41 Inches 240-hours			
Storm Representative Dewpoint	76.0 F	24		
Storm Representative Dewpoint Location	37.00 N	102.5 W	Aug	Sep
Maximum Dewpoint	76.5 F		78.50	75.00
Moisture Inflow Vector	SE @ 255	Miles		
In-place Maximization Factor	**1.03**			
Temporal Transposition (Date)	31-Aug			
Transposition Dewpoint Location	37.26 N	104.13 W	Aug	Sep
Transposition Maximum Dewpoint	77.0 F		78.50	75.50
Transposition Adjustment Factor	**0.84**			
Average Basin Elevation	7,381	50sqmi ave		
Highest Elevation in Basin	14,344			
Inflow Barrier Height	7,381			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**0.86**			

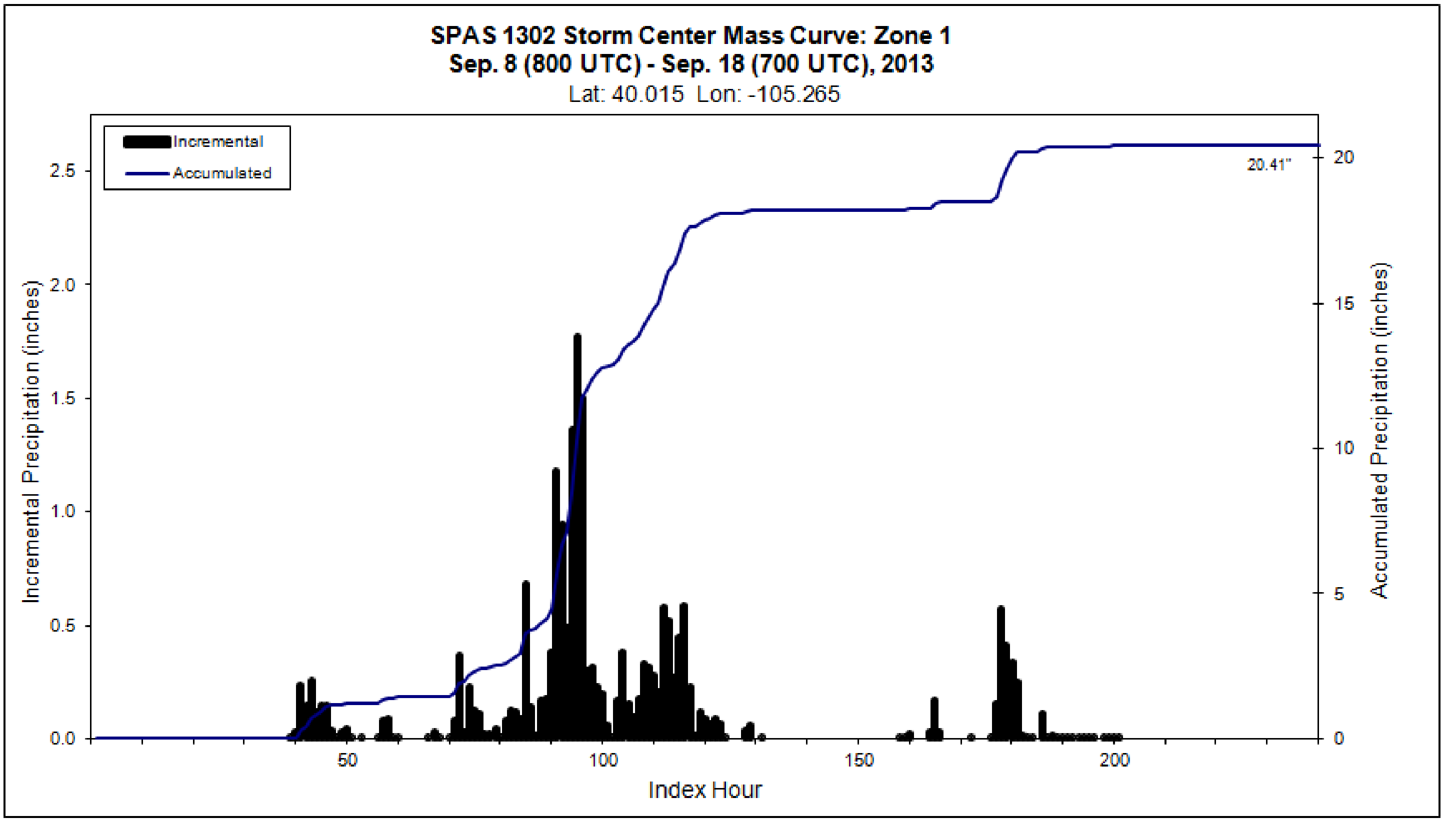
Appendix F: Table F.2: Storm spreadsheet for Boulder, CO September 8, 2013

Storm 1302 - Sep. 8 (800 UTC) - Sep. 18 (700 UTC), 2013 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)																
	Duration (hours)															
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	120	144	168	192	216	240	Total
0.4	2.59	4.83	7.25	9.46	11.21	12.44	15.04	16.24	16.89	18.2	18.93	20.23	20.41	20.41	20.41	20.41	20.41
1	2.52	4.72	6.49	9.18	10.94	12.08	14.31	15.32	15.8	17.64	17.95	18.93	19.13	19.13	19.13	19.13	19.13
10	2.2	4.31	5.57	7.23	9.15	10.64	12.79	14.33	14.73	16.27	16.42	17.94	18.23	18.24	18.33	18.33	18.33
25	1.97	3.9	5.15	6.75	8.66	10.08	12.32	13.68	14.35	15.56	15.7	17.18	17.51	17.53	17.61	17.61	17.61
50	1.67	3.33	4.5	6.5	8.27	9.8	11.85	13.04	13.79	14.84	15.25	16.35	16.86	16.87	16.98	16.98	16.98
100	1.26	2.85	4.31	6.24	7.74	9.32	11.29	12.41	13.15	14.4	14.48	15.59	16.13	16.13	16.2	16.2	16.20
200	1.06	2.59	3.98	5.79	7.07	8.46	10.61	11.8	12.42	13.49	13.77	14.75	15.21	15.36	15.36	15.36	15.36
300	1.03	2.42	3.86	5.38	6.79	8.31	10.18	11.26	11.95	12.92	13.18	14.19	14.71	14.74	14.75	14.75	14.75
400	0.89	2.27	3.66	5.22	6.25	7.78	9.71	10.72	11.35	12.03	12.28	13.09	14.04	14.2	14.22	14.23	14.23
500	0.85	2.12	3.49	4.87	6.1	7.54	9.33	10.27	10.91	11.85	12.07	12.96	13.55	13.64	13.79	13.81	13.81
1,000	0.59	1.72	2.99	3.91	5.12	6.61	7.97	8.73	9.27	9.93	10.15	11.34	11.41	12.04	12.26	12.28	12.28
2,000	0.44	1.32	2.29	3.29	4.06	5.35	6.49	6.88	7.74	8.43	8.44	9.62	9.67	10.45	10.5	10.51	10.51
5,000	0.24	0.64	1.09	1.94	2.41	2.99	4.05	4.46	5.29	5.83	6.92	7.58	7.75	8.16	8.2	8.24	8.24
10,000	0.14	0.41	0.75	0.98	1.23	1.58	2.32	3.51	3.96	4.46	5.29	5.74	5.94	6.23	6.26	6.3	6.30
16,014	0.1	0.29	0.54	0.85	1.11	1.53	2.14	2.54	2.91	3.37	3.95	4.31	4.54	4.65	4.67	4.68	4.68

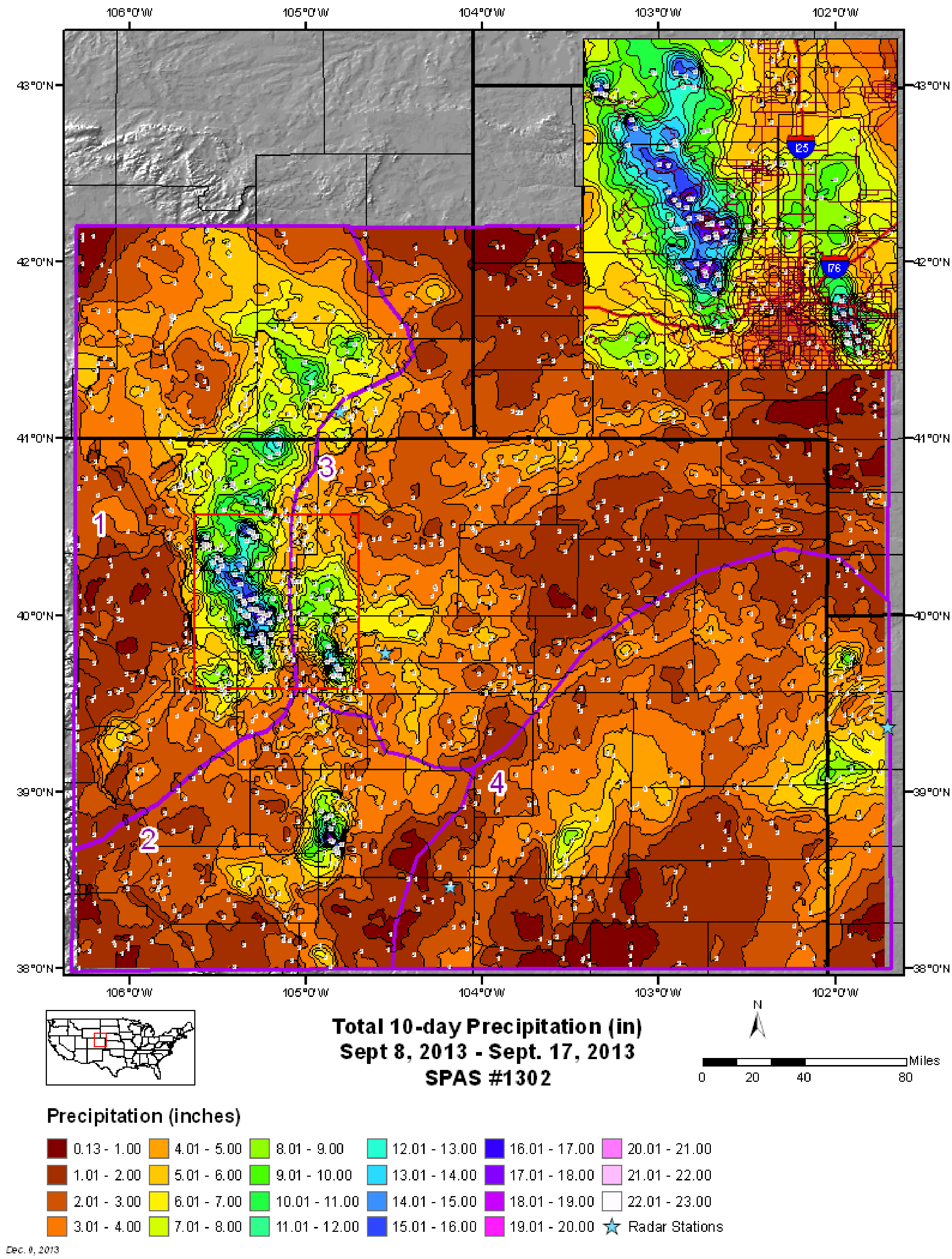
Appendix F: Table F.3: Depth-area-duration values for Boulder, CO September 8, 2013



Appendix F: Figure F.1: Depth-area-duration chart for Boulder, CO September 8, 2013



Appendix F: Figure F.2: Mass curve chart for Boulder, CO September 8, 2013



Appendix F: Figure F.3: Total storm isohyetal analysis for Boulder, CO September 8, 2013

Cheyenne Mountain, CO, AWA 85

September 8, 2013
Storm Type: Frontal
Grid Point Used: 14, 21-22

Storm Name:	SPAS 1302 Cheyenne Mountain, CC
Storm Date:	9/8-18/2013
AWA Analysis Date:	12/20/2013

Storm Adjustment for Grid Point 22

Temporal Transposition Date	31-Aug	
	Lat	Long
Storm center location	38.79 N	104.87 W
Storm Rep dew point location	37.00 N	102.5 W
Transposition dewpoint location	37.26 N	104.13 W
Basin location	39.00 N	106.50 W

Moisture Inflow Direction:	SE @ 180	miles
Grid Point Elevation	9,871	feet
Storm Center Elevation	9,380	feet
Storm Rep Analysis Duration	24	feet

The storm representative dew point is	76.0 F	with total precipitable water above sea level of		2.99	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of		3.07	inches.
The transpositioned maximum dew point is	76.0 F	with total precipitable water above sea level of		2.99	inches.
The in-place storm elevation is	9,380	which subtracts	1.83	inches of precipitable water at	76.0 F
The in-place storm elevation is	9,380	which subtracts	1.87	inches of precipitable water at	76.5 F
The transposition grid elevation at	9,871	which subtracts	1.89	inches of precipitable water at	76.0 F
The inflow barrier/grid elevation height is	9,871	which subtracts	1.89	inches of precipitable water at	76.0 F

The in-place storm maximization factor is	1.03
The transposition/elevation to basin factor is	0.92
The barrier adjustment factor is	1.00
The total adjustment factor is	0.95

Notes: DAD values taken from SPAS 1302 Zone 2. Storm representative dew point value was based on maximum 24-hr Td values between September 11-12, 2013 at KDHT, KCAO, KSPD and KLHX.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	4.5	8.5	9.7	10.4	11.7	12.3	12.7	12.9	13.4	18.0
10 sq miles	3.5	7.0	8.0	8.5	9.8	10.5	11.8	12.4	12.8	16.2
100 sq miles	1.2	2.8	3.2	4.4	4.9	6.9	8.3	8.4	8.9	10.2
200 sq miles	0.8	2.0	3.0	3.3	4.7	5.7	7.5	7.8	8.2	8.4
500 sq miles	0.5	1.5	2.0	2.8	3.6	4.4	5.2	6.0	6.4	6.4
1000 sq miles	0.4	0.8	1.7	2.1	2.6	2.9	4.4	4.6	4.7	5.1
2000 sq miles	0.3	0.6	1.2	1.9	2.1	2.4	2.8	2.8	4.1	4.1
5000 sq miles	0.2	0.3	0.5	0.8	1.2	1.7	2.3	2.5	2.7	2.8
10000 sq miles	-	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-	-
50000 sq miles	-	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

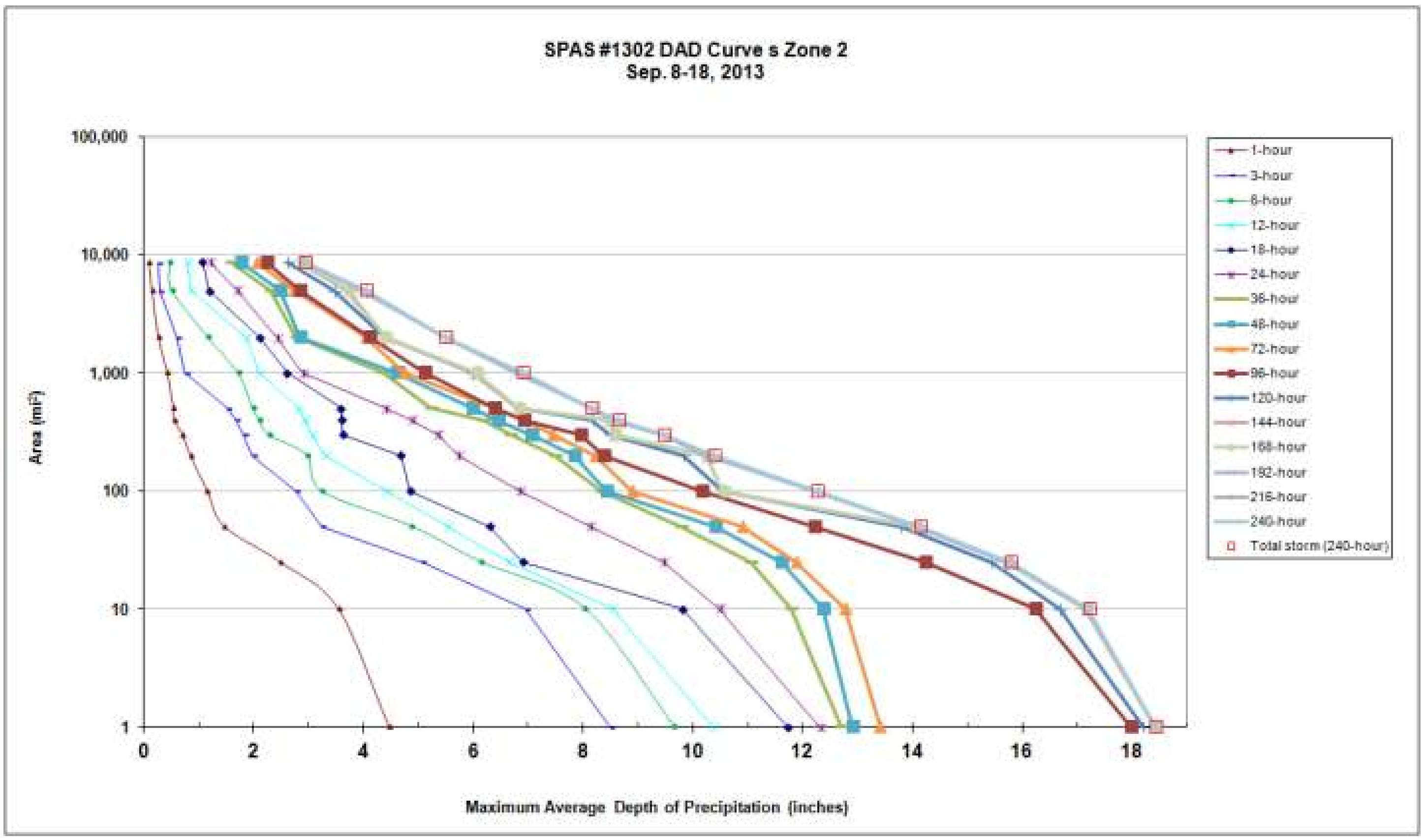
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	4.2	8.1	9.2	9.8	11.1	11.7	12.1	12.2	12.7	17.1
10 sq miles	3.4	6.6	7.6	8.1	9.3	9.9	11.2	11.7	12.1	15.4
100 sq miles	1.1	2.6	3.1	4.2	4.6	6.5	7.9	8.0	8.4	9.6
200 sq miles	0.8	1.9	2.8	3.1	4.4	5.4	7.1	7.4	7.8	7.9
500 sq miles	0.5	1.4	1.9	2.7	3.4	4.2	5.0	5.7	6.1	6.1
1000 sq miles	0.4	0.7	1.6	2.0	2.5	2.7	4.1	4.4	4.5	4.8
2000 sq miles	0.3	0.6	1.1	1.8	2.0	2.3	2.6	2.7	3.8	3.9
5000 sq miles	0.1	0.3	0.5	0.8	1.1	1.6	2.2	2.4	2.6	2.7
10000 sq miles	-	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	SPAS 1302 Cheyenne Mountain, CO Zone 2			
Storm Date(s)	9/8-18/2013			
Storm Type	Synoptic			
Storm Location	38.79 N	104.87 W		
Storm Center Elevation	9,380			
Precipitation Total & Duration	18.89 Inches 240-hours			
Storm Representative Dewpoint	76.0 F	24		
Storm Representative Dewpoint Location	37.00 N	102.5 W	Aug	Sep
Maximum Dewpoint	76.5 F		78.50	75.00
Moisture Inflow Vector	SE @ 180	Miles		
In-place Maximization Factor	1.03			
Temporal Transposition (Date)	31-Aug			
Transposition Dewpoint Location	37.26 N	104.13 W	Aug	Sep
Transposition Maximum Dewpoint	76.0 F		78.00	74.00
Transposition Adjustment Factor	0.92			
Average Basin Elevation	9,871	50sqmi ave		
Highest Elevation in Basin	14,344			
Inflow Barrier Height	9,871			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	0.95			

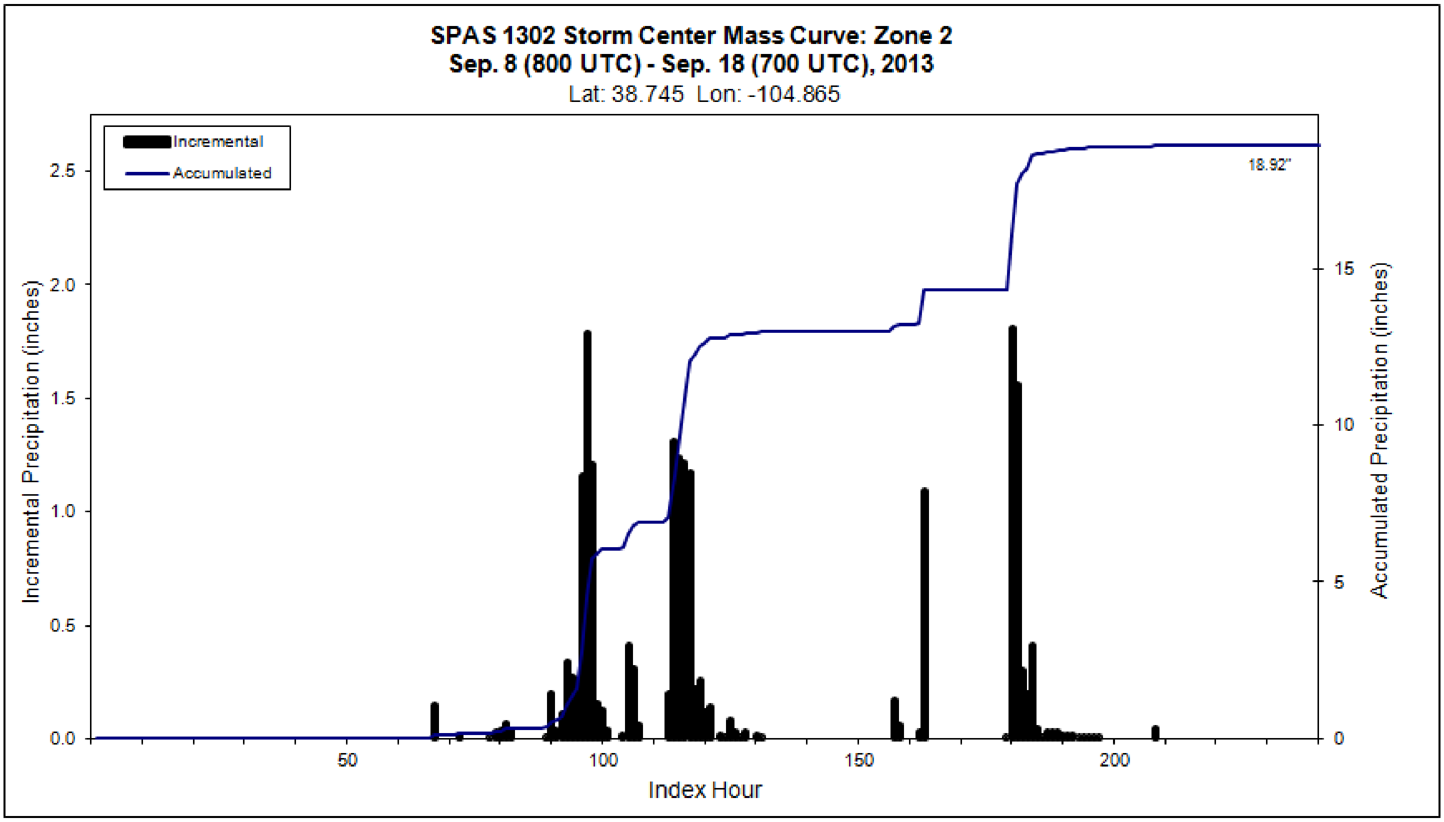
Appendix F: Table F.4: Storm spreadsheet for Cheyenne Mountain, CO September 8, 2013

	Storm 1302 - Sep. 8 (800 UTC) - Sep. 18 (700 UTC), 2013																
	MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)																
	Duration (hours)																
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	120	144	168	192	216	240	Total
0.4	4.51	8.72	9.85	10.52	11.89	12.46	12.94	13.08	13.79	18.29	18.7	18.92	18.92	18.92	18.92	18.92	18.92
1	4.47	8.49	9.66	10.36	11.73	12.31	12.71	12.9	13.41	17.98	18.2	18.42	18.42	18.42	18.42	18.42	18.42
10	3.54	6.95	8.03	8.53	9.81	10.48	11.8	12.37	12.77	16.23	16.68	17.15	17.16	17.16	17.2	17.2	17.20
25	2.47	5.06	6.14	6.66	6.9	9.46	11.06	11.61	11.89	14.23	15.42	15.7	15.71	15.71	15.77	15.77	15.77
50	1.46	3.23	4.88	5.53	6.3	8.13	9.78	10.41	10.9	12.21	13.78	14.04	14.04	14.07	14.12	14.12	14.12
100	1.15	2.76	3.24	4.42	4.85	6.86	8.34	8.41	8.89	10.17	10.53	10.55	10.55	12.22	12.26	12.26	12.26
200	0.84	1.97	2.97	3.3	4.68	5.74	7.49	7.84	8.22	8.37	9.82	10.25	10.25	10.25	10.38	10.38	10.38
300	0.7	1.82	2.28	3.07	3.62	5.36	6.69	7.06	7.45	7.96	8.48	8.58	8.58	9.42	9.46	9.46	9.46
400	0.55	1.67	2.1	2.92	3.6	4.88	6.18	6.44	6.92	6.92	8.16	8.45	8.45	8.54	8.63	8.63	8.63
500	0.54	1.51	1.99	2.82	3.59	4.4	5.22	5.98	6.39	6.39	6.82	6.82	6.83	8.12	8.14	8.14	8.14
1,000	0.43	0.75	1.72	2.11	2.61	2.89	4.36	4.59	4.74	5.11	5.99	6	6.06	6.77	6.88	6.89	6.89
2,000	0.27	0.6	1.17	1.85	2.1	2.42	2.77	2.84	4.05	4.11	4.38	4.39	4.39	5.47	5.48	5.48	5.48
5,000	0.15	0.29	0.53	0.84	1.19	1.69	2.3	2.48	2.74	2.84	3.46	3.68	3.73	3.96	4.04	4.04	4.04
8,675	0.09	0.26	0.48	0.79	1.07	1.21	1.59	1.76	2.06	2.24	2.62	2.83	2.9	2.92	2.92	2.92	2.92

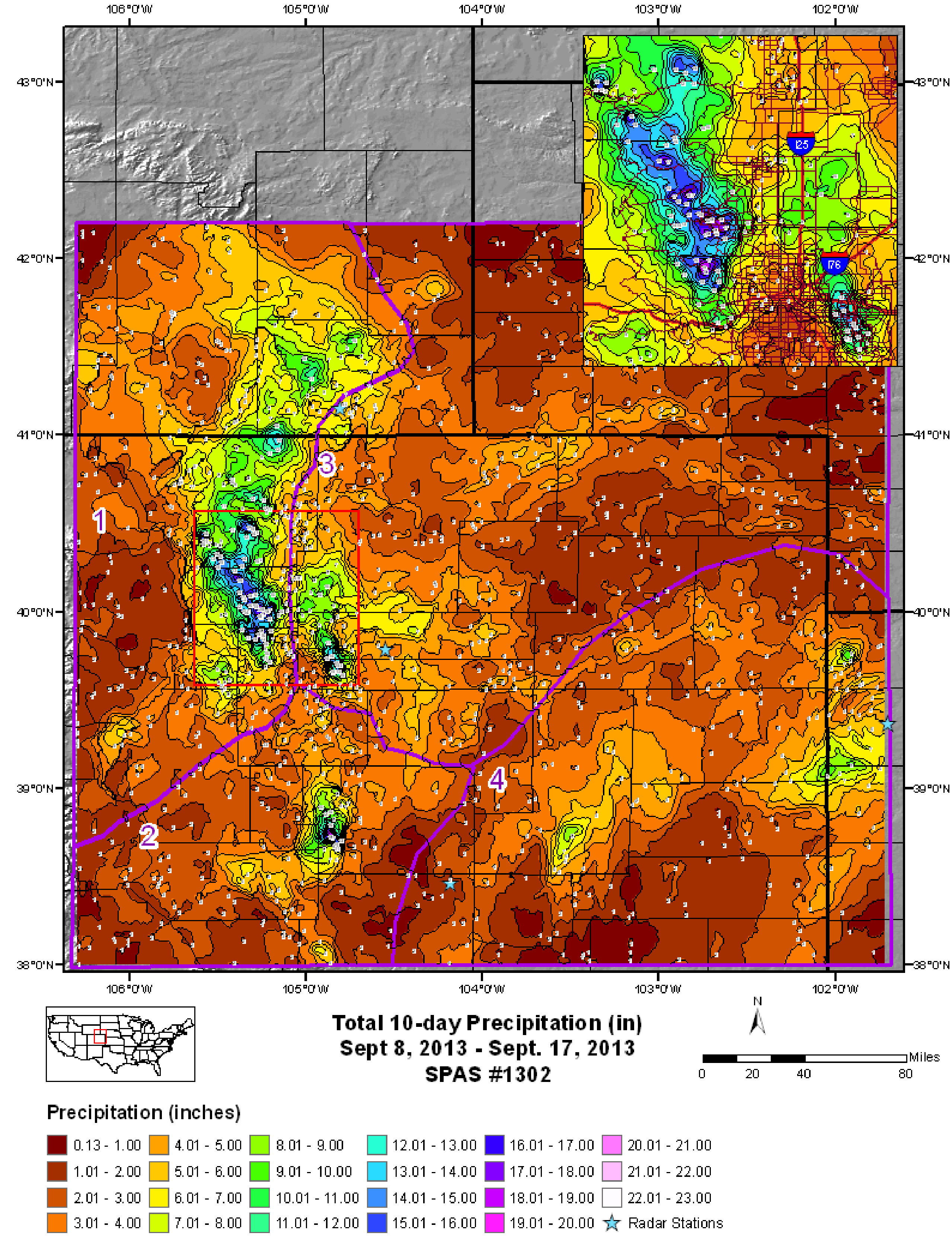
Appendix F: Table F.5: Depth-area-duration values for Cheyenne Mountain, CO September 8, 2013



Appendix F: Figure F.4: Depth-area-duration chart for Cheyenne Mountain, CO September 8, 2013



Appendix F: Figure F.5: Mass curve chart for Cheyenne Mountain, CO September 8, 2013



Appendix F: Figure F.6: Total storm isohyetal analysis for Cheyenne Mountain, CO September 8, 2013

Dubuque, IA, AWA 1

July 27, 2011

Storm Type: Frontal/MCC

Grid Point Used: 8-10, 16-18

Storm Name:	SPAS1220 Dubuque, IA	Storm Adjustment for ANO Grid Point 8
Storm Date:	7/27-28/2011	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	42.44 N	90.75 W
Storm Rep Dew Point Location	40.95 N	90.27 W
Transposition Dew Point Location	41.24 N	92.10 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SSE @ 105	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	900	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	900	which subtracts	0.26	inches of precipitable water at	79.0 F	
The in-place storm elevation is	900	which subtracts	0.28	inches of precipitable water at	81.0 F	
The transposition basin elevation at	1,200	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place storm maximization factor is	1.09
The transposition/elevation to basin factor is	0.99
The barrier adjustment factor is	1.00
The total adjustment factor is	1.09

Notes: DAD values taken from SPAS 1220. Storm representative dew point value was based on maximum 12-hr Td values between July 25-28, 2011 at WBAN 04949, 14842, and 14923.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.1	9.1	10.6	14.4	14.7	14.7	-	-	-
10 sq miles	3.9	8.6	10.2	13.7	14.4	14.5	-	-	-
100 sq miles	2.9	5.7	9.1	12.4	13.2	13.3	-	-	-
200 sq miles	2.3	5.6	8.8	11.9	12.6	12.7	-	-	-
500 sq miles	2.1	4.6	7.9	10.9	11.7	11.7	-	-	-
1000 sq miles	1.7	3.9	7.0	9.6	10.2	10.4	-	-	-
2000 sq miles	1.3	3.0	5.2	7.7	8.4	8.6	-	-	-
5000 sq miles	0.7	1.6	3.3	4.9	5.4	5.9	-	-	-
10000 sq miles	0.4	1.0	1.9	2.9	3.5	3.8	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

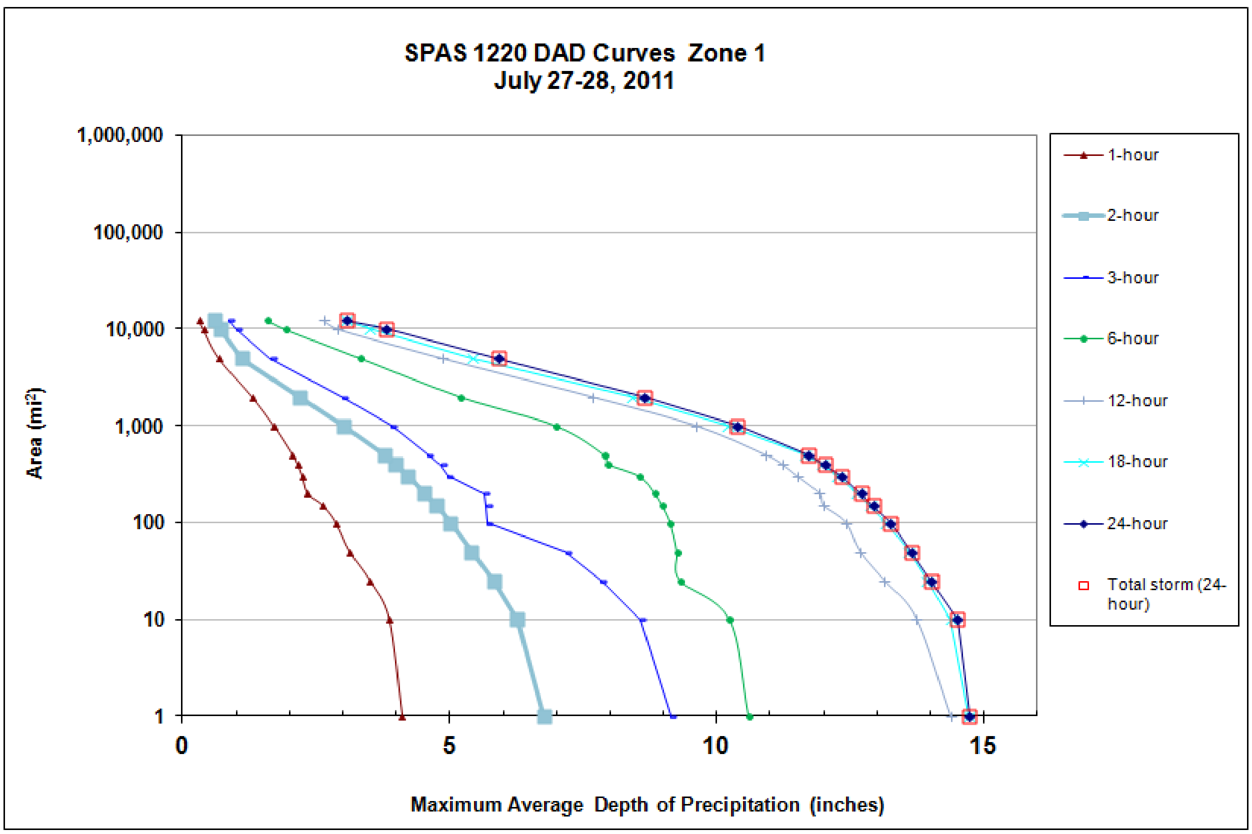
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.5	9.9	11.5	15.6	16.0	16.0	-	-	-
10 sq miles	4.2	9.3	11.1	14.9	15.6	15.8	-	-	-
100 sq miles	3.1	6.2	9.9	13.5	14.3	14.4	-	-	-
200 sq miles	2.5	6.1	9.6	13.0	13.7	13.8	-	-	-
500 sq miles	2.2	5.0	8.6	11.9	12.7	12.7	-	-	-
1000 sq miles	1.9	4.2	7.6	10.5	11.1	11.3	-	-	-
2000 sq miles	1.4	3.2	5.7	8.3	9.1	9.4	-	-	-
5000 sq miles	0.7	1.8	3.6	5.3	5.9	6.4	-	-	-
10000 sq miles	0.4	1.1	2.1	3.2	3.8	4.1	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**SPAS1220 Dubuque, IA**	
Storm Date(s)	7/27-28/2011	
Storm Type	MCC	
Storm Location	42.44 N	90.75 W
Storm Center Elevation	900	
Precipitation Total & Duration	15.14 Inches 24-hours	
Storm Representative Dew Point	79.0 F	12
Storm Representative Dew Point Location	40.95 N	90.27 W
Maximum Dew Point	81.0 F	
Moisture Inflow Vector	SSE @ 105	Miles
In-place Maximization Factor	**1.09**	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	41.24 N	92.10 W
Transposition Maximum Dew Point	81.0 F	
Transposition Adjustment Factor	**0.99**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.09**	

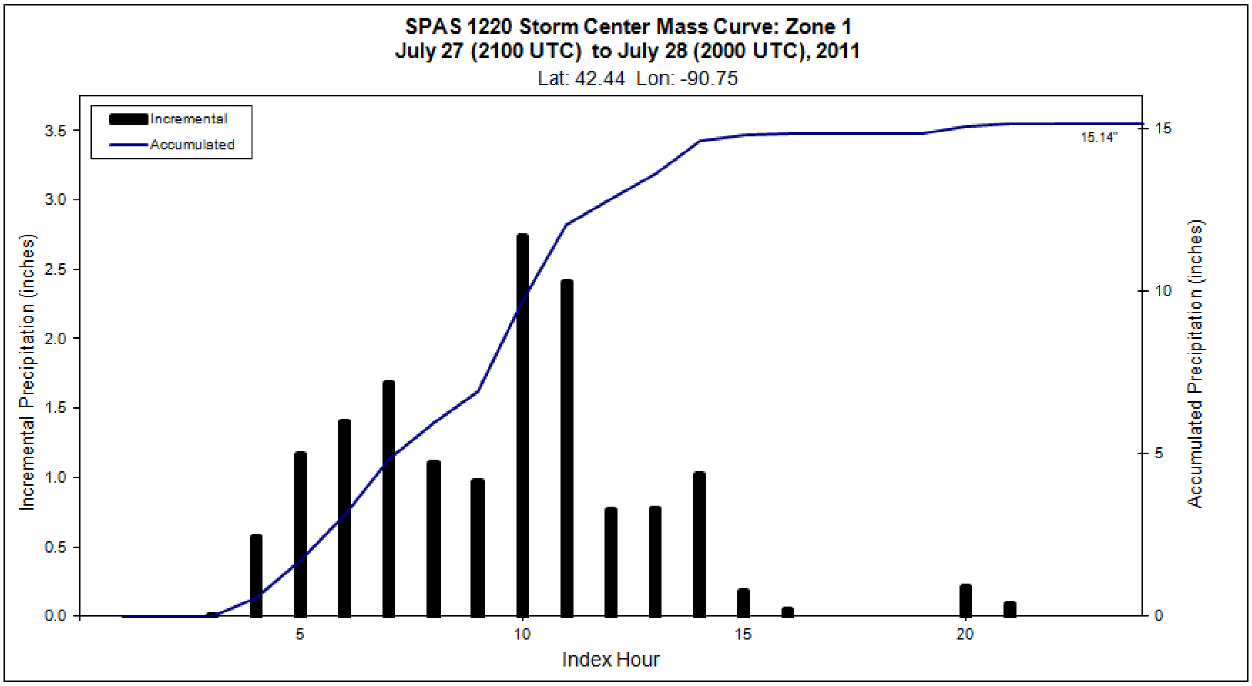
Appendix F: Table F.6: Storm spreadsheet for Dubuque, IA July 27, 2011

Storm 1220 - July 27 (2100 UTC) - July 28 (2000 UTC), 2011								
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)								
	Duration (hours)							
Area (mi^2)	1	2	3	6	12	18	24	Total
0.4	4.2	6.92	9.38	10.9	14.8	15.14	15.14	15.14
1	4.1	6.76	9.13	10.6	14.37	14.72	14.73	14.73
10	3.86	6.26	8.56	10.24	13.74	14.38	14.5	14.50
25	3.5	5.82	7.83	9.32	13.14	13.94	14	14.00
50	3.12	5.41	7.15	9.26	12.68	13.59	13.64	13.64
100	2.86	5.01	5.69	9.13	12.42	13.17	13.25	13.25
150	2.62	4.75	5.68	8.98	12	12.87	12.93	12.93
200	2.34	4.53	5.63	8.84	11.92	12.63	12.7	12.70
300	2.24	4.21	4.95	8.56	11.51	12.26	12.33	12.33
400	2.15	3.98	4.82	7.97	11.22	11.97	12.02	12.02
500	2.06	3.78	4.58	7.9	10.92	11.65	11.7	11.70
1,000	1.71	3.01	3.9	6.99	9.62	10.19	10.38	10.38
2,000	1.3	2.18	2.98	5.2	7.67	8.4	8.63	8.63
5,000	0.68	1.1	1.64	3.33	4.86	5.44	5.91	5.91
10,000	0.39	0.71	0.99	1.92	2.91	3.49	3.8	3.80
12,295	0.31	0.6	0.86	1.59	2.63	3.06	3.07	3.07

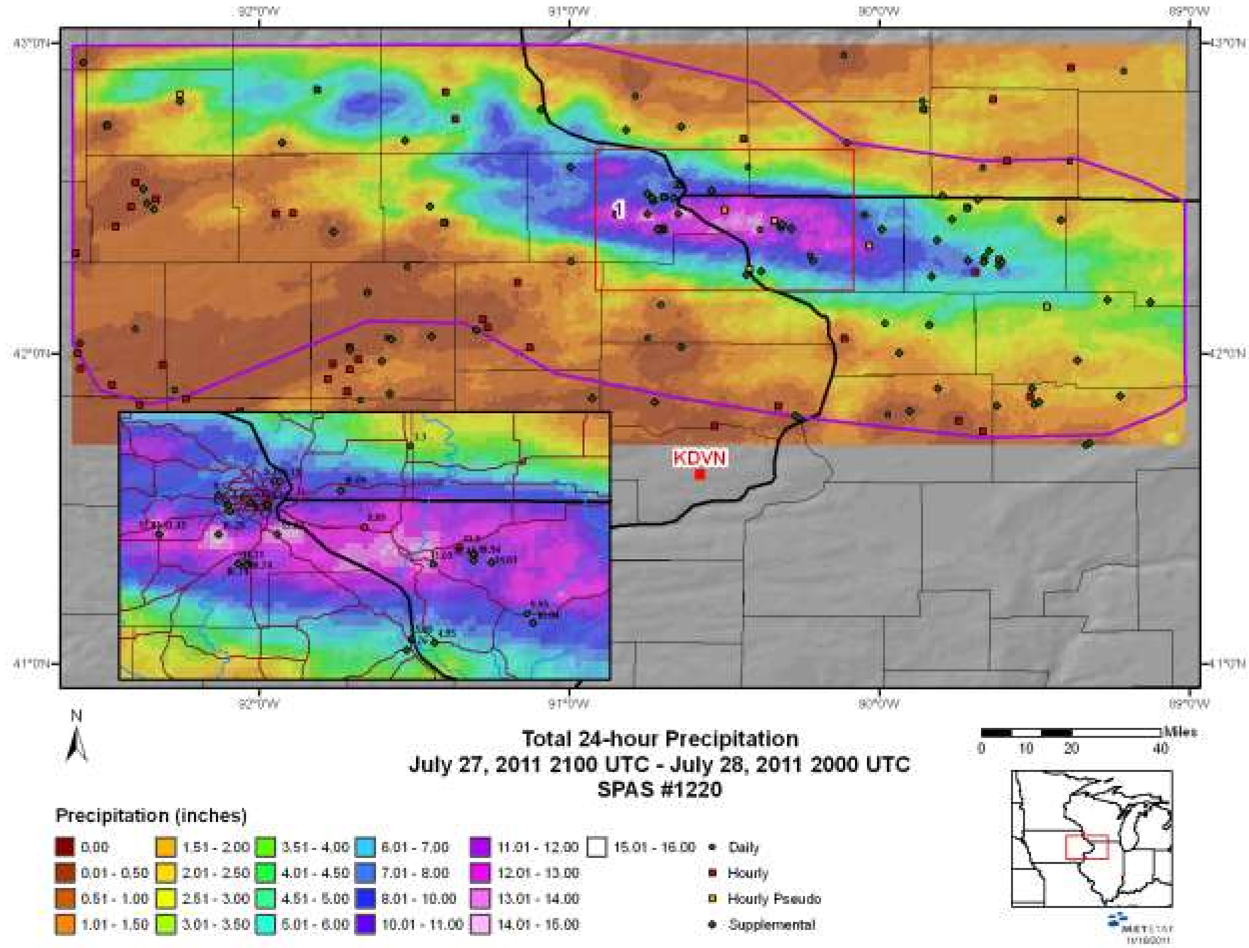
Appendix F: Table F.7: Depth-area-duration values for Dubuque, IA July 27, 2011



Appendix F: Figure F.7: Depth-area-duration chart for Dubuque, IA July 27, 2011



Appendix F: Figure F.8: Mass curve chart for Dubuque, IA July 27,2011



Appendix F: Figure F.9: Total storm isohyetal analysis for Dubuque, IA July 2011

Warner Park, TN, AWA 2

April 30, 2010

Storm Type: Frontal/MCC

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	SPAS 1208, Warner Park, TN	Storm Adjustment for ANO Grid Point 1
Storm Date:	5/1-3/2010	
AWA Analysis Date:	12/20/2013	

Temporal Transposition Date	15-May				
	Lat	Long	Moisture Inflow Direction	SSW @ 360	miles
Storm Center Location	36.06 N	86.91 W	Grid Point Elevation	350	feet
Storm Rep Dew Point Location	31.50 N	90.00 W	Storm Center Elevation	600	feet
Transposition Dew Point Location	38.16 N	95.94 W	Storm Rep Analysis Duration	12	hours
Grid Point Location	35.31 N	93.23 W			

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place storm elevation is	600	which subtracts	0.15	inches of precipitable water at	75.0 F	
The in-place storm elevation is	600	which subtracts	0.16	inches of precipitable water at	76.5 F	
The transposition storm elevation at	350	which subtracts	0.25	inches of precipitable water at	75.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.25	inches of precipitable water at	75.0 F	

The in-place maximization factor is	1.08
The transposition/elevation factor is	0.90
The barrier adjustment factor is	1.00
The total adjustment factor is	0.96

Notes: Storm representative Td value was based on 12-hr surface dewpoint values between on May 1 along with Hysplit backward trajectory. Values were selected in region where temperature did not vary more than a degree over a large area. Used an average of KJAN, KMCB, KHBG, and KASD.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	4.4	15.0	17.3	18.0	18.1	19.0	19.2	19.4	-
100 sq miles	3.7	13.2	15.9	16.5	16.6	18.3	18.5	18.7	-
200 sq miles	3.4	12.2	15.0	15.6	15.8	17.8	18.1	18.3	-
500 sq miles	2.8	10.6	13.5	14.3	14.6	16.8	17.4	17.7	-
1000 sq miles	2.3	9.0	12.6	13.3	13.5	16.4	16.9	17.1	-
2000 sq miles	1.8	7.4	11.1	12.0	12.6	15.7	16.1	16.4	-
5000 sq miles	1.4	5.2	9.2	10.3	10.9	14.1	14.8	15.0	-
10000 sq miles	1.0	3.8	7.4	8.4	8.6	12.2	13.0	13.1	-
20000 sq miles	0.7	2.9	5.4	6.3	7.2	10.2	11.0	11.2	-

Adjusted Storm Depth-Area-Duration

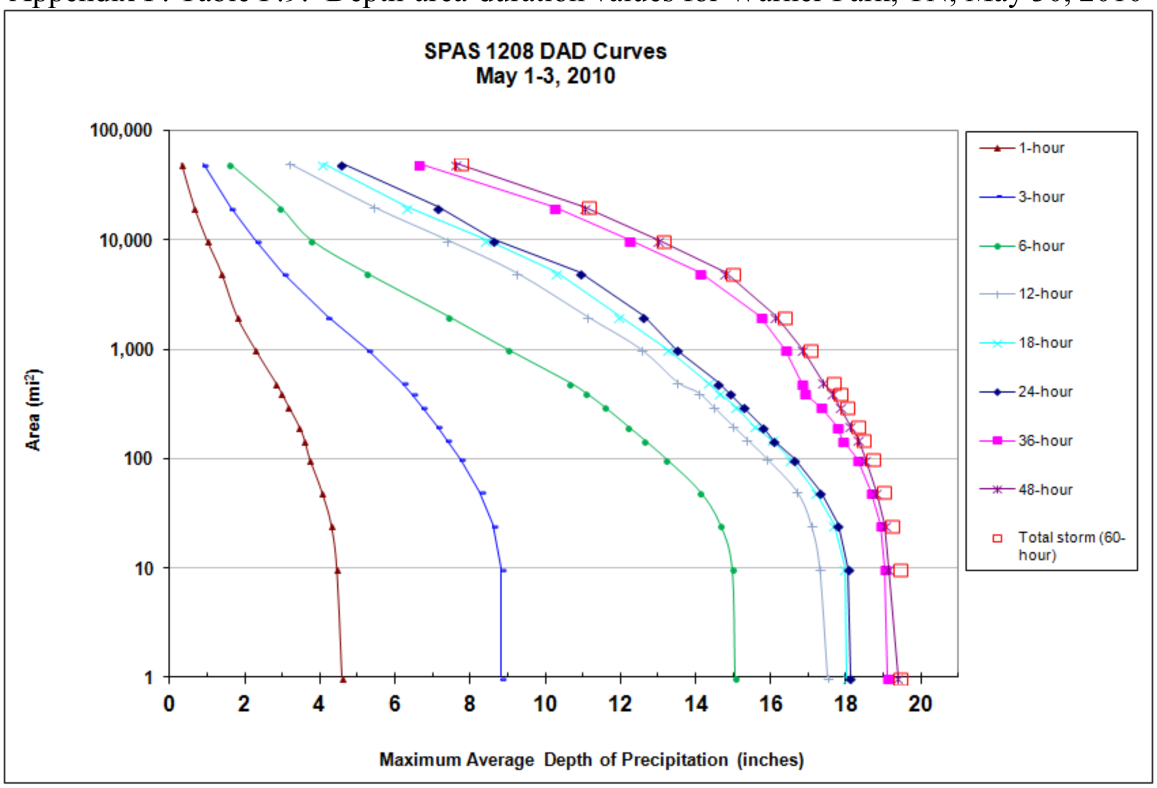
	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	4.3	14.4	16.7	17.3	17.4	18.3	18.4	18.7	-
100 sq miles	3.6	12.7	15.3	15.9	16.0	17.6	17.8	18.0	-
200 sq miles	3.3	11.7	14.4	15.0	15.2	17.1	17.4	17.6	-
500 sq miles	2.7	10.2	13.0	13.8	14.1	16.2	16.8	17.0	-
1000 sq miles	2.2	8.7	12.1	12.8	13.0	15.8	16.2	16.4	-
2000 sq miles	1.7	7.1	10.7	11.5	12.2	15.1	15.5	15.8	-
5000 sq miles	1.3	5.0	8.9	9.9	10.5	13.6	14.2	14.4	-
10000 sq miles	1.0	3.6	7.1	8.1	8.3	11.8	12.5	12.6	-
20000 sq miles	0.6	2.8	5.2	6.1	6.9	9.9	10.6	10.7	-

Storm or Storm Center Name	**SPAS 1208, Warner Park, TN**	
Storm Date(s)	5/1-3/2010	
Storm Type	Synoptic	
Storm Location	36.06 N	86.91 W
Storm Center Elevation	600	
Precipitation Total & Duration (10 sq mi)	19.71 inches in 60 hours	
Storm Representative Td	75.0 F	12
Storm Representative Td Location	31.50 N	90.00 W
In-place Maximum Td	76.5 F	
Moisture Inflow Vector	SSW @ 360	
In-place Maximization Factor	**1.08**	
Temporal Transposition (Date)	15-May	
Transposition Td Location	38.16 N	95.94 W
Transposition Maximum Td	75.0 F	
Transposition Adjustment Factor	**0.90**	
Grid point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**0.96**	

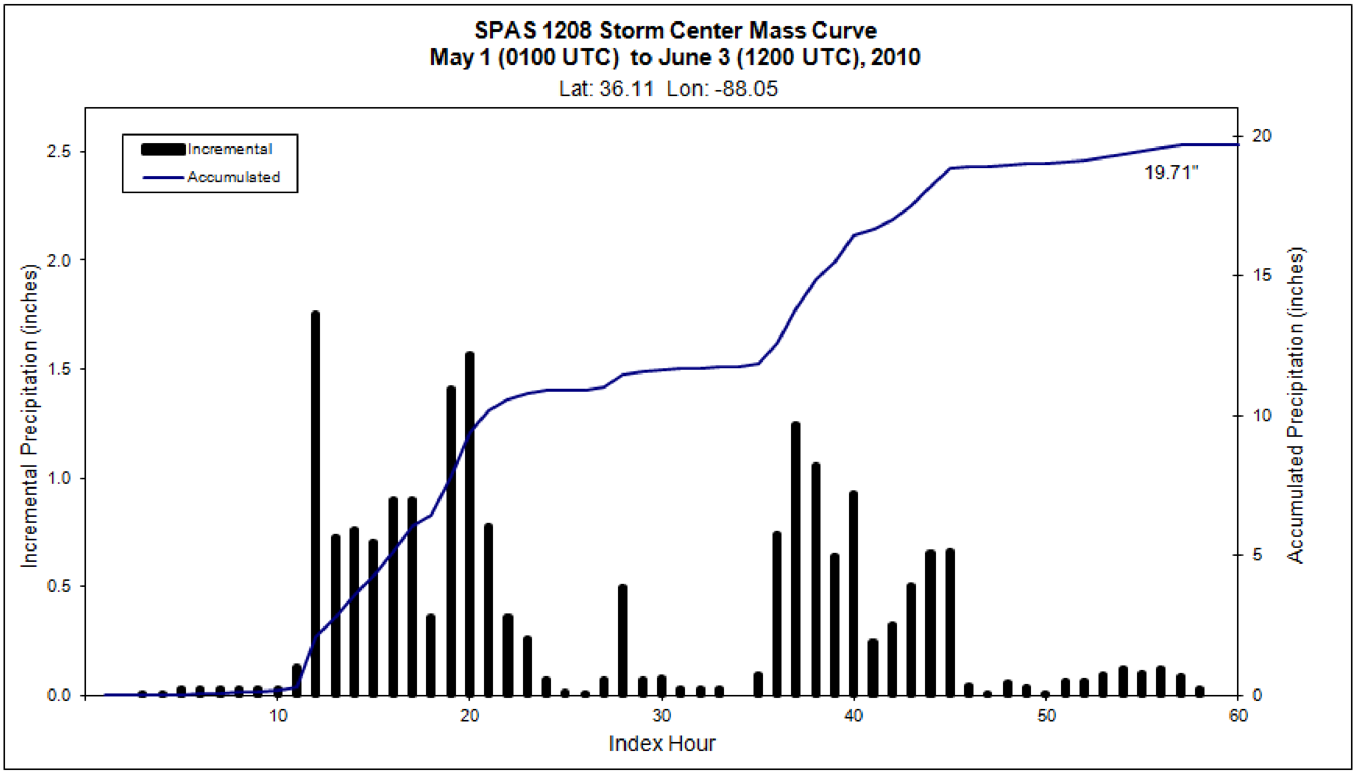
Appendix F: Table F.8: Storm spreadsheet for Warner Park, TN May 30, 2010

Storm 1208 - May 1 (0100 UTC) - May 3 (1200 UTC), 2010										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi^2)	1	3	6	12	18	24	36	48	60	Total
0.4	4.63	8.92	15.31	17.77	18.33	18.39	19.36	19.66	19.71	19.71
1	4.58	8.82	15.06	17.52	18.03	18.12	19.11	19.38	19.45	19.45
10	4.44	8.81	14.98	17.31	17.97	18.06	19.04	19.15	19.43	19.43
25	4.29	8.61	14.66	17.08	17.69	17.8	18.91	19.05	19.24	19.24
50	4.04	8.25	14.12	16.7	17.2	17.33	18.67	18.82	19.01	19.01
100	3.72	7.72	13.21	15.9	16.52	16.63	18.31	18.51	18.71	18.71
150	3.58	7.37	12.62	15.37	16.04	16.07	17.91	18.35	18.48	18.48
200	3.43	7.12	12.18	14.99	15.57	15.78	17.75	18.11	18.32	18.32
300	3.16	6.72	11.56	14.47	15.07	15.28	17.33	17.85	18.05	18.05
400	2.97	6.44	11.07	14.08	14.65	14.91	16.9	17.65	17.85	17.85
500	2.81	6.19	10.63	13.52	14.34	14.61	16.84	17.4	17.67	17.67
1,000	2.27	5.26	8.99	12.55	13.27	13.5	16.39	16.86	17.05	17.05
2,000	1.79	4.19	7.41	11.11	11.96	12.62	15.72	16.14	16.37	16.37
5,000	1.38	3	5.23	9.24	10.3	10.93	14.12	14.79	15	15.00
10,000	0.99	2.28	3.76	7.39	8.42	8.64	12.21	13	13.13	13.13
20,000	0.66	1.6	2.93	5.44	6.33	7.16	10.24	11.04	11.15	11.15
50,000	0.32	0.88	1.58	3.19	4.08	4.59	6.63	7.63	7.75	7.75

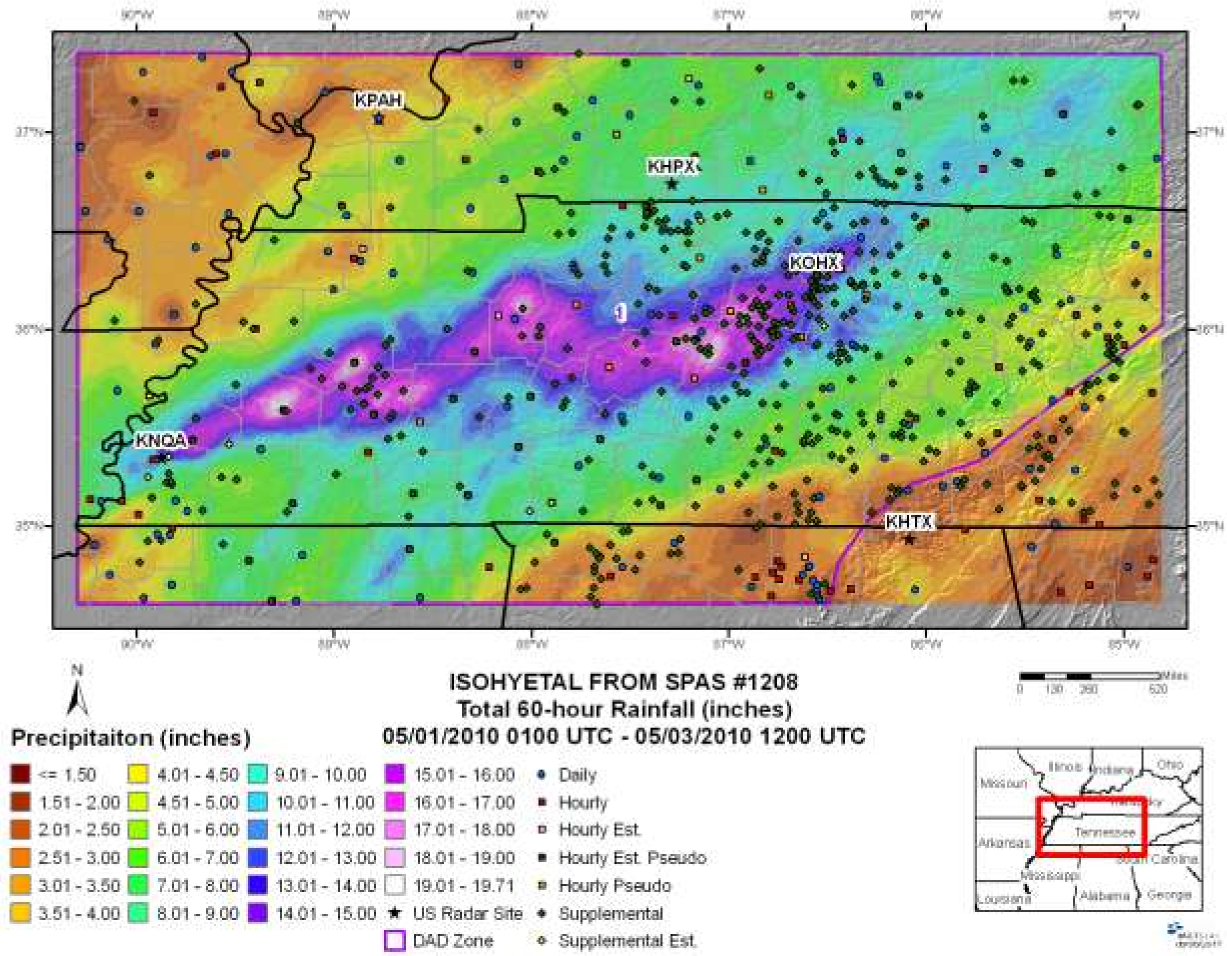
Appendix F: Table F.9: Depth-area-duration values for Warner Park, TN, May 30, 2010



Appendix F: Figure F.10: Depth-area-duration chart for Warner Park, TN, May 30, 2010



Appendix F: Figure F.11: Mass curve chart for Warner Park, TN, May 30, 2010



Appendix F: Figure F.12: Total storm isohyetal analysis for Warner Park, TN, May 30, 2010

Alley Spring, MO, AWA 3

March 17, 2008

Storm Type: Frontal

Grid Points Used: 8-10, 16-17

Storm Name:	**SPAS 1242 Alley Spring, MO**		
Storm Date:	**3/17-20/2008**		**Storm Adjustment for ANO Grid Point 1**
AWA Analysis Date:	**12/13/2013**		

Temporal Transposition Date **1-Apr**

	Lat	Long
Storm Center Location	**37.16 N**	**91.45 W**
Storm Rep Dew Point Location	**31.30 N**	**86.40 W**
Transposition Dew Point Location	**36.85 N**	**87.18 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**SE @ 500**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**1,050**	feet
Storm Rep Analysis Duration	**24**	hrs

The storm representative dew point is	**66.0 F**	with total precipitable water above sea level of			**1.86**	inches.
The in-place maximum dew point is	**71.0 F**	with total precipitable water above sea level of			**2.36**	inches.
The transpositioned maximum dew point is	**67.0 F**	with total precipitable water above sea level of			**1.95**	inches.
The in-place storm elevation is	**1,050**	which subtracts	**0.20**	inches of precipitable water at	**66.0 F**	
The in-place storm elevation is	**1,050**	which subtracts	**0.23**	inches of precipitable water at	**71.0 F**	
The transposition storm elevation at	**350**	which subtracts	**0.19**	inches of precipitable water at	**67.0 F**	
The Grid Point/inflow barrier height is	**1,000**	which subtracts	**0.19**	inches of precipitable water at	**67.0 F**	

The in-place maximization factor is	**1.28**
The transposition factor is	**0.83**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.06**

Notes: Storm representative dew point value was based on maximum 24-hr Td values for March 16-17, 2008 at KGZH, KPRN, KOZR, KCEW, and K79J.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.2**	**6.0**	**8.9**	**11.0**	**12.9**	**14.3**	**14.7**		**14.7**
10 sq miles	**2.0**	**5.9**	**8.7**	**11.0**	**12.9**	**14.3**	**14.7**		**14.7**
100 sq miles	**1.6**	**5.0**	**8.0**	**10.8**	**12.7**	**13.7**	**14.0**		**14.1**
200 sq miles	**1.4**	**4.6**	**7.7**	**10.5**	**12.4**	**13.4**	**13.6**		**13.8**
500 sq miles	**1.3**	**3.9**	**7.1**	**9.8**	**11.8**	**12.7**	**13.0**		**13.2**
1000 sq miles	**1.2**	**3.8**	**6.2**	**8.9**	**11.0**	**12.2**	**12.5**		**12.6**
2000 sq miles	**1.1**	**3.3**	**5.9**	**8.1**	**10.5**	**11.6**	**11.9**		**12.0**
5000 sq miles	**0.9**	**2.8**	**5.2**	**7.2**	**9.4**	**10.6**	**11.0**		**11.0**
10000 sq miles	**0.7**	**2.5**	**4.7**	**6.5**	**8.3**	**9.7**	**10.0**		**10.1**
20000 sq miles	**0.6**	**2.2**	**4.1**	**5.6**	**7.0**	**8.6**	**8.9**		**9.0**

Adjusted Storm Depth-Area-Duration

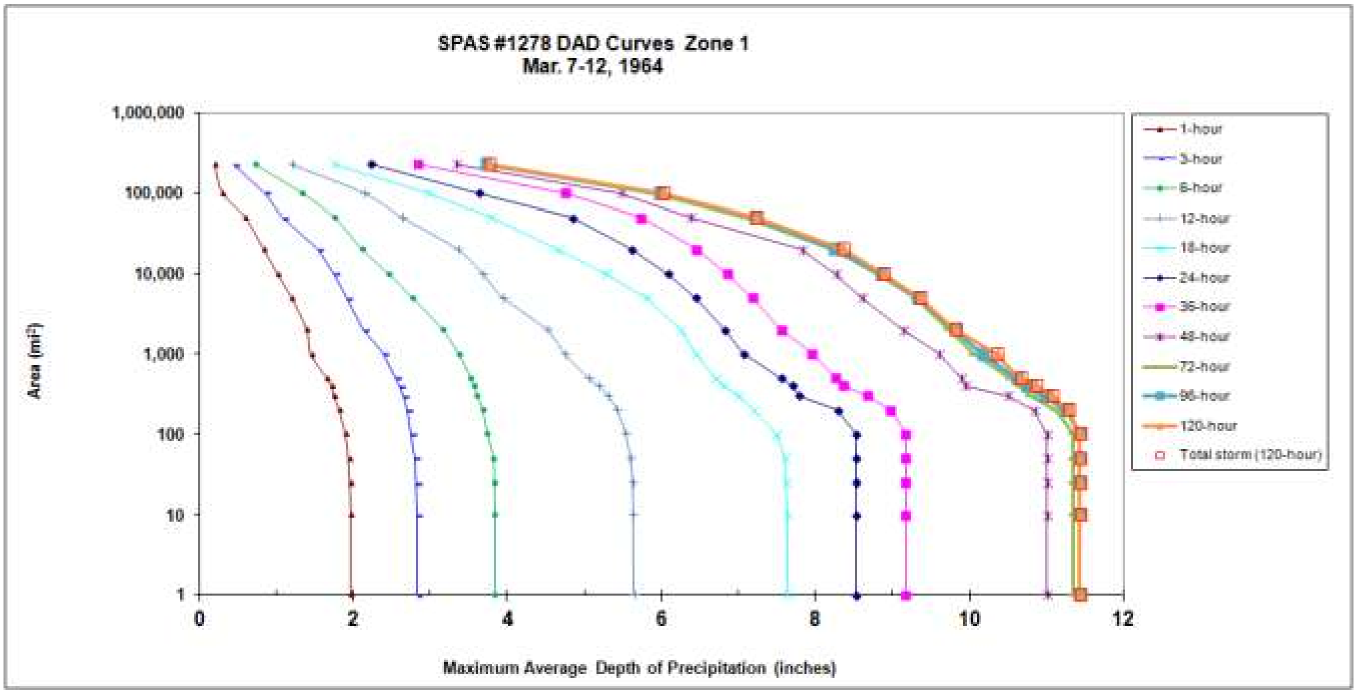
	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.3**	**6.4**	**9.4**	**11.6**	**13.6**	**15.1**	**15.6**	-	**15.6**
10 sq miles	**2.1**	**6.2**	**9.2**	**11.6**	**13.6**	**15.1**	**15.6**	-	**15.6**
100 sq miles	**1.7**	**5.3**	**8.4**	**11.5**	**13.4**	**14.4**	**14.8**	-	**14.9**
200 sq miles	**1.5**	**4.9**	**8.1**	**11.1**	**13.1**	**14.1**	**14.4**	-	**14.6**
500 sq miles	**1.4**	**4.1**	**7.5**	**10.4**	**12.4**	**13.4**	**13.7**	-	**13.9**
1000 sq miles	**1.3**	**4.0**	**6.6**	**9.4**	**11.6**	**12.9**	**13.2**	-	**13.3**
2000 sq miles	**1.2**	**3.5**	**6.3**	**8.6**	**11.0**	**12.3**	**12.6**	-	**12.7**
5000 sq miles	**1.0**	**3.0**	**5.5**	**7.6**	**9.9**	**11.2**	**11.6**	-	**11.6**
10000 sq miles	**0.8**	**2.7**	**4.9**	**6.9**	**8.7**	**10.2**	**10.6**	-	**10.7**
20000 sq miles	**0.6**	**2.3**	**4.3**	**5.9**	**7.4**	**9.1**	**9.4**	-	**9.5**

Storm or Storm Center Name	**SPAS 1242 Alley Spring, MO**			
Storm Date(s)	3/17-20/2008			
Storm Type	General Storm			
Storm Location	37.16 N	91.45 W		
Storm Center Elevation	1050			
Precipitation Total & Duration (10 sq mi)	15.09 inches in 72 hours			
Storm Representative Dew Point	66.0 F	24		
Storm Representative Dew Point Location	31.30 N	86.40 W	Mar	Apr
Maximum Dew Point	71.0 F		69.5	72
Moisture Inflow Vector	SE @ 500			
In-place Maximization Factor	**1.28**			
Temporal Transposition (Date)	1-Apr			
Transposition Dew Point Location	36.85 N	87.18 W	Mar	Apr
Transposition Maximum Dew Point	67.0 F		65	68.5
Transposition Adjustment Factor	**0.83**			
Grid Point Basin Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.06**			

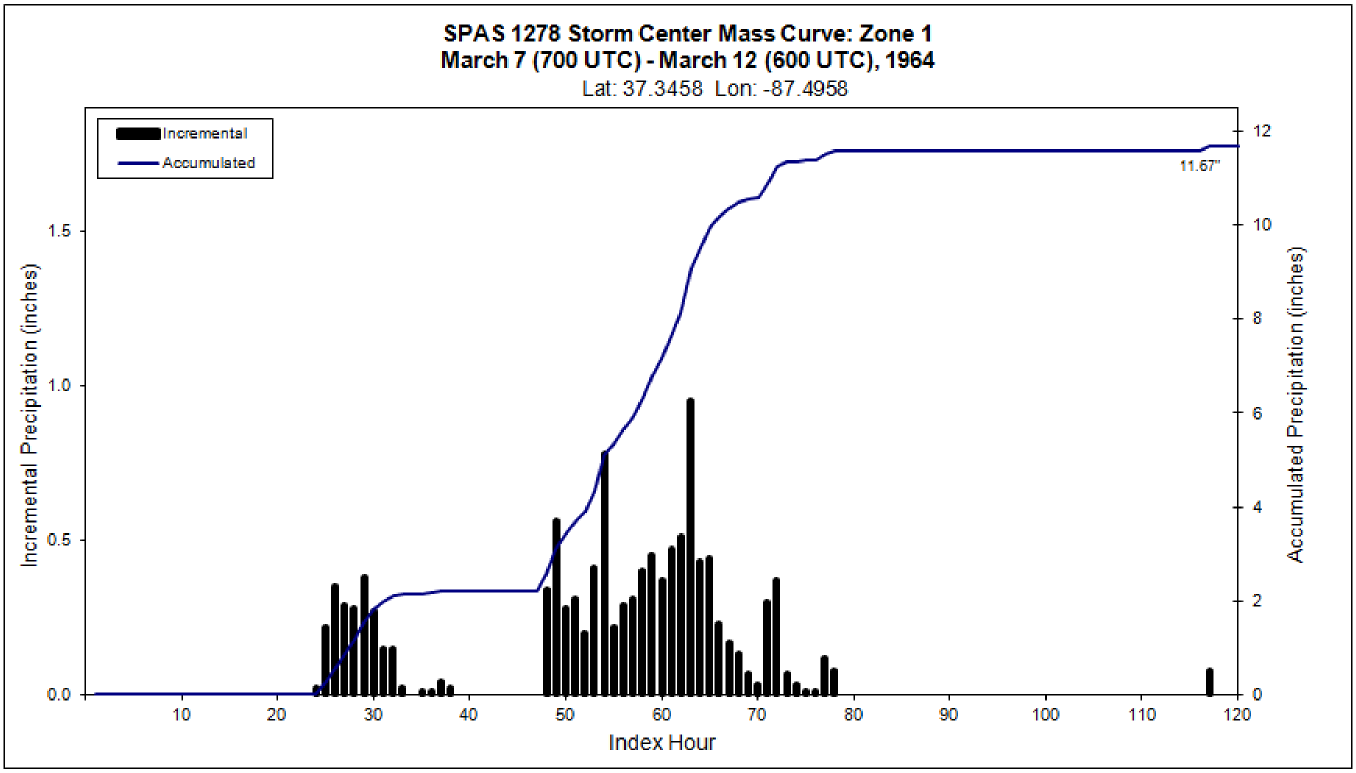
Appendix F: Table F.10: Storm spreadsheet for Alley Spring, MO, March 17, 2008

Storm 1278 - March 7 (0700 UTC) - Mach 12 (0600 UTC), 1964												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
	Duration (hours)											
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	120	Total
0.3	2	2.89	3.9	5.64	7.74	8.71	9.37	11.25	11.59	11.67	11.67	11.67
1	1.97	2.83	3.84	5.64	7.63	8.52	9.17	11	11.34	11.43	11.43	11.43
10	1.97	2.83	3.84	5.63	7.63	8.52	9.17	11	11.34	11.43	11.43	11.43
25	1.96	2.82	3.83	5.62	7.62	8.52	9.17	11	11.34	11.43	11.43	11.43
50	1.94	2.8	3.82	5.59	7.61	8.52	9.17	11	11.34	11.43	11.43	11.43
100	1.9	2.76	3.74	5.53	7.49	8.52	9.17	11	11.34	11.43	11.43	11.43
200	1.82	2.7	3.68	5.42	7.19	8.29	8.97	10.83	11.12	11.25	11.28	11.28
300	1.75	2.65	3.61	5.3	7	7.78	8.67	10.49	10.79	10.96	11.06	11.06
400	1.72	2.6	3.57	5.18	6.81	7.71	8.37	9.94	10.65	10.74	10.85	10.85
500	1.66	2.55	3.53	5.05	6.7	7.55	8.27	9.89	10.53	10.61	10.65	10.65
1,000	1.45	2.39	3.37	4.74	6.45	7.07	7.96	9.59	10.05	10.16	10.34	10.34
2,000	1.4	2.13	3.16	4.51	6.25	6.82	7.56	9.13	9.72	9.8	9.81	9.81
5,000	1.2	1.92	2.77	3.95	5.81	6.44	7.18	8.6	9.3	9.32	9.35	9.35
10,000	1.02	1.75	2.46	3.68	5.29	6.09	6.86	8.26	8.82	8.84	8.88	8.88
20,000	0.84	1.54	2.12	3.36	4.64	5.61	6.46	7.82	8.23	8.24	8.36	8.36
50,000	0.6	1.08	1.76	2.64	3.79	4.84	5.74	6.38	7.1	7.2	7.23	7.23
100,000	0.3	0.86	1.34	2.14	2.98	3.63	4.76	5.47	5.9	5.97	6.01	6.01
227,343	0.2	0.45	0.73	1.2	1.76	2.24	2.85	3.34	3.72	3.72	3.77	3.77

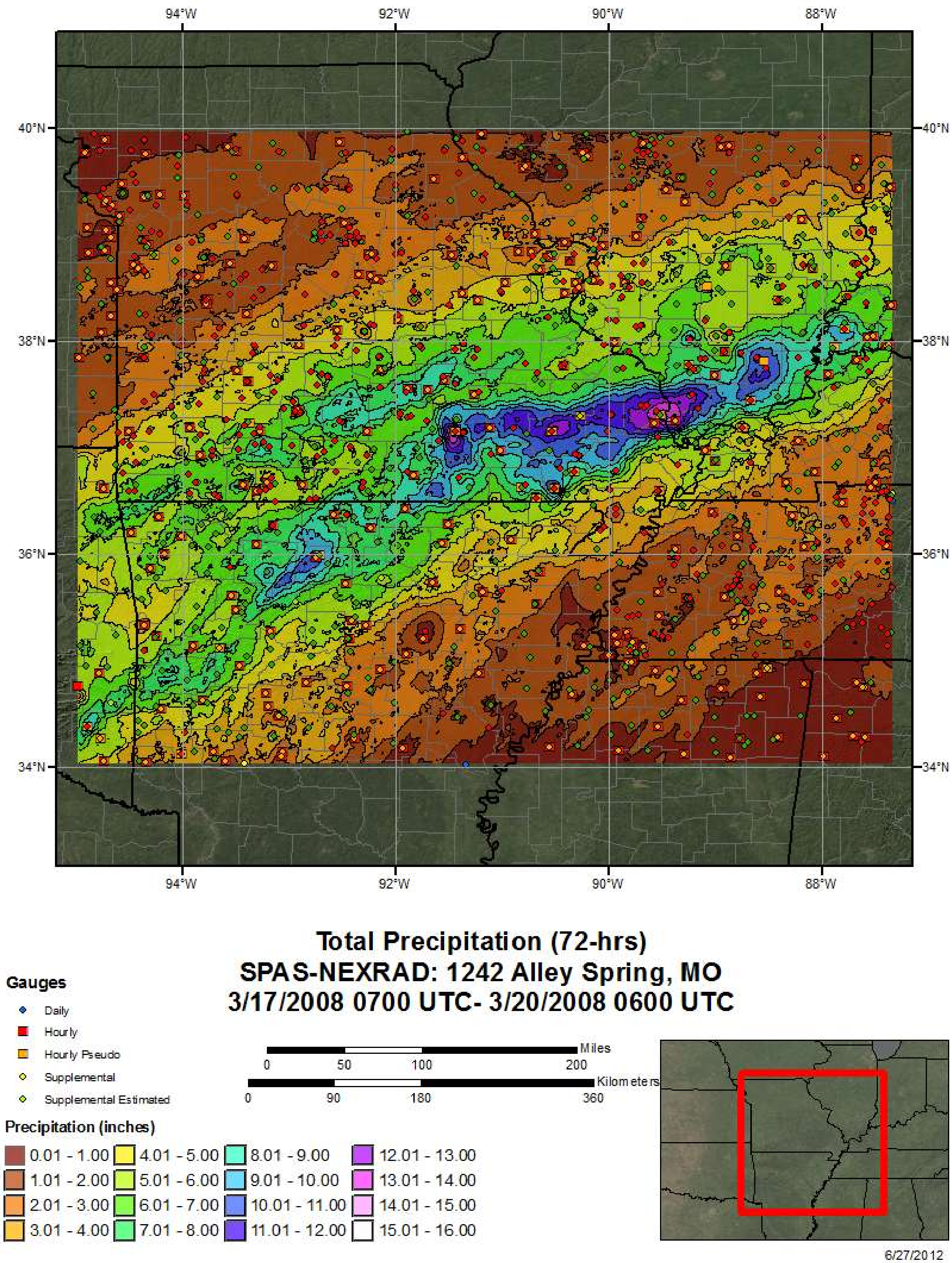
Appendix F: Table F.11: Depth-area-duration values for Alley Spring, MO March 17, 2008



Appendix F: Figure F.13: Depth-area-duration chart for Alley Spring, MO March 17, 2008



Appendix F: Figure F.14: Mass curve chart for Alley Spring, MO March 17, 2008



Appendix F: Figure F.15: Total storm isohyetal analysis for Alley Spring, MO March 2008

Larto Lake, LA, AWA 4

September 1, 2008
Storm Type: Tropical
Grid Points Used: 1-2

Storm Name:	SPAS 1182-Larto Lake, LA
Storm Date:	9/1-5/2008
AWA Analysis Date:	12/13/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	15-Aug	
	Lat	Long
Storm center location	31.22 N	92.13 W
Storm Rep Td location	30.00 N	94.00 W
Transposition Td location	34.10 N	95.19 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	SW @ 150	miles
Grid Point Elevation	400	feet
Storm Center Elevation	50	feet
Storm Rep Analysis Duration	24	hours

The storm representative Td is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum Td is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum Td is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The in-place storm elevation is	50	which subtracts	0.03	inches of precipitable water at	76.0 F	
The in-place storm elevation is	50	which subtracts	0.03	inches of precipitable water at	80.0 F	
The transposition storm elevation at	400	which subtracts	0.12	inches of precipitable water at	79.5 F	
The Grid point/inflow barrier height is	400	which subtracts	0.12	inches of precipitable water at	79.5 F	

The in-place maximization factor is	1.21
The transposition factor is	0.95
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.15

Notes:

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.9	12.8	14.8	16.1	-	18.6	22.0	-	22.4
100 sq miles	7.9	11.9	13.7	14.9	-	17.5	20.2	-	21.1
200 sq miles	7.4	11.5	13.5	14.3	-	17.0	20.2	-	20.7
500 sq miles	6.7	10.2	12.3	13.2	-	16.2	19.5	-	19.8
1000 sq miles	6.0	9.2	11.1	12.0	-	15.5	18.1	-	18.9
2000 sq miles	5.3	8.1	9.5	10.3	-	14.4	16.5	-	17.7
5000 sq miles	3.9	6.7	8.0	9.1	-	12.3	14.7	-	14.9
10000 sq miles	3.2	5.6	6.9	8.1	-	10.4	12.4	-	12.6
20000 sq miles	2.5	4.5	5.6	6.9	-	8.5	10.3	-	11.1

Adjusted Storm Depth-Area-Duration

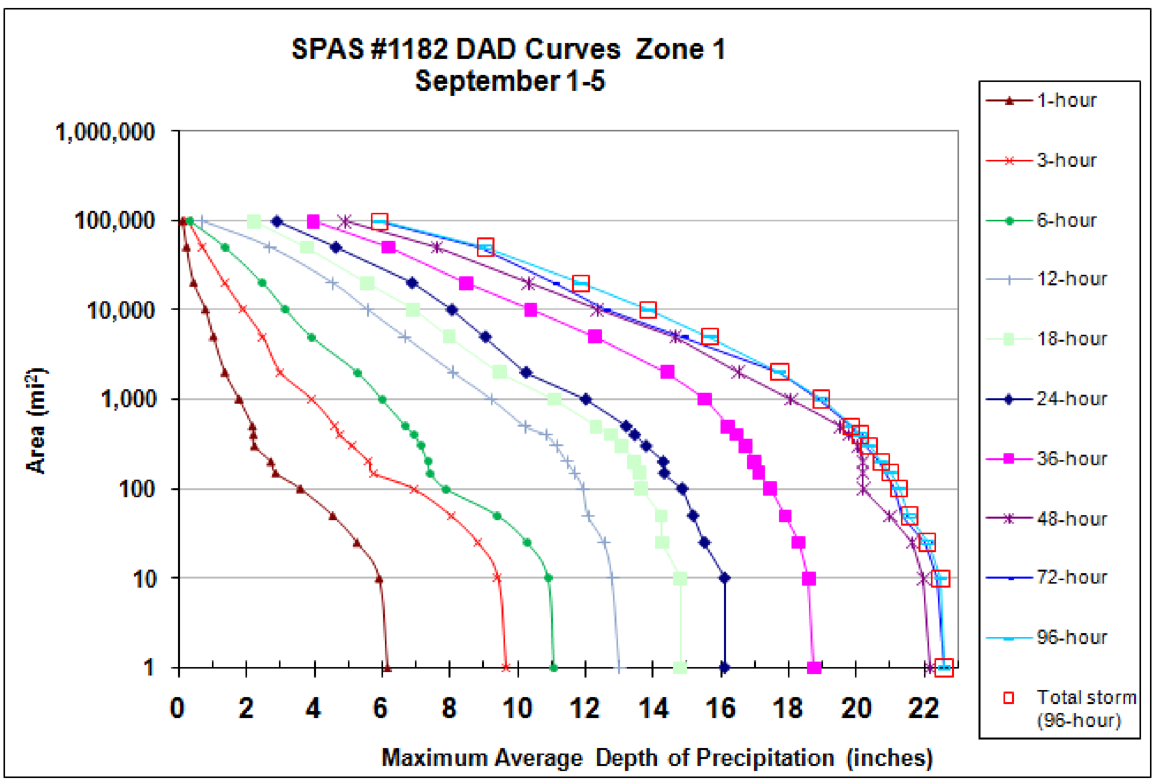
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	12.5	14.7	17.0	18.5	-	21.4	25.2	-	25.7
100 sq miles	9.1	13.7	15.7	17.1	-	20.1	23.2	-	24.2
200 sq miles	8.4	13.2	15.4	16.4	-	19.5	23.2	-	23.7
500 sq miles	7.7	11.7	14.2	15.2	-	18.6	22.4	-	22.8
1000 sq miles	6.9	10.6	12.7	13.8	-	17.9	20.8	-	21.7
2000 sq miles	6.1	9.3	10.9	11.8	-	16.6	19.0	-	20.4
5000 sq miles	4.5	7.7	9.2	10.4	-	14.1	16.9	-	17.1
10000 sq miles	3.6	6.4	8.0	9.3	-	11.9	14.2	-	14.4
20000 sq miles	2.8	5.2	6.4	7.9	-	9.7	11.8	-	12.7

Storm or Storm Center Name	**SPAS 1182-Larto Lake, LA**		
Storm Date(s)	9/1-5/2008		
Storm Type	Tropical Storm	**Gustav**	
Storm Location	31.22 N	92.13 W	
Storm Center Elevation	50		
Precipitation Total & Duration (10 sq mi)	23.31 inches in 72hrs		
Storm Representative Td	76.0 F		
Storm Representative Td Location	30.00 N	94.00 W	A
In-place Maximum Td	80.0 F		79
Moisture Inflow Vector	SW @ 150		
In-place Maximization Factor			
Temporal Transposition (Date)	15-Aug		
Transposition Dewpoint Location	34.10 N	95.19 W	A
Transposition Maximum Td	79.5 F		78.5
Transposition Adjustment Factor			
Grid Point Elevation	400		
Highest Elevation in Basin	14,344		
Inflow Barrier Height	N/A		
Elevation Adjustment Factor			
Total Adjustment Factor	**1.15**		

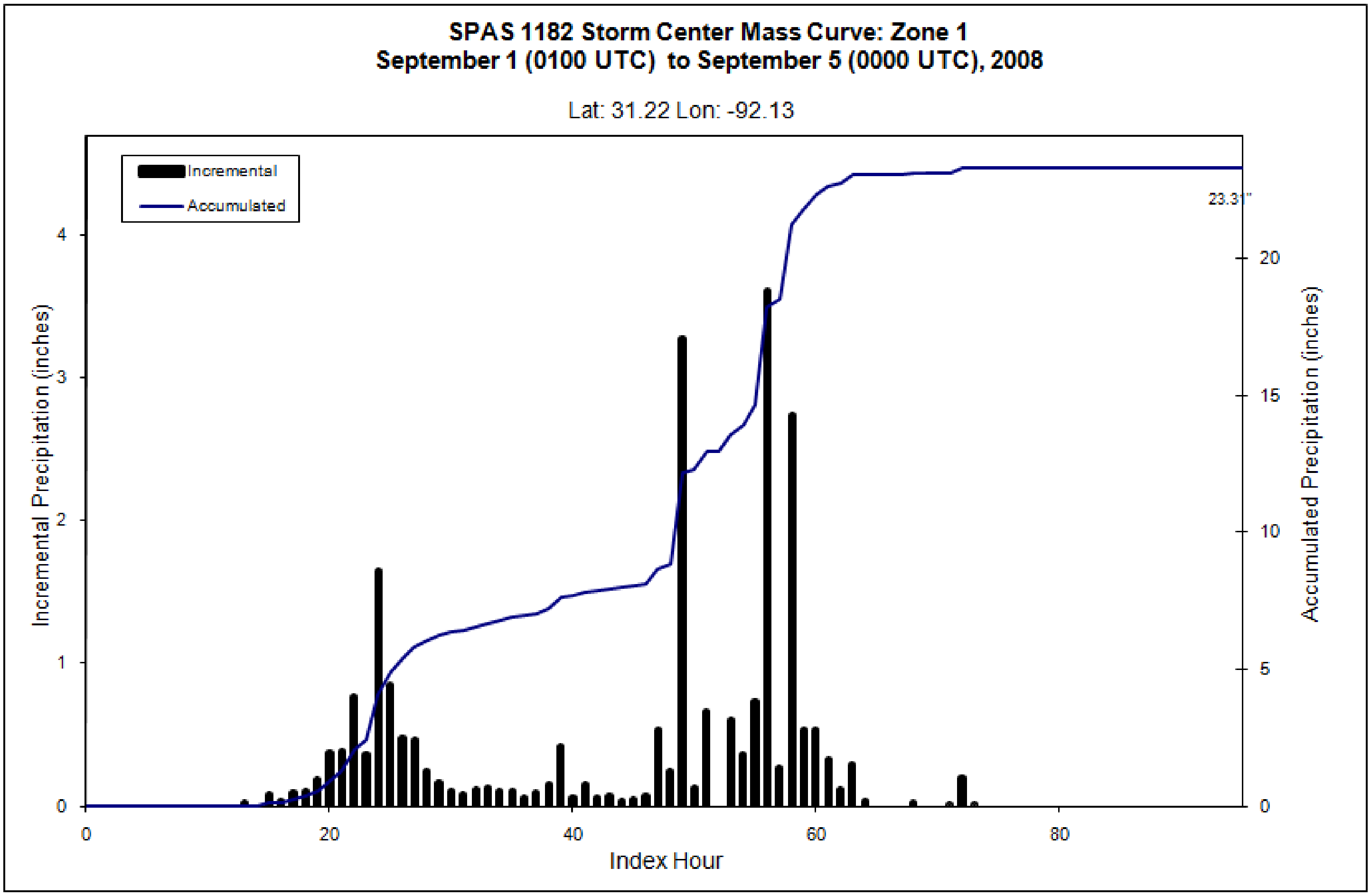
Appendix F: Table F.12: Storm spreadsheet for Larto Lake, LA, September 1, 2008

Storm 1182 - September 1 (0100 UTC) to September 5 (0000 UTC), 2008 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	Total
0.40	6.35	9.89	11.34	13.44	15.26	16.55	19.37	22.93	23.31	23.31	23.31
1	6.15	9.65	11.08	13.02	14.80	16.10	18.75	22.17	22.60	22.60	22.60
10	5.90	9.42	10.91	12.80	14.80	16.10	18.59	21.98	22.37	22.48	22.48
25	5.25	8.82	10.29	12.56	14.26	15.51	18.29	21.66	22.03	22.10	22.10
50	4.54	8.03	9.42	12.09	14.24	15.17	17.89	21.00	21.34	21.56	21.56
100	3.58	6.92	7.88	11.94	13.66	14.85	17.47	20.21	21.11	21.28	21.28
150	2.85	5.72	7.44	11.70	13.60	14.32	17.11	20.20	20.89	21.01	21.01
200	2.71	5.61	7.35	11.46	13.45	14.29	16.99	20.19	20.67	20.73	20.73
300	2.23	5.10	7.15	11.15	13.09	13.79	16.72	20.03	20.25	20.39	20.39
400	2.20	4.74	6.96	10.84	12.75	13.45	16.45	19.77	20.04	20.13	20.13
500	2.17	4.61	6.70	10.22	12.32	13.20	16.21	19.51	19.83	19.87	19.87
1,000	1.78	3.93	6.00	9.23	11.08	12.01	15.54	18.07	18.90	18.98	18.98
2,000	1.36	3.00	5.27	8.09	9.47	10.25	14.42	16.52	17.74	17.75	17.75
5,000	1.02	2.48	3.92	6.66	7.99	9.05	12.30	14.67	14.86	15.67	15.67
10,000	0.79	1.91	3.16	5.57	6.93	8.06	10.39	12.35	12.57	13.85	13.85
20,000	0.44	1.35	2.47	4.52	5.55	6.89	8.47	10.31	11.06	11.87	11.87
50,000	0.23	0.71	1.36	2.68	3.78	4.64	6.20	7.63	8.86	9.05	9.05
97,260	0.12	0.28	0.34	0.67	2.22	2.90	3.98	4.89	5.86	5.94	5.94

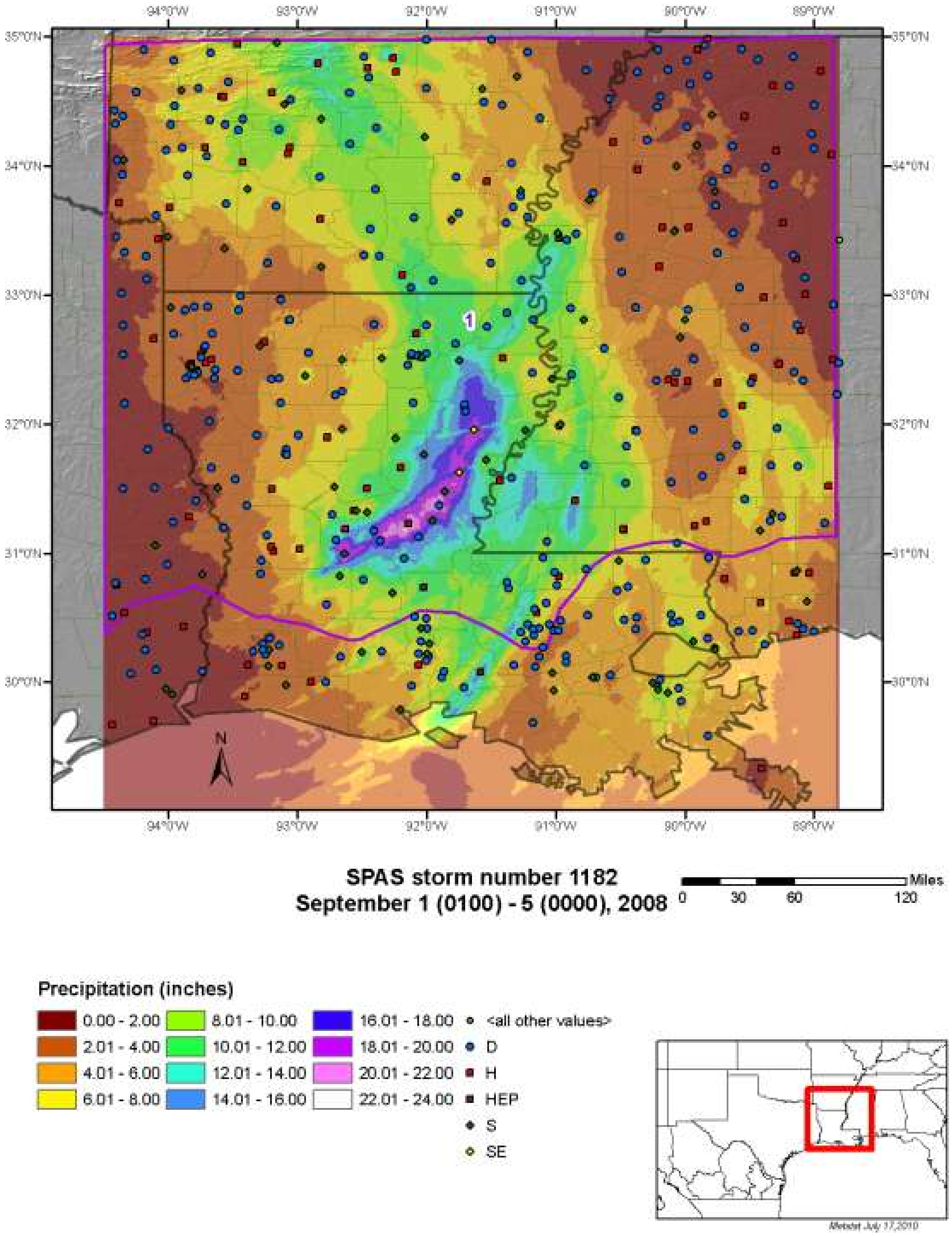
Appendix F: Table F.13: Depth-area-duration values for Larto Lake, LA, September 1, 2008



Appendix F: Figure F.16: Depth-area-duration chart for Larto Lake, LA, September 1, 2008



Appendix F: Figure F.17: Mass curve chart for Larto Lake, LA, September 1, 2008



Appendix F: Figure F.18 Total storm isohyetal analysis for Larto Lake, LA, September 1, 2008

Fall River, KS, AWA 5

June 30, 2007

Storm Type: Frontal/MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	SPAS 1228 Fall River, KS	Storm Adjustment for ANO Grid Point 1
Storm Date:	6/28/2007 - 7/2/2007	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	37.63 N	96.05 W
Storm Rep Dew Point Location	31.00 N	95.50 W
Transposition Dew Point Location	36.10 N	92.00 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 460	miles
Grid Point Elevation	350	feet
Storm Center Elevation	900	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The in-place maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	900	which subtracts	0.21	inches of precipitable water at	76.5 F	
The in-place storm elevation is	900	which subtracts	0.27	inches of precipitable water at	80.0 F	
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F	
The grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.17
The transposition/elevation to basin factor is	1.02
The barrier adjustment factor is	1.00
The total adjustment factor is	1.18

Notes: DAD values taken from SPAS 1228. Storm representative dew point value was based on maximum 24-hr Td values between June 27-28, 2007 at KDKR and KUTS.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.6	6.4	8.9	11.0	14.4	14.5	17.2	22.1	24.8
10 sq miles	4.2	6.3	8.8	10.7	13.8	13.9	17.1	21.9	24.8
100 sq miles	3.1	5.1	7.6	10.2	12.7	13.0	15.7	18.1	21.7
200 sq miles	2.8	4.7	7.0	9.6	11.8	11.9	14.8	17.1	20.7
500 sq miles	2.2	3.5	5.9	8.4	10.4	10.7	13.2	15.5	19.2
1000 sq miles	1.6	3.3	4.8	7.2	9.0	10.0	12.1	14.2	18.1
2000 sq miles	1.1	2.4	3.9	6.0	7.8	9.0	10.8	12.6	16.0
5000 sq miles	0.7	1.8	2.9	4.7	6.3	6.4	9.0	10.4	13.7
10000 sq miles	0.4	1.4	2.2	3.7	5.1	6.0	7.5	8.7	11.1
20000 sq miles	0.3	0.6	1.5	2.7	3.8	4.6	5.7	7.0	9.2

Adjusted Storm Depth-Area-Duration

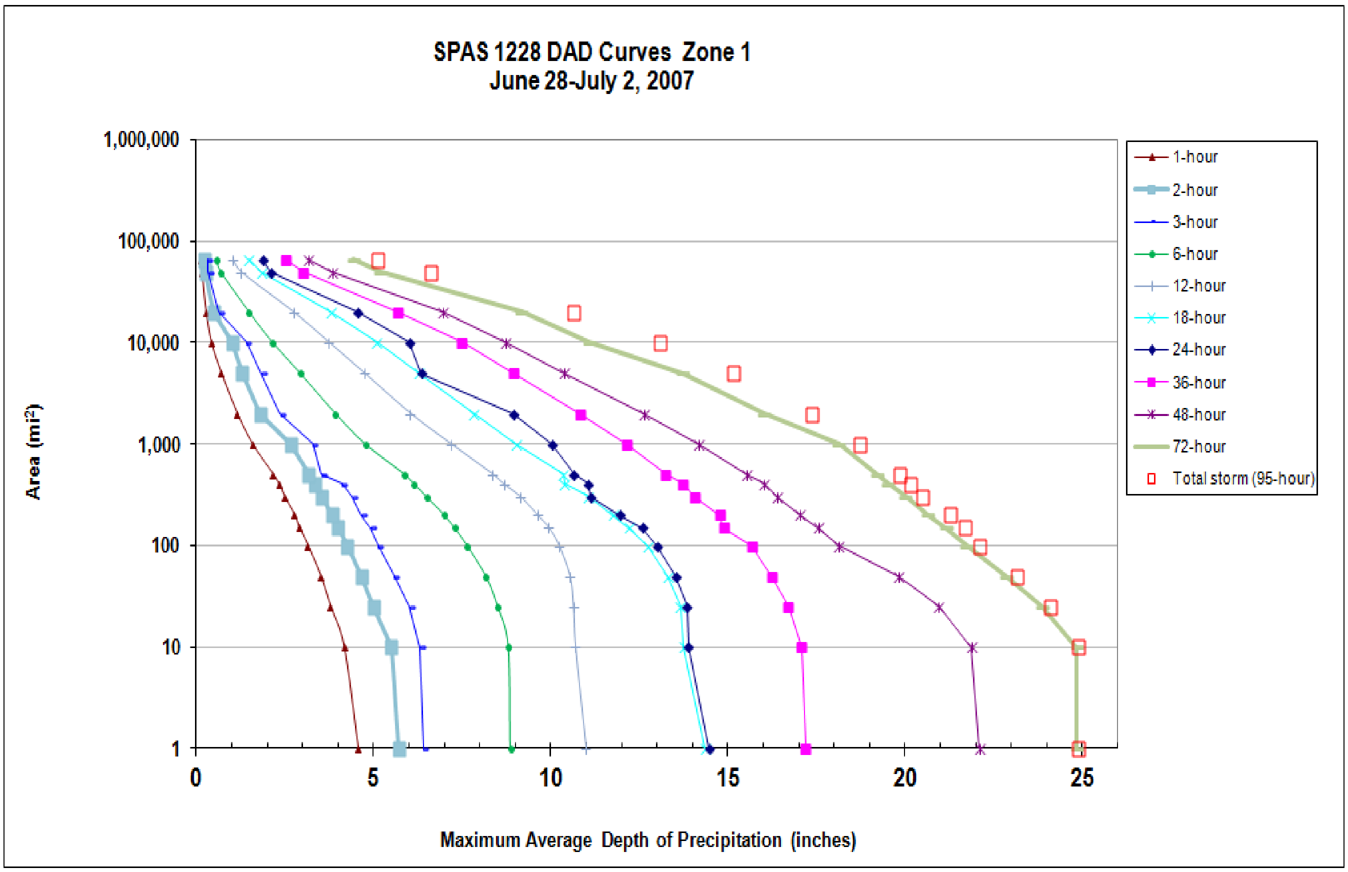
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	5.4	7.6	10.5	13.0	17.0	17.1	20.4	26.2	29.4
10 sq miles	4.9	7.5	10.4	12.7	16.3	16.4	20.2	25.9	29.4
100 sq miles	3.7	6.1	9.0	12.1	15.1	15.4	18.6	21.5	25.7
200 sq miles	3.3	5.5	8.3	11.4	13.9	14.1	17.5	20.2	24.4
500 sq miles	2.6	4.2	6.9	9.9	12.3	12.6	15.7	18.4	22.7
1000 sq miles	1.9	3.9	5.6	8.5	10.7	11.9	14.4	16.8	21.5
2000 sq miles	1.3	2.8	4.6	7.1	9.3	10.6	12.8	14.9	19.0
5000 sq miles	0.8	2.2	3.5	5.6	7.4	7.5	10.6	12.3	16.3
10000 sq miles	0.5	1.7	2.5	4.4	6.0	7.1	8.9	10.3	13.1
20000 sq miles	0.3	0.7	1.8	3.2	4.5	5.4	6.7	8.2	10.9

Storm or Storm Center Name	SPAS 1228 Fall River, KS	
Storm Date(s)	6/28/2007 - 7/2/2007	
Storm Type	Synoptic	
Storm Location	37.63 N	96.05 W
Storm Center Elevation	900	
Precipitation Total & Duration	25.50 Inches 95-hours	
Storm Representative Dew Point	76.5 F	24
Storm Representative Dew Point Location	31.00 N	95.50 W
Maximum Dew Point	80.0 F	
Moisture Inflow Vector	S @ 460	Miles
In-place Maximization Factor	1.17	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	36.10 N	92.00 W
Transposition Maximum Dew Point	80.5 F	
Transposition Adjustment Factor	1.02	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.18	

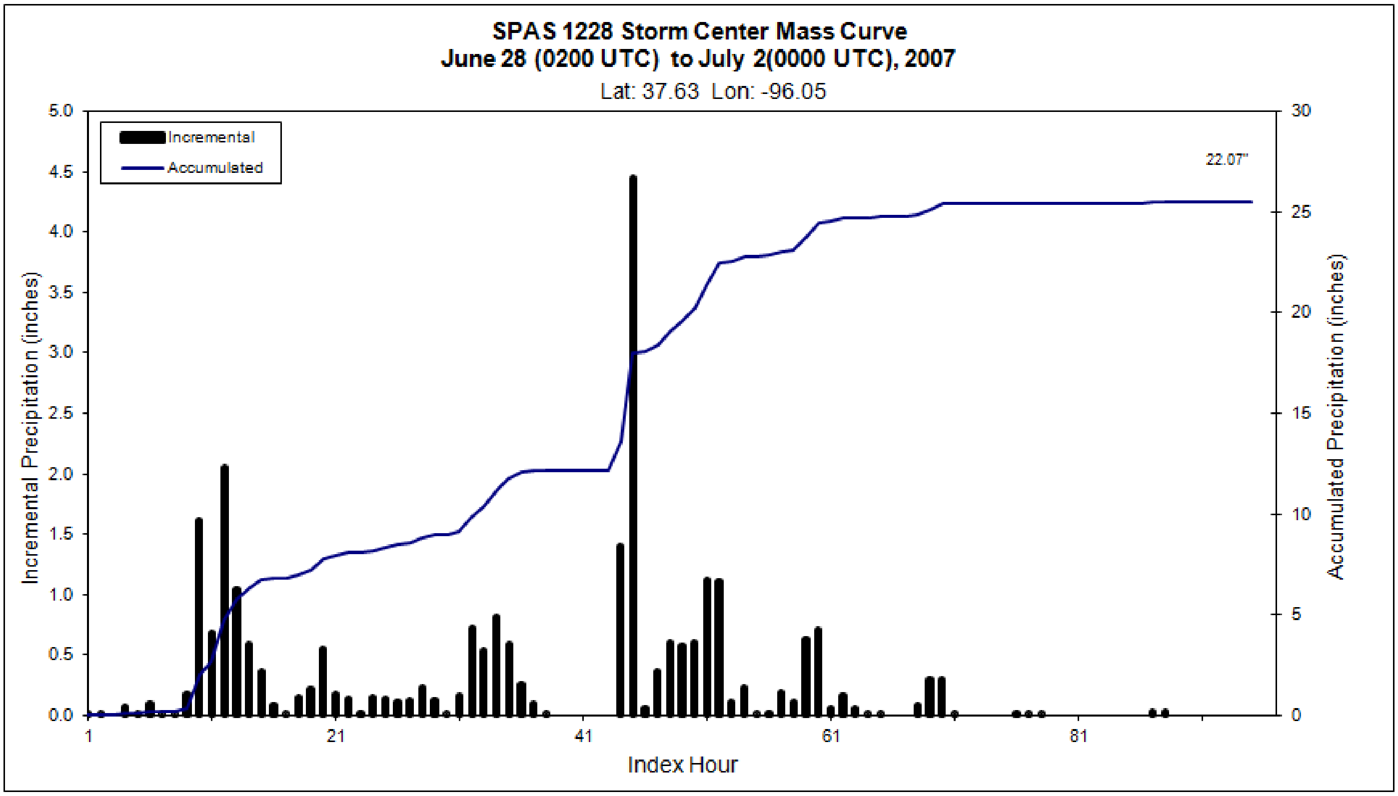
Appendix F: Table F.14: Storm spreadsheet for Fall River, KS, June 30, 2007

Storm 1228 - June 28 (0200 UTC) - July 2 (0000 UTC), 2007											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	2	3	6	12	18	24	36	48	72	Total
0.4	4.68	5.84	6.6	9.12	11.37	14.72	14.91	17.72	22.66	25.43	25.50
1	4.56	5.7	6.41	8.86	10.99	14.35	14.46	17.2	22.09	24.84	24.90
10	4.16	5.5	6.31	8.81	10.69	13.76	13.89	17.08	21.88	24.84	24.90
25	3.78	4.99	6.02	8.51	10.63	13.66	13.85	16.71	20.96	23.86	24.10
50	3.5	4.66	5.58	8.17	10.53	13.31	13.53	16.24	19.81	22.86	23.18
100	3.14	4.26	5.12	7.64	10.22	12.73	13.01	15.68	18.13	21.74	22.11
150	2.9	4	4.91	7.28	9.93	12.22	12.58	14.89	17.55	21.16	21.69
200	2.76	3.83	4.65	6.99	9.61	11.77	11.94	14.76	17.05	20.65	21.28
300	2.49	3.54	4.4	6.5	9.14	11.07	11.13	14.05	16.39	20.02	20.49
400	2.33	3.35	4.11	6.15	8.67	10.39	11.07	13.73	16.03	19.53	20.17
500	2.16	3.18	3.52	5.87	8.36	10.36	10.65	13.24	15.53	19.21	19.84
1,000	1.57	2.66	3.29	4.76	7.18	9.02	10.04	12.13	14.17	18.13	18.71
2,000	1.14	1.79	2.37	3.92	6.03	7.83	8.95	10.82	12.62	16.03	17.37
5,000	0.69	1.29	1.83	2.92	4.73	6.29	6.35	8.96	10.39	13.73	15.17
10,000	0.41	1	1.4	2.15	3.74	5.09	6.01	7.5	8.72	11.08	13.09
20,000	0.26	0.48	0.63	1.48	2.73	3.79	4.55	5.68	6.95	9.18	10.66
50,000	0.14	0.25	0.34	0.68	1.24	1.84	2.11	3.02	3.82	5.21	6.63
65,761	0.12	0.23	0.31	0.55	1.03	1.48	1.87	2.51	3.15	4.44	5.10

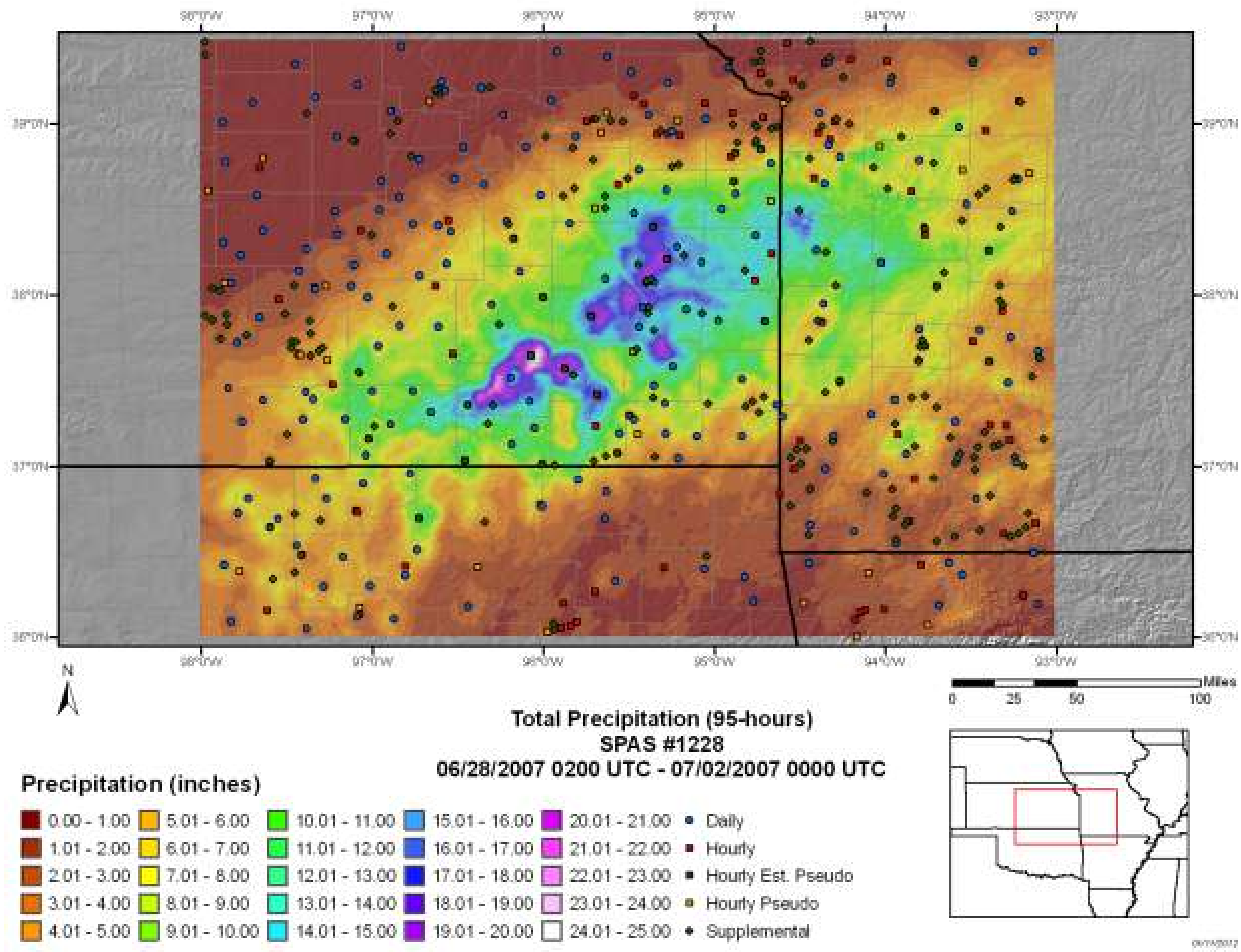
Appendix F: Table F.15: Depth-area-duration values for Fall River, KS June 30, 2007



Appendix F: Figure F.19: Depth-area-duration chart for Fall River, KS June 30, 2007



Appendix F: Figure F.20: Mass curve chart for Fall River, KS June 30, 2007



Appendix F: Figure F.21: Total storm isohyetal analysis for Fall River, KS June 30, 2007

Hokah, MN, AWA 6

August 18, 2007

Storm Type: Frontal/MCC

Grid Points Used: 8-11, 16-18

Storm Name:	**Hokah, MN-SPAS 1048**		
Storm Date:	**18-Aug-2007**		
AWA Analysis Date:	**12/13/2013**		

Storm Adjustment for ANO Grid Point 8

Temporal Transposition Date **3-Aug**

	Lat	Long
Storm Center Location	**43.81 N**	**91.52 W**
Storm Rep Dew Point Location	**38.91 N**	**93.85 W**
Transposition Dew Point Location	**37.83 N**	**94.87 W**
Grid Point Location	**37.50 N**	**93.00 W**

Moisture Inflow Direction	**SSW @ 360**	miles
Grid Point Elevation	**1,200**	feet
Storm Center Elevation	**1,000**	feet
Storm Rep Analysis Duration	**24**	hours

The storm representative dew point is	**74.0 F**	with total precipitable water above sea level of			**2.73**	inches.
The in-place maximum dew point is	**80.5 F**	with total precipitable water above sea level of			**3.68**	inches.
The transpositioned maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The in-place storm elevation is	**1,000**	which subtracts	**0.24**	inches of precipitable water at	**74.0 F**	
The in-place storm elevation is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**80.5 F**	
The transposition basin elevation at	**1,200**	which subtracts	**0.29**	inches of precipitable water at	**80.0 F**	
The Grid point /inflow barrier height is	**1,000**	which subtracts	**0.29**	inches of precipitable water at	**80.0 F**	

The in-place storm maximization factor is	**1.36**
The transposition/elevation to basin factor is	**0.98**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.33**

Notes: DAD values taken from SPAS 1048. 24hr ave Td from KIXD, KLXT, KMCI, KMKC, KOJC, KSTJ, KSZL 17th 00Z to 18th 00Z

Observed Storm Depth-Area-Duration

	1 Hour	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.12**	**7.6**	**11.6**	**14.6**	**17.1**	-	**17.6**	**18.2**	-	**18.3**
10 sq miles	**2.12**	**7.5**	**11.1**	**13.9**	**16.0**	-	**16.3**	**17.0**	-	**17.2**
100 sq miles	**2.09**	**6.3**	**9.4**	**11.5**	**13.3**	-	**13.9**	**14.8**	-	**15.1**
200 sq miles	**2.03**	**6.0**	**8.9**	**11.0**	**12.6**	-	**13.4**	**14.2**	-	**14.5**
500 sq miles	**1.79**	**5.5**	**8.1**	**10.1**	**11.6**	-	**12.3**	**13.0**	-	**13.3**
1000 sq miles	**1.53**	**5.0**	**7.3**	**9.2**	**10.5**	-	**11.1**	**11.8**	-	**12.1**
2000 sq miles	**0.95**	**4.4**	**6.2**	**8.1**	**9.3**	-	**9.9**	**10.5**	-	**10.8**
5000 sq miles	**0.87**	**3.5**	**5.2**	**6.5**	**7.6**	-	**8.2**	**8.8**	-	**9.0**
10000 sq miles	**0.63**	**2.7**	**4.0**	**5.4**	**6.1**	-	**6.8**	**7.3**	-	**7.5**
20000 sq miles	**0.41**	**1.8**	**3.0**	**4.0**	**4.5**	-	**5.1**	**5.6**	-	**5.9**

Adjusted Storm Depth-Area-Duration

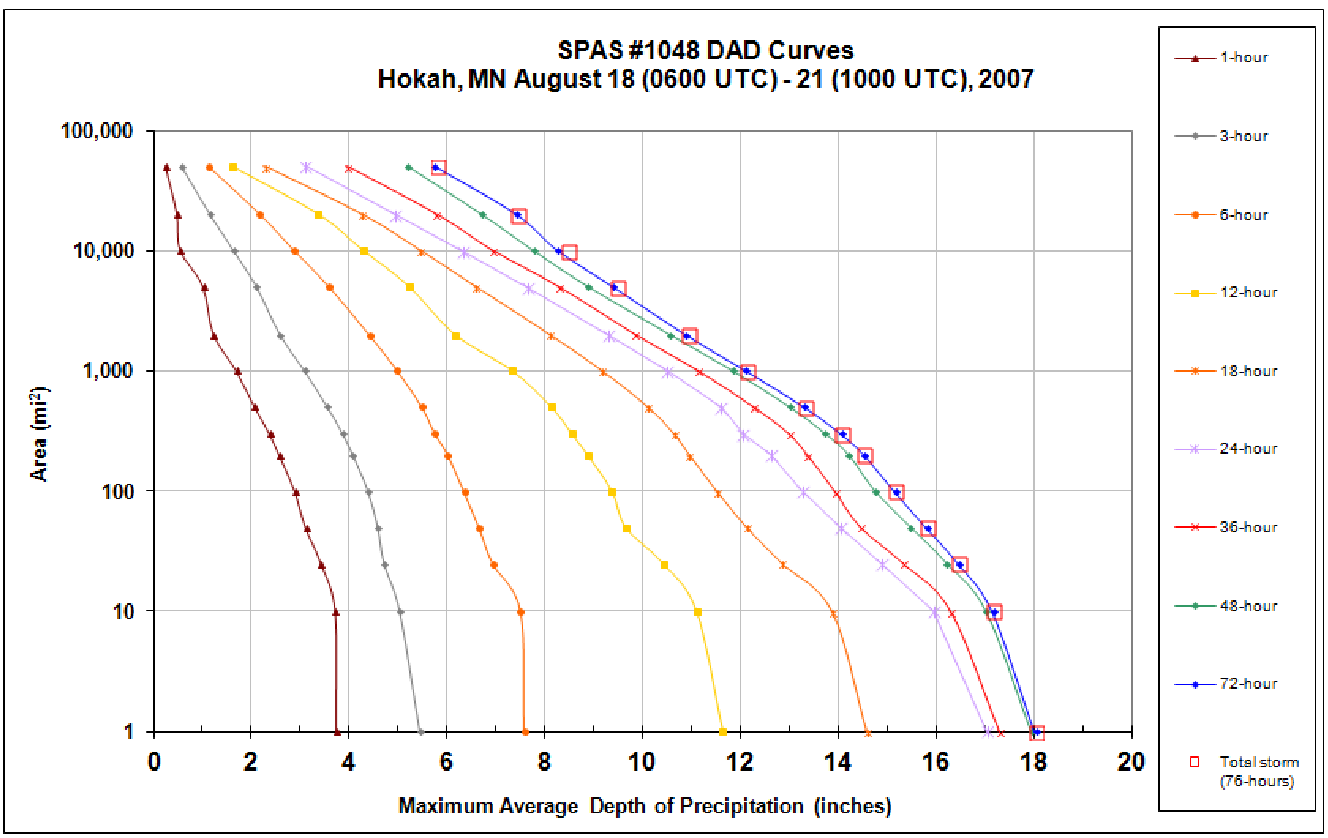
	1 Hour	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.8**	**10.0**	**15.5**	**19.4**	**22.7**	-	**23.3**	**24.2**	-	**24.3**
10 sq miles	**2.8**	**10.0**	**14.8**	**18.5**	**21.2**	-	**21.7**	**22.6**	-	**22.8**
100 sq miles	**2.8**	**8.4**	**12.5**	**15.3**	**17.6**	-	**18.5**	**19.6**	-	**20.1**
200 sq miles	**2.7**	**8.0**	**11.8**	**14.6**	**16.8**	-	**17.8**	**18.9**	-	**19.3**
500 sq miles	**2.4**	**7.3**	**10.8**	**13.4**	**15.4**	-	**16.3**	**17.3**	-	**17.7**
1000 sq miles	**2.0**	**6.6**	**9.7**	**12.2**	**14.0**	-	**14.8**	**15.7**	-	**16.0**
2000 sq miles	**1.3**	**5.8**	**8.2**	**10.8**	**12.4**	-	**13.1**	**14.0**	-	**14.3**
5000 sq miles	**1.2**	**4.6**	**6.9**	**8.7**	**10.1**	-	**10.9**	**11.7**	-	**11.9**
10000 sq miles	**0.8**	**3.6**	**5.3**	**7.2**	**8.1**	-	**9.0**	**9.7**	-	**10.0**
20000 sq miles	**0.5**	**2.4**	**4.0**	**5.3**	**6.0**	-	**6.8**	**7.5**	-	**7.8**

Storm or Storm Center Name	**Hokah, MN-SPAS 1048**			
Storm Date(s)	18-Aug-2007			
Storm Type	Synoptic/Thunderstorms			
Storm Location	43.81 N	91.52 W		
Storm Center Elevation	1,000			
Precipitation Total & Duration	18.93 Inches 72-hours-SPAS 1048			
Storm Representative Dew Point	74.0 F	24		
Storm Representative Dew Point Location	38.91 N	93.85 W		
Maximum Dew Point	80.5 F			
Moisture Inflow Vector	SSW @ 360			
In-place Maximization Factor	**1.36**			
Temporal Transposition (Date)	3-Aug			
Transposition Dew Point Location	37.83 N	94.87 W	J	A
Transposition Maximum Dew Point	80.0 F		80.5	80
Transposition Adjustment Factor	**0.98**			
Grid Point Elevation	1,200			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.33**			

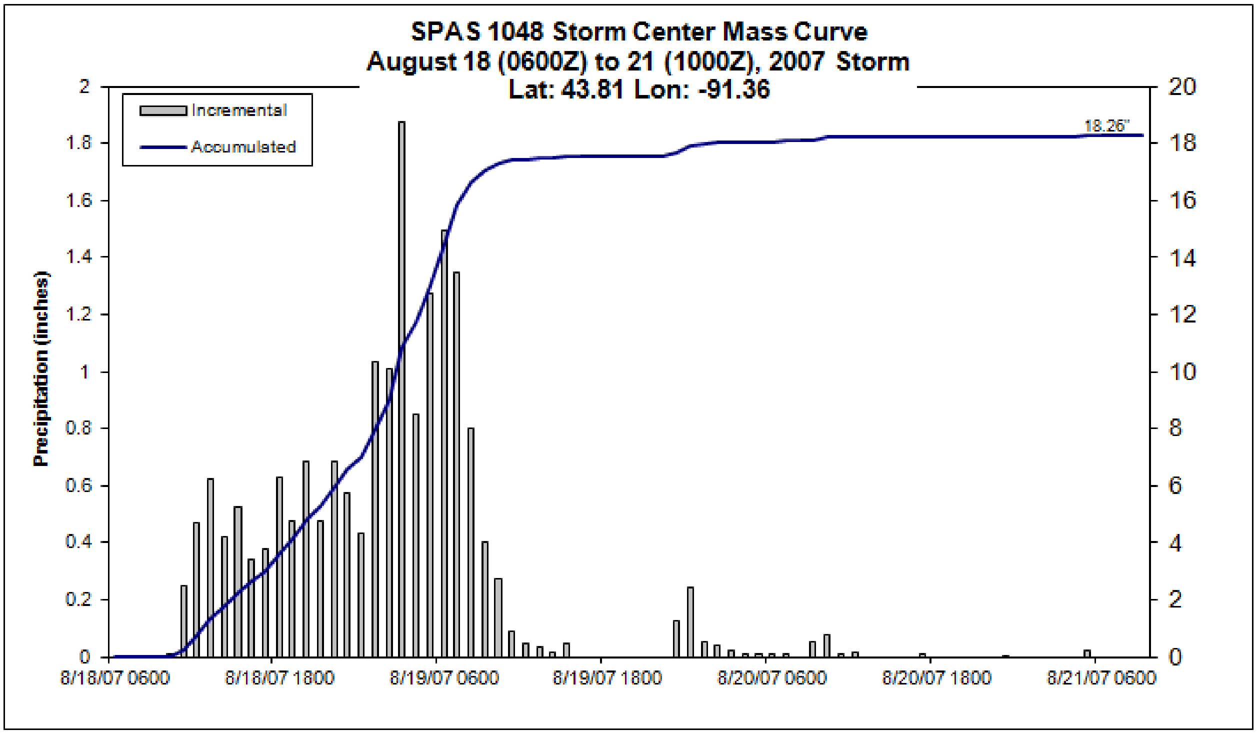
Appendix F: Table F.16: Storm spreadsheet for Hokah, MN, August 18, 2007

Storm 1048 - Hokah, MN August 18 - August 21, 2007										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi^2)	1	3	6	12	18	24	36	48	72	Total
0.24	4.02	5.71	7.85	11.89	14.88	17.31	17.55	18.19	18.26	18.26
1	3.72	5.43	7.56	11.64	14.59	17.05	17.31	17.95	18.02	18.02
10	3.70	5.02	7.49	11.10	13.88	15.96	16.31	17.03	17.15	17.17
25	3.41	4.70	6.92	10.42	12.86	14.89	15.34	16.23	16.45	16.46
50	3.09	4.57	6.64	9.65	12.13	14.05	14.46	15.49	15.79	15.79
100	2.87	4.37	6.33	9.37	11.52	13.27	13.93	14.76	15.14	15.14
200	2.55	4.06	6.00	8.87	10.96	12.62	13.37	14.22	14.52	14.52
300	2.35	3.85	5.74	8.55	10.64	12.06	12.99	13.74	14.04	14.04
500	2.05	3.54	5.47	8.13	10.11	11.60	12.27	13.01	13.29	13.30
1,000	1.67	3.07	4.97	7.33	9.17	10.51	11.13	11.84	12.09	12.12
2,000	1.21	2.57	4.39	6.16	8.10	9.30	9.85	10.56	10.86	10.92
5,000	0.99	2.09	3.57	5.23	6.59	7.65	8.28	8.89	9.37	9.47
10,000	0.53	1.62	2.86	4.29	5.46	6.33	6.93	7.77	8.24	8.45
20,000	0.46	1.14	2.16	3.37	4.26	4.95	5.78	6.71	7.39	7.43
50,000	0.23	0.56	1.11	1.61	2.28	3.11	3.95	5.20	5.72	5.80

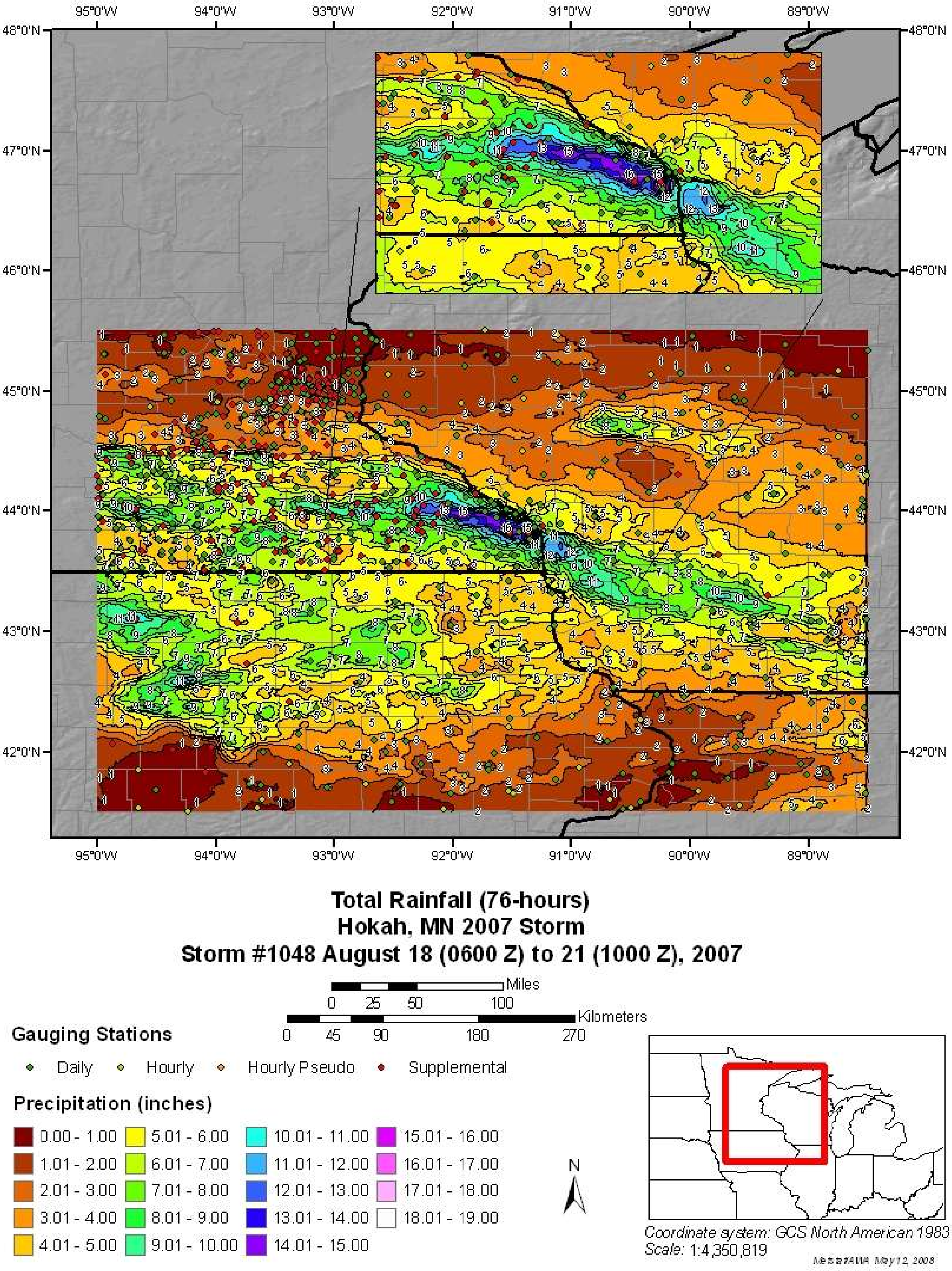
Appendix F: Table F.17: Depth-area-duration values for Hokah, MN, June 2007



Appendix F: Figure F.22: Depth-area-duration chart for Hokah, MN, June 2007



Appendix F: Figure F.23: Mass curve chart for Hokah, MN, June 2007



Appendix F: Figure F.24: Total storm isohyetal analysis for Hokah, MN, June 2007

Ogallala, NE, AWA 7

July 6, 2002

Storm Type: MCC

Grid Points Used: 5, 12, 19-20

Storm Name:	Ogallala, NE		
Storm Date:	06-Jul-2002		
AWA Analysis Date:	12/13/2013		

Storm Adjustment for ANO Grid Point 5

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm center location	41.03 N	101.78 W
Storm Rep dew point location	39.34 N	101.97 W
Transposition dewpoint location	40.56 N	101.00 W
Grid Point location	35.00 N	102.00 W

Moisture Inflow Direction:	S @ 125	miles
Grid Point Elevation	3,700	feet
Storm Center Elevation	3,428	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	74.5 F	with total precipitable water above sea level of			2.79	inches.
The in-place maximum dew point is	81.5 F	with total precipitable water above sea level of			3.84	inches.
The transpositioned maximum dew point is	82.0 F	with total precipitable water above sea level of			3.92	inches.
The in-place storm elevation is	3,428	which subtracts	0.775	inches of precipitable water at	74.5 F	
The in-place storm elevation is	3,428	which subtracts	0.99	inches of precipitable water at	81.5 F	
The transposition basin elevation at	3,700	which subtracts	0.9	inches of precipitable water at	82.0 F	
The Grid point/inflow barrier height is	3,117	which subtracts	0.9	inches of precipitable water at	82.0 F	

The in-place storm maximization factor is	1.41
The transposition/elevation to basin factor is	1.06
The barrier adjustment factor is	1.00
The total adjustment factor is	1.50

Notes: 6hr average, Td taken from KGDC and KIRT from 07-06-2002 04Z local to 07-06-2002 11Z, DAD values taken from SPAS 1033

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	12.5	14.4	14.4	14.5	0.0	0.0	0.0	0.0	0.0
100 sq miles	10.1	11.7	11.7	11.8	0.0	0.0	0.0	0.0	0.0
200 sq miles	8.8	10.2	10.3	10.5	0.0	0.0	0.0	0.0	0.0
500 sq miles	6.7	8.1	8.3	8.5	0.0	0.0	0.0	0.0	0.0
1000 sq miles	5.1	6.2	6.6	6.8	0.0	0.0	0.0	0.0	0.0
5000 sq miles	2.0	2.7	3.1	3.2	0.0	0.0	0.0	0.0	0.0
10000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Adjusted Storm Depth-Area-Duration

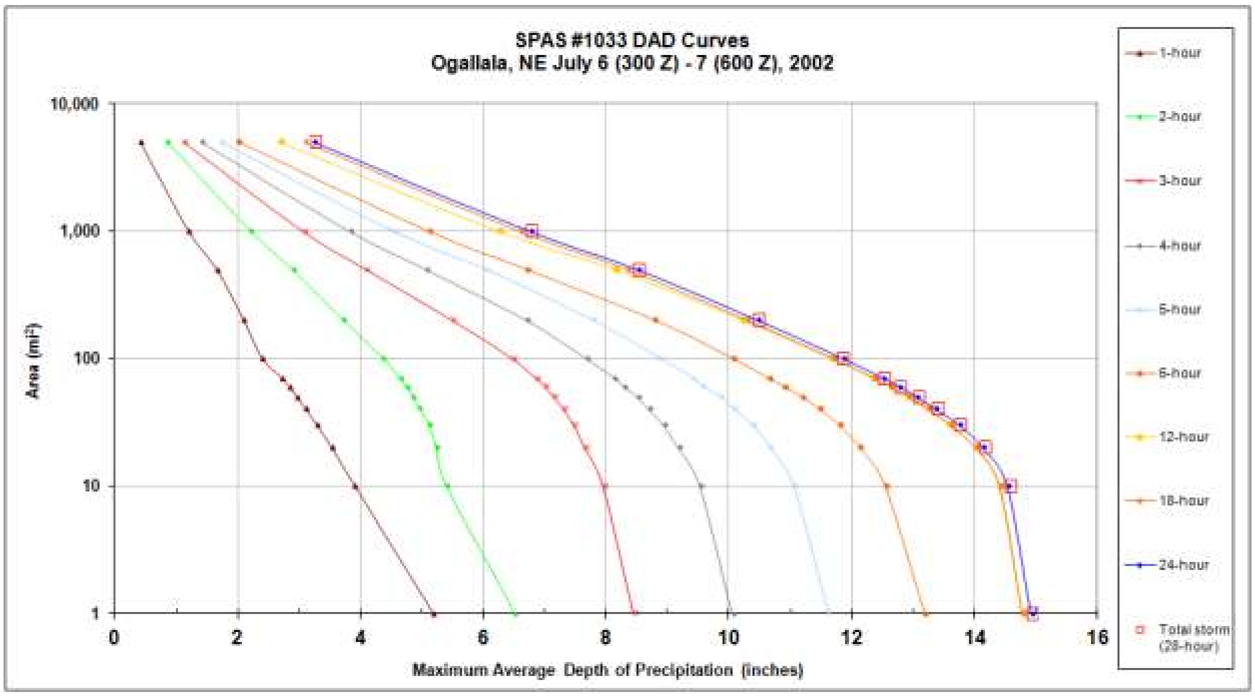
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	18.8	21.6	21.6	21.8	0.0	0.0	0.0	0.0	0.0
100 sq miles	15.1	17.5	17.5	17.7	0.0	0.0	0.0	0.0	0.0
200 sq miles	13.2	15.3	15.4	15.7	0.0	0.0	0.0	0.0	0.0
500 sq miles	10.0	12.2	12.5	12.7	0.0	0.0	0.0	0.0	0.0
1000 sq miles	7.7	9.4	9.9	10.1	0.0	0.0	0.0	0.0	0.0
5000 sq miles	3.0	4.0	4.6	4.8	0.0	0.0	0.0	0.0	0.0
10000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Storm or Storm Center Name	Ogallala, NE	
Storm Date(s)	6-Jul-2002	
Storm Type	Synoptic-Thunderstorms	
Storm Location	41.03 N	101.78 W
Storm Center Elevation	3,428	
Precipitation Total & Duration	14.92 in 24hrs from SPAS 1033	
Storm Representative Dewpoint	74.5 F	6
Storm Representative Dewpoint Location	39.34 N	101.97 W
Maximum Dewpoint	81.5 F	
Moisture Inflow Vector	S @ 125	
In-place Maximization Factor	1.41	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	40.56 N	101.00 W
Transposition Maximum Dewpoint	82.0 F	
Grid Point Elevation	3,700	
Highest Elevation in Basin	14,344	
Transposition to Basin Adjustment Factor	1.06	
Higher of Basin Elevation - Inflow Barrier Height	3,117	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.50	

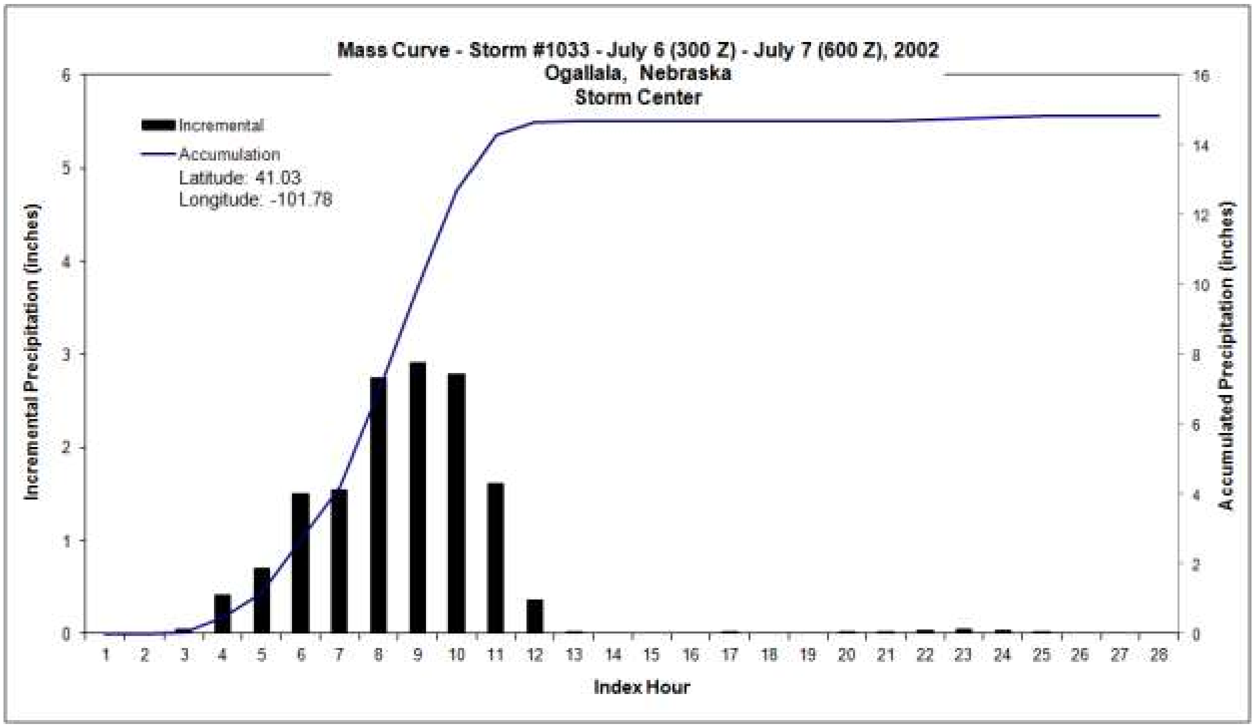
Appendix F: Table F.18: Storm spreadsheet for Ogallala, NE, July 6, 2002

Storm 1033 - Ogallala, NE July 6 (300 Z) - July 7 (600 Z), 2002											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	2	3	4	5	6	12	18	24	28	total
1	5.18	6.51	8.45	10.06	11.61	13.19	14.77	14.78	14.92	14.92	14.92
10	3.90	5.40	7.95	9.53	11.04	12.54	14.39	14.41	14.53	14.57	14.57
20	3.52	5.23	7.65	9.17	10.66	12.12	14.00	14.01	14.12	14.16	14.16
30	3.28	5.12	7.47	8.93	10.38	11.79	13.57	13.60	13.74	13.74	13.74
40	3.10	4.96	7.30	8.69	10.08	11.47	13.22	13.25	13.36	13.39	13.39
50	2.95	4.86	7.14	8.50	9.85	11.18	12.90	12.93	13.05	13.08	13.08
60	2.83	4.75	7.00	8.29	9.57	10.90	12.61	12.63	12.77	12.78	12.78
70	2.71	4.64	6.85	8.13	9.41	10.65	12.34	12.36	12.50	12.51	12.51
100	2.39	4.37	6.46	7.67	8.88	10.06	11.66	11.69	11.84	11.84	11.84
200	2.09	3.72	5.49	6.69	7.78	8.79	10.22	10.30	10.46	10.46	10.46
500	1.65	2.89	4.09	5.07	6.04	6.70	8.14	8.34	8.50	8.51	8.51
1,000	1.19	2.21	3.06	3.82	4.54	5.11	6.24	6.59	6.75	6.76	6.76
5,000	0.41	0.84	1.11	1.40	1.72	2.00	2.68	3.09	3.23	3.25	3.25

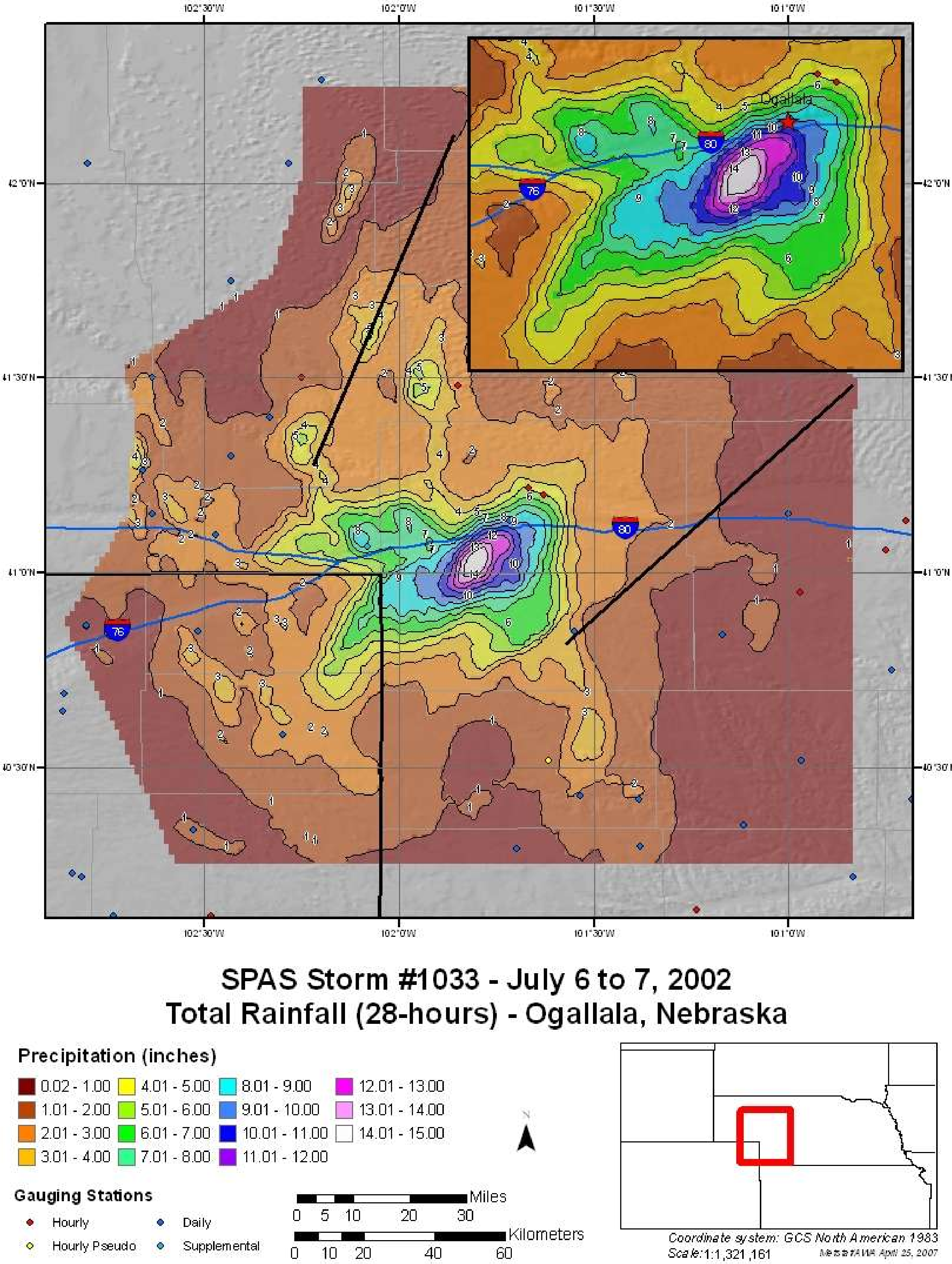
Appendix F: Table F.19: Depth-area-duration values for Ogallala, NE, July 6, 2002



Appendix F: Figure F.25: Depth-area-duration chart for Ogallala, NE, July 6, 2002



Appendix F: Figure F.26: Mass curve chart for Ogallala, NE, July 6, 2002



Appendix F: Figure F.27: Total storm isohyetal analysis for Ogallala, NE, July 6, 2002

Fort Collins, CO, AWA 8

July 28, 1997

Storm Type: MCC

Grid Points Used: 6, 13, 15, 21

Storm Name:	**SPAS 1230 Fort Collins, CO**	**Storm Adjustment for ANO Grid Point 6**
Storm Date:	**7/27-28/1997**	
AWA Analysis Date:	**3/9/2012**	

Temporal Transposition Date **15-Jul**

	Lat	Long
Storm center location	**40.55 N**	**105.13W**
Storm Rep dew point location	**40.00 N**	**103.35 W**
Transposition dewpoint location	**38.16 N**	**87.45 W**
Grid Point location	**34.50 N**	**104.00 W**

Moisture Inflow Direction:	**ESE @ 100**	miles
Grid Point Elevation	**4,400**	feet
Storm Center Elevation	**5,150**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**76.5 F**	with total precipitable water above sea level of			**3.07**	inches.
The in-place maximum dew point is	**79.0 F**	with total precipitable water above sea level of			**3.44**	inches.
The transpositioned maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The in-place storm elevation is	**5,150**	which subtracts	**1.17**	inches of precipitable water at	**76.5 F**	
The in-place storm elevation is	**5,150**	which subtracts	**1.27**	inches of precipitable water at	**79.0 F**	
The transposition basin elevation at	**4,400**	which subtracts	**x.xx**	inches of precipitable water at	**80.0 F**	
The Grid point/inflow barrier height is	**xx**	which subtracts	**x.xx**	inches of precipitable water at	**80.0 F**	

The in-place storm maximization factor is	**1.14**
The transposition/elevation to basin factor is	**#VALUE!**
The barrier adjustment factor is	**#VALUE!**
The total adjustment factor is	**#VALUE!**

Notes: DAD values taken from SPAS 1230. Storm representative dew point value was based on maximum 12-hr Td values July 28 at KAKO and KLIC.

Observed Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	18 Hours	24 Hours	31 Hours	36 Hours	56 Hours
1 sq mile	4.2	5.8	7.6	8.4	9.2	9.3	9.3	11.2	12.3	12.7	12.7	12.8
10 sq mile	3.4	4.9	6.3	6.9	7.5	7.6	7.7	9.5	10.9	12.2	12.2	12.2
50 sq mile	2.2	3.3	4.3	4.7	5.0	5.1	5.4	7.5	9.0	10.2	10.2	10.4
100 sq miles	1.7	2.5	3.2	3.7	3.9	3.9	4.3	6.1	7.4	8.7	8.7	8.8
200 sq miles	0.8	1.8	2.4	2.7	2.8	2.9	3.1	4.6	5.7	6.7	6.7	6.9
500 sq miles	0.5	0.8	1.1	1.2	1.3	1.4	1.7	2.2	3.0	3.7	4.2	4.2
627 sq miles	0.4	0.7	1.0	1.1	1.3	1.3	1.4	2.1	2.8	3.5	3.5	3.5

Adjusted Storm Depth-Area-Duration

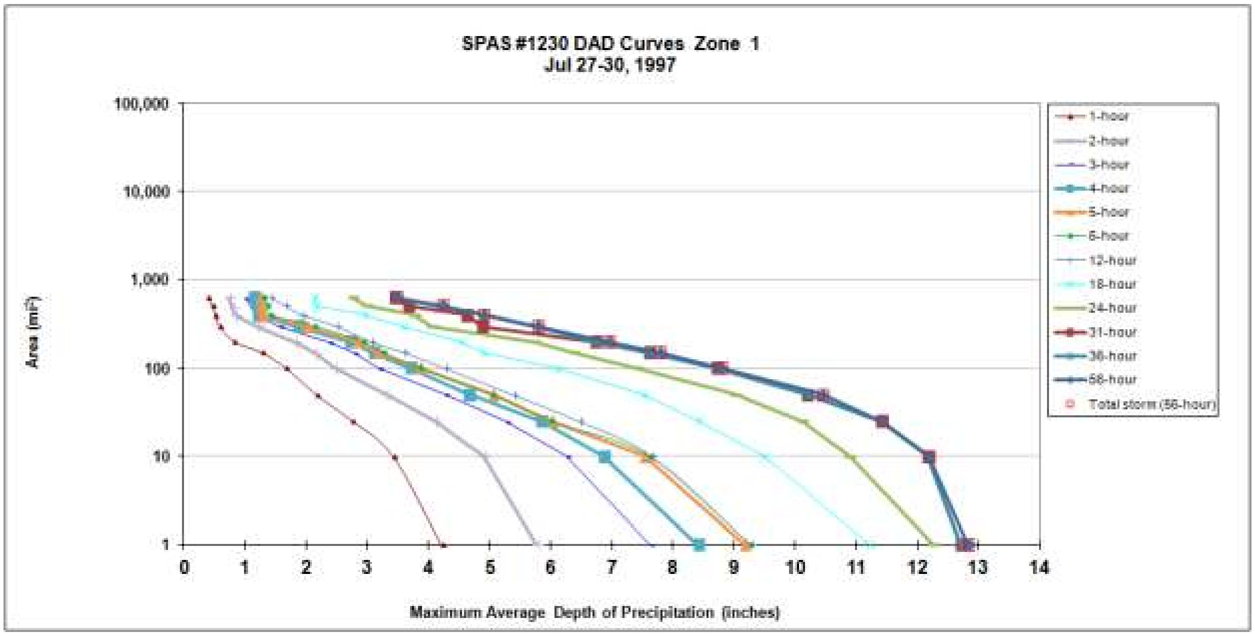
	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	18 Hours	24 Hours	31 Hours	36 Hours	56 Hours
10 sq mile	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
50 sq mile	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
100 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
200 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
500 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
627 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Storm or Storm Center Name	**SPAS 1230 Fort Collins, CO**			
Storm Date(s)	7/27-28/1997			
Storm Type	Convective			
Storm Location	40.55 N	105.13W		
Storm Center Elevation	5,150			
Precipitation Total & Duration	14.48 inches in 56 Hours			
Storm Representative Dewpoint	76.5 F	12		
Storm Representative Dewpoint Location	40.00 N	103.35 W	July	Aug
Maximum Dewpoint	79.0 F		78.78	78.6
Moisture Inflow Vector	ESE @ 100			
In-place Maximization Factor	**1.14**			
Temporal Transposition (Date)	15-Jul			
Transposition Dewpoint Location	**38.16 N**	**87.45 W**	July	Aug
Transposition Maximum Dewpoint	**80.0 F**			
Transposition Adjustment Factor	**#VALUE!**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**#VALUE!**			
Total Adjustment Factor	**#VALUE!**			

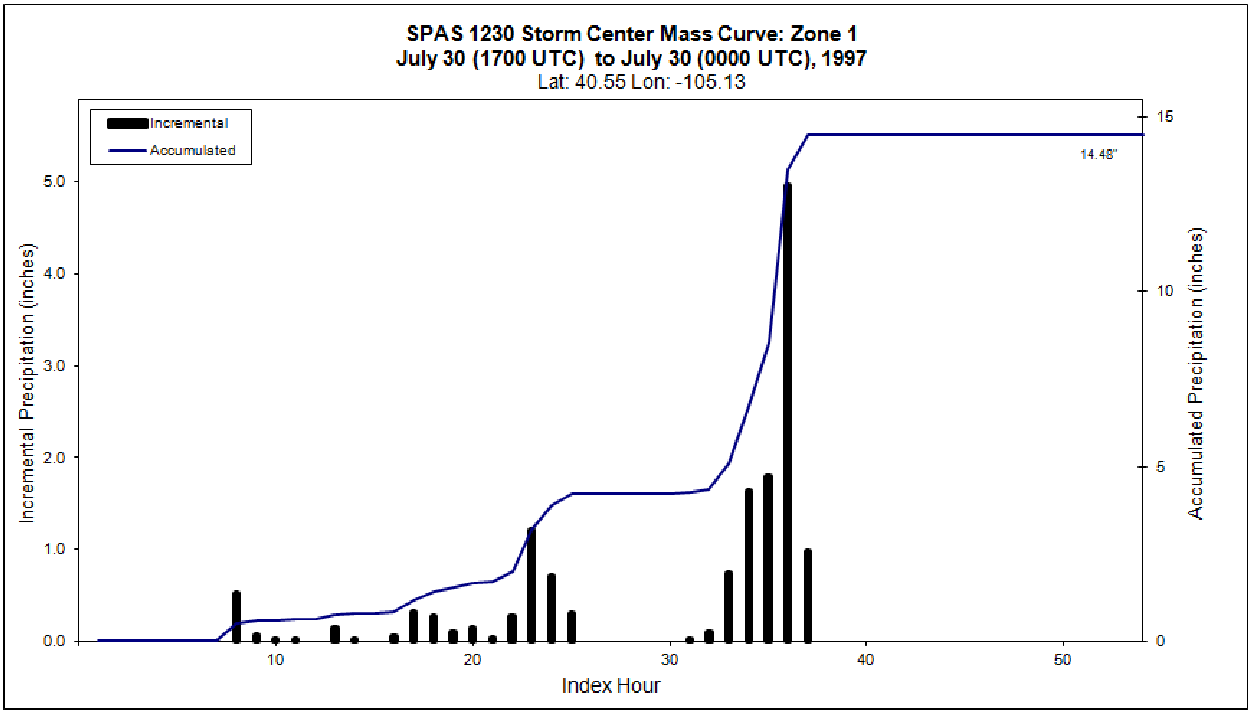
Appendix F: Table F.20: Storm spreadsheet for Fort Collins, CO, July 28, 1997

Storm 1230 - July 27 (1700 UTC) - July 30 (0000 UTC), 1997 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)													
	Duration (hours)												
Area (mi^2)	1	2	3	4	5	6	12	18	24	31	36	56	Total
0.1	4.96	6.76	8.4	9.38	10.13	10.24	10.26	12.95	13.72	14.48	14.48	14.48	14.48
1	4.22	5.76	7.63	8.41	9.17	9.28	9.28	11.21	12.26	12.71	12.71	12.83	12.83
10	3.43	4.9	6.25	6.86	7.53	7.63	7.65	9.49	10.89	12.17	12.17	12.18	12.18
25	2.76	4.11	5.26	5.84	6.01	6.01	6.46	8.43	10.1	11.4	11.4	11.4	11.40
50	2.17	3.31	4.28	4.66	5.04	5.05	5.38	7.51	9.03	10.19	10.19	10.43	10.43
100	1.67	2.48	3.19	3.7	3.86	3.87	4.27	6.09	7.39	8.71	8.71	8.79	8.79
150	1.28	2.14	2.78	3.1	3.18	3.26	3.61	4.89	6.37	7.61	7.61	7.78	7.78
200	0.82	1.81	2.38	2.72	2.84	2.93	3.06	4.55	5.73	6.74	6.74	6.94	6.94
300	0.58	1.2	1.56	1.86	2.01	2.15	2.49	3.59	4.06	4.88	5.74	5.78	5.78
400	0.51	0.83	1.17	1.2	1.27	1.42	1.93	2.95	3.76	4.62	4.88	4.88	4.88
500	0.46	0.79	1.09	1.18	1.26	1.37	1.67	2.17	3	3.68	4.18	4.22	4.22
627	0.39	0.73	1	1.14	1.26	1.31	1.42	2.14	2.77	3.45	3.45	3.48	3.48

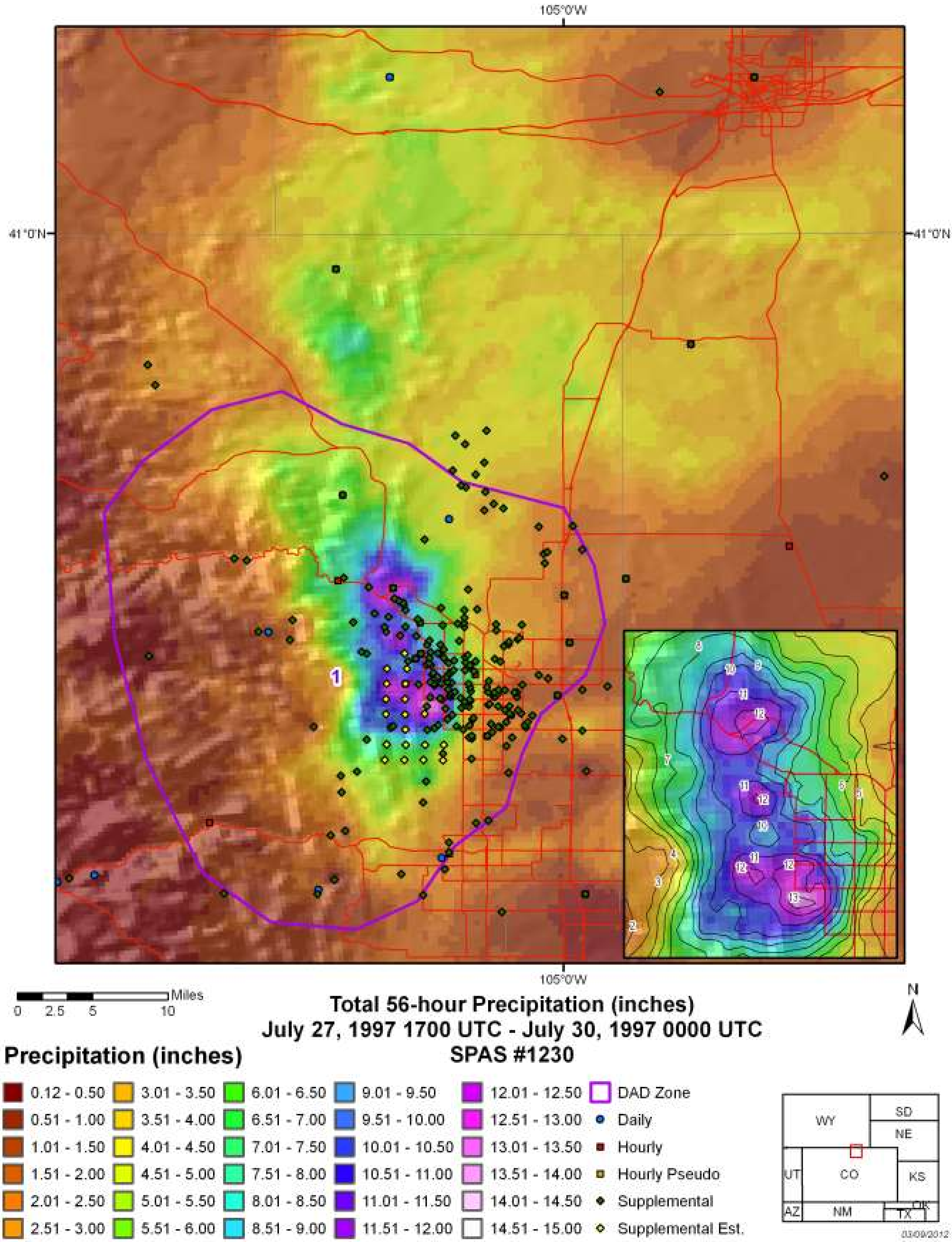
Appendix F: Table F.21: Depth-area-duration values for Fort Collins, CO, July 28, 1997



Appendix F: Figure F.28: Depth-area-duration chart for Fort Collins, CO, July 28, 1997



Appendix F: Figure F.29: Mass curve chart for Fort Collins, CO, July 28, 1997



Appendix F: Figure F.30: Total storm isohyetal analysis for Fort Collins, CO, July 28, 1997

Pawnee Creek, CO, AWA 9

July 29, 1997

Storm Type: MCC

Grid Points Used: 5-6, 12, 15, 19-20

Storm Name:	Pawnee Creek, CO	**Storm Adjustment for ANO Grid Point 5**
Storm Date:	28-Jul-1997	
AWA Analysis Date:	12/17/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm center location	40.78 N	103.63 W
Storm Rep dew point location	39.20 N	100.15 W
Transposition dewpoint location	41.43 N	98.96 W
Grid Point location	35.00 N	102.00 W

Moisture Inflow Direction:	SE @ 215 M	miles
Grid Point Elevation	3,700	feet
Storm Center Elevation	4,500	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	75.5 F	with total precipitable water above sea level of			2.92	inches.
The in-place maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The transpositioned maximum dew point is	82.5	with total precipitable water above sea level of			3.84	inches.
The in-place storm elevation is	4,500	which subtracts	1.02	inches of precipitable water at	75.5 F	
The in-place storm elevation is	4,500	which subtracts	1.22	inches of precipitable water at	81.0 F	
The transposition basin elevation at	3,700	which subtracts	1.215	inches of precipitable water at	82.5	
The Grid point/inflow barrier height is	4,432	which subtracts	1.215	inches of precipitable water at	82.5	

The in-place storm maximization factor is	1.34
The transposition/elevation to basin factor is	1.03
The barrier adjustment factor is	1.00
The total adjustment factor is	1.38

Notes: DAD values taken from SPAS 1036. Storm Rep Td Ave of KHLC 19Z/28th-01Z/29th, KHYS 21Z/28th-02Z/29th, KGLD 00Z-05Z/29th,original storm

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	12.3	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100 sq miles	9.5	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200 sq miles	8.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
500 sq miles	6.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000 sq miles	4.7	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5000 sq miles	1.7	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	16.9	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100 sq miles	13.2	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200 sq miles	11.1	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
500 sq miles	8.3	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000 sq miles	6.5	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5000 sq miles	2.3	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Storm or Storm Center Name	Pawnee Creek, CO	
Storm Date(s)	28-Jul-1997	
Storm Type	MCC-Thunderstorms	
Storm Location	40.78 N	103.63 W
Storm Center Elevation	4,500	
Precipitation Total & Duration	13.58" from SPAS 1037, 13.7 Inches 12-hours Colorado Climate Center report,	
Storm Representative Dewpoint	75.5 F	6
Storm Representative Dewpoint Location	39.20 N	100.15 W
Maximum Dewpoint	81.0 F	
Moisture Inflow Vector	SE @ 215 Miles	
In-place Maximization Factor	1.34	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	41.43 N	98.96 W
Transposition Maximum Dewpoint	82.5	
Grid Point Elevation	3,700	
Highest Elevation in Basin	14,344	
Transposition to Basin Adjustment Factor	1.03	
Higher of Basin Elevation - Inflow Barrier Height	4,432	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.38	

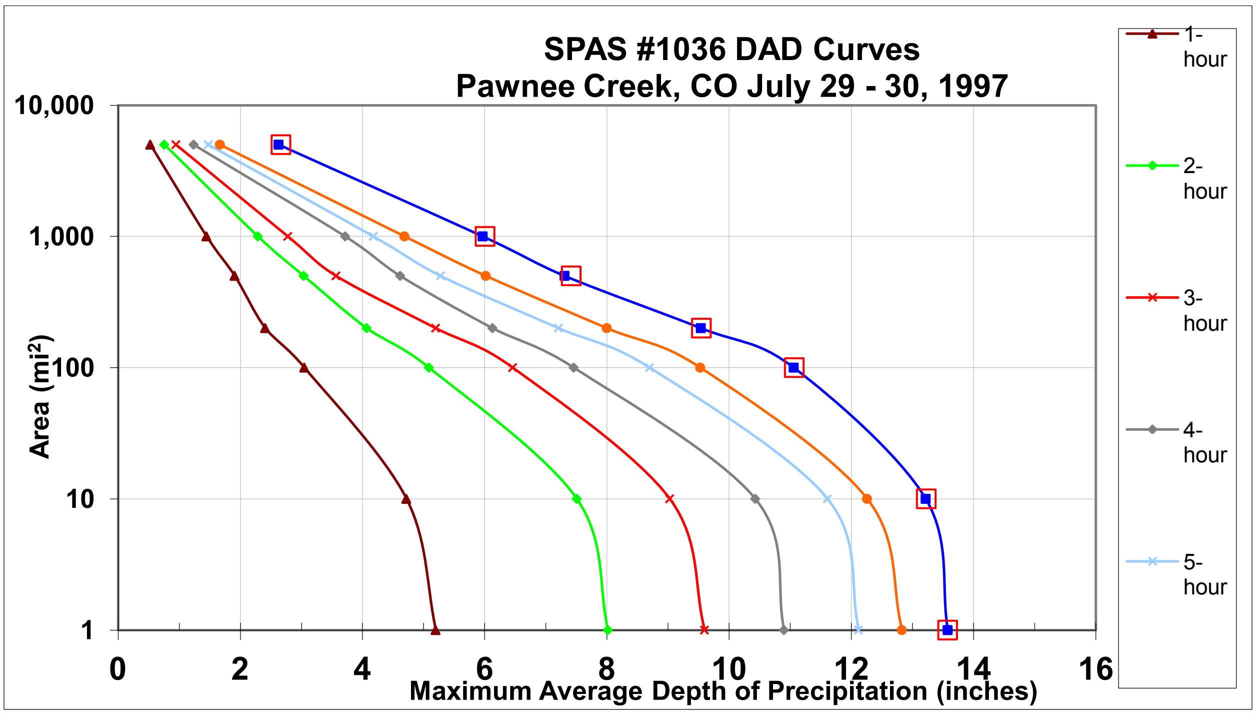
Appendix F: Table F.22: Storm spreadsheet for Pawnee Creek, CO, July 29, 1997

Storm 1036 - Pawnee Creek, CO July 29 - 30, 1997

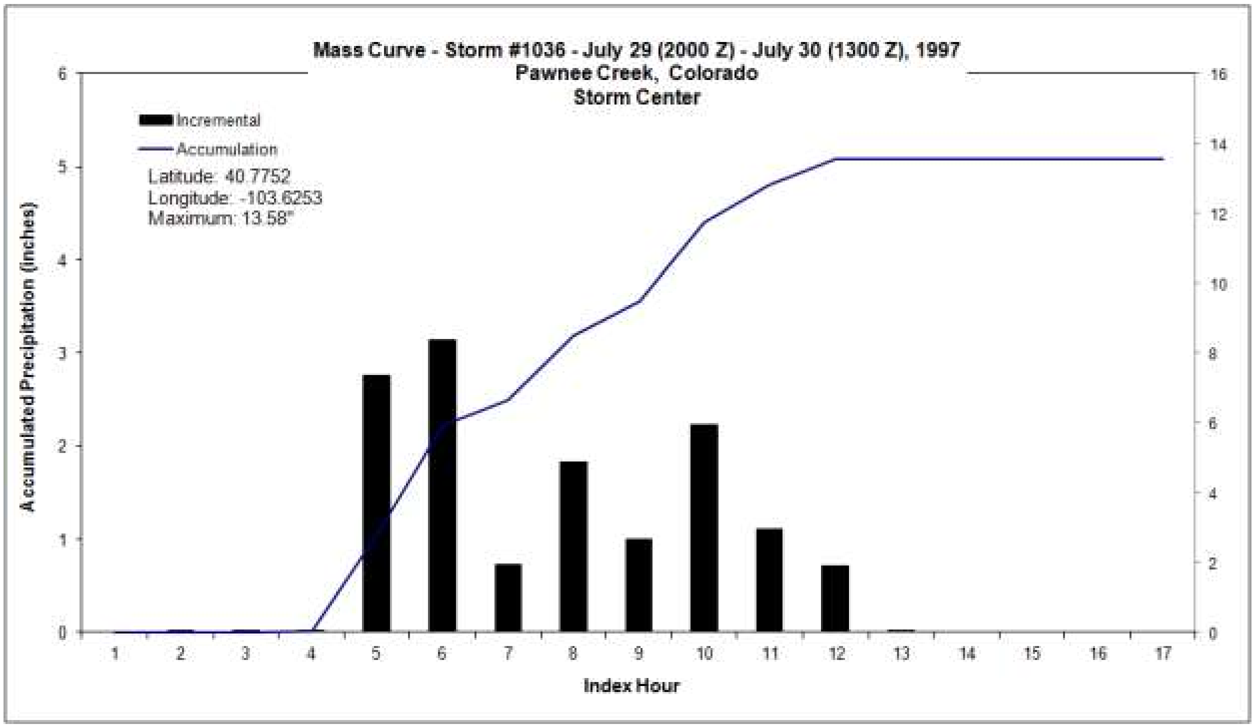
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)								
Area (mi^2)	1	2	3	4	5	6	12	17	total
1	5.20	8.02	9.60	10.90	12.12	12.83	13.58	13.58	13.58
10	4.72	7.51	9.03	10.43	11.61	12.26	13.22	13.23	13.23
100	3.05	5.09	6.46	7.46	8.70	9.53	11.06	11.07	11.07
200	2.41	4.07	5.20	6.13	7.21	8.00	9.54	9.55	9.55
500	1.91	3.04	3.57	4.62	5.28	6.02	7.31	7.42	7.42
1,000	1.45	2.29	2.78	3.72	4.18	4.69	5.97	6.01	6.01
5,000	0.53	0.76	0.95	1.24	1.48	1.67	2.63	2.67	2.67

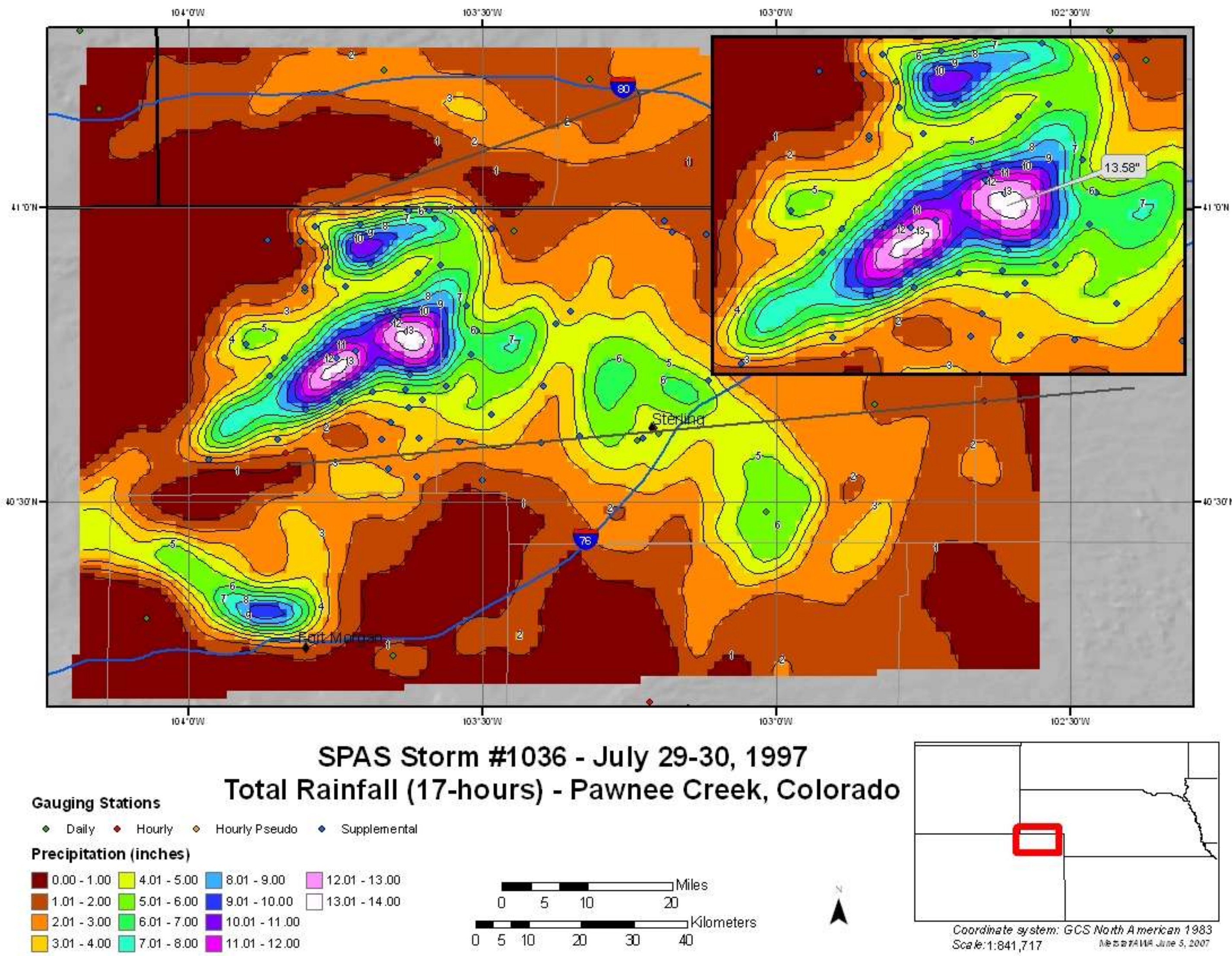
Appendix F: Table F.23: Depth-area-duration values for Pawnee Creek, CO, July 29, 1997



Appendix F: Figure F.31: Depth-area-duration chart for Pawnee Creek, CO, July 29, 1997



Appendix F: Figure F.32: Mass curve chart for Pawnee Creek, CO, July 29, 1997



Appendix F: Figure F.33: Total storm isohyetal analysis for Pawnee Creek, CO, July 29, 1997

Aurora College, IL, AWA 10

July 16, 1996

Storm Type: Frontal/MCC

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	**SPAS 1029-Aurora College, IL**	
Storm Date:	**17-Jul-1996**	**Storm Adjustment for ANO Grid Point 1**
AWA Analysis Date:	**12/13/2013**	

Temporal Transposition Date	**15-Jul**	
	Lat	**Long**
Storm Center Location	**41.46 N**	**88.07 W**
Storm Rep Dew Point Location	**38.63 N**	**92.24 W**
Transposition Dew Point Location	**39.61 N**	**96.54 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**SW @ 300**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**650**	feet
Storm Rep Analysis Duration	**24**	hours

The storm representative dew point is	**74.0 F**	with total precipitable water above sea level of			**2.73**	inches.
The in-place maximum dew point is	**80.5 F**	with total precipitable water above sea level of			**3.68**	inches.
The transpositioned maximum dew point is	**80.5 F**	with total precipitable water above sea level of			**3.68**	inches.
The in-place storm elevation is	**650**	which subtracts	**0.16**	inches of precipitable water at	**74.0 F**	
The in-place storm elevation is	**650**	which subtracts	**0.20**	inches of precipitable water at	**80.5 F**	
The transposition basin elevation at	**350**	which subtracts	**0.30**	inches of precipitable water at	**80.5 F**	
The Grid Point/Inflow Barrier height is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**80.5 F**	

The in-place storm maximization factor is	**1.35**
The transposition/elevation to basin factor is	**0.97**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.32**

Notes: DAD values taken from SPAS 1029. 24hr average Td from 07-17-96 0000 CDT to 07-17-96 2300 CDT.

Observed Storm Depth-Area-Duration

	1 Hour	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**6.1**	**14.4**	**15.4**	**17.3**	**17.6**	-	**17.6**	-	-	-
10 sq miles	**5.9**	**14.0**	**15.1**	**17.2**	**17.2**	-	**17.5**	-	-	-
100 sq miles	**4.3**	**12.1**	**13.4**	**15.6**	**16.0**	-	**16.1**	-	-	-
200 sq miles	**3.6**	**10.4**	**12.5**	**14.6**	**15.1**	-	**15.1**	-	-	-
500 sq miles	**3.1**	**9.0**	**10.9**	**12.8**	**13.1**	-	**13.4**	-	-	-
1000 sq miles	**2.5**	**7.9**	**9.7**	**11.0**	**11.2**	-	**12.1**	-	-	-
5000 sq miles	**1.6**	**4.8**	**6.2**	**7.8**	**8.1**	-	**8.4**	-	-	-
10000 sq miles	**0.7**	**3.5**	**5.0**	**6.1**	**6.6**	-	**7.0**	-	-	-
20000 sq miles	**0.4**	**1.6**	**3.6**	**4.6**	**5.2**	-	**5.4**	-	-	-

Adjusted Storm Depth-Area-Duration

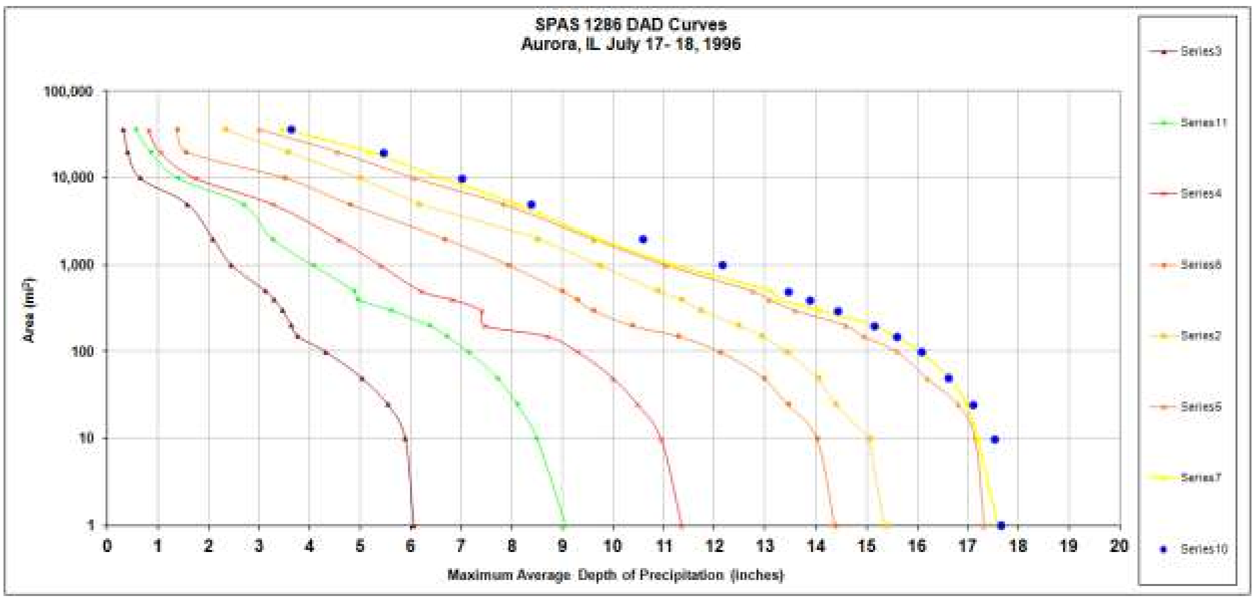
	1 Hour	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**8.0**	**18.9**	**20.2**	**22.8**	**23.1**	-	**23.2**	-	-	-
10 sq miles	**7.7**	**18.4**	**19.8**	**22.6**	**22.6**	-	**23.0**	-	-	-
100 sq miles	**5.7**	**15.9**	**17.6**	**20.5**	**21.1**	-	**21.1**	-	-	-
200 sq miles	**4.8**	**13.6**	**16.4**	**19.2**	**19.9**	-	**19.9**	-	-	-
500 sq miles	**4.1**	**11.8**	**14.3**	**16.8**	**17.2**	-	**17.7**	-	-	-
1000 sq miles	**3.2**	**10.4**	**12.8**	**14.5**	**14.7**	-	**16.0**	-	-	-
5000 sq miles	**2.1**	**6.3**	**8.1**	**10.3**	**10.6**	-	**11.0**	-	-	-
10000 sq miles	**0.9**	**4.6**	**6.5**	**8.0**	**8.6**	-	**9.2**	-	-	-
20000 sq miles	**0.5**	**2.1**	**4.7**	**6.0**	**6.8**	-	**7.2**	-	-	-

Storm or Storm Center Name	**SPAS 1029-Aurora College, IL**	
Storm Date(s)	17-Jul-1996	
Storm Type	Synoptic-Thunderstorms	
Storm Location	41.46 N	88.07 W
Storm Center Elevation	650	
Precipitation Total & Duration	18.13 in 24hrs from SPAS 1286	
Storm Representative Dew Point	74.0 F	24
Storm Representative Dew Point Location	38.63 N	92.24 W
Maximum Dew Point	80.5 F	
Moisture Inflow Vector	SW @ 300	
In-place Maximization Factor	**1.35**	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	39.61 N	96.54 W
Transposition Maximum Dew Point	80.5 F	
Transposition Adjustment Factor	**0.97**	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.32**	

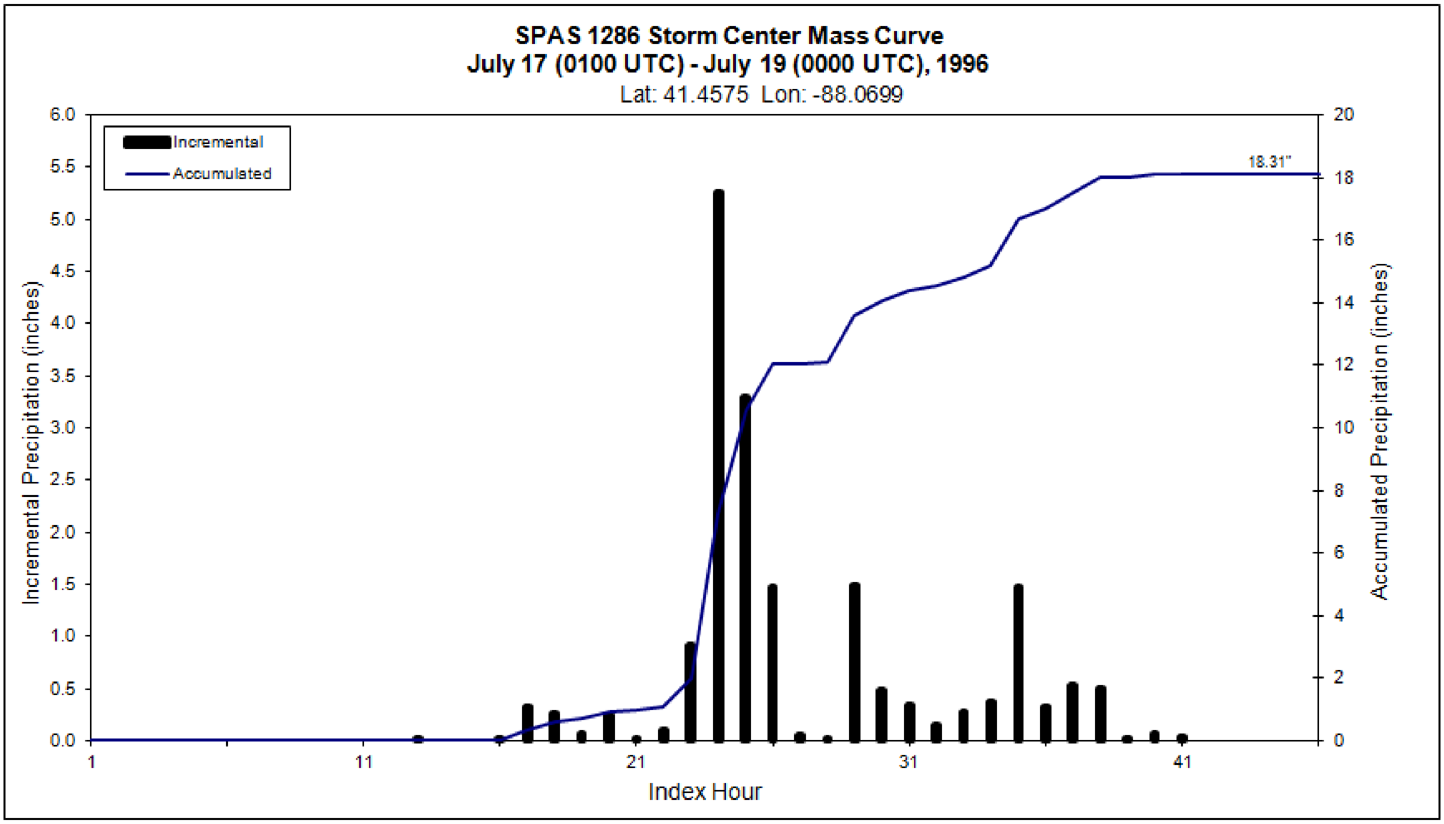
Appendix F: Table F.24: Storm spreadsheet for Aurora College, IL, July 16, 1996

Storm 1286 - Aurora, IL July 17- 18, 1996										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi^2)	1	2	3	4	5	6	12	18	24	total (36-hr)
1	6.06	9.05	11.35			14.38	15.35	17.33	17.58	17.64
10	5.89	8.48	10.94			14.02	15.05	17.15	17.18	17.51
25	5.54	8.09	10.47			13.44	14.38	16.81	16.96	17.09
50	5.03	7.70	9.99			12.97	14.04	16.19	16.61	16.61
100	4.31	7.13	9.28			12.11	13.42	15.60	16.04	16.06
150	3.76	6.71	8.69			11.28	12.94	14.94	15.53	15.58
200	3.64	6.37	7.45			10.37	12.46	14.59	15.12	15.14
300	3.46	5.61	7.38			9.60	11.71	13.59	14.04	14.42
400	3.29	4.95	6.82			9.28	11.34	13.08	13.24	13.86
500	3.13	4.88	6.20			8.98	10.87	12.76	13.10	13.43
1,000	2.45	4.07	5.40			7.93	9.72	11.04	11.18	12.13
2,000	2.09	3.26	4.56			6.68	8.50	9.60	9.67	10.56
5,000	1.58	2.69	3.26			4.79	6.15	7.82	8.05	8.36
10,000	0.65	1.40	1.73			3.51	4.98	6.07	6.55	7.00
20,000	0.41	0.87	1.05			1.56	3.57	4.56	5.16	5.44
36,456	0.32	0.57	0.82			1.38	2.33	3.00	3.43	3.61

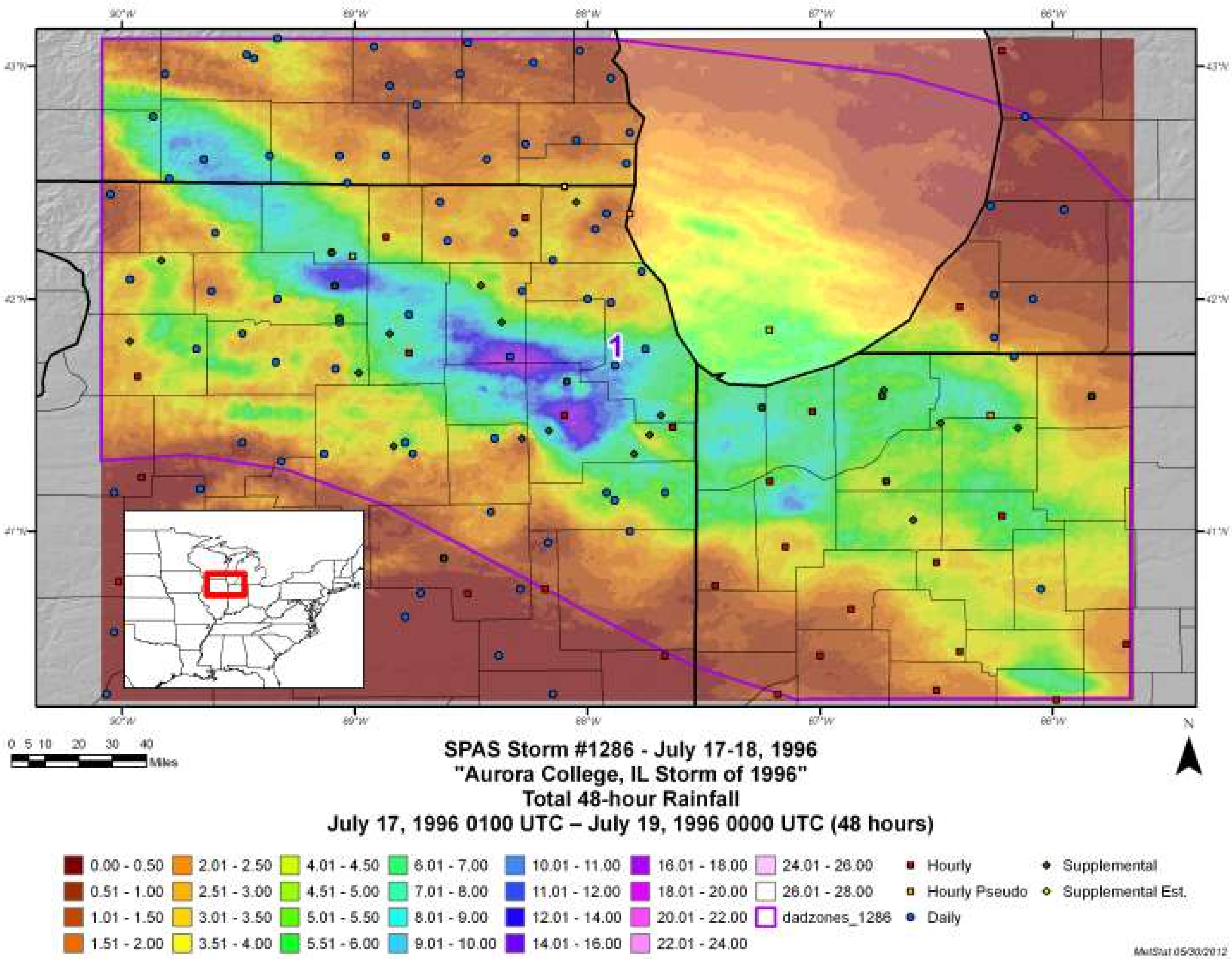
Appendix F: Table F.25: Depth-area-duration values for Aurora College, IL, July 16, 1996



Appendix F: Figure F.34: Depth-area-duration chart for Aurora College, IL, July 16, 1996



Appendix F: Figure F.35: Mass curve chart for Aurora College, IL, July 16, 1996



Appendix F: Figure F.36: Total storm isohyetal analysis for Aurora College, IL July 1996

Minneapolis, MN, AWA 11

July 23, 1987

Storm Type: MCC

Grid Points Used: 8-11, 16-18

Storm Name:	Minneapolis, MN SPAS 1210	Storm Adjustment for ANO Grid Point 8
Storm Date:	July 23-24, 1987	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	44.89 N	93.40 W
Storm Rep Dew Point Location	44.54 N	95.16 W
Transposition Dew Point Location	42.38 N	94.28 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	WSW @ 90	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	900	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place maximum dew point is	81.5 F	with total precipitable water above sea level of			3.83	inches.
The transpositioned maximum dew point is	82.0 F	with total precipitable water above sea level of			3.91	inches.
The in-place storm elevation is	900	which subtracts	0.25	inches of precipitable water at	78.0 F	
The in-place storm elevation is	900	which subtracts	0.29	inches of precipitable water at	81.5 F	
The transposition basin elevation at	1,200	which subtracts	0.31	inches of precipitable water at	82.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.31	inches of precipitable water at	82.0 F	

The in-place storm maximization factor is	1.16
The transposition/elevation to basin factor is	1.02
The barrier adjustment factor is	1.00
The total adjustment factor is	1.18

Notes: Storm representative dew point value was based on maximum 6-hr Td values July 23, 1987 at Redwood Falls, MN. This was fromt eh EPRI analysis. The Td climatology maps produced during the Nebraska statewide PMP study were used to maximized this event.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	5.0	9.8	11.1	11.3	11.4	11.4	11.4	11.4	12.0
10 sq miles	4.3	8.7	10.7	11.2	11.3	11.3	11.3	11.3	11.9
100 sq miles	3.0	7.3	9.4	10.1	10.2	10.2	10.2	10.2	10.9
200 sq miles	2.6	6.6	8.5	9.3	9.3	9.4	9.4	9.4	10.0
500 sq miles	2.1	5.3	7.0	7.6	7.9	8.0	8.0	8.0	8.6
1000 sq miles	1.6	4.1	5.8	6.6	6.7	6.8	6.8	6.8	7.3
2000 sq miles	1.1	2.9	4.5	5.5	5.5	5.6	5.6	5.6	5.9
5000 sq miles	0.7	1.5	2.7	3.6	3.6	3.8	3.8	3.8	4.1
10000 sq miles	0.4	0.9	1.9	2.5	2.6	2.6	2.6	2.6	2.8
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

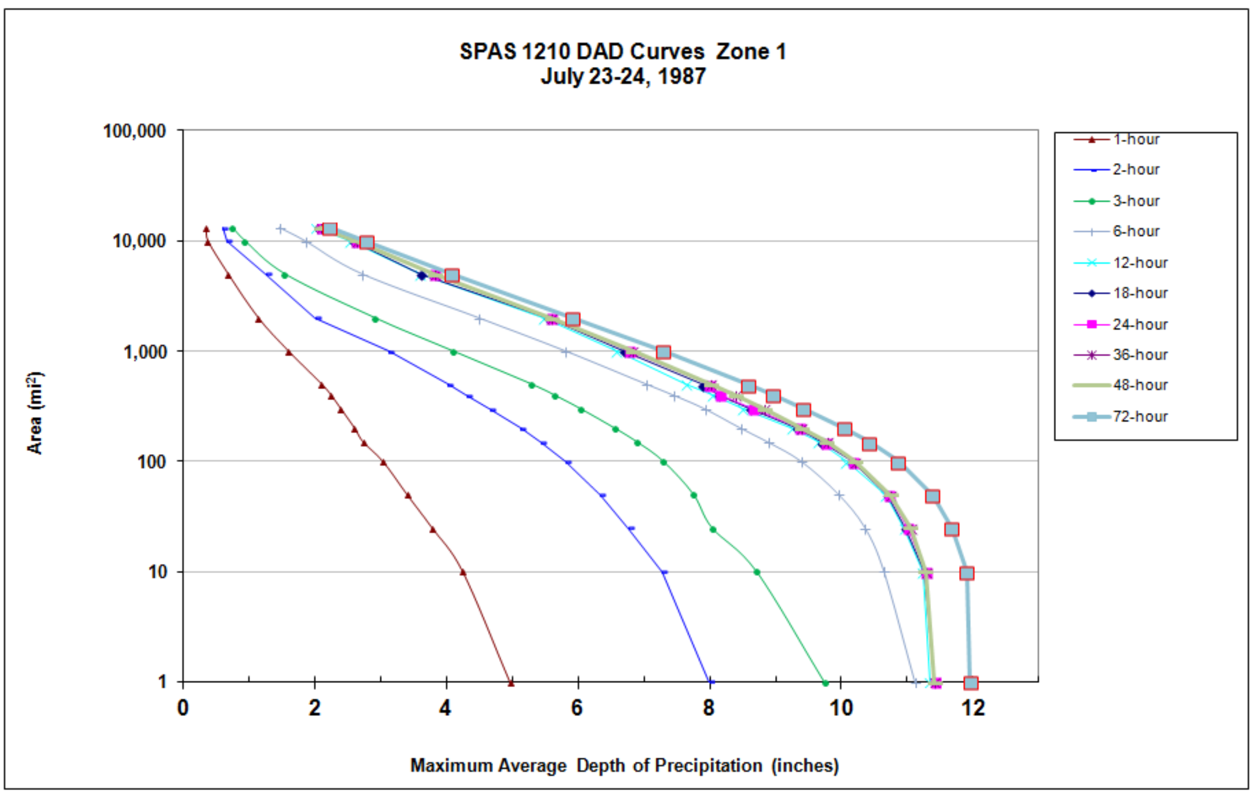
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	5.9	11.5	13.2	13.4	13.5	13.5	13.5	13.5	14.1
10 sq miles	5.0	10.3	12.6	13.3	13.3	13.3	13.3	13.3	14.1
100 sq miles	3.6	8.6	11.1	11.9	12.0	12.0	12.1	12.1	12.9
200 sq miles	3.1	7.8	10.0	10.9	11.0	11.1	11.1	11.1	11.9
500 sq miles	2.5	6.3	8.3	9.0	9.3	9.4	9.5	9.5	10.1
1000 sq miles	1.9	4.8	6.9	7.8	7.9	8.0	8.1	8.1	8.6
2000 sq miles	1.3	3.4	5.3	6.5	6.6	6.6	6.6	6.6	7.0
5000 sq miles	0.8	1.8	3.2	4.3	4.3	4.5	4.5	4.5	4.8
10000 sq miles	0.4	1.1	2.2	3.0	3.1	3.1	3.1	3.1	3.3
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**Minneapolis, MN SPAS 1210**	
Storm Date(s)	July 23-24, 1987	
Storm Type	MCC	
Storm Location	44.89 N	93.40 W
Storm Center Elevation	900	
Precipitation Total & Duration	12.13 Inches 72-hours	
Storm Representative Dewpoint	78.0 F	6
Storm Representative Dewpoint Location	44.54 N	95.16 W
Maximum Dewpoint	81.5 F	
Moisture Inflow Vector	WSW @ 90	
In-place Maximization Factor	**1.16**	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	42.38 N	94.28 W
Transposition Maximum Dewpoint	82.0 F	
Transposition Adjustment Factor	**1.02**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.18**	

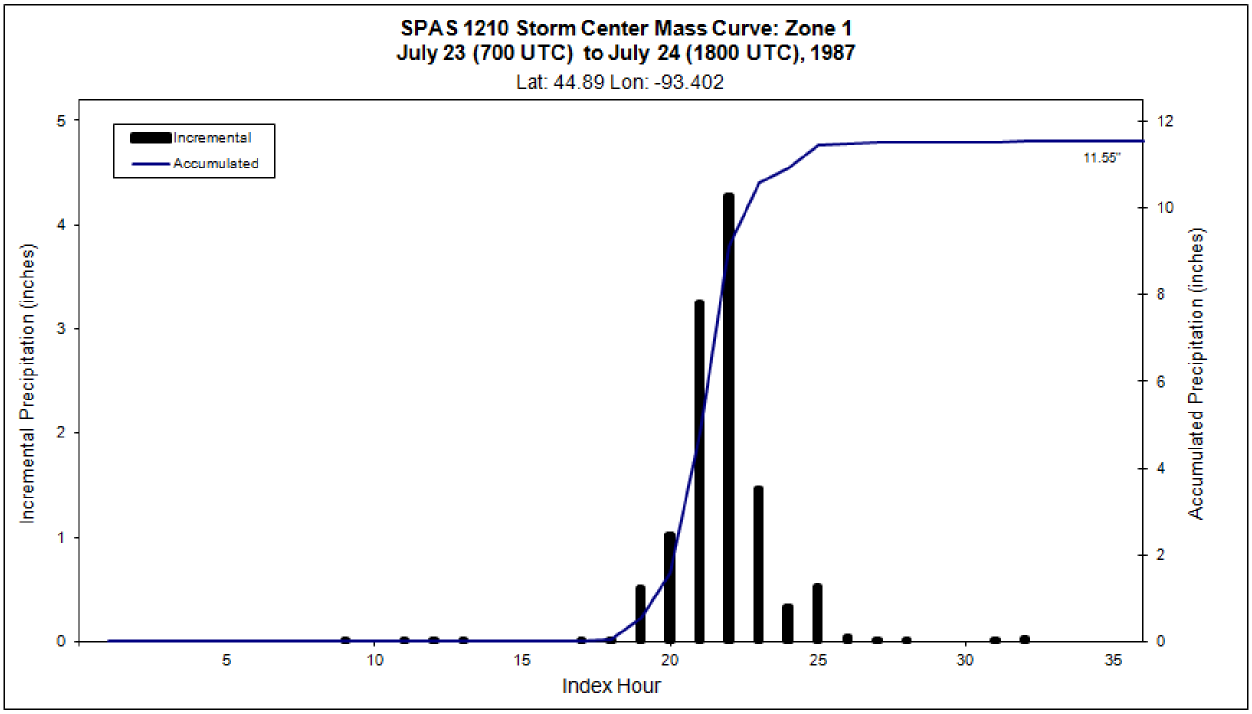
Appendix F: Table F.26: Storm spreadsheet for Minneapolis, MN July 23, 1987

Storm 1210 - July 23 (0700 UTC) - July 24 (1800 UTC),1987											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	2	3	6	12	18	24	36	48	72	Total
0	5.16	8.19	10	11.24	11.5	11.54	11.55	11.55	11.55	12.13	12.13
1	4.97	7.99	9.75	11.12	11.34	11.41	11.42	11.42	11.42	11.96	11.96
10	4.25	7.27	8.72	10.65	11.24	11.27	11.28	11.28	11.28	11.91	11.91
25	3.78	6.76	8.04	10.36	10.96	10.98	11.01	11.05	11.05	11.68	11.68
50	3.4	6.33	7.76	9.96	10.67	10.7	10.73	10.75	10.75	11.39	11.39
100	3.03	5.8	7.3	9.39	10.07	10.16	10.17	10.21	10.21	10.87	10.87
150	2.73	5.43	6.9	8.88	9.66	9.7	9.75	9.78	9.78	10.43	10.43
200	2.6	5.12	6.56	8.47	9.25	9.33	9.37	9.39	9.39	10.04	10.04
300	2.39	4.65	6.04	7.92	8.51	8.62	8.65	8.83	8.83	9.43	9.43
400	2.24	4.3	5.64	7.44	8.05	8.13	8.15	8.39	8.39	8.97	8.97
500	2.1	4.02	5.3	7.04	7.64	7.89	7.98	8.01	8.01	8.58	8.58
1,000	1.59	3.12	4.1	5.81	6.59	6.69	6.77	6.83	6.83	7.29	7.29
2,000	1.13	2	2.91	4.49	5.48	5.54	5.59	5.59	5.59	5.92	5.92
5,000	0.67	1.25	1.54	2.72	3.6	3.6	3.82	3.82	3.82	4.08	4.08
10,000	0.36	0.66	0.93	1.85	2.54	2.58	2.62	2.63	2.63	2.78	2.78
13,158	0.34	0.59	0.74	1.46	2.02	2.05	2.09	2.09	2.09	2.22	2.22

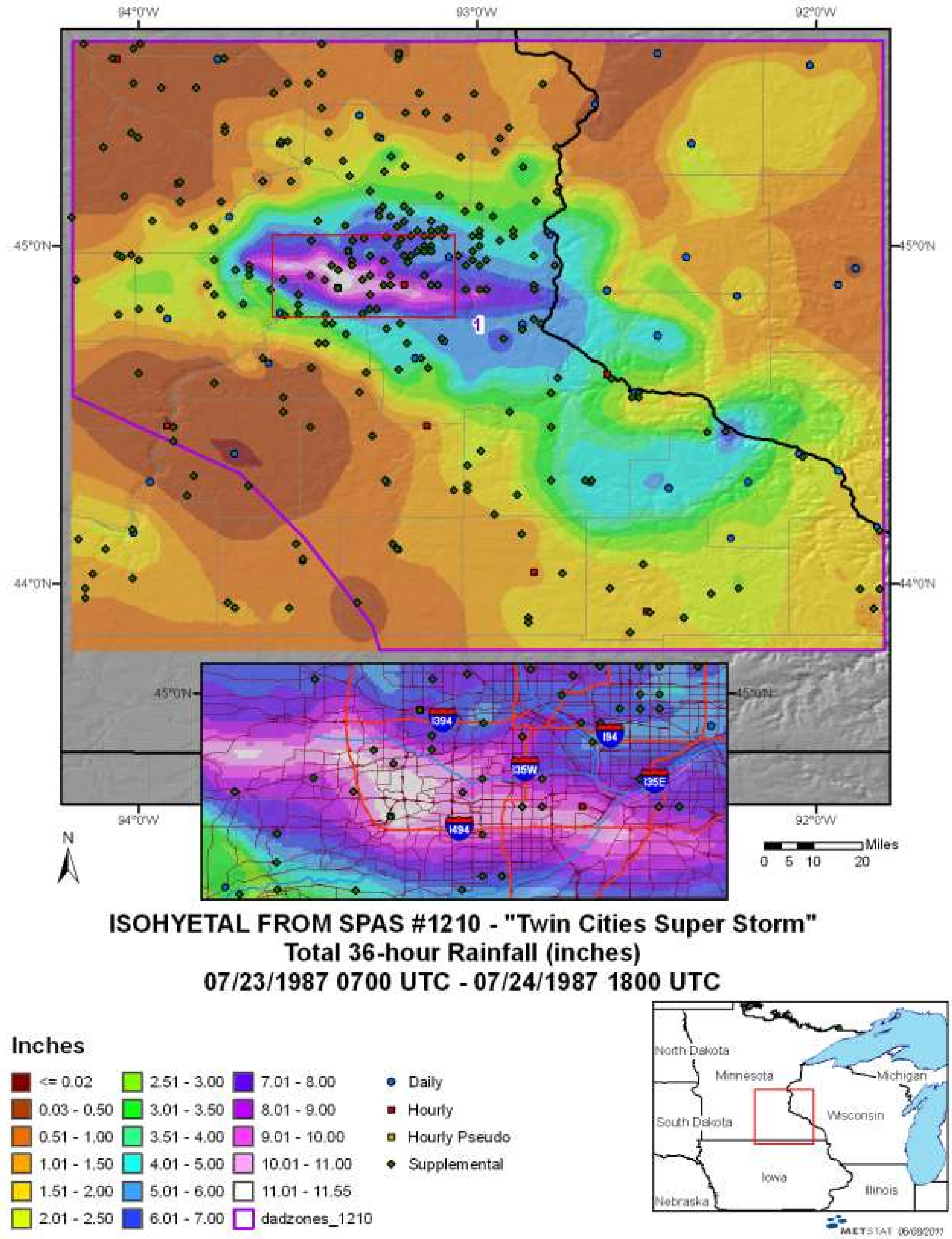
Appendix F: Table F.27: Depth-area-duration values for Minneapolis, MN July 23, 1987



Appendix F: Figure F.37: Depth-area-duration chart for Minneapolis, MN July 23, 1987



Appendix F: Figure F.38: Mass curve chart for Minneapolis, MN July 23, 1987



Appendix F: Figure F.39: Total storm isohyetal analysis Minneapolis, MN July 23, 1987

Big Rapids, MI, AWA 12

September 9, 1986

Storm Type: Frontal

Grid Points Used: 8-11, 16-18

Storm Name:	SPAS126 Big Rapids, MI	Storm Adjustment for ANO Grid Point 8
Storm Date:	9/9-12/1986	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	1-Sep				
	Lat	Long	Moisture Inflow Direction	SW @ 230	miles
Storm Center Location	43.61 N	85.31 W	Grid Point Elevation	1,200	feet
Storm Rep Dew Point Location	41.36 N	88.68 W	Storm Center Elevation	950	feet
Transposition Dew Point Location	40.48 N	95.91 W	Storm Rep Analysis Duration	24	hours
Grid Point Location	37.50 N	93.00 W			

The storm representative dew point is	70.5 F	with total precipitable water above sea level of			2.31	inches.
The in-place maximum dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The transpositioned maximum dew point is	77.5 F	with total precipitable water above sea level of			3.22	inches.
The in-place storm elevation is	950	which subtracts	0.21	inches of precipitable water at	70.5 F	
The in-place storm elevation is	950	which subtracts	0.26	inches of precipitable water at	77.0 F	
The transposition basin elevation at	1,200	which subtracts	0.28	inches of precipitable water at	77.5 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.28	inches of precipitable water at	77.5 F	

The in-place storm maximization factor is	1.38
The transposition/elevation to basin factor is	1.02
The barrier adjustment factor is	1.00
The total adjustment factor is	1.40

Notes: DAD values taken from SPAS 1206. Storm representative dew point value was based on maximum 24-hr Td values between September 8-12, 1986 at KMMO. Values were selected in region where temperature did not vary more than a 1-degree over a large area.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	2.7	4.3	4.7	6.1	7.6	9.7	11.3	12.7	13.0
10 sq miles	2.6	4.2	4.6	6.0	7.6	9.7	11.3	12.7	13.0
100 sq miles	2.2	3.5	3.9	5.8	7.5	9.4	11.2	12.7	13.0
200 sq miles	2.0	3.2	3.8	5.6	7.3	9.3	11.1	12.6	12.9
500 sq miles	1.7	2.7	3.6	5.4	7.1	9.0	10.9	12.3	12.6
1000 sq miles	1.4	2.1	3.4	5.2	6.9	8.6	10.7	11.9	12.2
2000 sq miles	1.1	1.9	3.0	4.9	6.5	8.1	10.3	11.2	11.6
5000 sq miles	0.7	1.6	2.7	4.4	6.0	7.5	9.7	10.6	10.7
10000 sq miles	0.5	1.2	2.2	3.8	5.3	6.6	8.7	9.5	9.5
20000 sq miles	0.3	0.9	1.6	3.1	4.2	5.4	7.4	7.9	8.1

Adjusted Storm Depth-Area-Duration

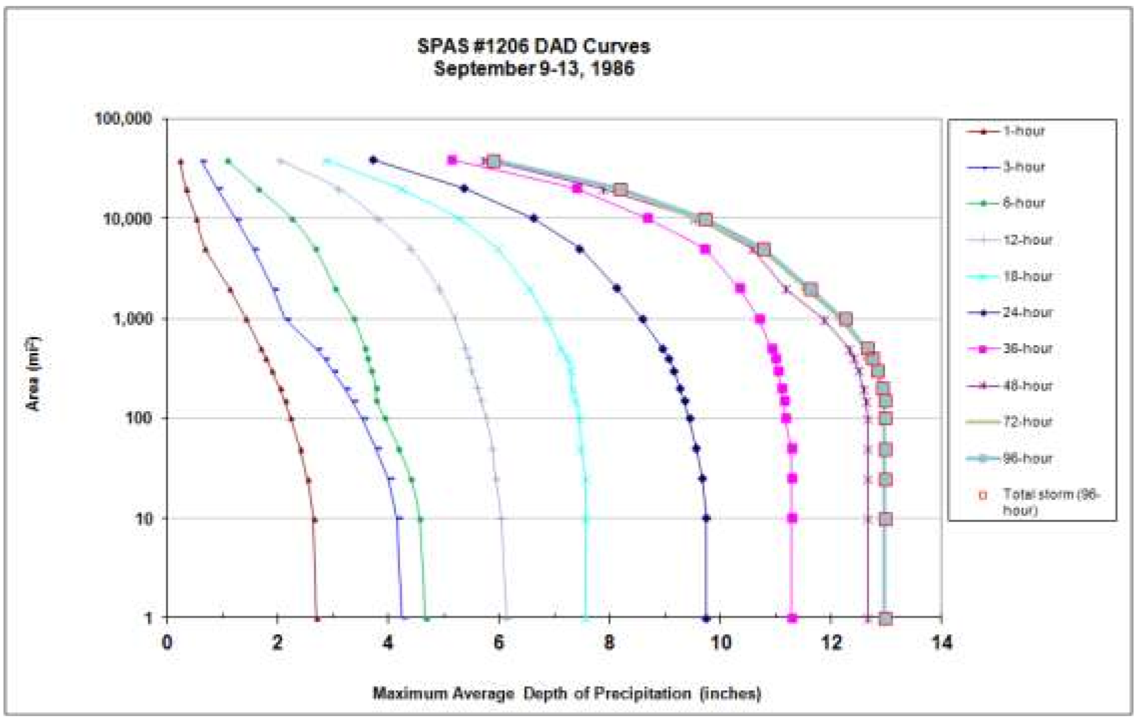
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	3.8	6.0	6.5	8.6	10.6	13.6	15.8	17.7	18.2
10 sq miles	3.7	5.8	6.4	8.4	10.6	13.6	15.8	17.7	18.2
100 sq miles	3.1	4.9	5.5	8.1	10.4	13.2	15.6	17.7	18.2
200 sq miles	2.8	4.5	5.3	7.8	10.3	13.0	15.6	17.6	18.1
500 sq miles	2.4	3.8	5.0	7.5	10.0	12.6	15.3	17.3	17.7
1000 sq miles	2.0	3.0	4.7	7.3	9.6	12.0	15.0	16.6	17.0
2000 sq miles	1.6	2.7	4.2	6.9	9.2	11.4	14.5	15.6	16.2
5000 sq miles	1.0	2.2	3.7	6.2	8.3	10.4	13.6	14.8	15.0
10000 sq miles	0.7	1.7	3.1	5.3	7.4	9.3	12.1	13.4	13.4
20000 sq miles	0.5	1.3	2.3	4.3	5.9	7.5	10.4	11.0	11.4

Storm or Storm Center Name	SPAS126 Big Rapids, MI			
Storm Date(s)	9/9-12/1986			
Storm Type	Synoptic			
Storm Location	43.61 N	85.31 W		
Storm Center Elevation	950			
Precipitation Total & Duration	13.18 Inches	72-hours		
Storm Representative Dew Point	70.5 F	24		
Storm Representative Dew Point Location	41.36 N	88.68 W	Aug	Sep
Maximum Dew Point	77.0 F		79	74.5
Moisture Inflow Vector	SW @ 230	Miles		
In-place Maximization Factor	1.38			
Temporal Transposition (Date)	1-Sep			
Transposition Dew Point Location	40.48 N	95.91 W	Aug	Sep
Transposition Maximum Dew Point	77.5 F		80	75
Transposition Adjustment Factor	1.02			
Grid Point Elevation	1,200			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.40			

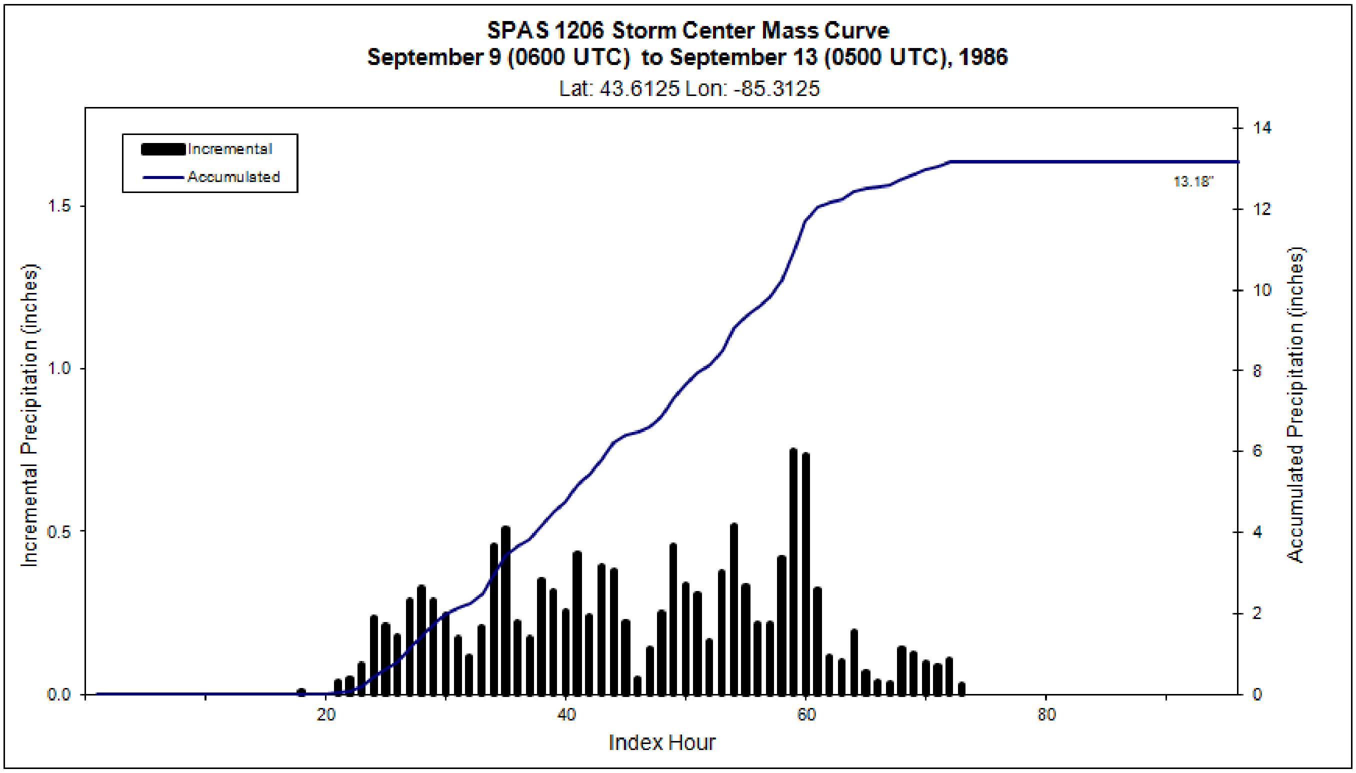
Appendix F: Table F.28: Storm spreadsheet for Big Rapids, MI September 9, 1986

Storm 1206 - Sep 9 (0600 UTC) - Sep 13 (0500 UTC), 1986											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	Total
0	2.73	4.29	4.69	6.18	7.69	9.86	11.42	12.86	13.18	13.18	13.18
1	2.7	4.25	4.66	6.12	7.57	9.74	11.28	12.66	12.97	12.97	12.97
10	2.64	4.15	4.55	6.02	7.57	9.74	11.28	12.66	12.97	12.97	12.97
25	2.53	3.99	4.39	5.92	7.56	9.68	11.28	12.66	12.97	12.97	12.97
50	2.4	3.78	4.18	5.86	7.48	9.57	11.28	12.66	12.97	12.97	12.97
100	2.23	3.52	3.92	5.75	7.45	9.44	11.17	12.66	12.97	12.97	12.97
150	2.12	3.35	3.77	5.66	7.39	9.35	11.14	12.63	12.96	12.96	12.96
200	2.03	3.21	3.77	5.6	7.33	9.28	11.1	12.59	12.91	12.91	12.91
300	1.89	2.99	3.68	5.49	7.29	9.16	11.04	12.5	12.82	12.82	12.82
400	1.78	2.82	3.61	5.43	7.22	9.07	10.98	12.41	12.67	12.73	12.73
500	1.69	2.69	3.57	5.37	7.12	8.96	10.92	12.33	12.63	12.65	12.65
1,000	1.42	2.13	3.36	5.18	6.87	8.59	10.69	11.86	12.17	12.23	12.23
2,000	1.12	1.9	3.03	4.9	6.54	8.13	10.33	11.17	11.55	11.61	11.61
5,000	0.68	1.55	2.66	4.39	5.96	7.45	9.71	10.56	10.72	10.75	10.75
10,000	0.52	1.23	2.24	3.79	5.27	6.61	8.67	9.54	9.54	9.71	9.71
20,000	0.33	0.9	1.63	3.08	4.23	5.36	7.39	7.86	8.13	8.17	8.17
38,326	0.22	0.6	1.07	2.02	2.87	3.73	5.13	5.72	5.88	5.88	5.88

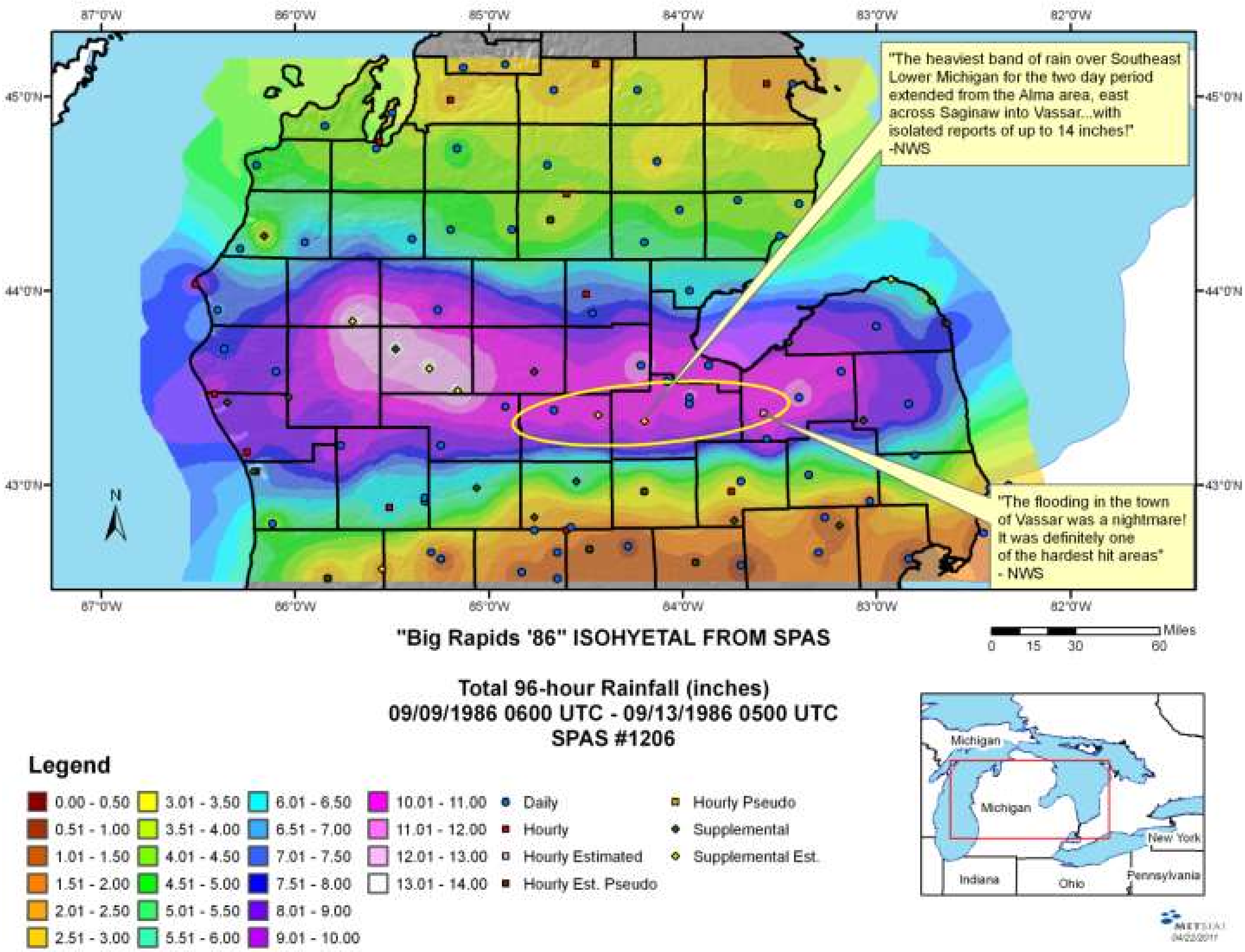
Appendix F: Table F.29: Depth-area-duration values for Big Rapids, MI September 9, 1986



Appendix F: Figure F.40: Depth-area-duration chart for Big Rapids, MI September 9, 1986



Appendix F: Figure F.41: Mass curve chart for Big Rapids, MI September 9, 1986



Appendix F: Figure F.42: Total storm isohyetal analysis for Big Rapids, MI September 9, 1986

Cheyenne, WY, AWA 13

August 1, 1985
Storm Type: Thunderstorm
Grid Points Used: 6, 13, 15, 21

Storm Name:	SPAS 1213 Cheyenne, WY		
Storm Date:	8/01/1985	**Storm Adjustment for ANO Grid Point 6**	
AWA Analysis Date:	12/17/2013		

Temporal Transposition Date	**15-Jul**					
	Lat	**Long**	**Moisture Inflow Direction:**	**S @ 95**	miles	
Storm center location	**41.14 N**	**104.82 W**	**Grid Point Elevation**	**4,400**	feet	
Storm Rep dew point location	**39.80 N**	**105.00 W**	**Storm Center Elevation**	**6,100**	feet	
Transposition dewpoint location	**38.16 N**	**87.45 W**	**Storm Rep Analysis Duration**	**6**	hours	
Grid Point location	**34.50 N**	**104.00 W**				

The storm representative dew point is	**77.0 F**	with total precipitable water above sea level of		**3.14**	inches.
The in-place maximum dew point is	**78.5 F**	with total precipitable water above sea level of		**3.37**	inches.
The transpositioned maximum dew point is	**78.0 F**	with total precipitable water above sea level of		**3.29**	inches.
The in-place storm elevation is	**6,100**	which subtracts **1.37**	inches of precipitable water at	**77.0 F**	
The in-place storm elevation is	**6,100**	which subtracts **1.44**	inches of precipitable water at	**78.5 F**	
The transposition basin elevation at	**4,400**	which subtracts **x.xx**	inches of precipitable water at	**78.0 F**	
The Grid Point/Inflow barrier height is	**xx**	which subtracts **x.xx**	inches of precipitable water at	**78.0 F**	

The in-place storm maximization factor is	**1.09**
The transposition/elevation to basin factor is	**#VALUE!**
The barrier adjustment factor is	**#VALUE!**
The total adjustment factor is	**#VALUE!**

Notes: DAD values taken from SPAS 1213. Storm representative dew point value was based on maximum 6-hr Td values between Aug 1, 1985 at KBJC, KDNR, and KAPA.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.0	5.4	6.3	6.9	6.9	6.9	6.9	0.0	0.0
10 sq miles	3.5	4.6	5.4	6.0	6.0	6.0	6.0	0.0	0.0
100 sq miles	1.7	2.2	2.6	2.9	2.9	2.9	2.9	0.0	0.0
200 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
500 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Adjusted Storm Depth-Area-Duration

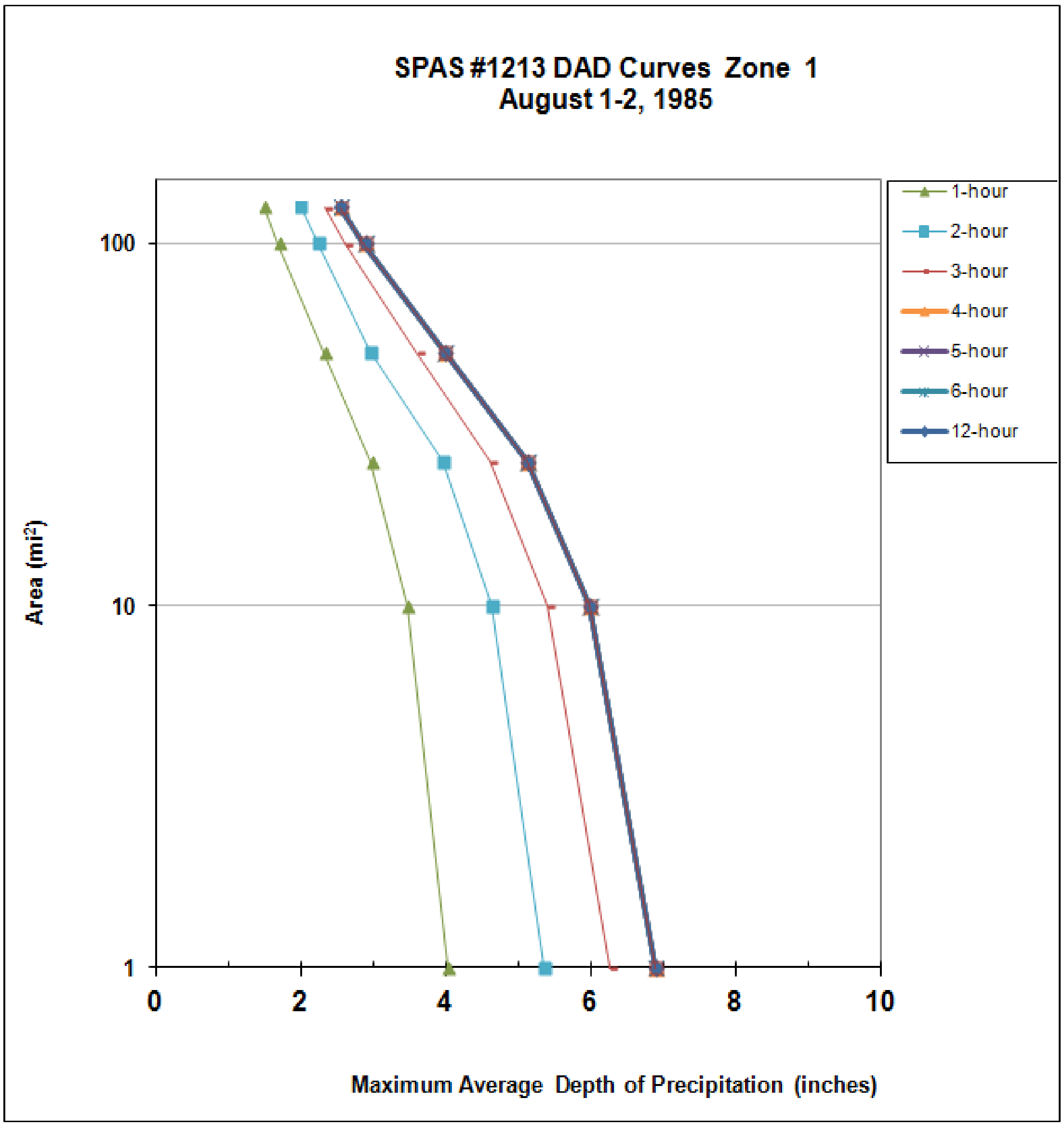
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
10 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
100 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
200 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
500 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
2000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
10000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
20000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Storm or Storm Center Name	**SPAS 1213 Cheyenne, WY**			
Storm Date(s)	8/01/1985			
Storm Type	Convective			
Storm Location	41.14 N	104.82 W		
Storm Center Elevation	6,100			
Precipitation Total & Duration	7.15 Inches 13-hours			
Storm Representative Dewpoint	77.0 F	6		
Storm Representative Dewpoint Location	39.80 N	105.00 W	Jul	Aug
Maximum Dewpoint	78.5 F		78.4	78.3
Moisture Inflow Vector	S @ 95			
In-place Maximization Factor	**1.09**			
Temporal Transposition (Date)	15-Jul			
Transposition Dewpoint Location	38.16 N	87.45 W	Jul	Aug
Transposition Maximum Dewpoint	78.0 F		75.18	79.15
Transposition Adjustment Factor	**#VALUE!**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**#VALUE!**			
Total Adjustment Factor	**#VALUE!**			

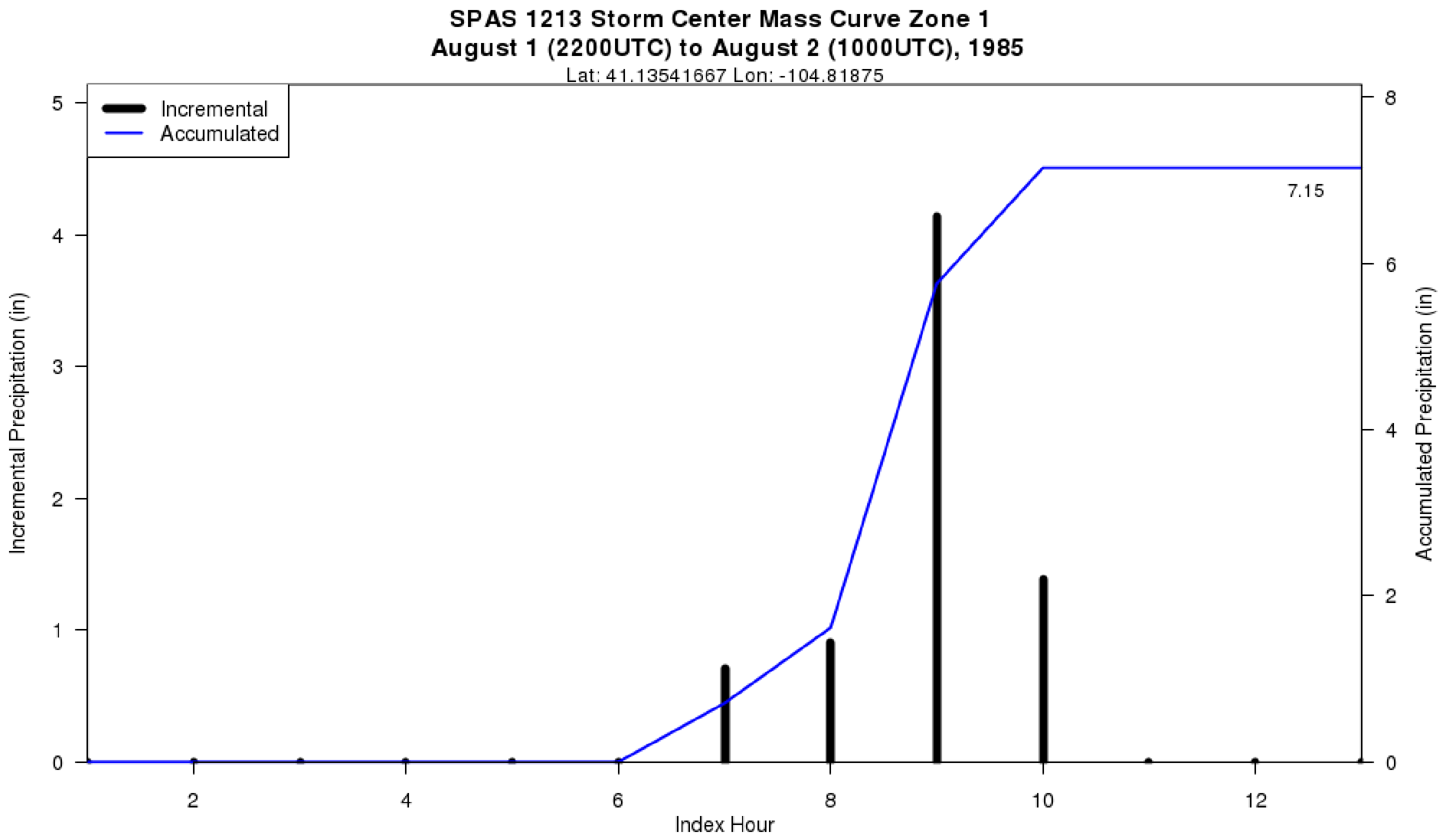
Appendix F: Table F.30: Storm spreadsheet for Cheyenne, WY, August 1, 1985

SPAS #1213 DAD Curves Zone 1 August 1-2, 1985						
Area (mi^2)	1	2	3	4	5	6
0.1	4.14	5.53	6.44	7.15	7.15	7.15
1	4.03	5.36	6.26	6.89	6.89	6.89
10	3.47	4.64	5.4	5.99	5.99	5.99
25	2.97	3.97	4.62	5.13	5.13	5.13
50	2.32	2.97	3.6	3.99	3.99	3.99
100	1.69	2.24	2.62	2.88	2.88	2.88
126	1.5	2	2.33	2.55	2.55	2.55

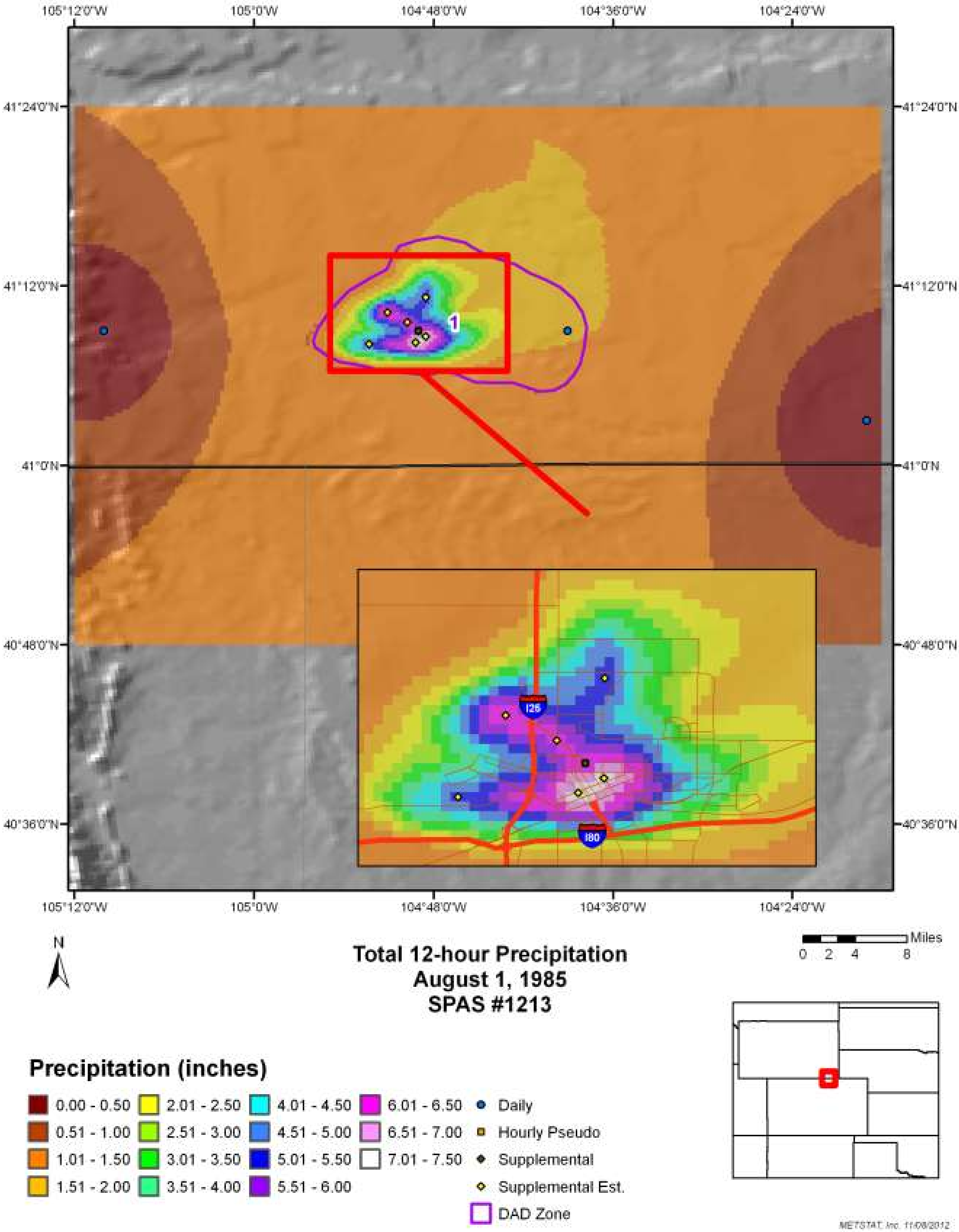
Appendix F: Table F.31: Depth-area-duration values for Cheyenne, WY, August 1, 1985



Appendix F: Figure F.43: Depth-area-duration chart for Cheyenne, WY, August 1, 1985



Appendix F: Figure F.44: Mass curve chart for Cheyenne, WY, August 1, 1985



Appendix F: Figure F.45: Total storm isohyetal analysis for Cheyenne, WY, August 1, 1985

Forest City, MN, AWA 14

June 20, 1983

Storm Type: MCC

Grid Points Used: 8-11, 16-18

Storm Name:	SPAS 1035-Forest City, MN	**Storm Adjustment for ANO Grid Point 8**
Storm Date:	21-Jun-1983	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	6-Jul	
	Lat	Long
Storm Center Location	45.24 N	94.54 W
Storm Rep Dew Point Location	44.02 N	92.94 W
Transposition Dew Point Location	41.51 N	91.04 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SE @ 115	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,100	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	72.0 F	with total precipitable water above sea level of			2.47	inches.
The in-place maximum dew point is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The transpositioned maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	1,100	which subtracts	0.25	inches of precipitable water at	72.0 F	
The in-place storm elevation is	1,100	which subtracts	0.34	inches of precipitable water at	79.5 F	
The transposition basin elevation at	1,200	which subtracts	0.29	inches of precipitable water at	80.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	80.0 F	

The in-place storm maximization factor is	1.43
The transposition/elevation to basin factor is	1.04
The barrier adjustment factor is	1.00
The total adjustment factor is	1.49

Notes: 1.61 calculated, but 1.50 used based on HMR 51 and HMR 55A guidance. DAD values taken from SPAS 1035. 12hr average Td taken from KRST, MCW, and KMSP 9hr ave from 06-20-83 22Z to 06-21-83 06Z

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	3.7	8.4	13.8	13.9	13.9	-	16.5	16.5	-	16.5
10 sq miles	3.3	7.7	12.7	12.7	12.7	-	15.3	15.3	-	15.3
100 sq miles	2.6	6.2	10.2	10.2	10.2	-	12.8	12.8	-	12.8
200 sq miles	2.4	5.8	9.4	9.5	9.5	-	12.0	12.0	-	12.0
500 sq miles	2.2	5.0	7.9	8.0	8.0	-	9.9	9.9	-	10.0
1000 sq miles	2.0	4.5	6.5	6.6	6.6	-	7.9	7.9	-	7.9
5000 sq miles	1.1	2.4	3.4	3.4	3.4	-	4.0	4.0	-	4.0
10000 sq miles	-	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	5.5	12.4	20.6	20.7	20.7	-	24.6	24.6	-	24.6
10 sq miles	4.9	11.5	19.0	19.0	19.0	-	22.9	22.9	-	22.9
100 sq miles	3.9	9.3	15.3	15.3	15.3	-	19.1	19.1	-	19.1
200 sq miles	3.6	8.6	14.0	14.1	14.1	-	17.8	17.8	-	17.8
500 sq miles	3.3	7.5	11.8	11.9	11.9	-	14.8	14.8	-	14.9
1000 sq miles	3.0	6.6	9.8	9.8	9.8	-	11.8	11.8	-	11.8
5000 sq miles	1.6	3.6	5.0	5.0	5.0	-	6.0	6.0	-	6.0
10000 sq miles	-	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-	-

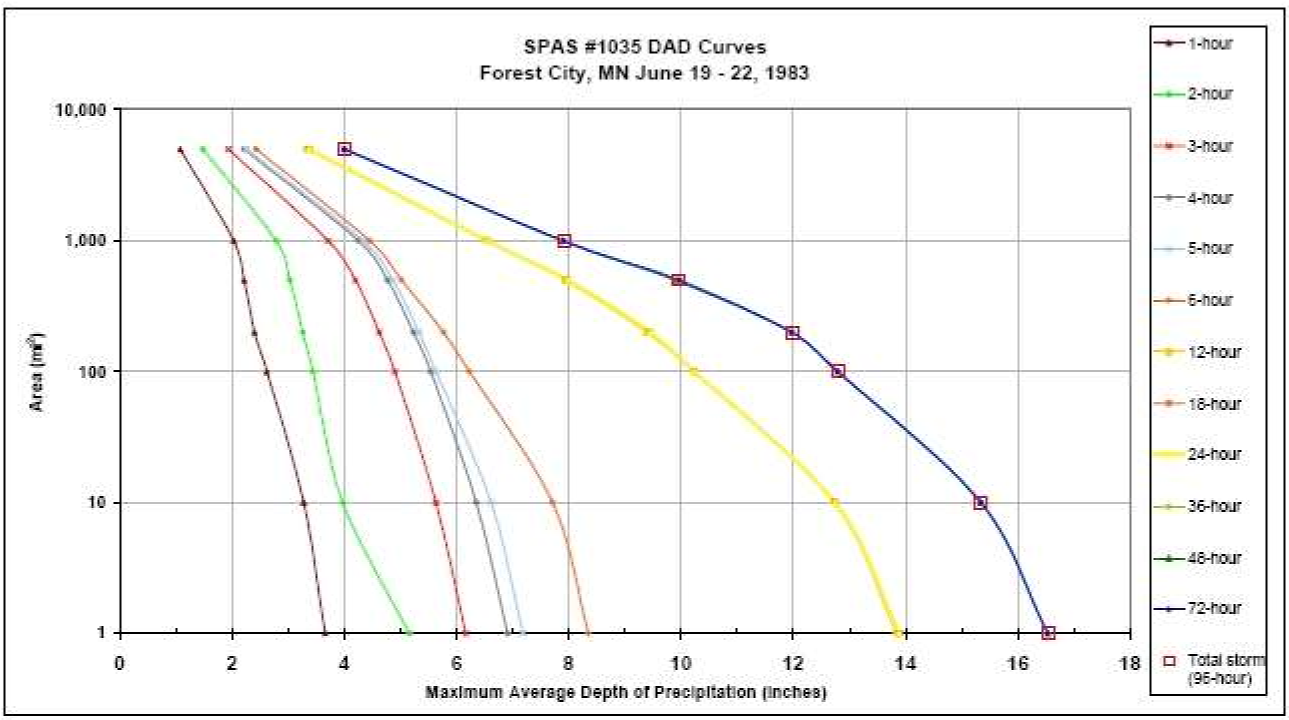
Storm or Storm Center Name	**SPAS 1035-Forest City, MN**			
Storm Date(s)	21-Jun-1983			
Storm Type	MCC-Thunderstorm Complex			
Storm Location	45.24 N	94.54 W		
Storm Center Elevation	1,100			
Precipitation Total & Duration	17.00 Inches 12-hours NCDC Storm Data report			
Storm Representative Dew Point	72.0 F	12		
Storm Representative Dew Point Location	44.02 N	92.94 W		
Maximum Dew Point	79.5 F			
Moisture Inflow Vector	SE @ 115			
In-place Maximization Factor	**1.43**			
Temporal Transposition (Date)	6-Jul			
Transposition Dew Point Location	41.51 N	91.04 W	June	July
Transposition Maximum Dew Point	80.0 F		78	81
Transposition Adjustment Factor	**1.04**			
Grid Point Elevation	1,200			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.49**			

Appendix F: Table F.32: Storm spreadsheet for Forest City, MN, June 20, 1983

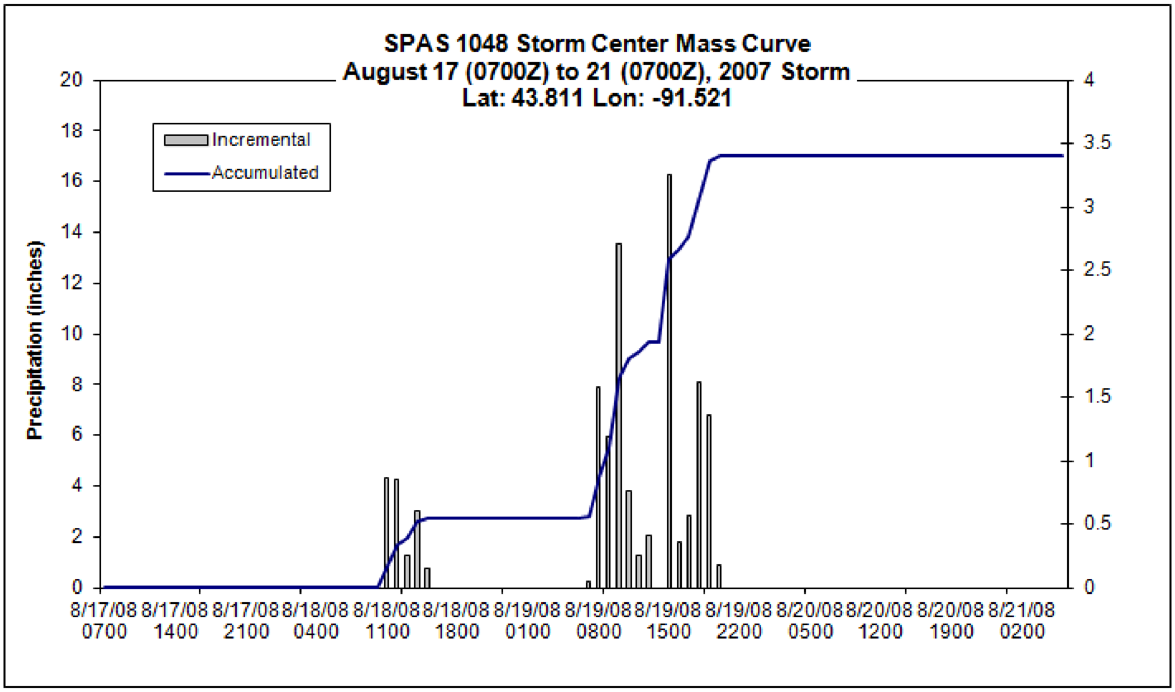
Storm 1035 - Forest City, MN June 19 - 22, 1983

MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

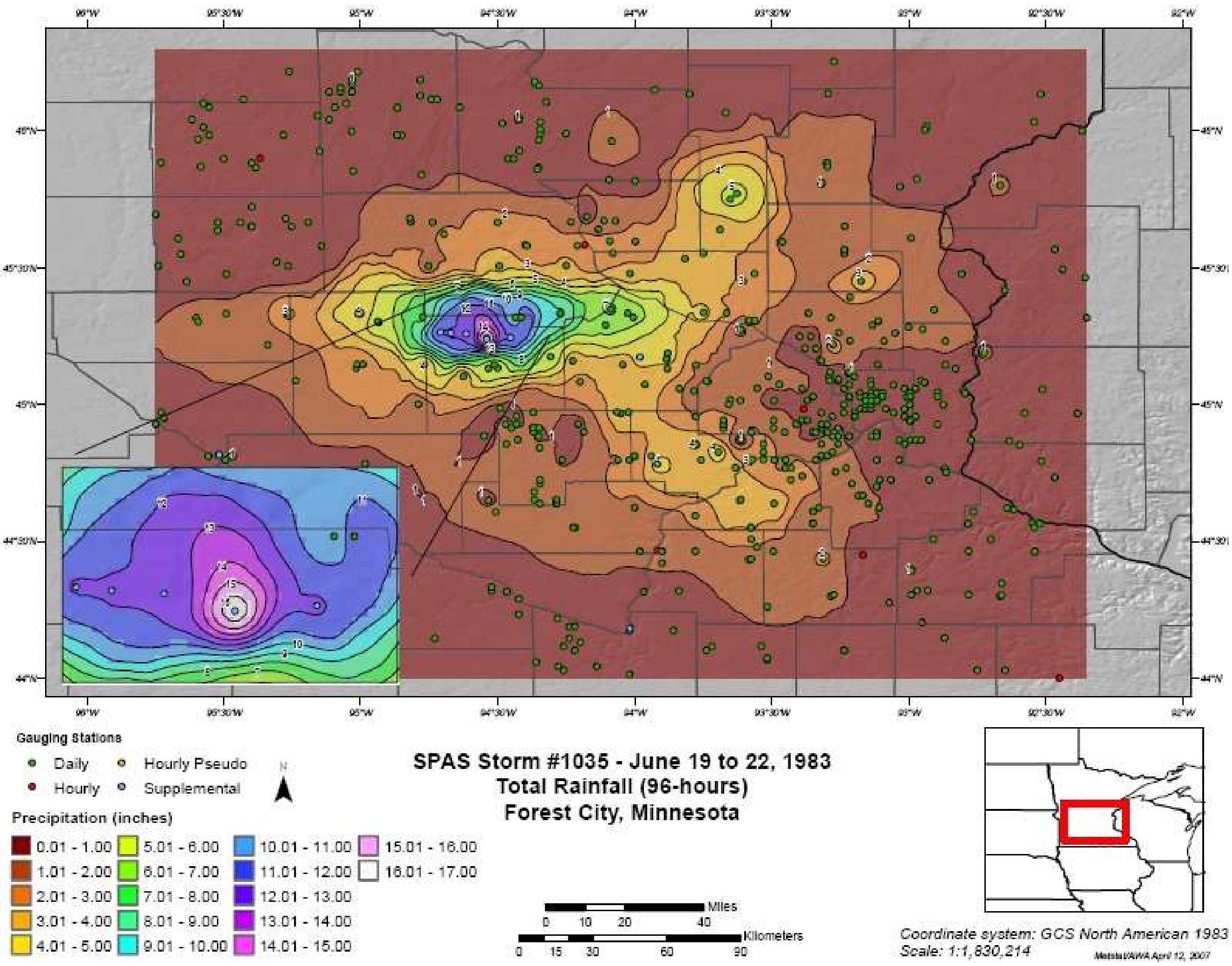
Area (mi^2)	Duration (hours)													
	1	2	3	4	5	6	12	18	24	36	48	72	96	total
1	3.66	5.16	6.16	6.91	7.18	8.35	13.84	13.89	13.89	16.53	16.53	16.53	16.53	16.53
10	3.28	3.97	5.63	6.35	6.62	7.71	12.73	12.74	12.74	15.34	15.34	15.34	15.34	15.34
100	2.62	3.44	4.90	5.54	5.63	6.23	10.23	10.23	10.23	12.79	12.79	12.79	12.79	12.79
200	2.40	3.26	4.62	5.23	5.33	5.77	9.38	9.45	9.45	11.97	11.97	11.97	11.97	11.97
500	2.22	3.03	4.20	4.77	4.87	5.02	7.94	7.98	7.98	9.90	9.90	9.97	9.97	9.97
1,000	2.03	2.79	3.71	4.25	4.33	4.45	6.54	6.55	6.55	7.89	7.89	7.91	7.91	7.91
5,000	1.08	1.48	1.94	2.22	2.26	2.43	3.35	3.38	3.38	4.00	4.00	4.00	4.01	4.01



Appendix F: Table F.33 and Figure F.46: Depth-area-duration values and Depth-area-duration chart for Forest City, MN, June 20, 1983



Appendix F: Figure F.47: Mass curve chart for Forest City, MN, June 20, 1983



Appendix F: Figure F.48: Total storm isohyetal analysis for Forest City, MN June 20, 1983

Big Fork, AR, AWA 15

December 1, 1982

Storm Type: Frontal

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	Big Fork, AR SPAS 1219	Storm Adjustment for ANO Grid Point 1
Storm Date:	Dec 1-5, 1982	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-Nov	
	Lat	Long
Storm Center Location	35.87 N	92.12 W
Storm Rep Dew Point Location	30.00 N	93.68 W
Transposition Dew Point Location	36.86 N	94.27 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 415	miles
Grid Point Elevation	350	feet
Storm Center Elevation	750	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	72.0 F	with total precipitable water above sea level of			2.47	inches.
The in-place maximum dew point is	73.0 F	with total precipitable water above sea level of			2.60	inches.
The transpositioned maximum dew point is	67.0 F	with total precipitable water above sea level of			1.95	inches.
The in-place storm elevation is	750	which subtracts	0.17	inches of precipitable water at	72.0 F	
The in-place storm elevation is	750	which subtracts	0.18	inches of precipitable water at	73.0 F	
The transposition basin elevation at	350	which subtracts	0.19	inches of precipitable water at	67.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.19	inches of precipitable water at	67.0 F	

The in-place storm maximization factor is	1.05
The transposition/elevation to basin factor is	0.73
The barrier adjustment factor is	1.00
The total adjustment factor is	0.77

Notes: Storm representative dew point value was based on maximum 24-hr Td values between Dec. 2-3, 1982 at KLCH, KBPT, KLFT, and KPOE. These stations did not have any rainfall during this maximum 24-hr period.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	2.4	5.2	6.6	9.7	13.1	14.2	14.7	15.1	15.5
10 sq miles	2.3	5.2	6.6	9.7	13.1	14.2	14.7	15.1	15.5
100 sq miles	2.1	4.8	6.0	9.0	12.1	13.7	14.4	14.7	15.0
200 sq miles	2.0	4.4	5.8	8.6	12.0	13.2	14.1	14.1	14.5
500 sq miles	1.7	3.9	5.5	8.3	11.4	12.6	13.6	13.8	14.2
1000 sq miles	1.5	3.2	5.1	7.7	10.9	12.2	12.9	13.3	13.6
2000 sq miles	1.4	3.1	4.7	7.3	10.4	11.8	12.5	12.7	13.0
5000 sq miles	1.1	2.5	4.0	6.6	9.5	10.8	11.7	11.9	12.1
10000 sq miles	0.9	2.0	3.5	5.8	8.4	9.6	10.8	10.9	11.2
20000 sq miles	0.8	1.7	2.8	4.7	6.9	8.1	9.2	9.7	10.0

Adjusted Storm Depth-Area-Duration

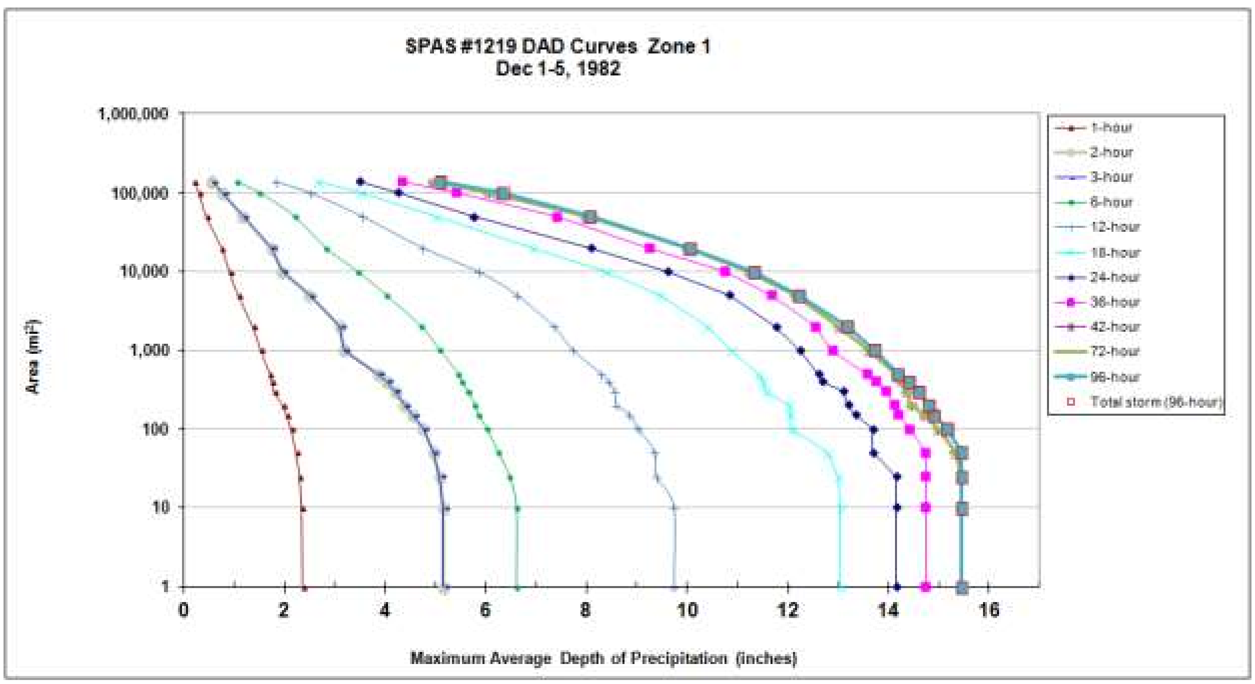
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	1.8	3.9	5.1	7.4	10.0	10.8	11.3	11.5	11.8
10 sq miles	1.8	3.9	5.1	7.4	10.0	10.8	11.3	11.5	11.8
100 sq miles	1.6	3.6	4.6	6.9	9.2	10.5	11.0	11.3	11.5
200 sq miles	1.5	3.4	4.4	6.6	9.2	10.1	10.8	10.8	11.1
500 sq miles	1.3	3.0	4.2	6.3	8.7	9.6	10.4	10.6	10.8
1000 sq miles	1.2	2.4	3.9	5.9	8.3	9.4	9.9	10.2	10.4
2000 sq miles	1.0	2.4	3.6	5.6	8.0	9.0	9.6	9.7	9.9
5000 sq miles	0.8	1.9	3.1	5.1	7.2	8.3	8.9	9.1	9.3
10000 sq miles	0.7	1.5	2.6	4.5	6.4	7.3	8.2	8.4	8.6
20000 sq miles	0.6	1.3	2.2	3.6	5.3	6.2	7.1	7.4	7.7

Storm or Storm Center Name	**Big Fork, AR SPAS 1219**	
Storm Date(s)	Dec 1-5, 1982	
Storm Type	Synoptic	
Storm Location	35.87 N	92.12 W
Storm Center Elevation	750	
Precipitation Total & Duration	15.45 Inches 72-hours	
Storm Representative Dew Point	72.0 F	24
Storm Representative Dew Point Location	30.00 N	93.68 W
Maximum Dew Point	73.0 F	
Moisture Inflow Vector	SSW @ 415	Miles
In-place Maximization Factor	**1.05**	
Temporal Transposition (Date)	15-Nov	
Transposition Dew Point Location	36.86 N	94.27 W
Transposition Maximum Dew Point	67.0 F	
Transposition Adjustment Factor	**0.73**	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**0.77**	

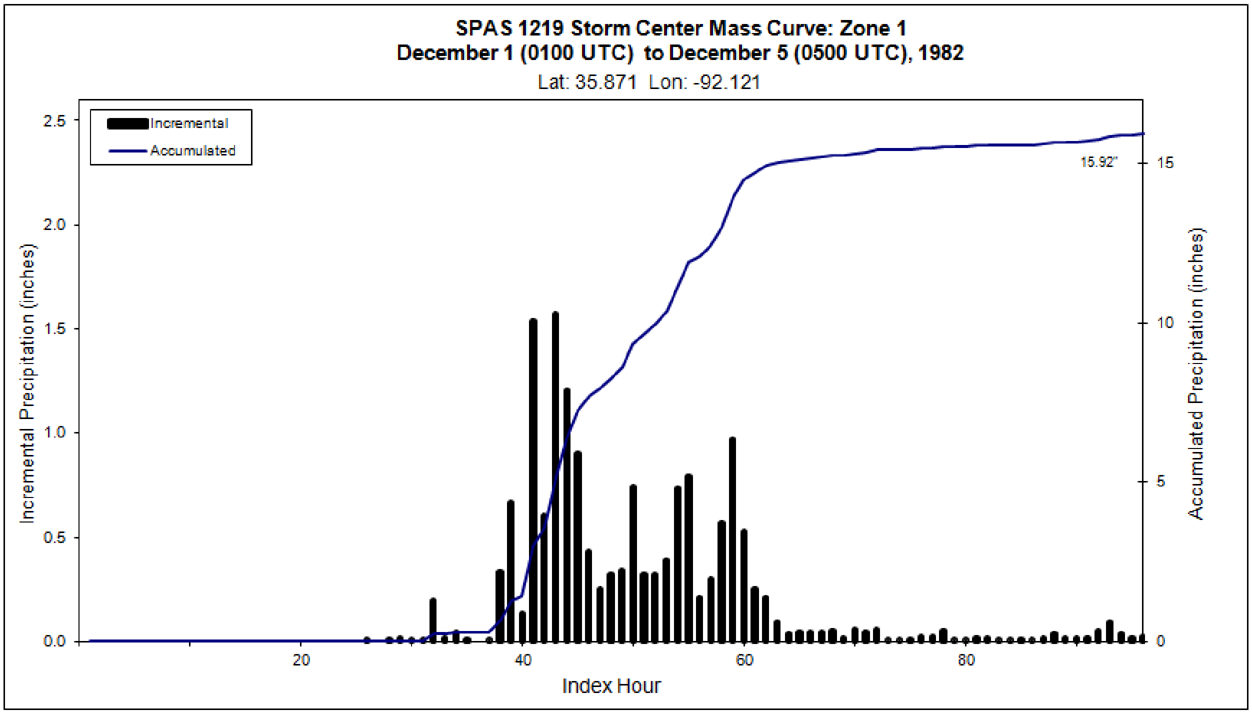
Appendix F: Table F.34: Storm spreadsheet for Big Fork, AR, December 1, 1982

Storm 1219 - Dec 1 (0100 UTC) - Dec 5 (0500 UTC), 1982											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	Total
0.3	2.41	5.36	6.75	10	13.44	14.58	15.16	15.51	15.92	15.92	15.92
1	2.36	5.16	6.6	9.73	13.05	14.15	14.73	15.09	15.45	15.45	15.45
10	2.34	5.16	6.6	9.73	13.05	14.15	14.73	15.09	15.45	15.45	15.45
25	2.3	5.09	6.46	9.38	13	14.15	14.73	15.09	15.45	15.45	15.45
50	2.23	4.96	6.24	9.35	12.77	13.68	14.73	15.01	15.32	15.45	15.45
100	2.13	4.75	6.02	9.02	12.07	13.68	14.41	14.73	14.98	15.16	15.16
150	2.04	4.55	5.84	8.86	12.05	13.34	14.19	14.5	14.71	14.9	14.90
200	1.96	4.38	5.78	8.59	12.02	13.18	14.12	14.12	14.45	14.8	14.80
300	1.79	4.2	5.64	8.55	11.57	13.09	13.94	14.02	14.35	14.6	14.60
400	1.75	4.03	5.53	8.43	11.51	12.68	13.75	13.92	14.25	14.4	14.40
500	1.71	3.86	5.46	8.29	11.42	12.59	13.56	13.82	14.15	14.19	14.19
1,000	1.53	3.18	5.09	7.72	10.88	12.24	12.88	13.32	13.6	13.72	13.72
2,000	1.37	3.1	4.72	7.34	10.39	11.75	12.53	12.73	13	13.17	13.17
5,000	1.08	2.49	4.02	6.61	9.46	10.83	11.67	11.9	12.14	12.22	12.22
10,000	0.91	1.95	3.45	5.84	8.37	9.6	10.75	10.94	11.23	11.33	11.33
20,000	0.75	1.73	2.81	4.74	6.92	8.07	9.24	9.69	10.01	10.05	10.05
50,000	0.45	1.16	2.2	3.55	5.01	5.75	7.39	7.67	7.97	8.07	8.07
100,000	0.3	0.76	1.5	2.5	3.5	4.25	5.4	5.97	6.05	6.3	6.35
138,276	0.2	0.55	1.05	1.82	2.66	3.49	4.34	4.72	4.95	5.1	5.10

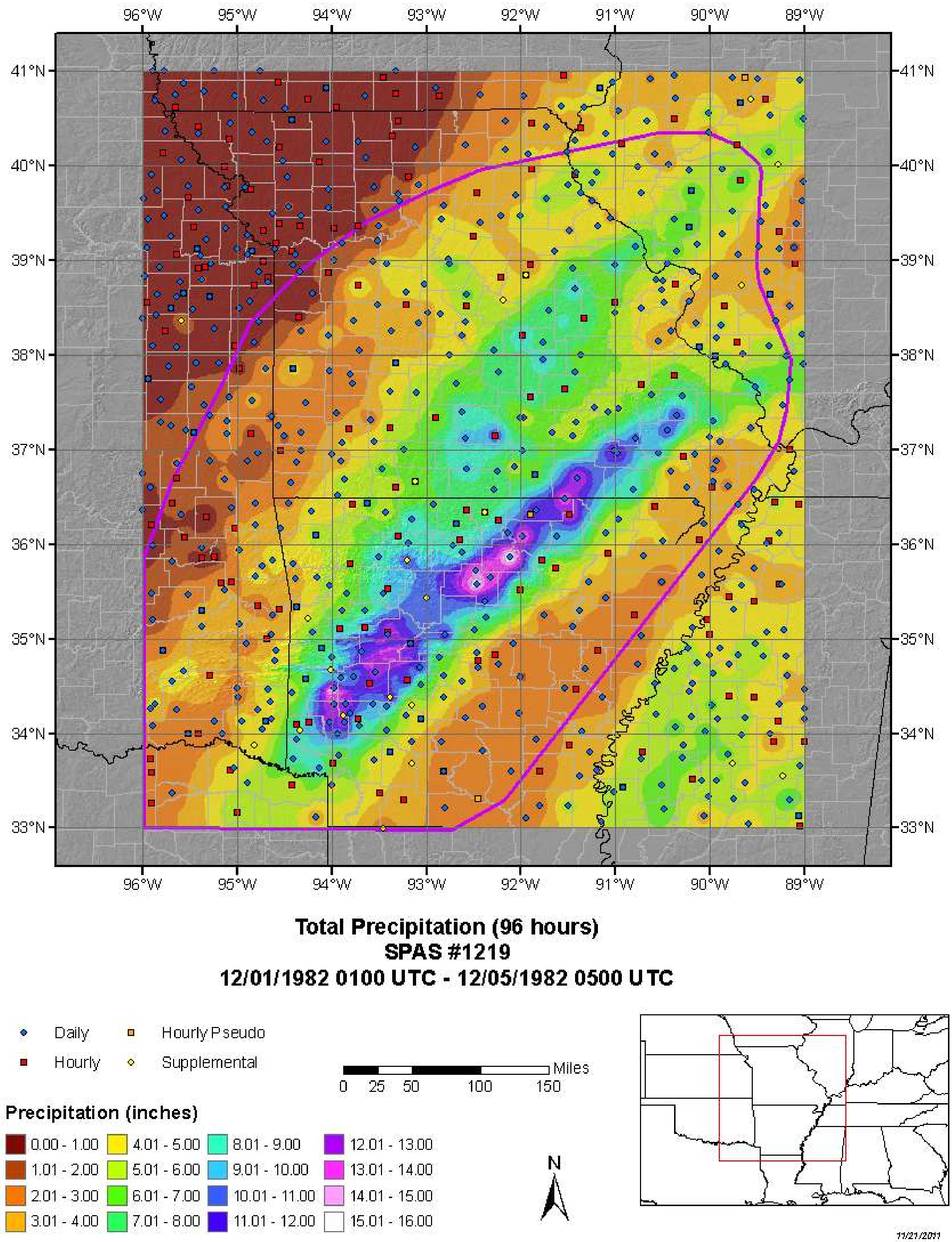
Appendix F: Table F.35: Depth-area-duration values for Big Fork, AR, December 1, 1982



Appendix F: Figure F.49: Depth-area-duration chart for Big Fork, AR, December 1, 1982



Appendix F: Figure F.50: Mass curve chart for Big Fork, AR, December 1, 1982



Appendix F: Figure F.51: Total storm isohyetal analysis for Big Fork, AR, December 1, 1982

Clyde, TX, AWA 65, SPAS 1184

October 10, 1981
Storm Type: Frontal/Tropical
Grid Points Used: 8, 10-11, 16-18

Storm Name:	SPAS 1184-Clyde, TX		**Storm Adjustment for ANO Grid Point 8**
Storm Date:	10/10-14/1981		
AWA Analysis Date:	12/13/2013		

Temporal Transposition Date	25-Sep	
	Lat	Long
Storm Center Location	32.48 N	99.48 W
Storm Rep Dew Point Location	29.50 N	97.00 W
Transposition Dew Point Location	39.68 N	89.83 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SE @ 255	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,900	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of		2.99	inches.
The in-place maximum dew point is	77.5 F	with total precipitable water above sea level of		3.22	inches.
The transpositioned maximum dew point is	74.0 F	with total precipitable water above sea level of		2.73	inches.
The in-place storm elevation is	1,900	which subtracts	0.48	inches of precipitable water at	76.0 F
The in-place storm elevation is	1,900	which subtracts	0.50	inches of precipitable water at	77.5 F
The transposition storm elevation at	1,200	which subtracts	0.24	inches of precipitable water at	74.0 F
The Grid Point/inflow barrier height is	1,000	which subtracts	0.24	inches of precipitable water at	74.0 F

The in-place maximization factor is	1.08
The transposition factor is	0.92
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	0.99

Notes:

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.1	14.2	-	18.1	-	21.7	22.3	-	22.4
100 sq miles	8.8	12.5	-	15.7	-	19.5	20.4	-	20.6
200 sq miles	7.8	11.5	-	14.6	-	18.6	19.6	-	19.8
500 sq miles	6.7	9.9	-	13.0	-	16.7	17.8	-	17.9
1000 sq miles	5.7	9.2	-	12.5	-	15.5	17.1	-	17.5
2000 sq miles	5.0	8.4	-	10.9	-	14.2	15.8	-	16.7
5000 sq miles	4.1	7.0	-	9.4	-	13.0	14.4	-	14.8
10000 sq miles	3.5	5.9	-	8.1	-	11.5	13.0	-	13.3
20000 sq miles	2.6	4.7	-	6.8	-	9.2	10.6	-	11.0

Adjusted Storm Depth-Area-Duration

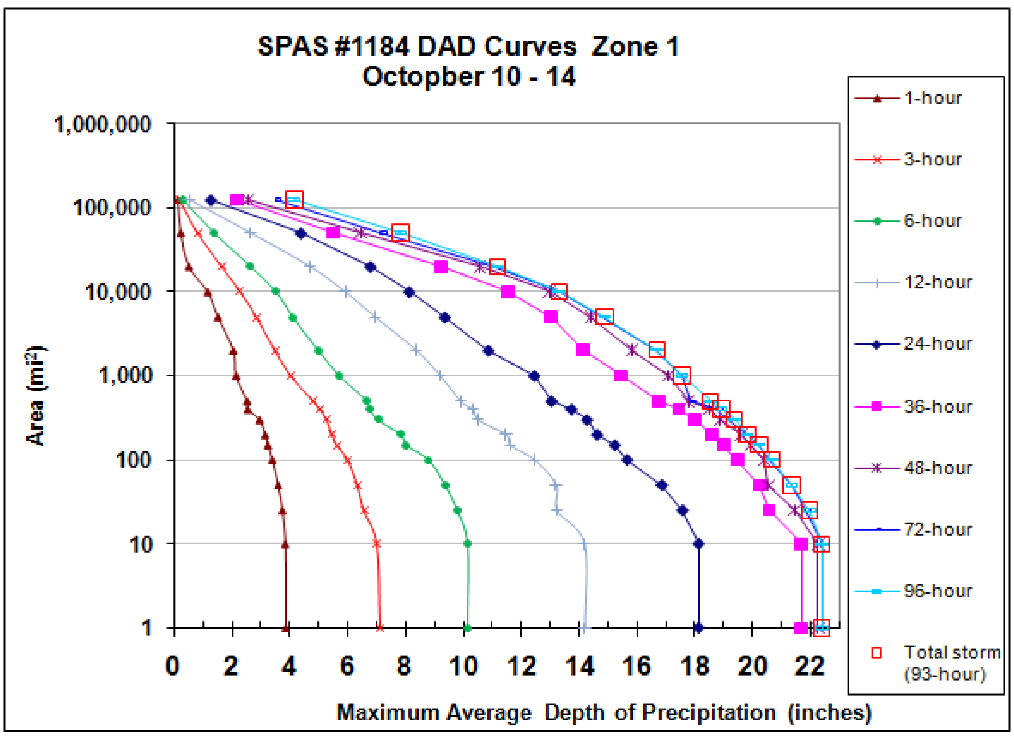
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.1	14.1	-	18.0	-	21.5	22.1	-	22.2
100 sq miles	8.7	12.4	-	15.5	-	19.3	20.2	-	20.4
200 sq miles	7.8	11.4	-	14.5	-	18.4	19.4	-	19.7
500 sq miles	6.6	9.8	-	12.9	-	16.6	17.6	-	17.7
1000 sq miles	5.7	9.1	-	12.4	-	15.3	16.9	-	17.4
2000 sq miles	4.9	8.3	-	10.8	-	14.0	15.7	-	16.5
5000 sq miles	4.1	6.9	-	9.3	-	12.9	14.3	-	14.7
10000 sq miles	3.5	5.9	-	8.1	-	11.4	12.9	-	13.2
20000 sq miles	2.6	4.7	-	6.7	-	9.1	10.5	-	10.9

Storm or Storm Center Name	**SPAS 1184-Clyde, TX**			
Storm Date(s)	10/10-14/1981			
Storm Type	General Storm			
Storm Location	32.48 N	99.48 W		
Storm Center Elevation	1900			
Precipitation Total & Duration (10 sq mi)	23.23 inches in 93hrs, 22.4 inches in 72hrs			
Storm Representative Dew Point	76.0 F	24		
Storm Representative Dew Point Location	29.50 N	97.00 W	S	O
Maximum Dew Point	77.5 F		78	77
Moisture Inflow Vector	SE @ 255			
In-place Maximization Factor	**1.08**			
Temporal Transposition (Date)	25-Sep			
Transposition Dew Point Location	39.68 N	89.83 W	S	O
Transposition Maximum Dew Point	74.0 F		75	72.5
Transposition Adjustment Factor	**0.92**			
Grid Point Elevation	1,200			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**0.99**			

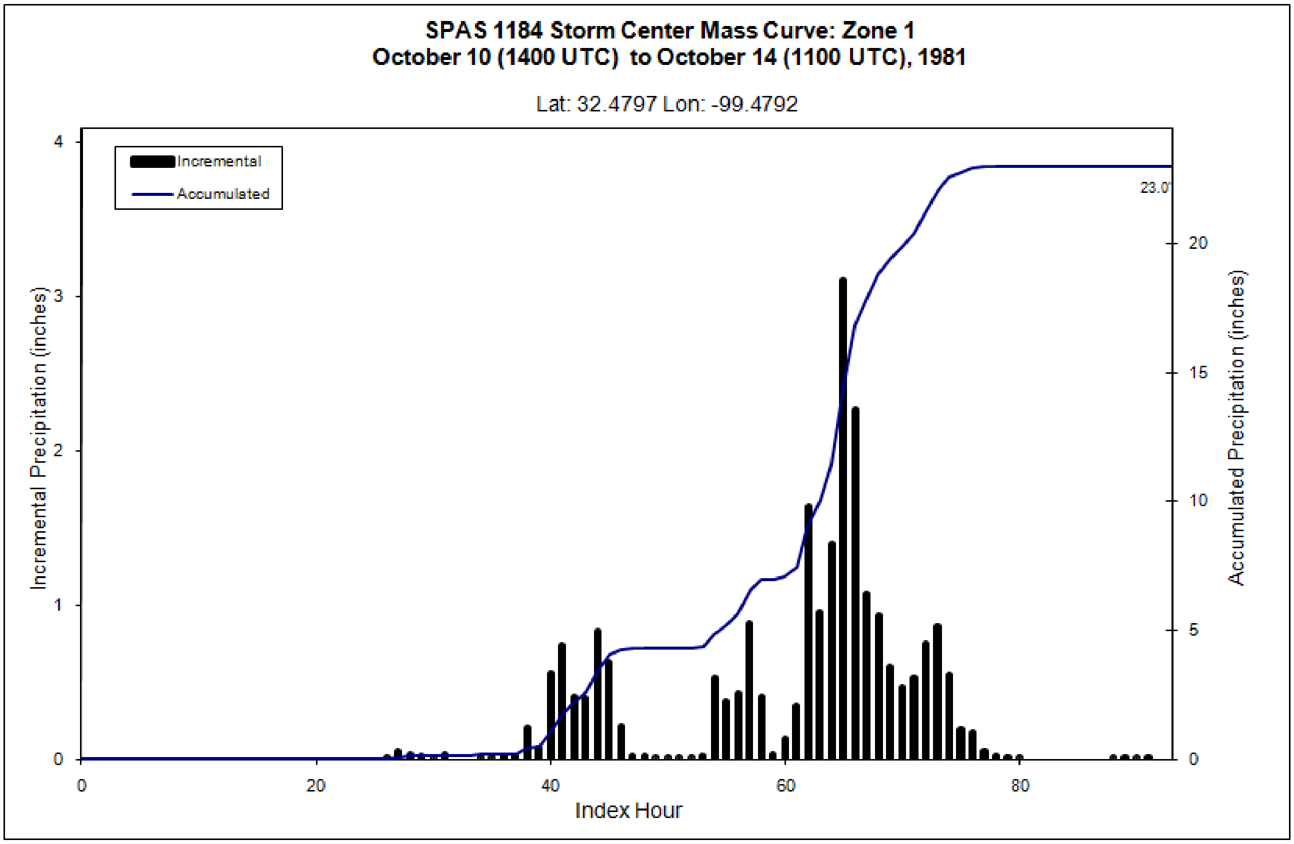
Appendix F: Table F.36: Storm spreadsheet for Clyde, TX, October 10, 1981

Storm 1184 - October 10 (1400 UTC) to October 14 (1100 UTC), 1981 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi²)	1	3	6	12	24	36	48	72	93	Total
0.30	3.97	7.32	10.44	14.56	18.64	22.27	22.88	23.00	23.00	23.00
1	3.87	7.14	10.14	14.19	18.13	21.69	22.26	22.39	22.39	22.39
10	3.85	7.02	10.14	14.18	18.13	21.69	22.26	22.39	22.39	22.39
25	3.75	6.57	9.78	13.23	17.58	20.59	21.45	21.81	21.96	21.96
50	3.60	6.34	9.36	13.20	16.86	20.24	20.54	21.34	21.36	21.36
100	3.40	6.01	8.79	12.46	15.66	19.48	20.40	20.60	20.66	20.66
150	3.25	5.64	8.04	11.62	15.23	19.00	19.93	20.22	20.22	20.22
200	3.15	5.46	7.83	11.47	14.62	18.59	19.60	19.81	19.81	19.81
300	2.96	5.28	7.05	10.50	14.27	18.00	18.89	19.08	19.37	19.37
400	2.55	5.04	6.75	10.32	13.73	17.43	18.51	18.76	18.93	18.93
500	2.53	4.81	6.66	9.90	13.04	16.74	17.78	17.86	18.55	18.55
1,000	2.15	4.04	5.71	9.19	12.45	15.47	17.08	17.53	17.56	17.56
2,000	2.05	3.49	4.98	8.37	10.86	14.16	15.83	16.65	16.69	16.69
5,000	1.53	2.85	4.10	6.95	9.35	13.03	14.42	14.83	14.89	14.89
10,000	1.17	2.29	3.52	5.91	8.12	11.53	12.97	13.28	13.31	13.31
20,000	0.52	1.64	2.64	4.69	6.78	9.21	10.56	11.00	11.17	11.17
50,000	0.24	0.81	1.38	2.64	4.37	5.50	6.45	7.14	7.83	7.83
124,876	0.14	0.19	0.30	0.53	1.26	2.18	2.56	3.48	4.14	4.15

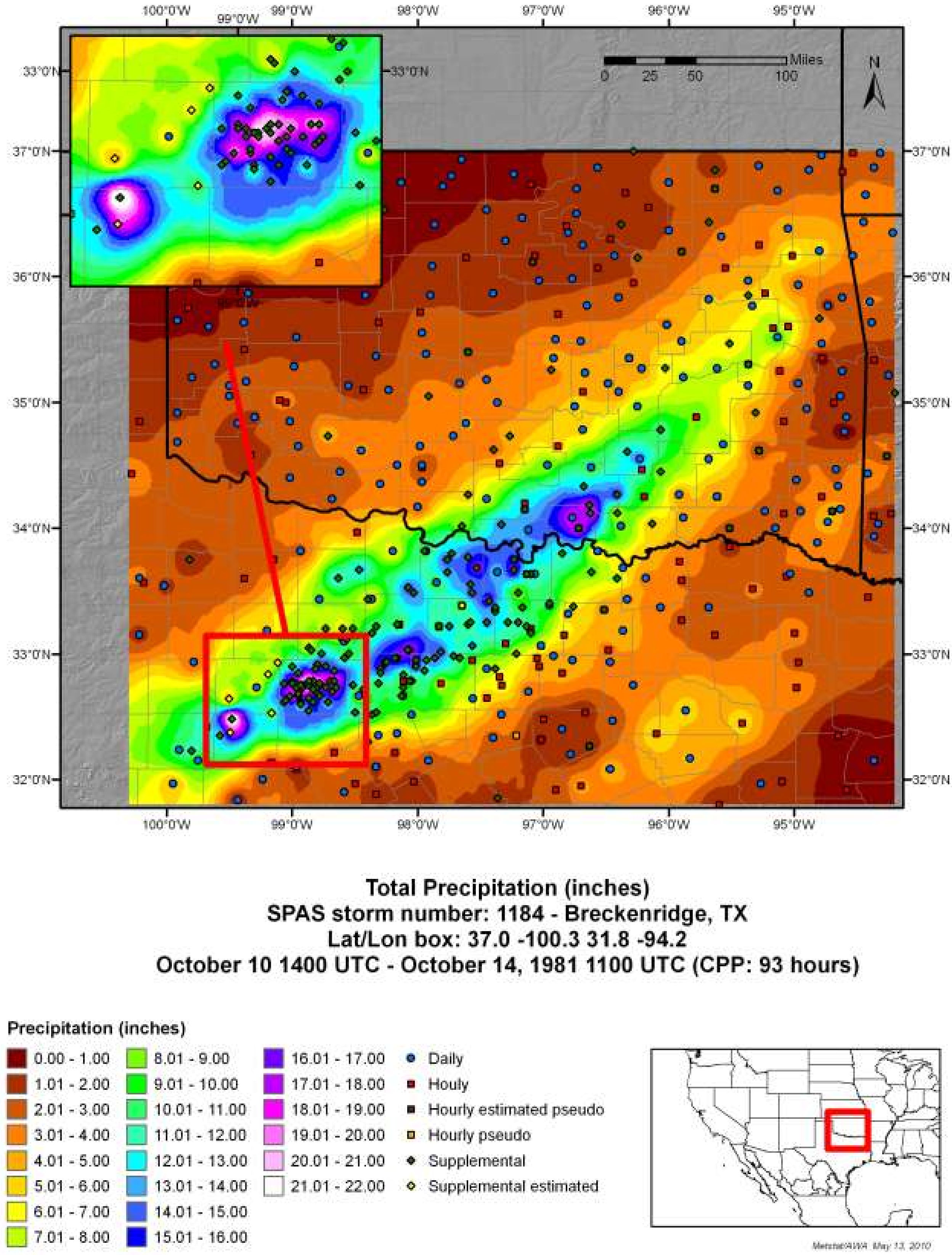
Appendix F: Table F.37: Depth-area-duration values for Clyde, TX, October 10, 1981



Appendix F: Figure F.52: Depth-area-duration chart for Clyde, TX, October 10, 1981



Appendix F: Figure F.53: Mass curve chart for Clyde, TX, October 10, 1981



Appendix F: Figure F.54: Total storm isohyetal analysis for Clyde, TX, October 10, 1981

Frijole Creek, CO, AWA 17

July 3, 1981

Storm Type: Thunderstorm

Grid Points Used: 6, 13, 15, 21

Storm Name:	SPAS 1247 Frijole Creek, CO	Storm Adjustment for ANO Grid Point 6
Storm Date:	7/2-5/1981	
AWA Analysis Date:	12/20/2013	

Temporal Transposition Date	20-Jul	
	Lat	Long
Storm center location	37.10 N	104.40 W
Storm Rep dew point location	35.40 N	104.45 W
Transposition dewpoint location	33.70 N	104.50 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	S @ 120	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	6,550	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum dew point is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The transpositioned maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	6,550	which subtracts	1.45	inches of precipitable water at	77.0 F	
The in-place storm elevation is	6,550	which subtracts	1.58	inches of precipitable water at	79.5 F	
The transposition basin elevation at	4,400	which subtracts	1.16	inches of precipitable water at	80.0 F	
The Grid Point/inflow barrier height is	4,400	which subtracts	1.16	inches of precipitable water at	80.0 F	

The in-place storm maximization factor is	1.15
The transposition/elevation to basin factor is	1.26
The barrier adjustment factor is	1.00
The total adjustment factor is	1.44

Notes: Storm rep dew point taken from the 6hr average at KTCC, KLVS, and KABQ July 1 11Z to 23Z.

Observed Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	18 Hours	24 Hours
1 sq miles	6.0	12.1	14.4	16.0	16.0	16.0	16.0	16.1	16.1
10 sq miles	5.6	11.2	13.3	14.9	14.9	14.9	14.9	14.9	14.9
100 sq miles	3.5	6.9	8.3	9.5	9.5	9.5	9.5	9.5	9.5
200 sq miles	2.8	5.5	6.7	7.7	7.7	7.7	7.8	7.9	7.9
500 sq miles	2.0	4.0	4.7	5.6	5.6	5.6	5.7	5.8	5.9
1000 sq miles	1.4	2.8	3.2	4.2	4.2	4.3	4.3	4.4	4.4
2000 sq miles	0.4	0.9	1.4	1.6	1.6	1.7	1.7	2.1	2.4
5000 sq miles	0.2	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9
10000 sq miles	0.2	0.5	0.5	0.7	0.7	0.7	0.8	0.8	0.8
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Adjusted Storm Depth-Area-Duration

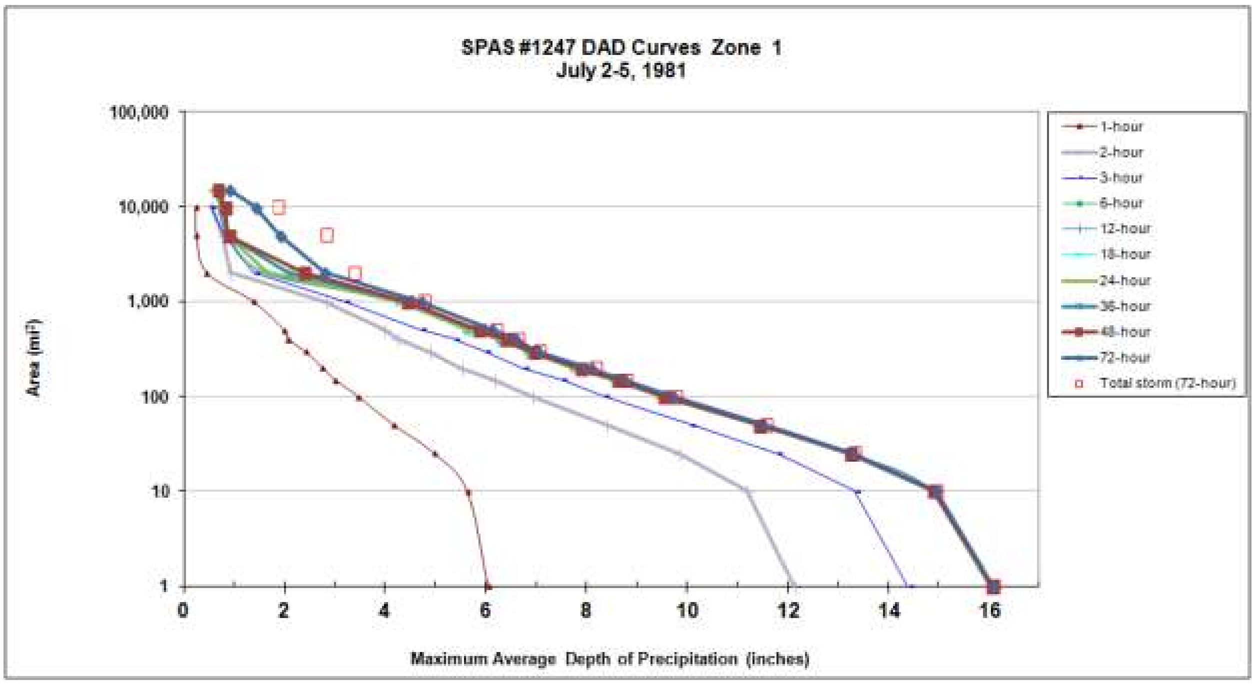
	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	18 Hours	24 Hours
1 sq miles	8.7	17.5	20.8	23.1	23.1	23.1	23.1	23.2	23.2
10 sq miles	8.1	16.2	19.2	21.5	21.5	21.5	21.5	21.5	21.5
100 sq miles	5.0	10.0	12.0	13.6	13.7	13.7	13.7	13.8	13.8
200 sq miles	4.0	8.0	9.7	11.1	11.2	11.2	11.2	11.3	11.4
500 sq miles	2.9	5.7	6.8	8.1	8.1	8.1	8.2	8.4	8.4
1000 sq miles	2.0	4.0	4.6	6.1	6.1	6.1	6.2	6.4	6.4
2000 sq miles	0.6	1.3	2.0	2.2	2.4	2.4	2.4	3.0	3.4
5000 sq miles	0.3	1.1	1.1	1.2	1.3	1.3	1.3	1.3	1.3
10000 sq miles	0.3	0.8	0.8	1.0	1.0	1.1	1.1	1.1	1.2
20000 sq miles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Storm or Storm Center Name	SPAS 1247 Frijole Creek, CO			
Storm Date(s)	7/2-5/1981			
Storm Type	Convective			
Storm Location	37.10 N	104.40 W		
Storm Center Elevation	6,550			
Precipitation Total & Duration	16.08 Inches 72-hours			
Storm Representative Dewpoint	77.0 F	6		
Storm Representative Dewpoint Location	35.40 N	104.45 W	Jul	Aug
Maximum Dewpoint	79.5 F		79.51	79.59
Moisture Inflow Vector	S @ 120			
In-place Maximization Factor	1.15			
Temporal Transposition (Date)	20-Jul			
Transposition Dewpoint Location	33.70 N	104.50 W	Jul	Aug
Transposition Maximum Dewpoint	80.0 F		80	80
Transposition Adjustment Factor	1.26			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.44			

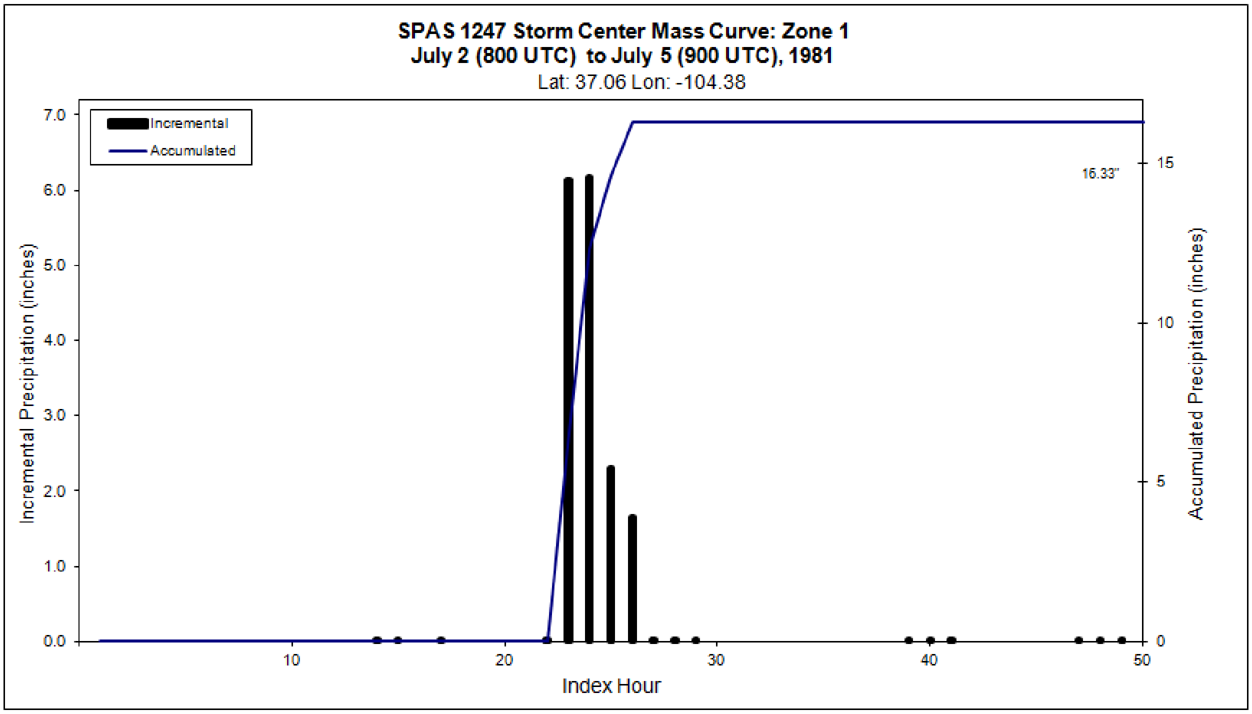
Appendix F: Table F.38: Storm spreadsheet for Frijole Creek, CO, July 3, 1981

Storm 1247 - July 2 (8 UTC) - July 5 (7 UTC), 1981 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
	Duration (hours)											
Area (mi^2)	1	2	3	4	5	6	12	18	24	48	72	Total
0.3	6.17	12.30	14.60	16.26	16.27	16.27	16.28	16.30	16.30	16.33	16.33	16.33
1	6.04	12.12	14.39	16.02	16.03	16.03	16.03	16.05	16.05	16.08	16.08	16.08
10	5.63	11.19	13.32	14.86	14.87	14.87	14.88	14.88	14.88	14.93	14.94	14.94
25	4.98	9.84	11.79	13.20	13.22	13.22	13.23	13.23	13.23	13.29	13.30	13.30
50	4.17	8.38	10.07	11.35	11.40	11.41	11.41	11.41	11.42	11.52	11.55	11.55
100	3.46	6.91	8.34	9.45	9.47	9.47	9.48	9.54	9.54	9.71	9.75	9.75
150	3.00	6.15	7.51	8.50	8.53	8.53	8.56	8.59	8.62	8.74	8.77	8.77
200	2.75	5.52	6.73	7.70	7.73	7.73	7.76	7.85	7.87	8.08	8.16	8.16
300	2.40	4.88	5.99	6.80	6.83	6.84	6.85	6.88	6.94	7.03	7.04	7.04
400	2.06	4.24	5.36	6.19	6.23	6.23	6.26	6.33	6.39	6.57	6.61	6.61
500	1.98	3.98	4.71	5.58	5.62	5.62	5.66	5.79	5.85	6.11	6.18	6.18
1,000	1.36	2.80	3.20	4.20	4.24	4.25	4.29	4.40	4.44	4.71	4.77	4.77
2,000	0.44	0.91	1.39	1.55	1.63	1.65	1.65	2.07	2.37	2.80	3.38	3.38
5,000	0.24	0.76	0.79	0.86	0.87	0.87	0.88	0.88	0.88	1.91	2.81	2.81
10,000	0.23	0.53	0.53	0.70	0.72	0.73	0.75	0.77	0.81	1.41	1.86	1.86
15,205	0.18	0.35	0.46	0.53	0.56	0.57	0.59	0.67	0.67	0.90	0.90	0.90

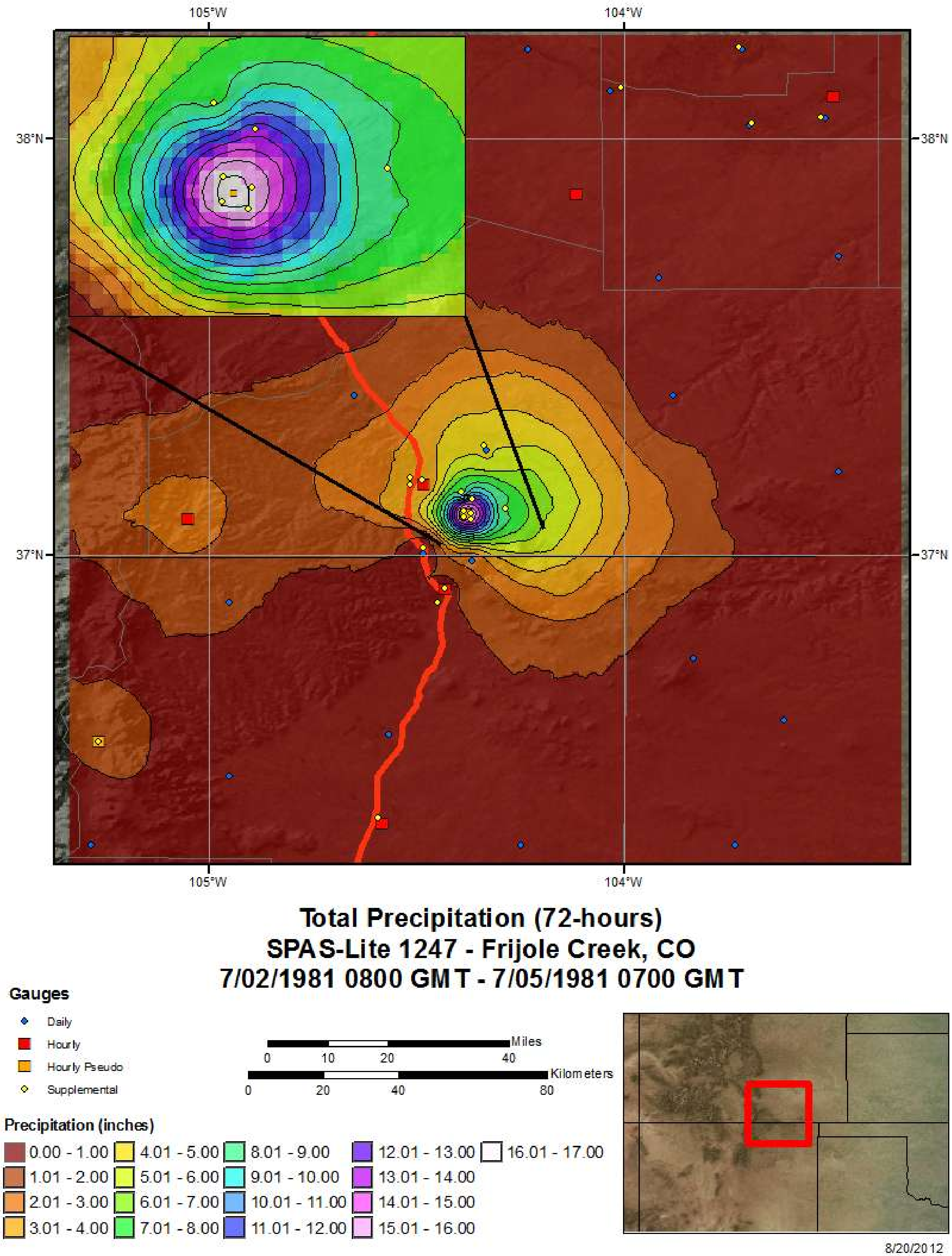
Appendix F: Table F.39: Depth-area-duration values for Frijole Creek, CO, July 3, 1981



Appendix F: Figure F.55: Depth-area-duration chart for Frijole Creek, CO, July 3, 1981



Appendix F: Figure F.56: Mass curve chart for Frijole Creek, CO, July 3, 1981



Appendix F: Figure F.57: Total storm isohyetal analysis for Frijole Creek, CO, July 3, 1981

Albany, TX AWA 18

August 3, 1978

Storm Type: Frontal/Tropical

Grid Points Used: 2-4

Storm Name:	SPAS 1179 Amelia- Albany, TX	**Storm Adjustment for ANO Grid Point 2**
Storm Date:	8/1-5/1978	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm center location	32.74 N	99.33 W
Storm Rep SST location	29.30 N	97.50 W
Transposition Dew Point Location	31.08 N	93.65 W
Grid Point location	34.50 N	95.50 W

Moisture Inflow Direction:	SSE @ 260	miles
Grid Point Elevation	550	feet
Storm Center Elevation	1,500	feet
Storm Rep Analysis Duration	12	hours

The storm representative SST is	78.0 F	with total precipitable water above sea level of		3.29	inches.
The in-place maximum SST is	80.0 F	with total precipitable water above sea level of		3.60	inches.
The transpositioned maximum SST is	81.0 F	with total precipitable water above sea level of		3.76	inches.
The in-place storm elevation is	1,500	which subtracts	0.41	inches of precipitable water at	78.0 F
The in-place storm elevation is	1,500	which subtracts	0.43	inches of precipitable water at	80.0 F
The transposition storm elevation at	550	which subtracts	0.175	inches of precipitable water at	81.0 F
The grid point/inflow barrier height is	550	which subtracts	0.175	inches of precipitable water at	81.0 F

The in-place maximization factor is	1.10
The transposition factor is	1.13
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.24

Notes: Storm Rep Td taken from ave of KSJT, KJCT, KATT, KSAT

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	20.8	26.4	-	29.7	-	31.4	31.5	-	31.6
100 sq miles	15.3	23.8	-	27.6	-	29.2	29.4	-	29.5
200 sq miles	10.3	20.9	-	24.4	-	26.6	26.8	-	27.0
500 sq miles	8.4	16.0	-	19.0	-	20.9	23.1	-	23.4
1000 sq miles	6.6	12.6	-	15.8	-	18.4	20.8	-	21.0
2000 sq miles	4.7	7.5	-	12.2	-	15.7	17.4	-	17.7
5000 sq miles	2.7	4.2	-	7.8	-	8.5	12.0	-	13.2
10000 sq miles	1.9	3.2	-	5.1	-	7.5	8.8	-	9.6
20000 sq miles	1.3	2.3	-	3.4	-	3.7	4.3	-	6.7

Adjusted Storm Depth-Area-Duration

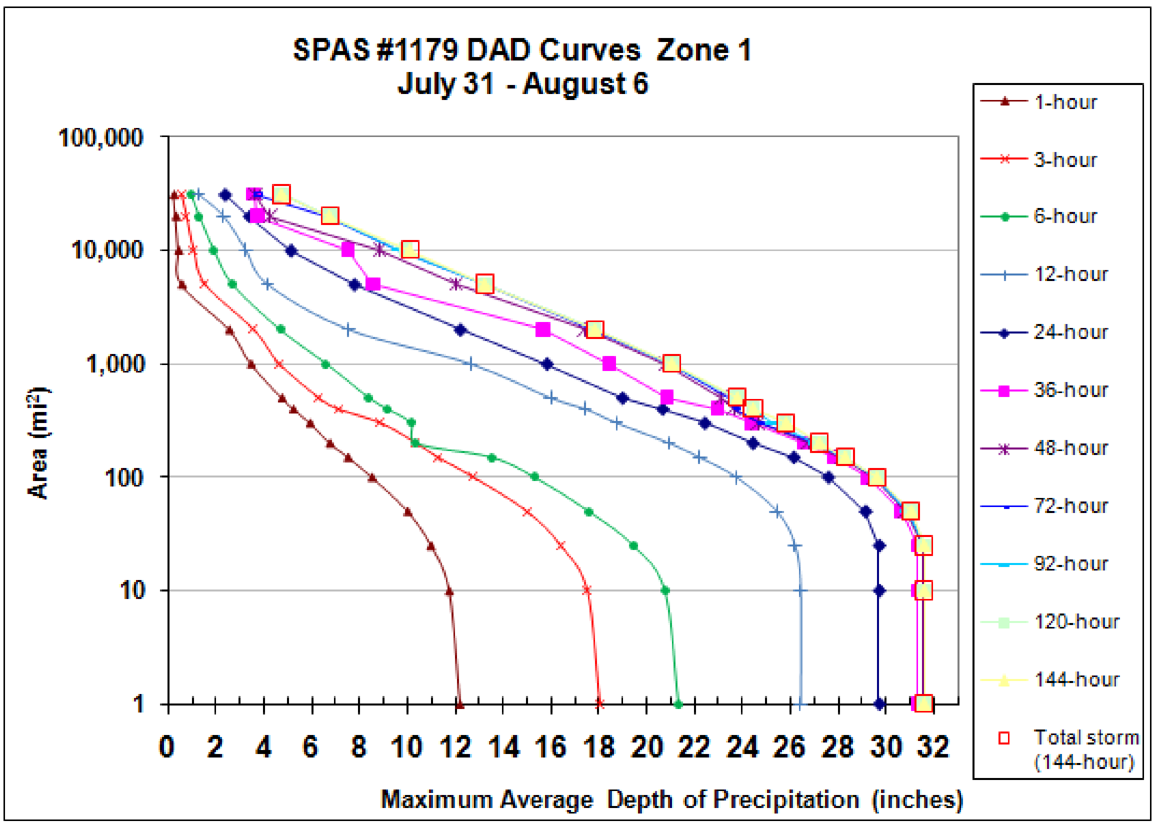
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	25.8	32.9	-	37.0	-	39.0	39.2	-	39.3
100 sq miles	19.1	29.6	-	34.3	-	36.4	36.6	-	36.7
200 sq miles	12.9	26.1	-	30.4	-	33.1	33.3	-	33.6
500 sq miles	10.5	19.9	-	23.6	-	26.0	28.8	-	29.1
1000 sq miles	8.2	15.7	-	19.7	-	22.9	25.9	-	26.2
2000 sq miles	5.8	9.4	-	15.2	-	19.5	21.6	-	22.0
5000 sq miles	3.3	5.2	-	9.7	-	10.6	15.0	-	16.4
10000 sq miles	2.4	4.0	-	6.3	-	9.3	11.0	-	12.0
20000 sq miles	1.6	2.9	-	4.2	-	4.6	5.3	-	8.3

Storm or Storm Center Name	**SPAS 1179 Amelia- Albany, TX**		
Storm Date(s)	8/1-5/1978		
Storm Type	Remnant Tropical-Frontal		
Storm Location	32.74 N	99.33 W	
Storm Center Elevation	1500		
Precipitation Total & Duration (10 sq mi)	32.5 inches in 48 hours, 29.5 " 24 hours, 12.47" in 1hr, 21.94" in 6hrs		
Storm Representative SST	78.0 F	12	
Storm Representative SST Location	29.30 N	97.50 W	J
In-place Maximum SST	80.0 F		80
Moisture Inflow Vector	SSE @ 260		
In-place Maximization Factor			
Temporal Transposition (Date)	15-Jul		
Transposition Dewpoint Location	31.08 N	93.65 W	J
Transposition Maximum SST	81.0 F		81
Transposition Adjustment Factor			
Grid Point Elevation	550		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	**1.24**		

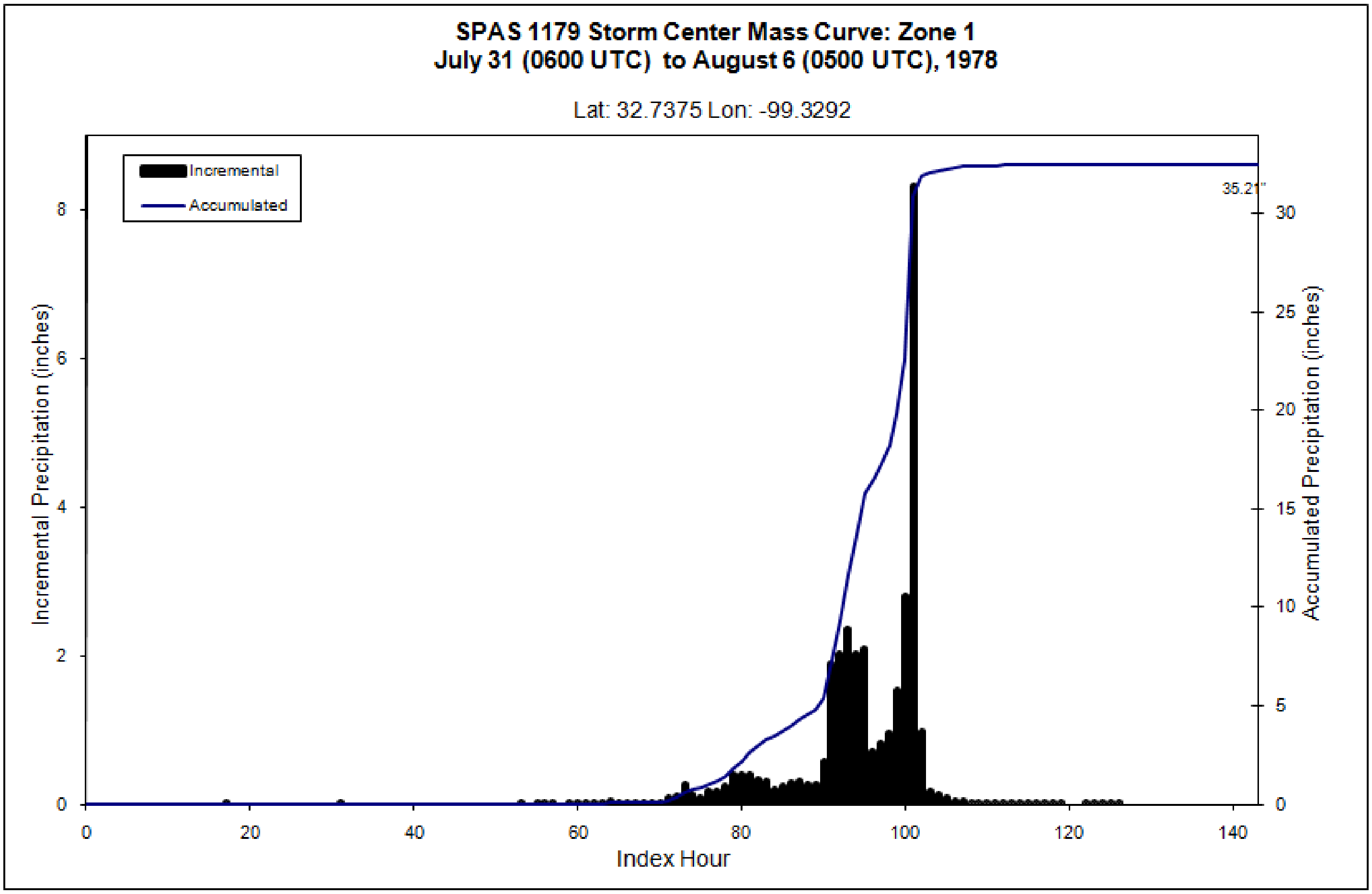
Appendix F: Table F.40: Storm spreadsheet for Albany, TX, August 3, 1978

Storm 1179 - July 31, 1978 (0600 UTC) - August 6, 1978 (0500 UTC)												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
	Duration (hours)											
Area (mi^2)	1	3	6	12	24	36	48	72	96	120	144	Total
0.30	12.47	18.53	21.94	27.16	30.54	32.22	32.41	32.50	32.51	32.51	32.51	32.51
1	12.19	18.01	21.33	26.43	29.71	31.35	31.52	31.60	31.60	31.60	31.60	31.60
10	11.74	17.48	20.76	26.43	29.71	31.35	31.52	31.60	31.60	31.60	31.60	31.60
25	10.98	16.38	19.45	26.20	29.71	31.35	31.52	31.60	31.60	31.60	31.60	31.60
50	10.00	14.97	17.59	25.44	29.14	30.67	30.83	30.91	30.91	31.06	31.06	31.06
100	8.51	12.74	15.32	23.75	27.58	29.22	29.44	29.51	29.51	29.62	29.62	29.62
150	7.51	11.25	13.52	22.20	26.13	27.86	28.13	28.26	28.27	28.27	28.29	28.29
200	6.75	10.34	10.34	20.94	24.43	26.58	26.77	27.03	27.03	27.21	27.22	27.22
300	5.92	8.87	10.15	18.76	22.41	24.40	24.66	24.69	25.23	25.77	25.83	25.83
400	5.22	7.08	9.16	17.42	20.65	22.97	23.63	23.67	24.45	24.45	24.45	24.45
500	4.74	6.28	8.40	15.98	18.97	20.85	23.11	23.41	23.78	23.78	23.79	23.79
1,000	3.45	4.62	6.61	12.63	15.81	18.43	20.77	21.03	21.04	21.05	21.06	21.06
2,000	2.54	3.55	4.67	7.54	12.19	15.66	17.39	17.66	17.78	17.82	17.84	17.84
5,000	0.55	1.52	2.68	4.15	7.76	8.54	12.04	13.19	13.21	13.22	13.23	13.23
10,000	0.42	1.04	1.91	3.24	5.10	7.50	8.83	9.63	9.65	9.94	10.11	10.11
20,000	0.30	0.74	1.29	2.31	3.38	3.71	4.25	6.67	6.74	6.75	6.75	6.75
31,010	0.22	0.54	0.95	1.27	2.35	3.57	3.63	3.63	4.74	4.75	4.75	4.75

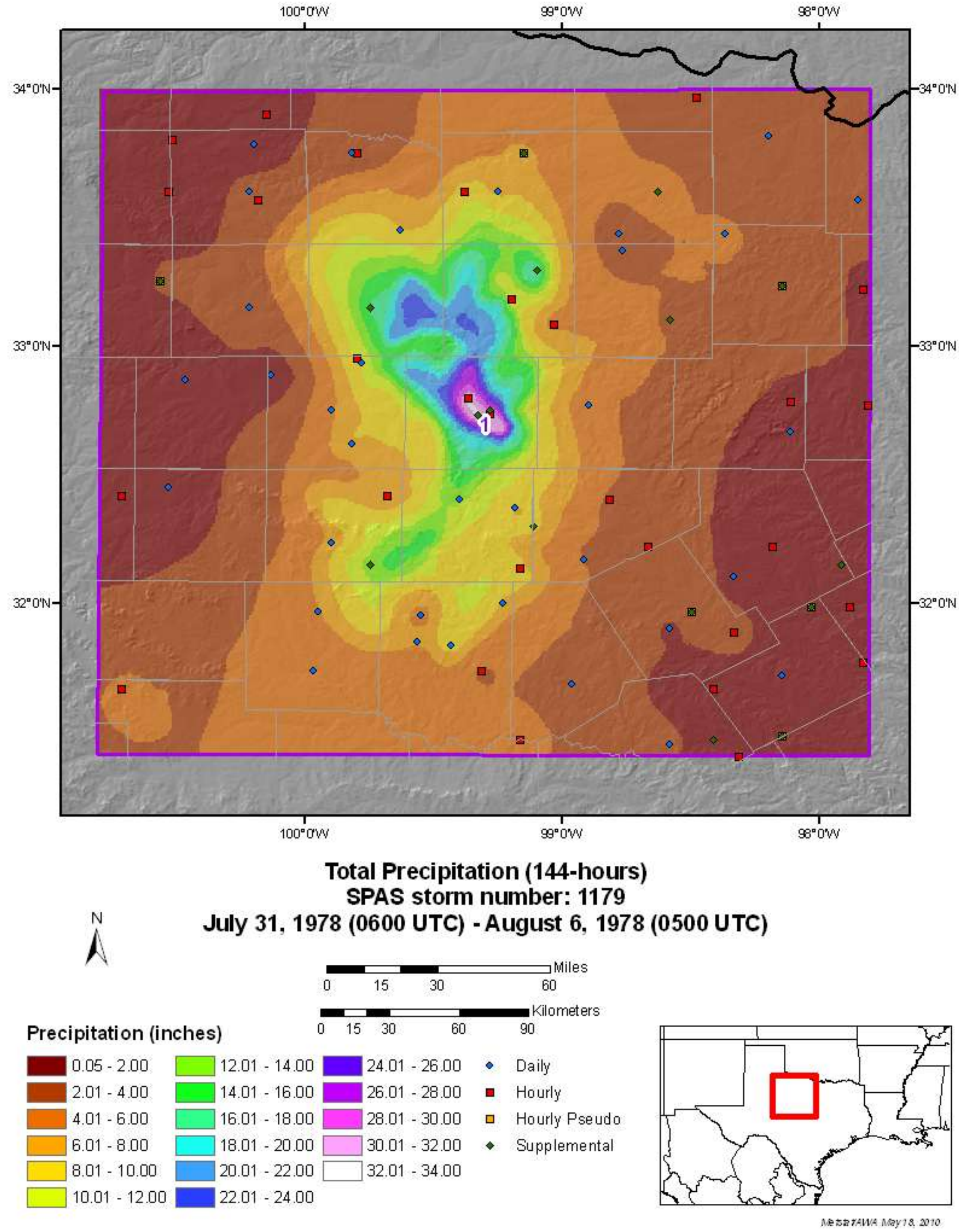
Appendix F: Table F.41: Depth-area-duration values for Albany, TX, August 3, 1978



Appendix F: Figure F.58: Depth-area-duration chart for Albany, TX, August 3, 1978



Appendix F: Figure F.59: Mass curve chart for Albany, TX, August 3, 1978



Appendix F: Figure F.60. Total storm isohyetal analysis for Albany, TX, August 3, 1978

Big Thompson Canyon, CO, AWA 19

July, 31, 1976

Storm Type: 7, 13-14, 21

Storm Name:	SPAS-1231 Big Thompson, CO	**Storm Adjustment for ANO Grid Point 7**
Storm Date:	7/31/1976 - 8/3/1976	
AWA Analysis Date:	12/20/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm center location	40.48 N	105.43 W
Storm Rep dew point location	39.80 N	102.40 W
Transposition dewpoint location	33.70 N	104.50 W
Grid Point location	36.00 N	105.50 W

Moisture Inflow Direction:	ESE @ 165	miles
Grid Point Elevation	7,500	feet
Storm Center Elevation	8,133	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The in-place maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	8,133	which subtracts	1.78	inches of precipitable water at	78.5 F	
The in-place storm elevation is	8,133	which subtracts	1.88	inches of precipitable water at	80.0 F	
The transposition basin elevation at	7,500	which subtracts	1.79	inches of precipitable water at	80.0 F	
The Grid Point/inflow barrier height is	7,500	which subtracts	1.79	inches of precipitable water at	80.0 F	

The in-place storm maximization factor is	1.09
The transposition/elevation to basin factor is	1.05
The barrier adjustment factor is	1.00
The total adjustment factor is	1.14

Notes: Used 6hr average from KGLD and KAKO. HMR55A used storm Td of 71 based on KAKO, KGLD, and KHLC, max Td value of 77 (pg 86). In-place moisture max adjustment 1.34/1.48 page 86 and 90.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	7.1	9.3	10.0	10.4	10.4	10.5	11.1	12.2	12.4
10 sq miles	6.5	8.9	9.7	10.1	10.1	10.2	10.9	11.9	12.0
100 sq miles	4.9	7.4	8.3	8.7	8.7	8.9	9.5	10.6	10.7
200 sq miles	3.9	6.1	6.9	7.4	7.5	7.5	8.2	9.2	9.3
500 sq miles	2.8	4.5	5.0	5.6	5.7	5.8	6.3	7.7	7.8
1000 sq miles	1.7	2.7	3.2	3.4	3.5	3.6	3.9	5.3	5.4
2000 sq miles	1.0	1.7	2.0	2.3	2.3	2.3	2.8	3.8	3.8
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	8.1	10.6	11.4	11.9	11.9	11.9	12.6	13.9	14.2
10 sq miles	7.4	10.1	11.0	11.5	11.5	11.6	12.4	13.6	13.7
100 sq miles	5.6	8.5	9.5	9.9	10.0	10.1	10.9	12.1	12.2
200 sq miles	4.4	7.0	7.8	8.4	8.5	8.6	9.3	10.6	10.7
500 sq miles	3.2	5.1	5.8	6.4	6.5	6.6	7.2	8.8	8.9
1000 sq miles	1.9	3.1	3.7	3.9	4.0	4.1	4.4	6.1	6.2
2000 sq miles	1.2	1.9	2.3	2.6	2.6	2.6	3.2	4.3	4.3
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**SPAS-1231 Big Thompson, CO**			
Storm Date(s)	7/31/1976 - 8/3/1976			
Storm Type	Convective			
Storm Location	40.48 N	105.43 W		
Storm Center Elevation	8133			
Precipitation Total & Duration (10 sq mi)	12.52 inches 54 hour (SPAS 1231 DAD)			
Storm Representative Dewpoint	78.5 F	6 6hr ave from KGLD and KAKO		
Storm Representative Dewpoint Location	39.80 N	102.40 W	Jul	Aug
In-place Maximum Dewpoint	80.0 F		79.98	79.57
Moisture Inflow Vector	ESE @ 165			
In-place Maximization Factor	**1.09**			
Temporal Transposition (Date)	15-Jul			
Transposition Dewpoint Location	33.70 N	104.50 W	Jul	Aug
Transposition Maximum Dewpoint	80.0 F		80	80
Transposition Adjustment Factor	**1.05**			
Grid Point Elevation	7,500			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.14**			

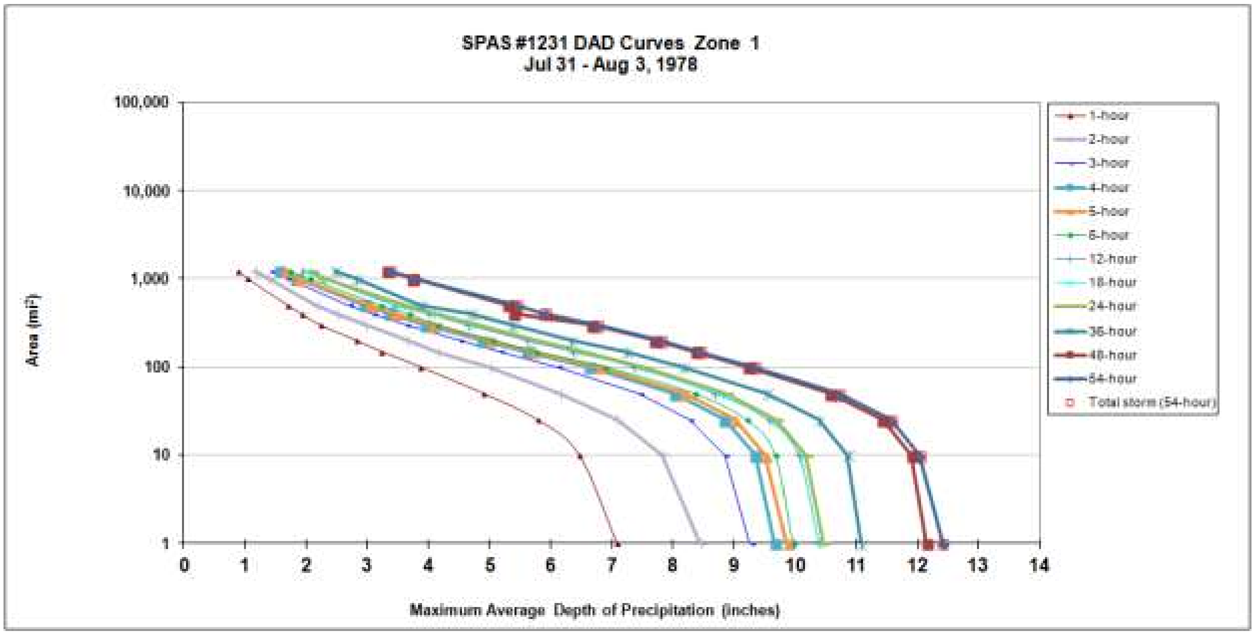
Appendix F: Table F.42: Storm spreadsheet for Big Thompson Canyon, CO, July 31, 1976

Storm 1231 - July 31 (2300 UTC) - August 3 (0500 UTC), 1978

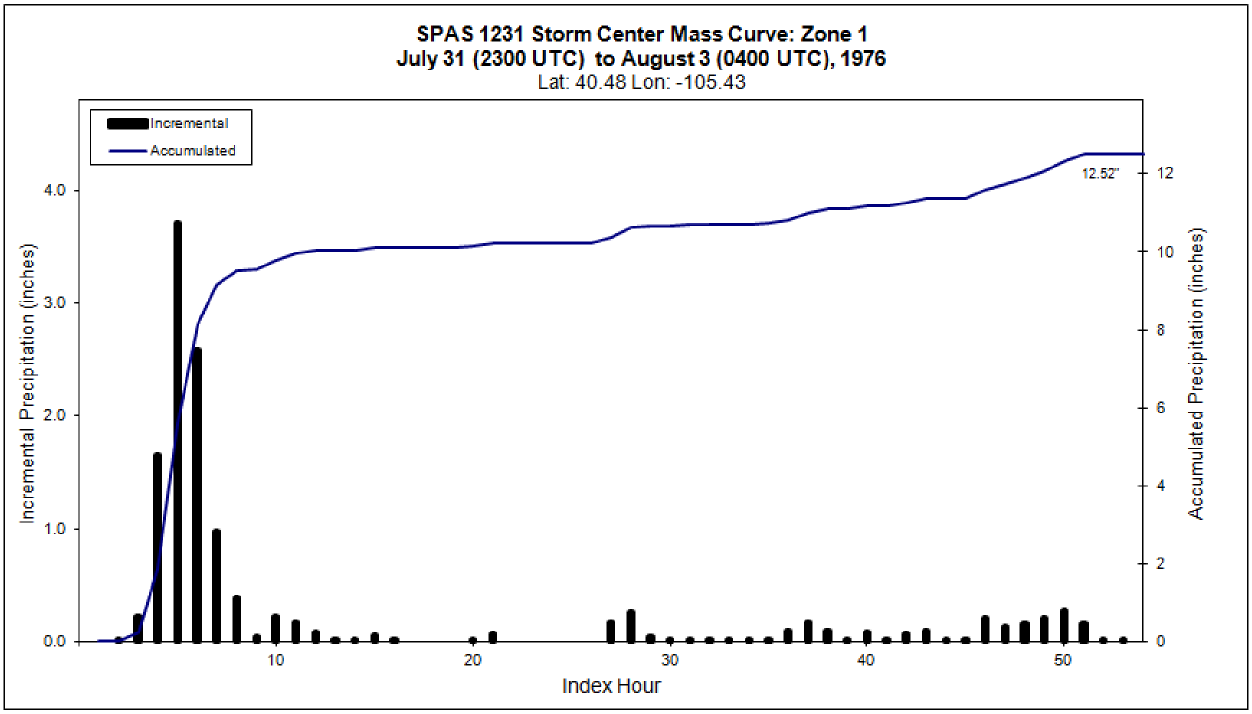
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)												
Area (mi²)	1	2	3	4	5	6	12	18	24	36	48	54	Total
0.3	7.16	8.58	9.41	9.82	9.95	10.12	10.5	10.55	10.62	11.28	12.34	12.52	12.52
1	7.08	8.45	9.26	9.67	9.86	9.95	10.38	10.38	10.45	11.07	12.15	12.41	12.41
10	6.46	7.83	8.85	9.35	9.51	9.67	10.05	10.08	10.17	10.85	11.9	12.03	12.03
25	5.78	7.08	8.26	8.84	9.02	9.2	9.56	9.64	9.69	10.38	11.42	11.56	11.56
50	4.89	6.14	7.44	8.02	8.18	8.34	8.68	8.74	8.87	9.53	10.57	10.71	10.71
100	3.87	5	6.12	6.63	6.8	6.87	7.36	7.46	7.53	8.17	9.24	9.33	9.33
150	3.23	4.14	5.16	5.6	5.73	5.75	6.34	6.43	6.55	7.23	8.37	8.43	8.43
200	2.82	3.65	4.5	4.87	5	5.04	5.61	5.68	5.75	6.32	7.7	7.79	7.79
300	2.23	2.97	3.63	3.95	4.08	4.15	4.64	4.69	4.79	5.36	6.68	6.75	6.75
400	1.92	2.5	3.08	3.36	3.45	3.67	4	4.03	4.12	4.69	5.39	5.89	5.89
500	1.69	2.16	2.69	2.95	3.04	3.21	3.44	3.47	3.63	3.87	5.3	5.43	5.43
1,000	1.04	1.37	1.67	1.83	1.87	2.04	2.27	2.27	2.27	2.81	3.75	3.75	3.75
1,220	0.88	1.16	1.42	1.56	1.66	1.72	1.94	1.99	2.1	2.47	3.33	3.37	3.37

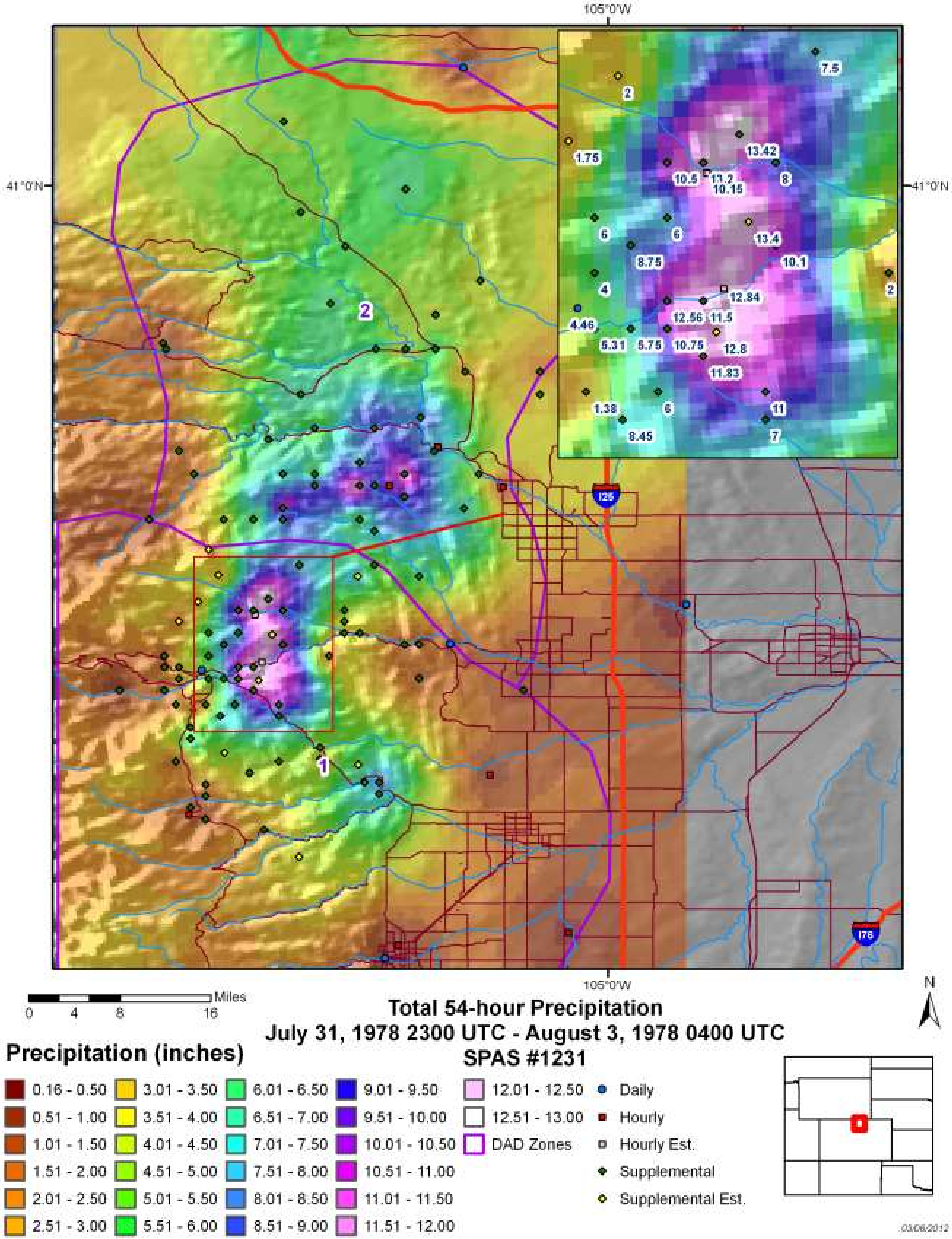
Appendix F: Table F.43: Depth-area-duration values for Big Thompson Canyon, CO, July 31, 1976



Appendix F: Figure F.61: Depth-area-duration chart for Big Thompson Canyon, CO, July 31, 1976



Appendix F: Figure F.62: Mass curve chart for Big Thompson Canyon, CO, July 31, 1976



Appendix F: Figure F.63: Total storm isohyetal analysis for Big Thompson Canyon, CO, July 31, 1976

Waterton Red Rock, Alberta, AWA 20

June 14, 1921

Storm Type: Frontal

Grid Points Used: 7, 14, 21-22

Storm Name:	SPAS 1252 Waterton Red Rocks,	**Storm Adjustment for ANO Grid Point 22**
Storm Date:	06/15-06/20/1975	
AWA Analysis Date:	9/11/2012	

Temporal Transposition Date	1-Jul	
	Lat	Long
Storm center location	49.09 N	114.05 W
Storm Rep SST location	43.15 N	99.95 W
Transposition SST location	33.33 N	94.23 W
Grid Point location	36.00 N	105.50 W

Moisture Inflow Direction:	ESE @ 810	miles
Grid Point Elevation	11,300	feet
Storm Center Elevation	8,000	feet
Storm Rep Analysis Duration	24	hours

The storm representative SST is	71.0 F	with total precipitable water above sea level of			2.36	inches.
The in-place maximum SST is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum SST is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The in-place storm elevation is	8,000	which subtracts	1.36	inches of precipitable water at	71.0 F	
The in-place storm elevation is	8,000	which subtracts	1.74	inches of precipitable water at	78.0 F	
The transposition storm elevation at	10,000	which subtracts	2.17	inches of precipitable water at	79.5 F	
The Grid point/inflow barrier height is	10,000	which subtracts	2.17	inches of precipitable water at	79.5 F	

The in-place maximization factor is	1.50
The transposition factor is	0.87
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.31

Notes: Storm rep Td value used from KMCK, KLBF, and KPIR 24hr ave and 24hr 100yr Td climatology.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	0.9	1.3	2.3	4.1	5.7	7.2	9.2	10.5	12.5
10 sq miles	0.8	1.3	2.3	4.1	5.7	7.2	9.2	10.5	12.5
100 sq miles	0.6	1.1	2.0	3.6	5.0	6.2	7.9	9.2	10.9
200 sq miles	0.4	1.0	1.8	3.4	4.3	5.7	7.3	8.5	10.1
500 sq miles	0.4	0.9	1.7	3.1	4.1	5.1	6.7	7.6	9.0
1000 sq miles	0.4	0.9	1.6	3.0	3.8	4.7	6.3	7.2	7.7
2000 sq miles	0.3	0.8	1.5	2.7	3.6	4.3	5.7	6.5	7.7
5000 sq miles	0.3	0.7	1.3	2.5	3.1	3.8	4.9	5.6	6.1
10000 sq miles	0.3	0.6	1.2	2.2	2.7	3.2	4.1	4.7	5.0
20000 sq miles	0.2	0.5	1.0	1.8	2.1	2.5	3.2	3.6	3.9

Adjusted Storm Depth-Area-Duration

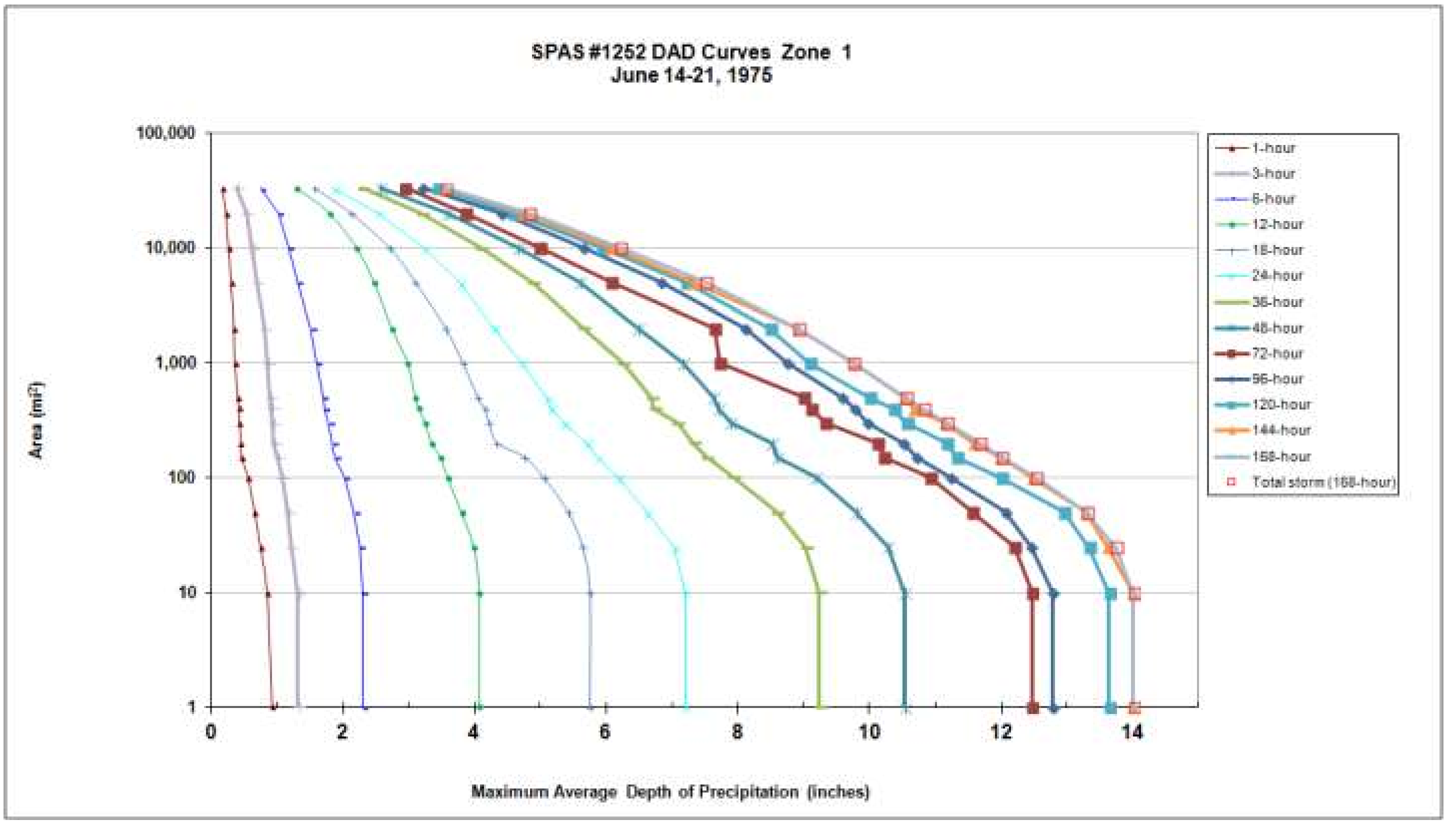
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	1.2	1.7	3.0	5.3	7.5	9.4	12.1	13.8	16.3
10 sq miles	1.1	1.7	3.0	5.3	7.5	9.4	12.1	13.8	16.3
100 sq miles	0.7	1.4	2.6	4.7	6.6	8.1	10.4	12.0	14.3
200 sq miles	0.6	1.2	2.4	4.4	5.7	7.4	9.6	11.1	13.2
500 sq miles	0.5	1.2	2.2	4.1	5.3	6.6	8.7	10.0	11.8
1000 sq miles	0.5	1.1	2.1	3.9	5.0	6.2	8.2	9.4	10.1
2000 sq miles	0.4	1.0	2.0	3.6	4.7	5.6	7.4	8.5	10.0
5000 sq miles	0.4	0.9	1.7	3.2	4.1	4.9	6.4	7.3	7.9
10000 sq miles	0.3	0.8	1.5	2.9	3.5	4.2	5.4	6.1	6.5
20000 sq miles	0.3	0.7	1.3	2.3	2.8	3.3	4.2	4.7	5.1

Storm or Storm Center Name	**SPAS 1252 Waterton Red Rocks, Alberta**				
Storm Date(s)	06/15-06/20/1975				
Storm Type	Synoptic				
Storm Location	49.09 N	114.05 W			
Storm Center Elevation	8,000				
Precipitation Total & Duration	14.46 Inches	144 hours			
Storm Representative SST	71.0 F	24			
Storm Representative SST Location	43.15 N	99.95 W	June	July	0
In-place Maximum SST	78.0 F				
Moisture Inflow Vector	ESE @ 810				
In-place Maximization Factor	**1.50**				
Temporal Transposition (Date)	1-Jul				
Transposition SST Location	33.33 N	94.23 W	June	July	
Transposition Maximum SST	79.5 F				
Transposition Adjustment Factor	**0.87**				
Grid Point Elevation	10,000				
Highest Elevation in Basin	14,344				
Inflow Barrier Height	1,150				
Elevation Adjustment Factor	**1.00**				
Total Adjustment Factor	**1.31**				

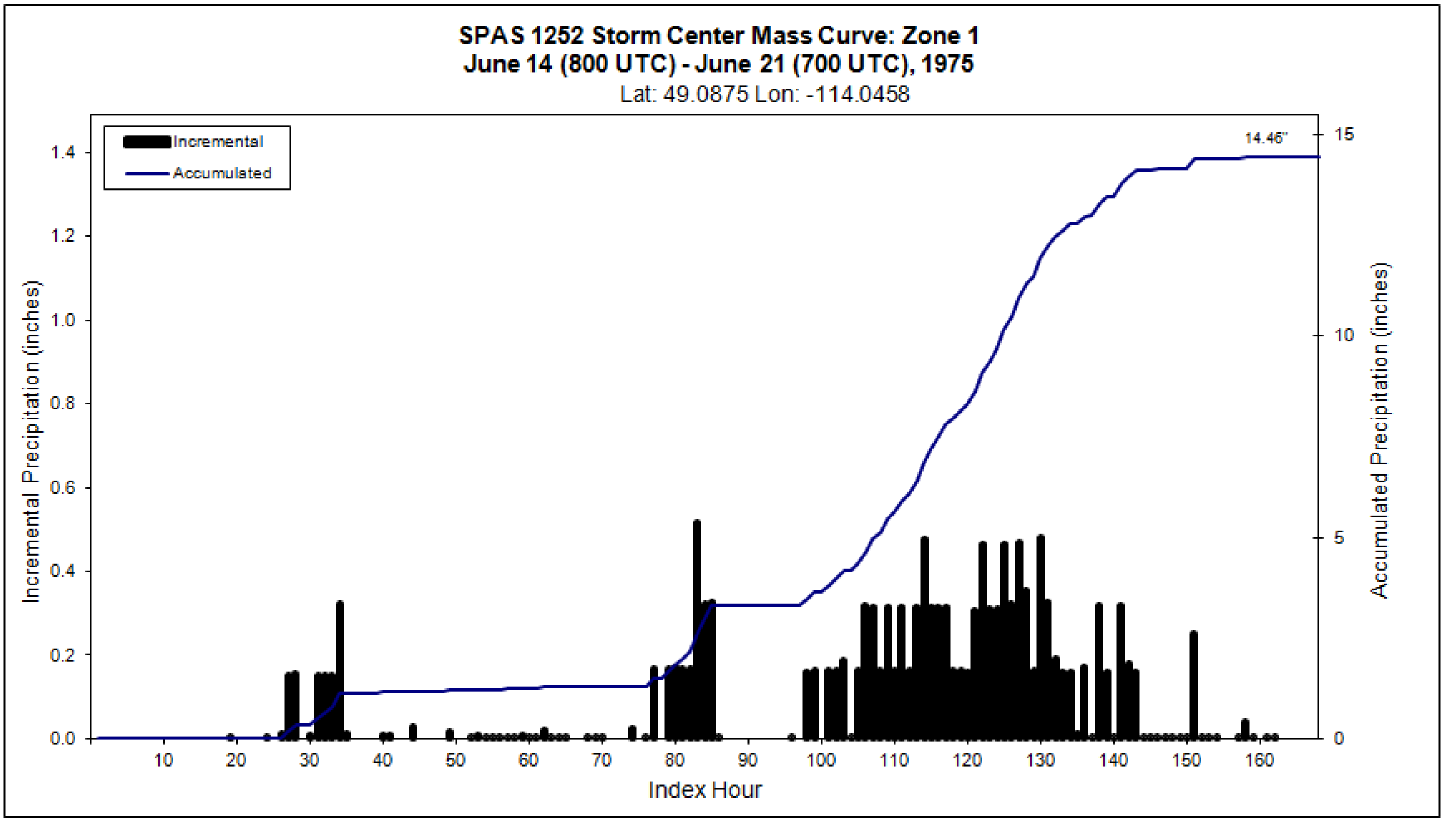
Appendix F: Table F.45: Storm spreadsheet for Waterton Red Rocks, AB, June 14, 1975

SPAS 1252 - June 14 (800 UTC) - June 21 (700 UTC), 1975 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)														
	Duration (hours)													
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	120	144	168	Total
0.2	0.94	1.37	2.38	4.19	5.93	7.4	9.51	10.87	12.88	13.18	14.13	14.46	14.46	14.46
1	0.92	1.32	2.29	4.07	5.74	7.2	9.24	10.53	12.47	12.79	13.64	14.01	14.01	14.01
10	0.84	1.32	2.29	4.07	5.74	7.2	9.24	10.53	12.47	12.78	13.64	14.01	14.01	14.01
25	0.74	1.21	2.26	3.99	5.63	7.03	9.03	10.29	12.21	12.46	13.33	13.61	13.74	13.74
50	0.65	1.16	2.17	3.8	5.41	6.62	8.59	9.8	11.57	12.06	12.95	13.28	13.29	13.29
100	0.55	1.07	2.02	3.59	5.04	6.18	7.93	9.19	10.92	11.24	11.99	12.48	12.53	12.53
150	0.45	1.01	1.88	3.48	4.76	5.87	7.53	8.6	10.22	10.71	11.31	11.98	12	12.00
200	0.44	0.95	1.84	3.35	4.34	5.7	7.32	8.52	10.13	10.51	11.17	11.59	11.67	11.67
300	0.42	0.93	1.78	3.25	4.22	5.36	7.08	7.89	9.33	9.98	10.56	11.13	11.17	11.17
400	0.41	0.91	1.71	3.15	4.15	5.15	6.72	7.7	9.12	9.77	10.37	10.68	10.81	10.81
500	0.39	0.89	1.69	3.1	4.05	5.09	6.68	7.63	9	9.58	9.99	10.53	10.54	10.54
1,000	0.35	0.85	1.6	2.98	3.82	4.72	6.25	7.17	7.72	8.75	9.09	9.76	9.76	9.76
2,000	0.33	0.8	1.51	2.74	3.56	4.3	5.65	6.48	7.65	8.12	8.49	8.91	8.91	8.91
5,000	0.29	0.69	1.31	2.47	3.1	3.78	4.88	5.59	6.07	6.83	7.2	7.32	7.51	7.51
10,000	0.25	0.62	1.17	2.2	2.71	3.23	4.1	4.66	5	5.66	5.93	6.06	6.21	6.21
20,000	0.21	0.53	1.02	1.79	2.12	2.54	3.2	3.59	3.87	4.41	4.59	4.74	4.83	4.83
33,046	0.16	0.39	0.74	1.29	1.57	1.86	2.3	2.58	2.95	3.22	3.44	3.55	3.56	3.56

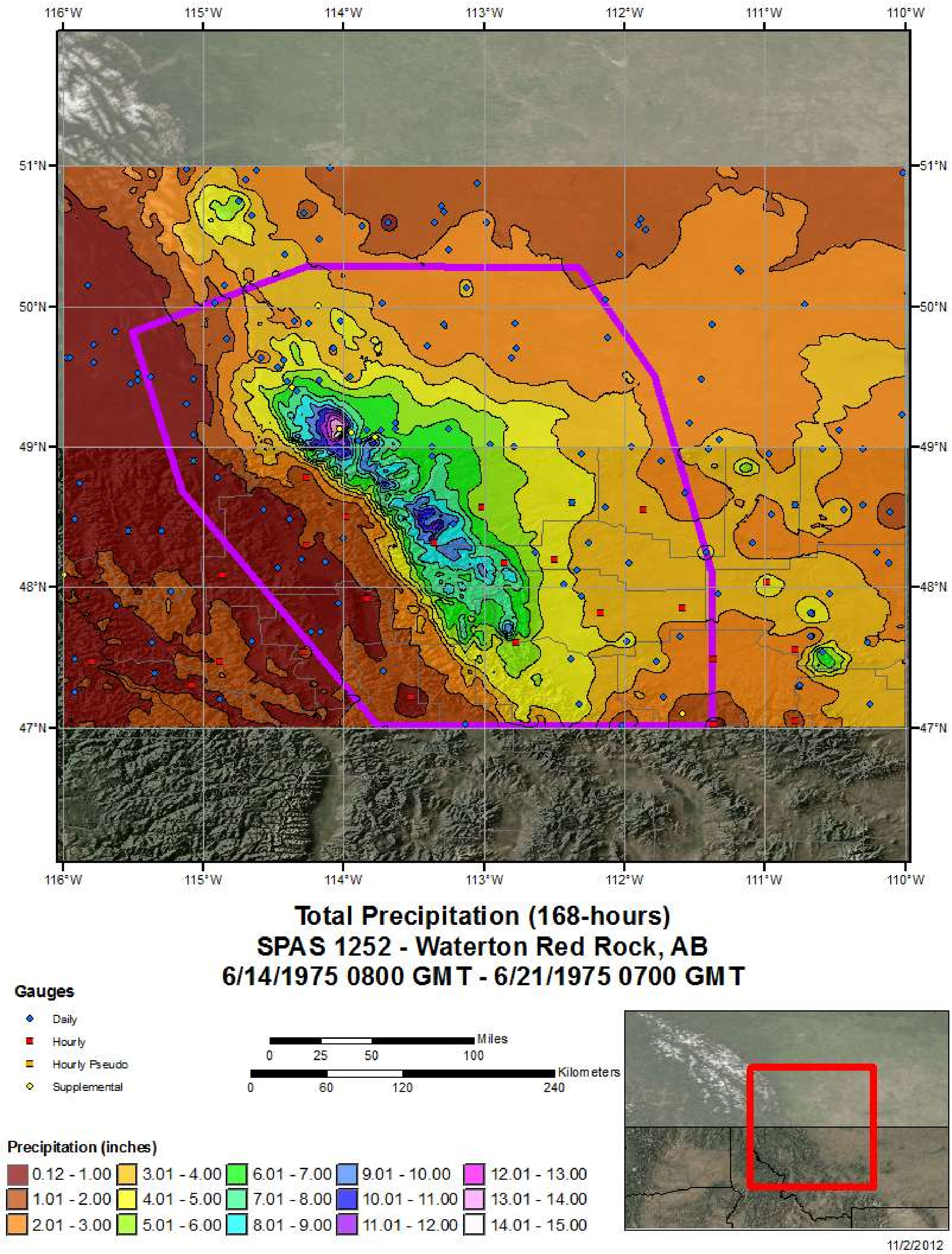
Appendix F: Table F.46: Depth-area-duration values for Waterton Red Rocks, AB, June 14, 1975



Appendix F: Figure F.64: Depth-area-duration chart for Waterton Red Rocks, AB, June 14, 1975



Appendix F: Figure F.65: Mass curve chart for Waterton Red Rocks, AB, June 14, 1975



Appendix F: Figure F.66: Total storm isohyetal analysis for Waterton Red Rocks, AB, June 14, 1975

Enid, OK, AWA 21

October 10, 1973

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	SPAS -1034-Enid, OK	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	10-Oct-1973	
AWA Analysis Date:	12/14/2013	

Temporal Transposition Date	25-Sep	
	Lat	Long
Storm center location	36.38 N	97.87 W
Storm Rep dew point location	33.35 N	96.55 W
Transposition dewpoint location	30.30 N	96.92 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	SSE @ 225	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,250	feet
Storm Rep Analysis Duration	12	hrs

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	77.5 F	with total precipitable water above sea level of			3.22	inches.
The in-place storm elevation is	1,250	which subtracts	0.31	inches of precipitable water at	75.0 F	
The in-place storm elevation is	1,250	which subtracts	0.325	inches of precipitable water at	76.5 F	
The transposition basin elevation at	0	which subtracts	0.285	inches of precipitable water at	77.5 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.285	inches of precipitable water at	77.5 F	

The in-place storm maximization factor is	1.08
The transposition/elevation to basin factor is	1.07
The barrier adjustment factor is	1.00
The total adjustment factor is	1.16

Notes: DAD values taken from SPAS 1034. 12hr average taken from KDFW and WACO from 2100CDT 10-9-73 to 0900CDT10-10-73

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	11.2	17.1	19.0	19.0	-	19.0	19.2	-	19.4
10 sq miles	10.7	16.3	18.1	18.1	-	18.1	18.3	-	18.5
100 sq miles	9.7	14.6	16.2	16.2	-	16.2	16.4	-	16.6
200 sq miles	9.1	13.7	15.2	15.2	-	15.2	15.3	-	15.5
500 sq miles	7.9	11.3	12.7	12.7	-	12.7	12.9	-	12.9
1000 sq miles	6.7	9.5	10.5	10.5	-	10.5	10.6	-	10.6
5000 sq miles	3.9	5.2	5.6	5.6	-	5.6	5.7	-	5.7
10000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0
20000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	13.0	19.7	21.9	22.0	-	22.0	22.2	-	22.4
10 sq miles	12.4	18.9	20.9	20.9	-	20.9	21.1	-	21.4
100 sq miles	11.2	16.9	18.7	18.7	-	18.7	18.9	-	19.2
200 sq miles	10.5	15.8	17.6	17.6	-	17.6	17.7	-	17.9
500 sq miles	9.1	13.1	14.7	14.7	-	14.7	14.9	-	14.9
1000 sq miles	7.8	10.9	12.2	12.2	-	12.2	12.2	-	12.3
5000 sq miles	4.5	6.0	6.5	6.5	-	6.5	6.6	-	6.6
10000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0
20000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0

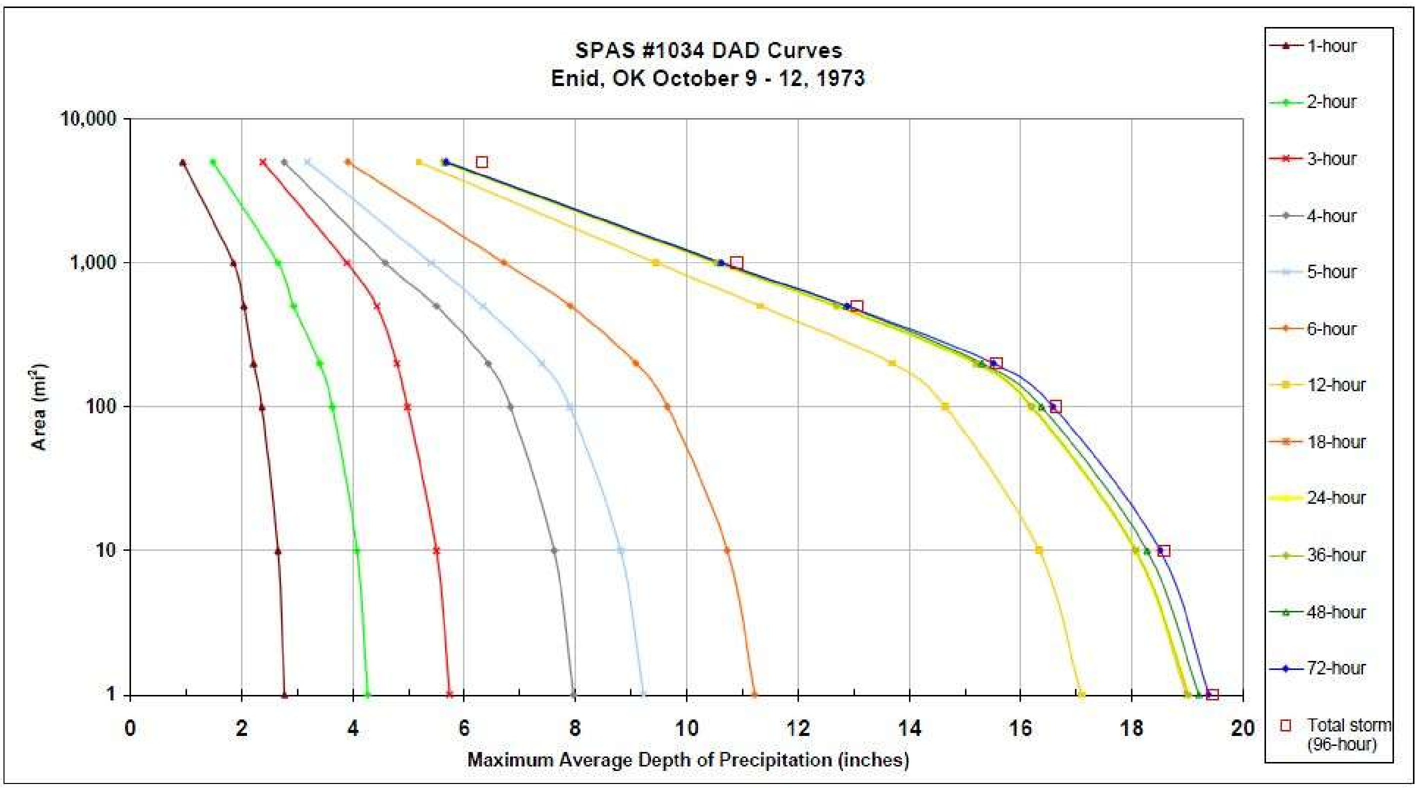
Storm or Storm Center Name	**SPAS -1034-Enid, OK**			
Storm Date(s)	10/10/73			
Storm Type	MCC			
Storm Location	36.38 N	97.87 W		
Storm Center Elevation	1,250			
Precipitation Total & Duration	20.00 Inches 15-hours NCDC Storm Data report			
Storm Representative Dewpoint	75.0 F	12		
Storm Representative Dewpoint Location	33.35 N	96.55 W		
Maximum Dewpoint	76.5 F			
Moisture Inflow Vector	SSE @ 225			
In-place Maximization Factor	1.08			
Temporal Transposition (Date)	25-Sep		S	O
Transposition Dewpoint Location	30.30 N	96.92 W	78	77
Transposition Maximum Dewpoint	77.5 F			
Transposition Adjustment Factor				
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height				
Elevation Adjustment Factor				
Total Adjustment Factor	**1.16**			

Appendix F: Table F.47: Storm spreadsheet for Enid, OK, October 10, 1973

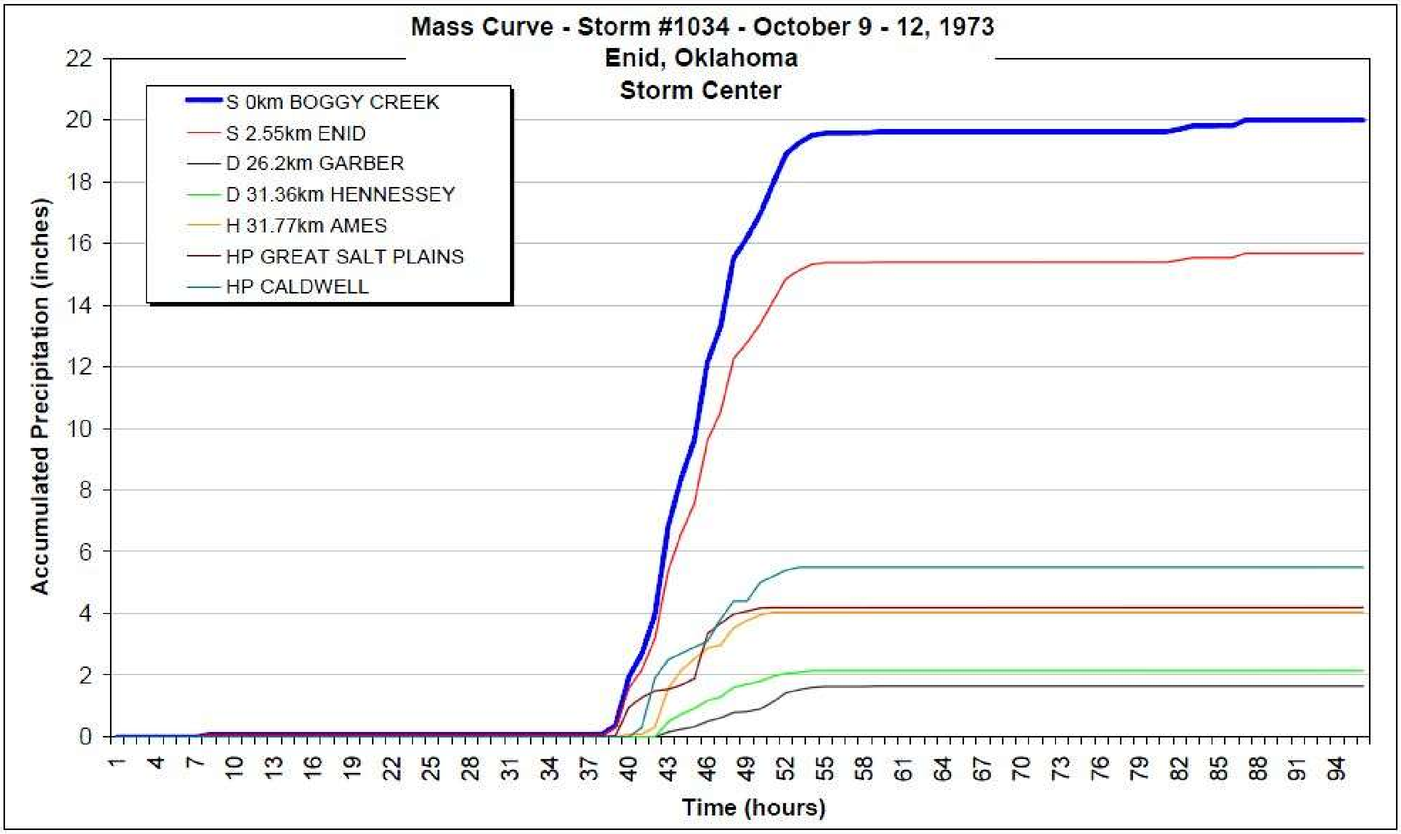
Storm 1034 - Enid OK, October 9 - 12, 1973

MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

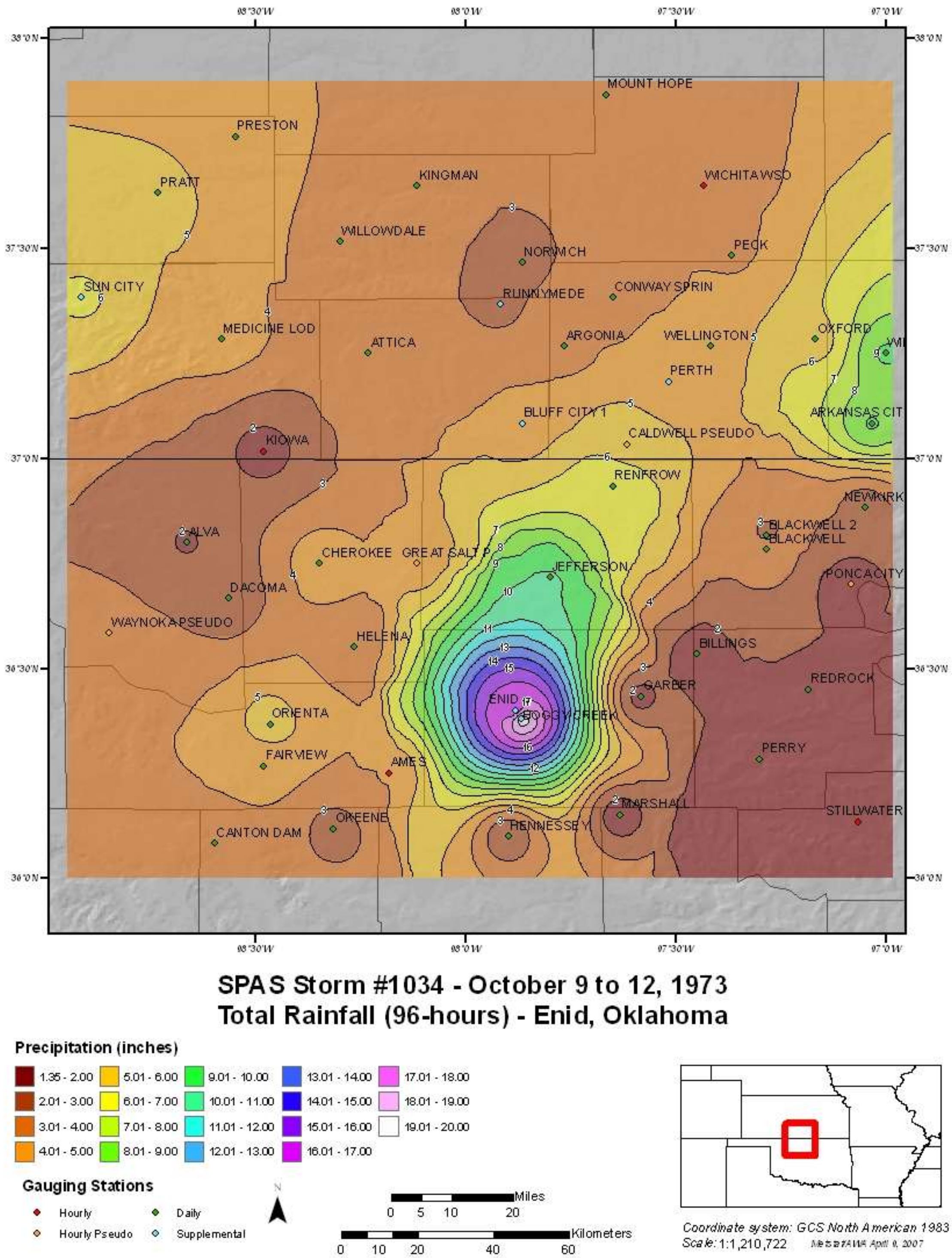
Area (mi²)	Duration (hours)													
	1	2	3	4	5	6	12	18	24	36	48	72	96	total
1	2.77	4.26	5.74	7.96	9.22	11.22	17.09	18.98	19.02	19.02	19.20	19.38	19.45	19.45
10	2.65	4.07	5.50	7.61	8.81	10.73	16.33	18.07	18.07	18.07	18.27	18.51	18.58	18.58
100	2.36	3.63	4.98	6.83	7.90	9.65	14.64	16.19	16.20	16.20	16.37	16.58	16.64	16.64
200	2.21	3.40	4.79	6.43	7.40	9.09	13.69	15.19	15.21	15.21	15.30	15.51	15.57	15.57
500	2.04	2.93	4.43	5.50	6.33	7.91	11.32	12.69	12.69	12.69	12.86	12.89	13.06	13.06
1,000	1.85	2.65	3.89	4.58	5.40	6.71	9.45	10.53	10.53	10.53	10.60	10.63	10.89	10.89
5,000	0.94	1.48	2.38	2.76	3.18	3.91	5.18	5.63	5.63	5.63	5.67	5.68	6.32	6.32



Appendix F: Table F.48: Depth-area-duration values Appendix F: Figure F.63: Depth-area-duration chart for Enid, OK, October 10, 1973



Appendix F: Figure F.67: Mass curve chart for Enid, OK, October 10, 1973



Appendix F: Figure F.68: Total storm isohyetal analysis for Enid, OK, October 10, 1973

Bayfield, CO, AWA 22

September 3, 1970
Storm Type: Remnant Tropical
Grid Points Used: 22

Storm Name:	SPAS-1075-Norma-Zone 4		
Storm Date:	9/4-6/1970		
AWA Analysis Date:	12/21/2013		

Storm Adjustment for ANO Grid Point 22

Temporal Transposition Date	20-Aug	
	Lat	Long
Storm center location	37.56 N	107.88 W
Storm Rep dew point location	32.79 N	112.13 W
Transposition dewpoint location	34.30 N	110.80 W
Grid Point location	39.00 N	106.50 W

Moisture Inflow Direction:	SW @ 410	miles
Grid Point Elevation	9,871	feet
Storm Center Elevation	9,825	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place storm elevation is	9,825	which subtracts	1.84	inches of precipitable water at	75.0 F	
The in-place storm elevation is	9,825	which subtracts	1.95	inches of precipitable water at	76.5 F	
The transposition barrier elevation at	9,871	which subtracts	1.91	inches of precipitable water at	76.0 F	
The Grid point/inflow barrier height is	9,871	which subtracts	1.91	inches of precipitable water at	76.0 F	

The in-place maximization factor is	1.11
The transposition factor is	0.96
Orographic Transpostion Factor	1.00
The total adjustment factor is	1.07

Notes: Storm rep Td taken from KGBN, KYUM 24hr ave

Observed Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	24 Hours	36 Hours	48 Hours
1 sq miles	1.5	2.3	3.3	3.8	4.1	4.6	7.9	11.1	11.5	11.7
10 sq miles	1.5	2.3	3.3	3.8	4.1	4.4	7.7	10.7	11.1	11.2
50 sq miles	1.5	2.3	3.1	3.5	3.7	4.0	6.6	9.8	10.0	10.2
100 sq miles	1.4	2.3	2.9	3.4	3.7	4.0	6.3	9.3	9.6	9.7
200 sq miles	1.3	2.2	2.8	3.2	3.6	3.9	6.1	8.8	9.0	9.1
500 sq miles	1.0	1.9	2.6	3.0	3.3	3.5	5.6	8.0	8.2	8.3
1000 sq miles	1.0	1.8	2.3	2.7	3.0	3.2	5.0	7.2	7.5	7.6
2000 sq miles	0.8	1.6	2.0	2.3	2.7	2.8	4.5	6.5	6.6	6.8
5000 sq miles	0.6	1.2	1.4	1.8	2.1	2.3	3.7	5.4	5.6	5.8
10000 sq miles	0.2	0.8	1.0	1.3	1.5	1.8	3.0	4.4	4.6	4.9

Adjusteded Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	24 Hours	36 Hours	48 Hours
1 sq miles	1.6	2.5	3.5	4.0	4.3	5.0	8.5	11.9	12.3	12.5
10 sq miles	1.6	2.5	3.5	4.0	4.3	4.7	8.3	11.5	11.8	12.0
50 sq miles	1.6	2.4	3.3	3.8	3.9	4.3	7.1	10.5	10.7	10.9
100 sq miles	1.5	2.4	3.0	3.7	3.9	4.2	6.8	10.0	10.2	10.4
200 sq miles	1.4	2.3	3.0	3.4	3.8	4.1	6.5	9.4	9.6	9.7
500 sq miles	1.1	2.0	2.8	3.2	3.5	3.8	6.0	8.6	8.8	8.9
1000 sq miles	1.1	1.9	2.5	2.8	3.2	3.4	5.4	7.7	8.0	8.2
2000 sq miles	0.8	1.7	2.2	2.5	2.9	3.0	4.8	6.9	7.1	7.3
5000 sq miles	0.6	1.2	1.5	2.0	2.2	2.5	4.0	5.8	6.0	6.2
10000 sq miles	0.3	0.9	1.1	1.4	1.6	2.0	3.2	4.7	4.9	5.2

Storm or Storm Center Name	SPAS-1075-Norma-Zone 4		
Storm Date(s)	9/4-6/1970		
Storm Type	Tropical		
Storm Location	37.56 N	107.88 W	
Storm Center Elevation	9825		
Precipitation Total & Duration (10 sq mi)	12.01 inches 48 hours 3.88" in 1hr and 11.42" in 24hrs (SPAS 1075 DAD)		
Storm Representative Dewpoint	75.0 F	24	hr ave KGBN, KYUM
Storm Representative Dewpoint Location	32.79 N	112.13 W	
In-place Maximum Dewpoint	76.5 F		
Moisture Inflow Vector	SW @ 410		
In-place Maximization Factor			
Temporal Transposition (Date)	20-Aug		
Transposition Dewpoint Location	34.30 N	110.80 W	
Transposition Maximum Dewpoint	76.0 F		
Transposition Adjustment Factor			
Grid Point Elevation	9,871		
Highest Elevation in Basin	14,344		
Inflow Barrier Height	9,871		
Elevation Adjustment Factor			
Total Adjustment Factor	1.07		

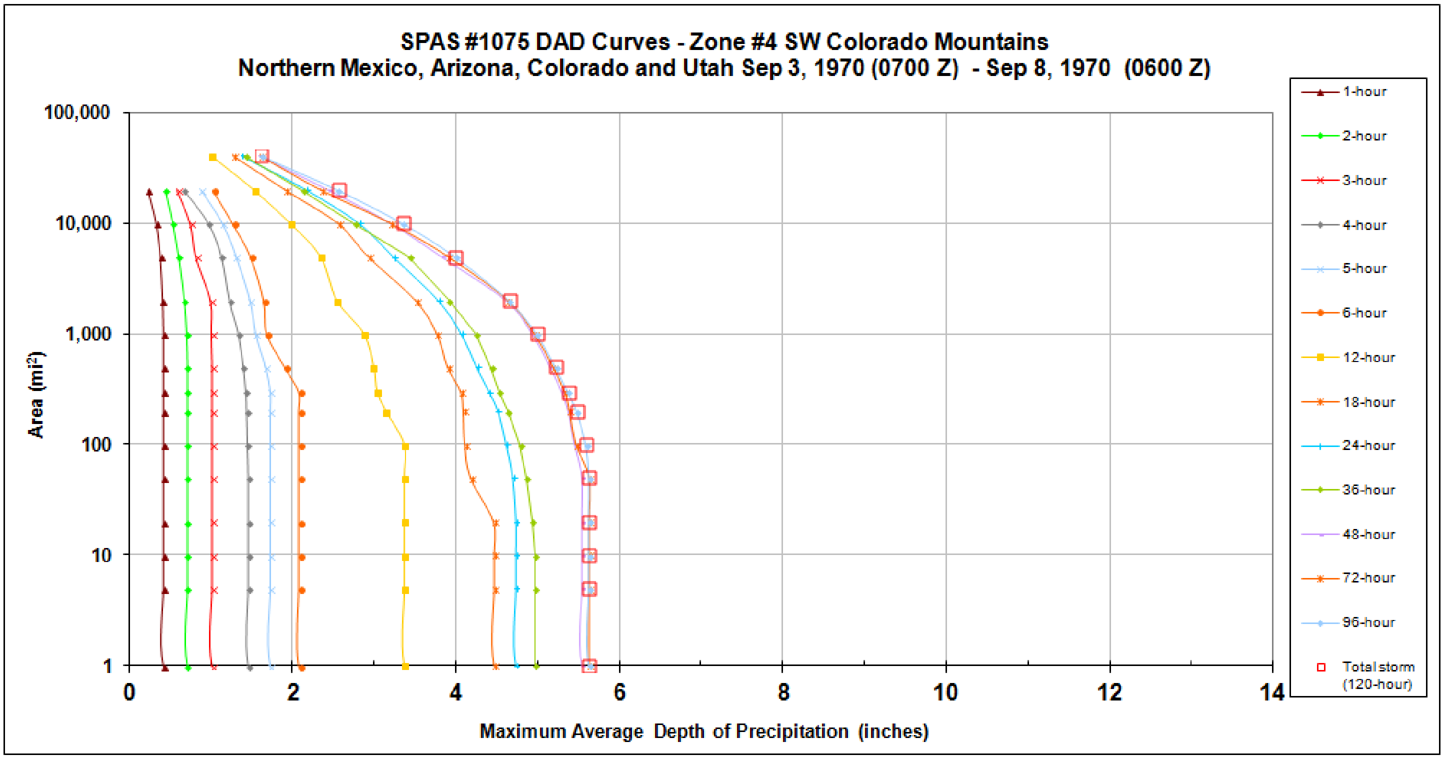
Appendix F: Table F.49

Storm 1075 - Northern Mexico, Arizona, Colorado and Utah Sep 3, 1970 (0700 Z) - Sep 8, 1970 (0600 Z)

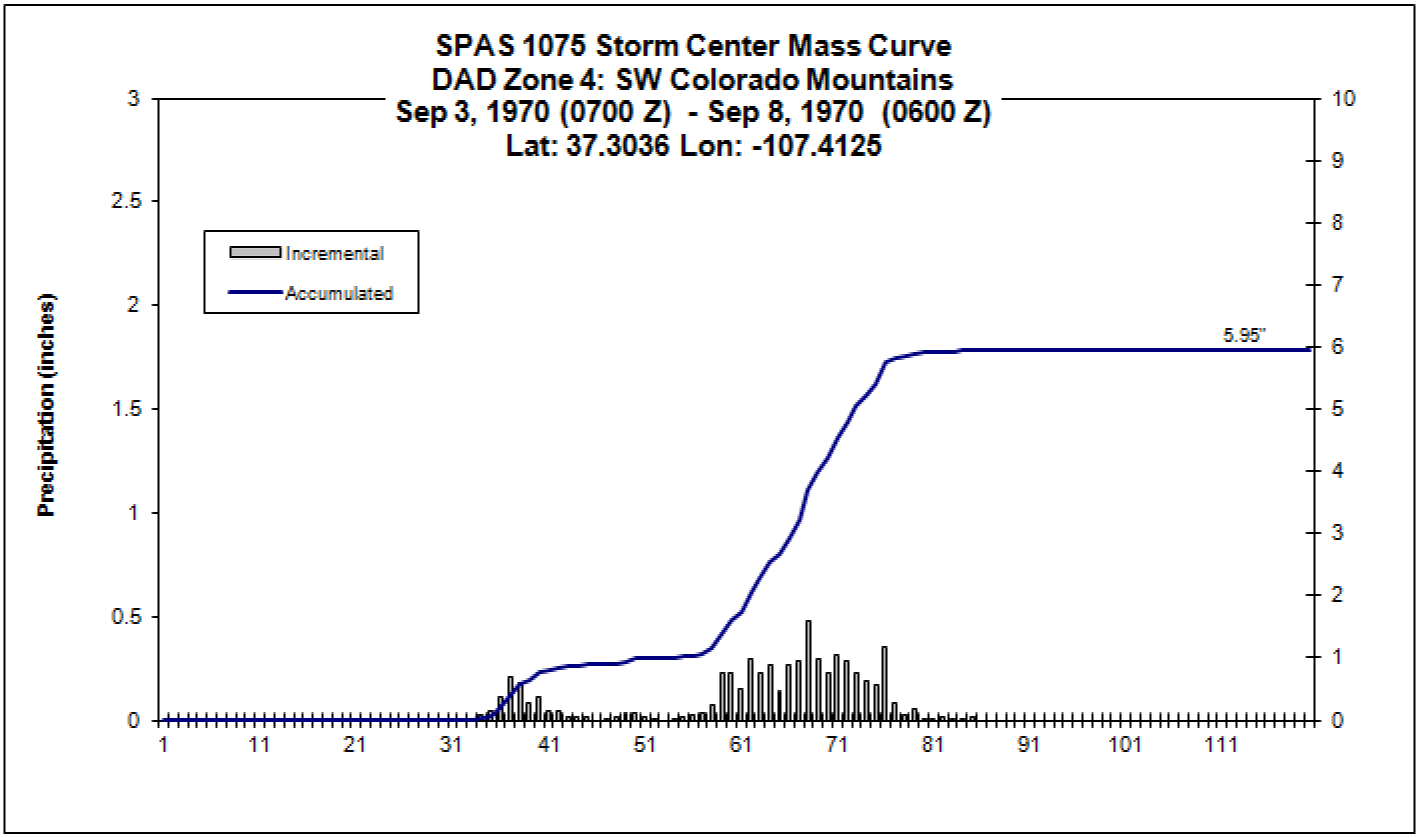
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)														
Area (mi^2)	1	2	3	4	5	6	12	18	24	36	48	72	96		Total
0.27	0.82	1.07	1.4	1.77	2.12	2.37	3.71	4.83	5.07	5.27	5.9	5.95	5.95		5.95
1	0.42	0.71	1.02	1.46	1.73	2.08	3.36	4.47	4.73	4.96	5.54	5.62	5.62		5.62
5	0.42	0.71	1.02	1.46	1.73	2.08	3.36	4.47	4.73	4.96	5.54	5.62	5.62		5.62
10	0.42	0.71	1.02	1.46	1.73	2.08	3.36	4.47	4.73	4.96	5.54	5.62	5.62		5.62
20	0.42	0.71	1.02	1.46	1.73	2.08	3.36	4.46	4.73	4.93	5.54	5.62	5.62		5.62
50	0.42	0.71	1.02	1.46	1.73	2.08	3.36	4.18	4.69	4.86	5.54	5.62	5.62		5.62
100	0.42	0.71	1.02	1.45	1.73	2.08	3.36	4.11	4.61	4.78	5.45	5.46	5.58		5.58
200	0.42	0.71	1.02	1.44	1.73	2.08	3.14	4.09	4.51	4.63	5.37	5.38	5.47		5.47
300	0.42	0.71	1.02	1.43	1.73	2.08	3.03	4.06	4.4	4.52	5.29	5.32	5.36		5.36
500	0.42	0.71	1.02	1.4	1.67	1.91	2.99	3.9	4.25	4.43	5.15	5.18	5.21		5.21
1,000	0.42	0.7	1.01	1.34	1.55	1.69	2.87	3.77	4.06	4.24	4.93	4.95	4.98		4.98
2,000	0.41	0.67	1	1.23	1.48	1.65	2.54	3.51	3.78	3.91	4.61	4.63	4.64		4.64
5,000	0.38	0.6	0.82	1.13	1.31	1.49	2.34	2.93	3.23	3.42	3.82	3.9	3.98		3.98
10,000	0.33	0.53	0.75	0.97	1.14	1.27	1.97	2.56	2.81	2.75	3.2	3.2	3.34		3.34
20,000	0.23	0.44	0.59	0.67	0.88	1.03	1.53	1.92	2.17	2.12	2.44	2.35	2.55		2.55
40,779							1.01	1.28	1.38	1.42	1.59	1.61	1.61		1.61

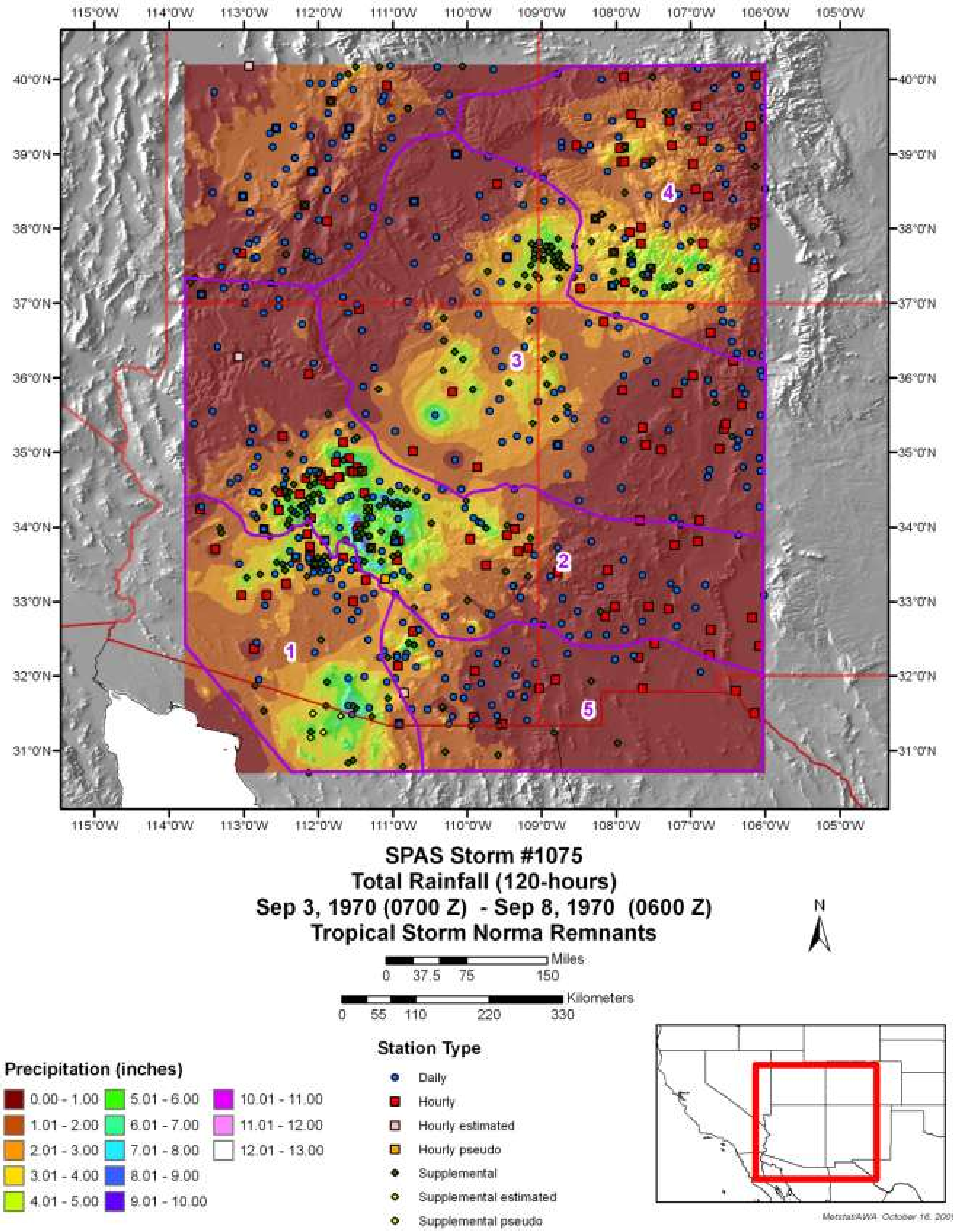
Appendix F: Table F.50: Depth-area-duration values for Bayfield, CO, September 3, 1970



Appendix F: Figure F.69: Depth-area-duration chart for Bayfield, CO, September 3, 1970



Appendix F: Figure F.70: Mass curve chart for Bayfield, CO, September 3, 1970



Appendix F: Figure F.71: Total storm isohyetal analysis for Bayfield, CO, September 3, 1970

Big Elk Meadow, CO, AWA 23

May 4, 1969

Storm Type: Frontal

Grid Points Used: 7, 13-14, 21

Storm Name:	SPAS-1253-Big Elk Meadow, CO	**Storm Adjustment for ANO Grid Point 7**	
Storm Date:	5/3-9/1969		
AWA Analysis Date:	12/21/2013		

Temporal Transposition Date	20-May	
	Lat	**Long**
Storm center location	40.27 N	105.42 W
Storm Rep dew point location	38.00 N	99.00 W
Transposition dewpoint location	33.75 N	99.45 W
Grid Point location	36.00 N	105.50 W

Moisture Inflow Direction:	ESE @ 375	miles
Grid Point Elevation	7,557	feet
Storm Center Elevation	8,000	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	65.0 F	with total precipitable water above sea level of			1.77	inches.
The in-place maximum dew point is	74.5 F	with total precipitable water above sea level of			2.79	inches.
The transpositioned maximum dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place storm elevation is	8,000	which subtracts	1.09	inches of precipitable water at	65.0 F	
The in-place storm elevation is	8,000	which subtracts	1.55	inches of precipitable water at	74.5 F	
The transposition basin elevation at	7,557	which subtracts	1.56	inches of precipitable water at	76.0 F	
The Grid Point/Inflow barrier height is	7,557	which subtracts	1.56	inches of precipitable water at	76.0 F	

The in-place storm maximization factor is	1.50
The transposition/elevation to basin factor is	1.15
The barrier adjustment factor is	1.00
The total adjustment factor is	1.73

Notes: Used 24hr average from KIAB, KRSL, and KDDC. *** Note max factor of 1.82 was capped at 1.50 based on HMR guidance. HMR 55A has a max factor of 1.82 (pg239).

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	0.9	1.8	3.5	5.9	8.2	10.5	12.9	15.9	19.1
10 sq miles	0.8	1.7	3.0	5.1	7.1	9.1	11.3	13.8	16.6
100 sq miles	0.7	1.3	2.1	3.6	5.1	6.4	8.0	9.5	11.5
200 sq miles	0.6	1.2	1.9	3.3	4.6	6.2	7.6	9.3	11.2
500 sq miles	0.5	1.1	1.7	2.9	4.1	5.4	6.7	7.9	9.5
1000 sq miles	0.5	0.9	1.5	2.7	3.8	4.8	6.0	17.1	9.4
2000 sq miles	0.4	0.8	1.3	2.4	3.4	4.1	5.2	6.3	8.7
5000 sq miles	0.3	0.6	1.0	1.9	2.4	3.2	4.2	4.7	6.4
10000 sq miles	0.2	0.5	0.9	1.6	2.0	2.4	3.3	3.5	4.4
20000 sq miles	0.1	0.3	0.7	1.2	1.5	1.8	2.4	2.7	3.1

Adjusted Storm Depth-Area-Duration

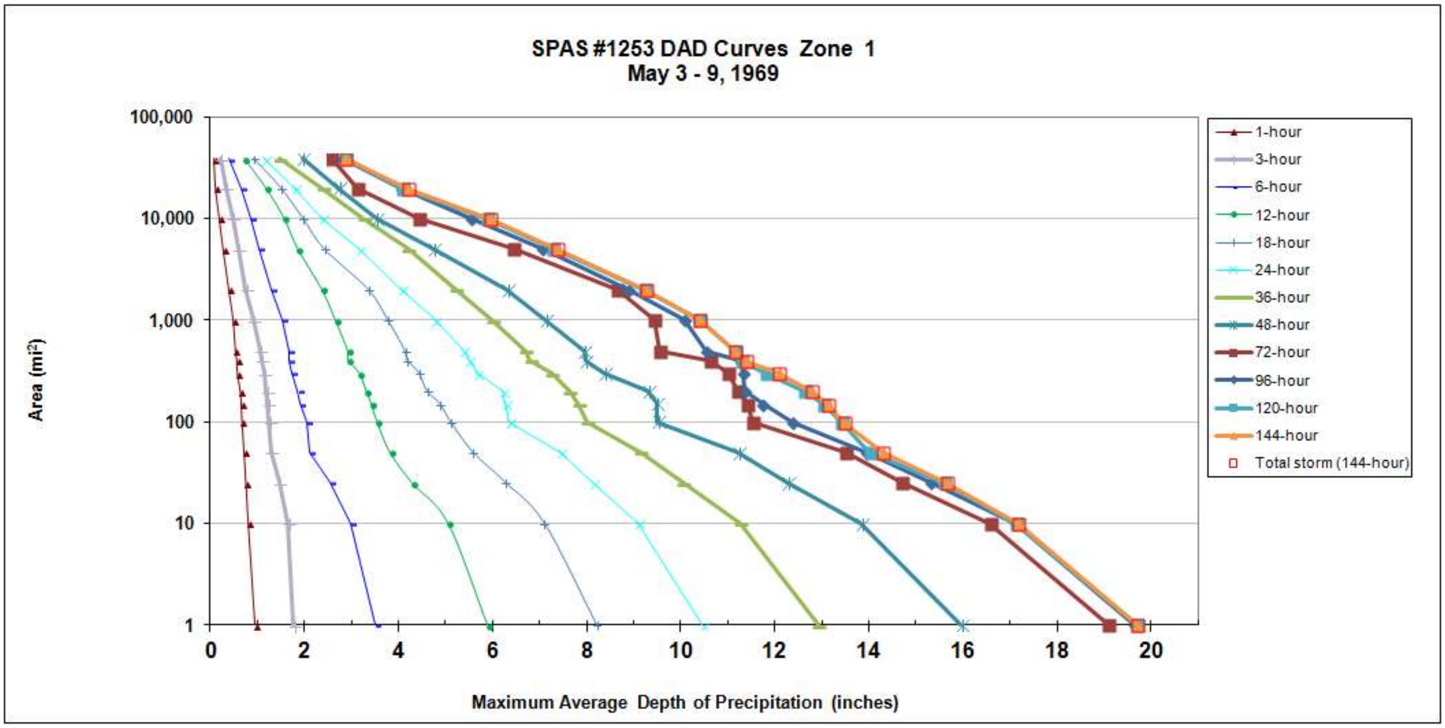
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	1.6	3.1	6.1	10.2	14.2	18.1	22.3	27.6	33.0
10 sq miles	1.4	2.9	5.1	8.8	12.3	15.7	19.5	23.9	28.7
100 sq miles	1.2	2.2	3.6	6.1	8.8	11.0	13.8	16.4	19.9
200 sq miles	1.1	2.1	3.2	5.7	8.0	10.7	13.2	16.1	19.4
500 sq miles	0.9	1.8	2.9	5.1	7.1	9.3	11.6	13.7	16.5
1000 sq miles	0.8	1.6	2.6	4.6	6.5	8.3	10.3	29.6	16.3
2000 sq miles	0.7	1.3	2.2	4.1	5.8	7.0	9.0	10.9	15.0
5000 sq miles	0.5	1.0	1.8	3.2	4.2	5.4	7.3	8.2	11.1
10000 sq miles	0.3	0.8	1.5	2.7	3.4	4.1	5.6	6.1	7.7
20000 sq miles	0.2	0.6	1.1	2.0	2.6	3.1	4.1	4.7	5.4

Storm or Storm Center Name	**SPAS-1253-Big Elk Meadow, CO**				
Storm Date(s)	5/3-9/1969				
Storm Type	Synoptic Storm				
Storm Location	40.27 N	105.42 W			
Storm Center Elevation	8,000	orographic			
Precipitation Total & Duration (10 sq mi)	20.01 inches 120 hour (SPAS 1253 DAD)				
Storm Representative Dewpoint	65.0 F		24 24hr ave from KIAB, KRSL, and KDDC		
Storm Representative Dewpoint Location	38.00 N	99.00 W		May	June
In-place Maximum Dewpoint	74.5 F			73.53	78.2
Moisture Inflow Vector	ESE @ 375				
In-place Maximization Factor	**1.50**				
Temporal Transposition (Date)	20-May				
Transposition Dewpoint Location	33.75 N	99.45 W		May	June
Transposition Maximum Dewpoint	76.0 F				
Transposition Adjustment Factor	**1.15**				
Grid Point Elevation	7,557				
Highest Elevation in Basin	14,344				
Inflow Barrier Height	7,557				
Elevation Adjustment Factor	**1.00**				
Total Adjustment Factor	**1.73**				

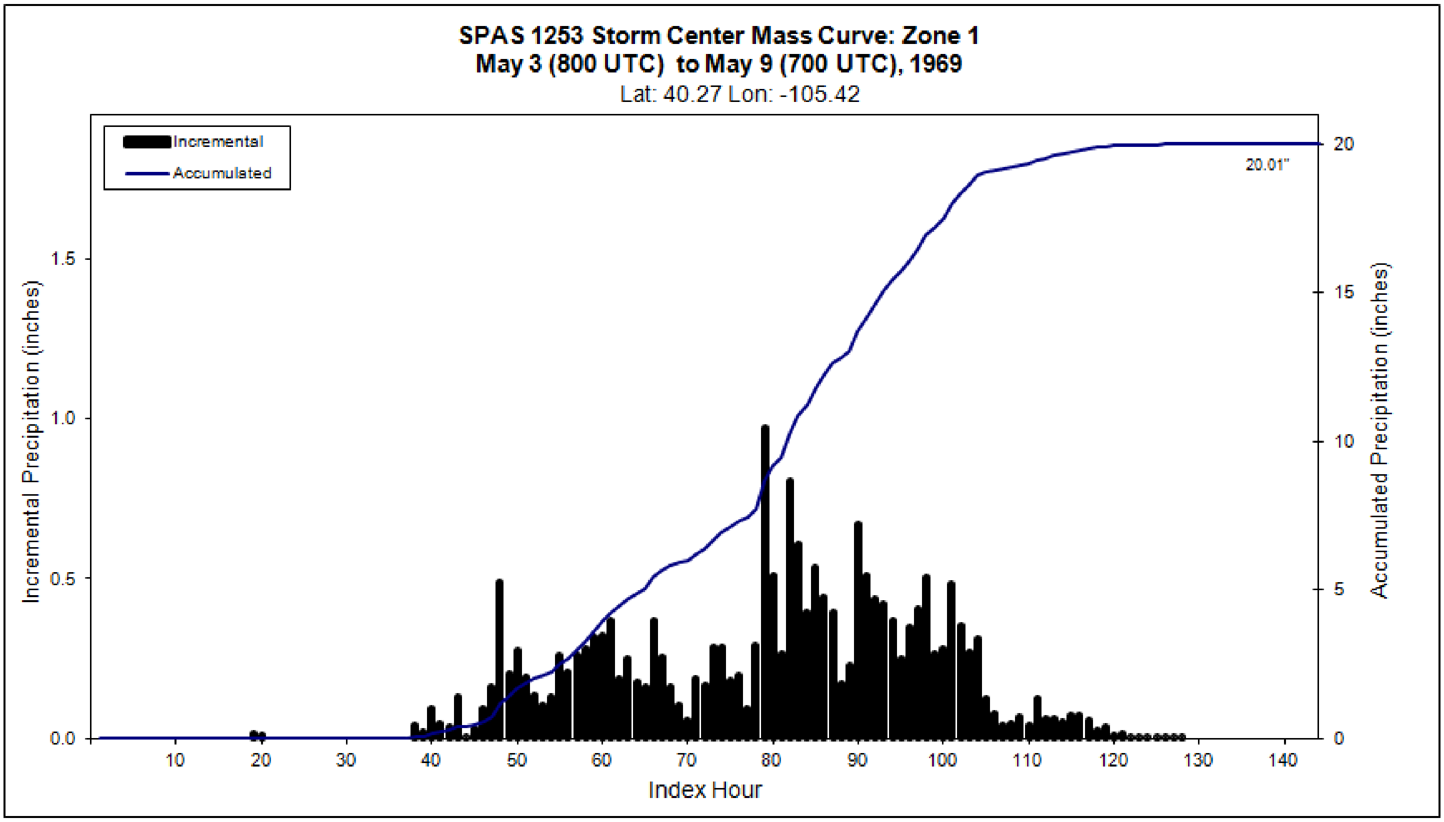
Appendix F: Table F.51: Storm spreadsheet for Big Elk Meadow, CO, May 4, 1969

SPAS 1253 - May 3 (800 UTC) - May 9 (700 UTC), 1969													
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)													
	Duration (hours)												
Area (mi²)	1	3	6	12	18	24	36	48	72	96	120	144	Total
0.3	0.97	1.82	3.56	6.00	8.34	10.64	13.13	16.21	19.41	19.97	20.01	20.01	20.01
1	0.94	1.77	3.50	5.90	8.20	10.46	12.92	15.94	19.09	19.65	19.69	19.69	19.69
10	0.80	1.65	2.97	5.06	7.09	9.08	11.26	13.83	16.57	17.10	17.12	17.16	17.16
25	0.75	1.47	2.55	4.29	6.27	8.13	10.04	12.25	14.70	15.32	15.58	15.64	15.64
50	0.71	1.30	2.11	3.82	5.57	7.42	9.14	11.22	13.51	13.93	14.01	14.28	14.28
100	0.67	1.25	2.06	3.55	5.10	6.36	8.00	9.49	11.53	12.37	13.41	13.46	13.46
150	0.65	1.22	1.91	3.42	4.87	6.27	7.81	9.48	11.40	11.73	13.01	13.11	13.11
200	0.63	1.19	1.86	3.32	4.60	6.21	7.63	9.29	11.21	11.36	12.61	12.76	12.76
300	0.57	1.14	1.74	3.17	4.43	5.67	7.25	8.36	11.00	11.32	11.80	12.06	12.06
400	0.56	1.09	1.66	2.93	4.18	5.50	6.80	7.97	10.63	11.26	11.27	11.36	11.36
500	0.53	1.05	1.66	2.92	4.13	5.38	6.70	7.94	9.54	10.54	11.14	11.14	11.14
1,000	0.48	0.91	1.52	2.66	3.77	4.77	5.98	7.11	9.43	10.07	10.38	10.38	10.38
2,000	0.39	0.75	1.29	2.37	3.35	4.06	5.21	6.30	8.65	8.87	9.20	9.23	9.23
5,000	0.27	0.60	1.04	1.86	2.42	3.15	4.20	4.72	6.44	7.05	7.27	7.35	7.35
10,000	0.19	0.47	0.85	1.57	1.97	2.38	3.25	3.52	4.44	5.54	5.87	5.93	5.93
20,000	0.11	0.32	0.65	1.18	1.50	1.79	2.38	2.73	3.12	4.06	4.08	4.18	4.18
38,492	0.08	0.21	0.39	0.72	0.93	1.15	1.47	1.95	2.58	2.82	2.86	2.86	2.86

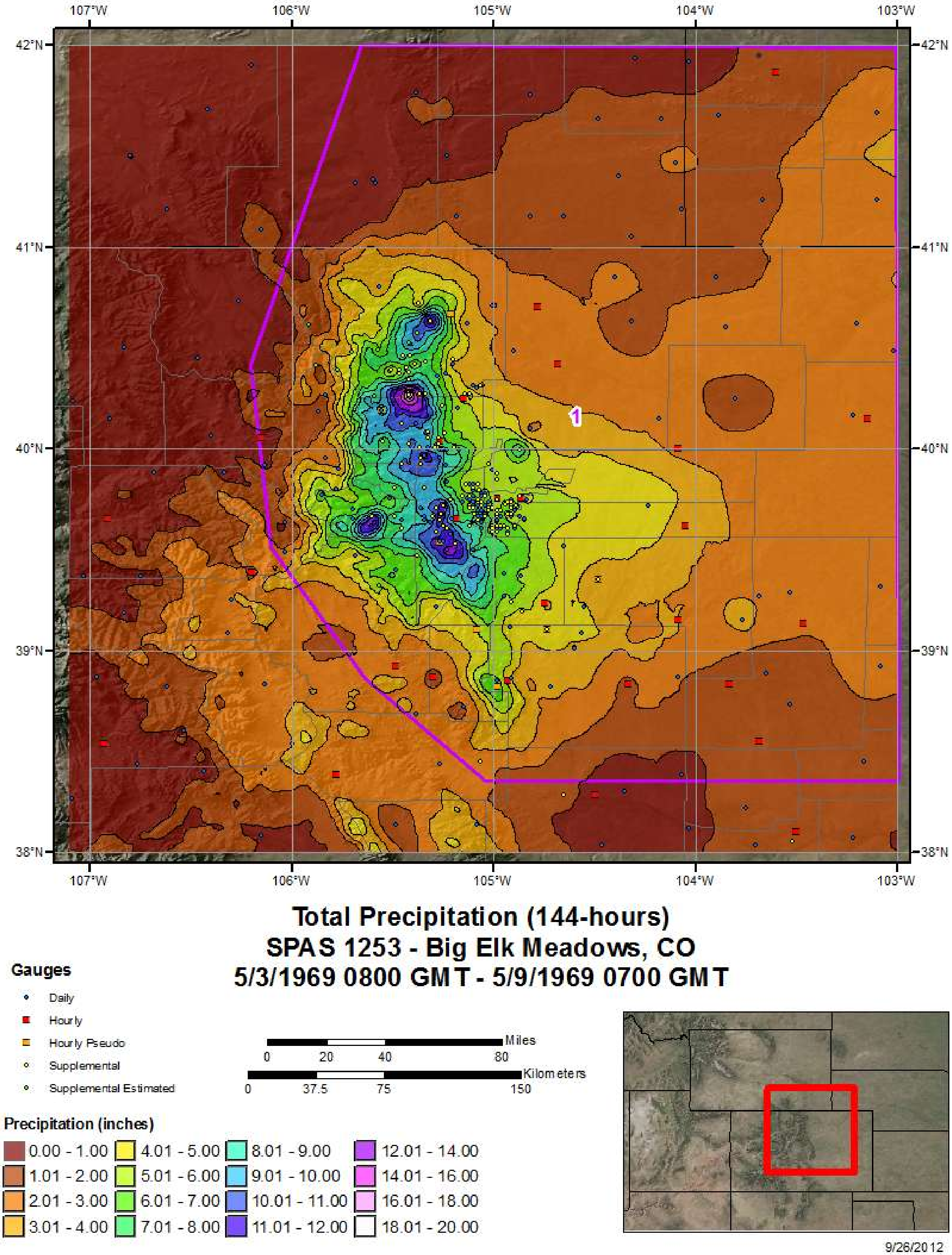
Appendix F: Table F.52: Depth-area-duration values for Big Elk Meadow, CO, May 4, 1969



Appendix F: Figure F.72: Depth-area-duration chart for Big Elk Meadow, CO, May 4, 1969



Appendix F: Figure F.73: Mass curve chart for Big Elk Meadow, CO, May 4, 1969



Appendix F: Figure F.74: Total storm isohyetal analysis for Big Elk Meadow, CO, May 4, 1969

Wooster, OH, AWA 24

July 4, 1969

Storm Type: Frontal/MCC

Grid Points Used: 8-11, 16-18

Storm Name:	Wooster, OH SPAS 1209
Storm Date:	7/4-7/1969
AWA Analysis Date:	12/14/2013

Storm Adjustment for ANO Grid Point 8

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	40.91 N	81.97 W
Storm Rep Dew Point Location	39.43 N	83.80 W
Transposition Dew Point Location	41.25 N	94.46 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SW @ 140	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,150	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,150	which subtracts	0.30	inches of precipitable water at	76.0 F	
The in-place storm elevation is	1,150	which subtracts	0.32	inches of precipitable water at	78.0 F	
The transposition basin elevation at	1,200	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.10
The transposition/elevation to basin factor is	1.14
The barrier adjustment factor is	1.00
The total adjustment factor is	1.25

Notes: DAD values taken from SPAS 1209. Storm representative dew point value was based on maximum 24-hr Td values between July 4-5, 1969 at KILN, KFFO, and KCVG.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.6	6.2	8.8	12.7	14.3	14.4	14.5	14.6	14.7
10 sq miles	4.2	6.0	8.7	12.3	13.7	13.7	13.8	14.0	14.0
100 sq miles	2.9	5.7	8.0	10.7	12.0	12.1	12.1	12.6	12.8
200 sq miles	2.5	5.5	7.7	10.4	11.6	11.6	11.7	12.2	12.4
500 sq miles	2.1	4.8	7.3	9.9	11.0	11.0	11.2	11.6	11.8
1000 sq miles	1.7	4.2	6.9	9.3	10.3	10.5	10.7	11.0	11.3
2000 sq miles	1.5	3.7	6.2	8.5	9.4	9.7	9.8	10.2	10.4
5000 sq miles	1.0	2.6	4.5	6.3	7.0	7.1	7.4	7.6	7.9
10000 sq miles	0.5	1.6	2.7	4.4	4.7	4.8	5.4	5.5	5.8
20000 sq miles	0.3	1.0	1.8	2.6	3.4	3.5	3.7	3.8	4.0

Adjusted Storm Depth-Area-Duration

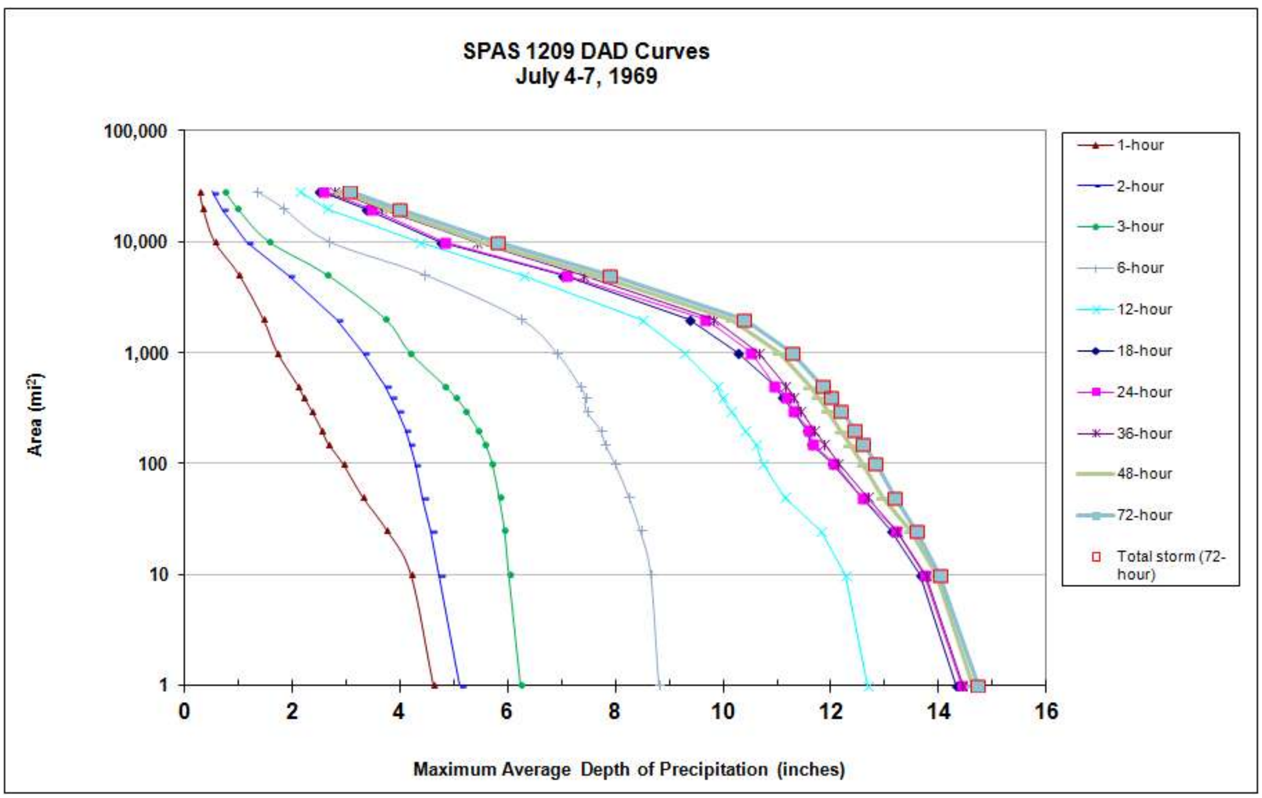
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	5.8	7.8	11.0	15.9	18.0	18.1	18.1	18.3	18.5
10 sq miles	5.3	7.6	10.9	15.4	17.1	17.2	17.3	17.5	17.6
100 sq miles	3.7	7.2	10.0	13.4	15.1	15.1	15.2	15.8	16.1
200 sq miles	3.2	6.8	9.7	13.0	14.5	14.5	14.7	15.3	15.6
500 sq miles	2.6	6.1	9.2	12.4	13.7	13.7	14.0	14.6	14.8
1000 sq miles	2.1	5.2	8.7	11.6	12.9	13.2	13.4	13.8	14.1
2000 sq miles	1.8	4.7	7.8	10.6	11.8	12.1	12.3	12.7	13.0
5000 sq miles	1.3	3.3	5.6	7.9	8.8	8.9	9.3	9.6	9.9
10000 sq miles	0.7	1.9	3.3	5.5	5.9	6.1	6.8	6.9	7.3
20000 sq miles	0.4	1.2	2.3	3.3	4.2	4.4	4.6	4.7	5.0

Storm or Storm Center Name	**Wooster, OH SPAS 1209**	
Storm Date(s)	7/4-7/1969	
Storm Type	Synoptic	
Storm Location	40.91 N	81.97 W
Storm Center Elevation	1,150	
Precipitation Total & Duration	14.73 Inches	72-hours
Storm Representative Dewpoint	76.0 F	24
Storm Representative Dewpoint Location	39.43 N	83.80 W
Maximum Dewpoint	78.0 F	
Moisture Inflow Vector	SW @ 140	Miles
In-place Maximization Factor	**1.10**	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	41.25 N	94.46 W
Transposition Maximum Dewpoint	80.5 F	
Transposition Adjustment Factor	**1.14**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.25**	

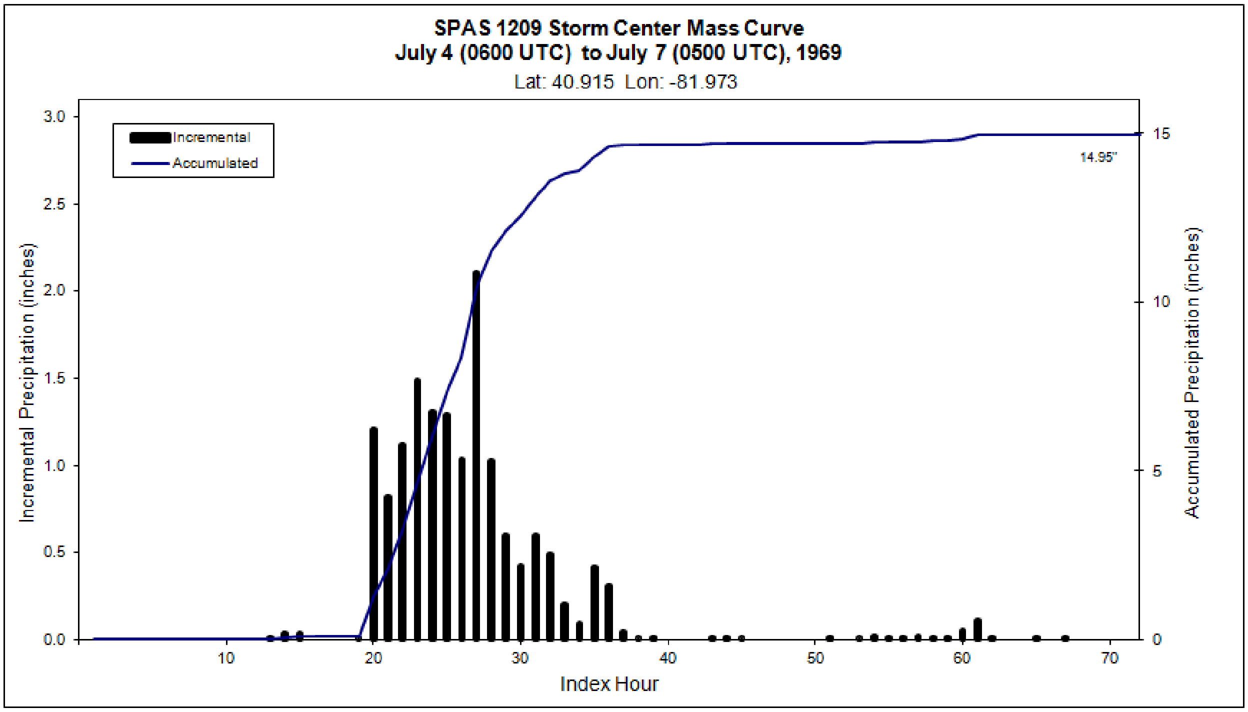
Appendix F: Table F.53: Storm spreadsheet for Wooster, OH July 4, 1969

Storm 1209 - July 4 (0600 UTC) - July 7 (0500 UTC),1969											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi²)	1	2	3	6	12	18	24	36	48	72	Total
0.3	4.82	5.33	6.41	8.95	13.02	14.58	14.67	14.69	14.94	14.95	14.95
1	4.62	5.11	6.24	8.81	12.67	14.32	14.44	14.45	14.63	14.73	14.73
10	4.2	4.72	6.02	8.66	12.26	13.66	13.74	13.77	13.97	14.02	14.02
25	3.75	4.56	5.94	8.46	11.81	13.13	13.21	13.23	13.47	13.58	13.58
50	3.3	4.42	5.84	8.25	11.14	12.57	12.59	12.69	12.97	13.19	13.19
100	2.93	4.27	5.71	7.99	10.72	12.02	12.06	12.14	12.59	12.83	12.83
150	2.66	4.17	5.58	7.81	10.59	11.63	11.66	11.88	12.35	12.6	12.60
200	2.54	4.09	5.45	7.72	10.4	11.56	11.6	11.69	12.18	12.44	12.44
300	2.35	3.96	5.22	7.46	10.14	11.3	11.3	11.44	11.94	12.19	12.19
400	2.2	3.83	5.02	7.44	9.97	11.1	11.18	11.31	11.75	12	12.00
500	2.1	3.72	4.83	7.34	9.88	10.95	10.96	11.16	11.61	11.84	11.84
1,000	1.71	3.31	4.18	6.9	9.27	10.28	10.52	10.66	11.04	11.27	11.27
2,000	1.45	2.82	3.72	6.23	8.48	9.38	9.67	9.83	10.15	10.39	10.39
5,000	1	1.93	2.64	4.45	6.27	7.02	7.09	7.4	7.62	7.9	7.90
10,000	0.54	1.14	1.55	2.66	4.35	4.74	4.83	5.42	5.52	5.81	5.81
20,000	0.33	0.69	0.97	1.82	2.64	3.37	3.47	3.65	3.78	3.98	3.98
28,279	0.27	0.51	0.74	1.33	2.13	2.5	2.59	2.79	2.89	3.06	3.06

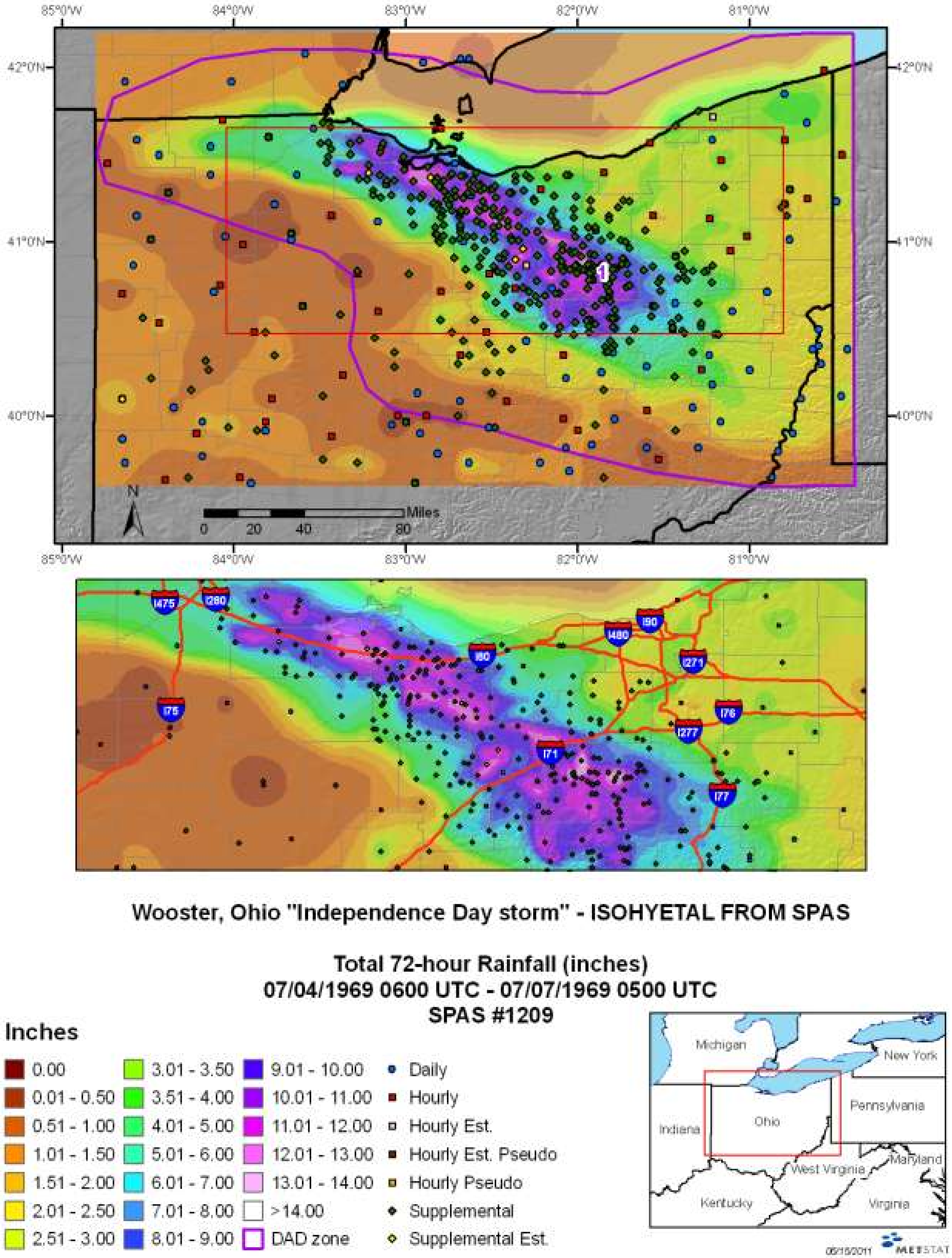
Appendix F: Table F.54: Depth-area-duration values for Wooster, OH July 4, 1969



Appendix F: Figure F.74: Depth-area-duration chart for Wooster, OH July 4, 1969



Appendix F: Figure F.75: Mass curve chart for Wooster, OH July 4, 1969



Appendix F: Figure F.76: Total storm isohyetal analysis for Wooster, OH July 4, 1969

Gladewater, TX, AWA 25

April 27, 1966

Storm Type: Frontal

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	SPAS 1181-Gladewater, TX		
Storm Date:	4/22-5-1/1966		
AWA Analysis Date:	12/14/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	15-May	
	Lat	Long
Storm center location	32.80 N	94.71 W
Storm Rep SST location	31.00 N	94.00 W
Transposition SST location	31.52 N	97.49 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	SSE @ 130	miles
Grid Point Elevation	350	feet
Storm Center Elevation	250	feet
Storm Rep Analysis Duration	24	hours

The storm representative SST is	71.5 F	with total precipitable water above sea level of			2.42	inches.
The in-place maximum SST is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The transpositioned maximum SST is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place storm elevation is	250	which subtracts	0.06	inches of precipitable water at	71.5 F	
The in-place storm elevation is	250	which subtracts	0.07	inches of precipitable water at	77.0 F	
The transposition storm elevation at	350	which subtracts	0.28	inches of precipitable water at	77.0 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.28	inches of precipitable water at	77.0 F	

The in-place maximization factor is	1.30
The transposition factor is	0.93
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.21

Notes:

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	8.8	10.6	10.8	14.1	-	17.5	18.1	-	20.5
100 sq miles	7.9	9.5	9.6	12.5	-	14.9	15.2	-	18.2
200 sq miles	7.4	9.0	9.1	11.6	-	13.1	14.3	-	17.0
500 sq miles	6.6	8.1	8.2	10.3	-	12.6	13.0	-	16.7
1000 sq miles	6.0	7.0	7.1	9.3	-	11.8	12.2	-	15.9
2000 sq miles	4.9	6.0	6.1	8.1	-	10.2	11.0	-	14.6
5000 sq miles	3.4	4.8	5.1	6.4	-	8.6	8.6	-	11.6
10000 sq miles	2.7	4.0	4.1	5.0	-	7.3	7.4	-	10.6
20000 sq miles	2.1	3.4	3.9	4.3	-	5.6	6.0	-	9.0

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.7	12.8	13.1	17.1	-	21.1	21.9	-	24.8
100 sq miles	9.5	11.5	11.6	15.1	-	18.1	18.5	-	22.1
200 sq miles	9.0	10.9	11.0	14.1	-	15.8	17.3	-	20.6
500 sq miles	8.0	9.8	9.9	12.5	-	15.3	15.8	-	20.2
1000 sq miles	7.2	8.5	8.7	11.2	-	14.3	14.7	-	19.2
2000 sq miles	6.0	7.2	7.4	9.9	-	12.4	13.3	-	17.7
5000 sq miles	4.1	5.9	6.2	7.7	-	10.4	10.4	-	14.0
10000 sq miles	3.2	4.9	5.0	6.1	-	8.8	9.0	-	12.9
20000 sq miles	2.6	4.1	4.7	5.2	-	6.8	7.2	-	10.9

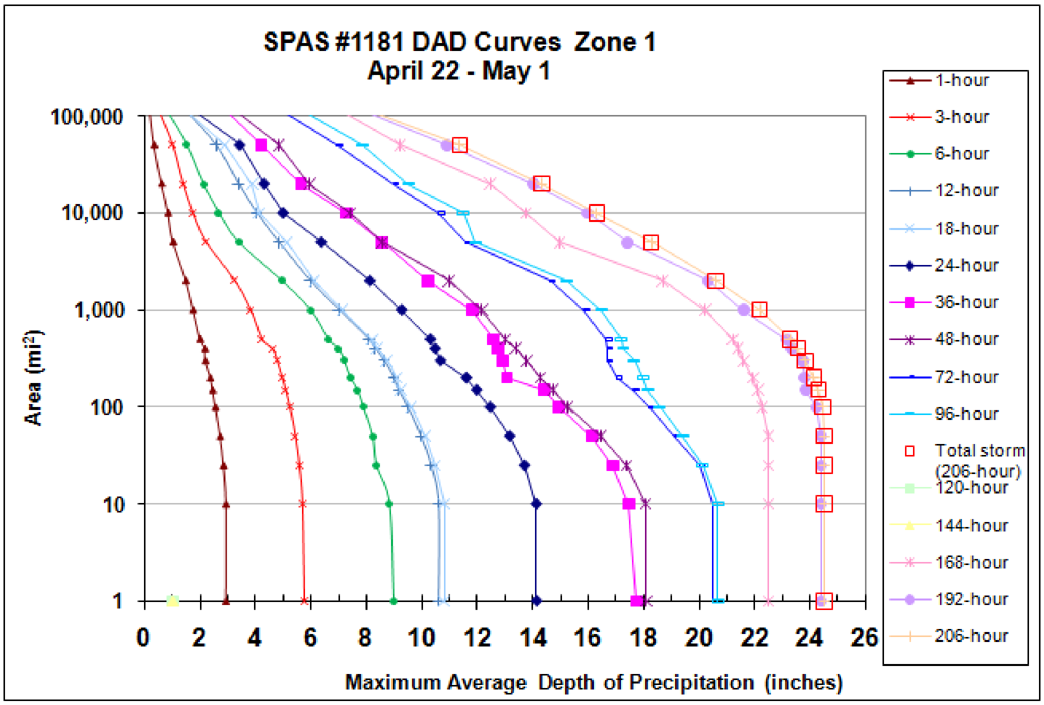
Storm or Storm Center Name	SPAS 1181-Gladewater, TX		
Storm Date(s)	4/22-5-1/1966		
Storm Type	General Storm		
Storm Location	32.80 N	94.71 W	
Storm Center Elevation	250		
Precipitation Total & Duration (10 sq mi)	25.35 inches in 206 hours, 18.57" in 72hrs		
Storm Representative SST	71.5 F		
Storm Representative SST Location	31.00 N	94.00 W	M
In-place Maximum SST	77.0 F		77
Moisture Inflow Vector	SSE @ 130		
In-place Maximization Factor			
Temporal Transposition (Date)	15-May		
Transposition Dewpoint Location	31.52 N	97.49 W	M
Transposition Maximum SST	77.0 F		77
Transposition Adjustment Factor			
Grid Point Elevation	350		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	1.21		

Appendix F: Table F.55: Storm spreadsheet for Gladewater, TX, April 27, 1966

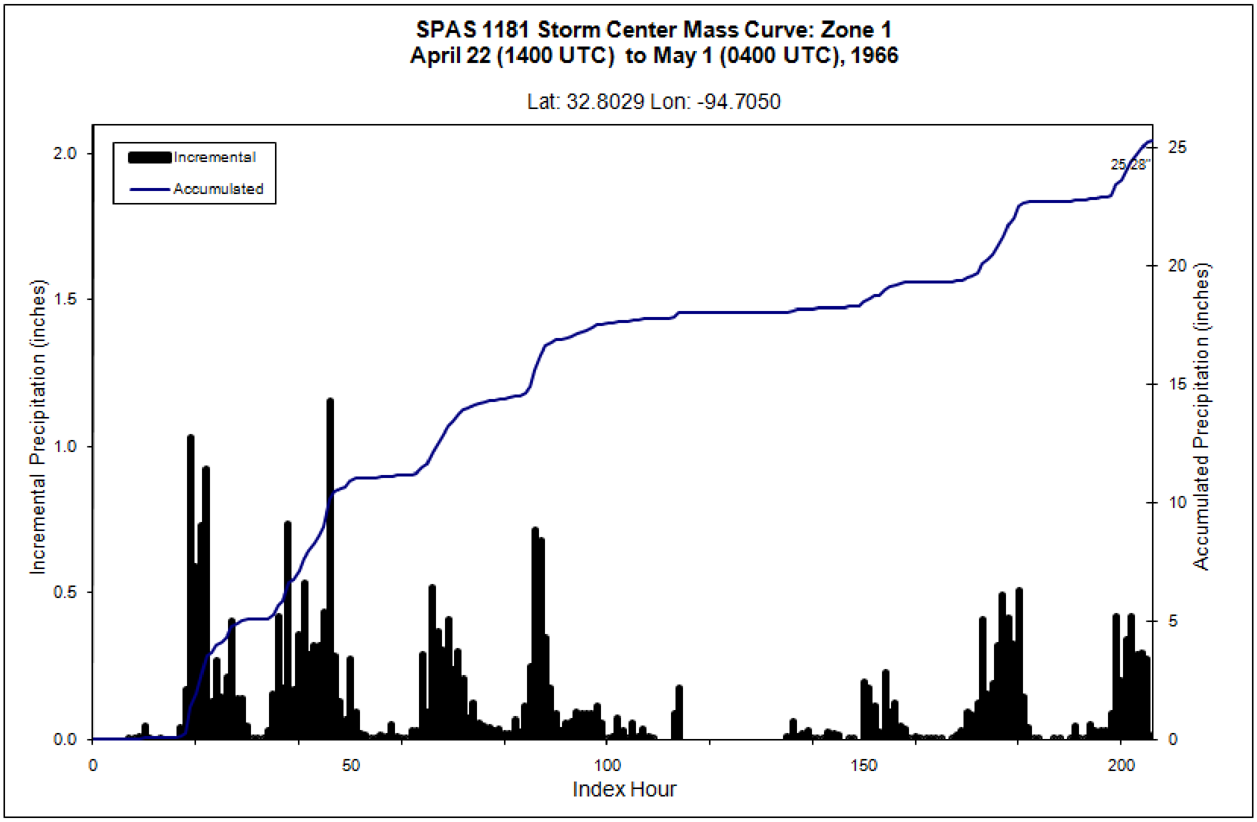
Storm 1181 - April 22, 1966 (1400 UTC) - May 1, 1966 (0400 UTC)
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)														
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	120	144	168	192	206	Total
0.30	2.98	5.88	9.17	10.89	11.12	14.53	18.21	18.57	21.04	21.17	21.17	21.59	23.27	25.21	25.28	25.28
1	2.92	5.75	8.97	10.59	10.80	14.13	17.74	18.09	20.49	20.68	20.69	21.10	22.51	24.41	24.52	24.52
10	2.92	5.68	8.82	10.59	10.80	14.12	17.45	18.07	20.49	20.68	20.69	21.10	22.51	24.41	24.52	24.52
25	2.83	5.57	8.35	10.32	10.47	13.69	16.88	17.38	20.01	20.13	20.13	20.61	22.51	24.41	24.52	24.52
50	2.71	5.43	8.21	9.96	10.13	13.16	16.14	16.47	19.11	19.42	19.46	19.53	22.51	24.41	24.52	24.52
100	2.54	5.23	7.87	9.48	9.61	12.46	14.93	15.23	18.20	18.57	18.57	19.35	22.28	24.22	24.46	24.46
150	2.44	5.08	7.67	9.15	9.24	11.98	14.43	14.74	17.64	18.15	18.15	19.02	22.12	23.84	24.30	24.30
200	2.36	4.96	7.42	8.98	9.09	11.60	13.07	14.28	17.02	17.98	18.02	18.89	21.95	23.80	24.14	24.14
300	2.18	4.77	7.19	8.63	8.74	10.67	12.91	13.78	16.67	17.65	17.88	18.63	21.61	23.72	23.82	23.82
400	2.16	4.61	6.99	8.31	8.38	10.48	12.75	13.39	16.67	17.27	17.30	18.31	21.41	23.32	23.55	23.55
500	1.99	4.23	6.62	8.08	8.19	10.31	12.59	13.01	16.66	17.19	17.26	17.90	21.21	23.15	23.29	23.29
1,000	1.74	3.82	5.97	7.01	7.14	9.28	11.83	12.17	15.85	16.49	16.70	17.35	20.22	21.60	22.20	22.20
2,000	1.48	3.24	4.94	5.97	6.10	8.13	10.22	10.97	14.62	15.22	15.34	16.02	18.68	20.32	20.60	20.60
5,000	1.02	2.21	3.38	4.84	5.13	6.38	8.56	8.56	11.57	11.93	13.28	13.60	14.97	17.43	18.28	18.28
10,000	0.84	1.73	2.68	4.04	4.14	5.01	7.27	7.41	10.61	11.50	11.87	12.20	13.75	15.98	16.30	16.30
20,000	0.61	1.38	2.11	3.38	3.88	4.32	5.64	5.95	8.98	9.52	9.53	9.92	12.48	14.03	14.34	14.34
50,000	0.34	1.00	1.52	2.57	2.88	3.44	4.20	4.84	6.94	7.86	7.97	8.44	9.21	10.90	11.37	11.37
110,790	0.20	0.52	0.81	1.50	1.50	1.77	2.92	3.28	4.96	5.68	5.80	6.18	7.06	7.87	8.14	8.14

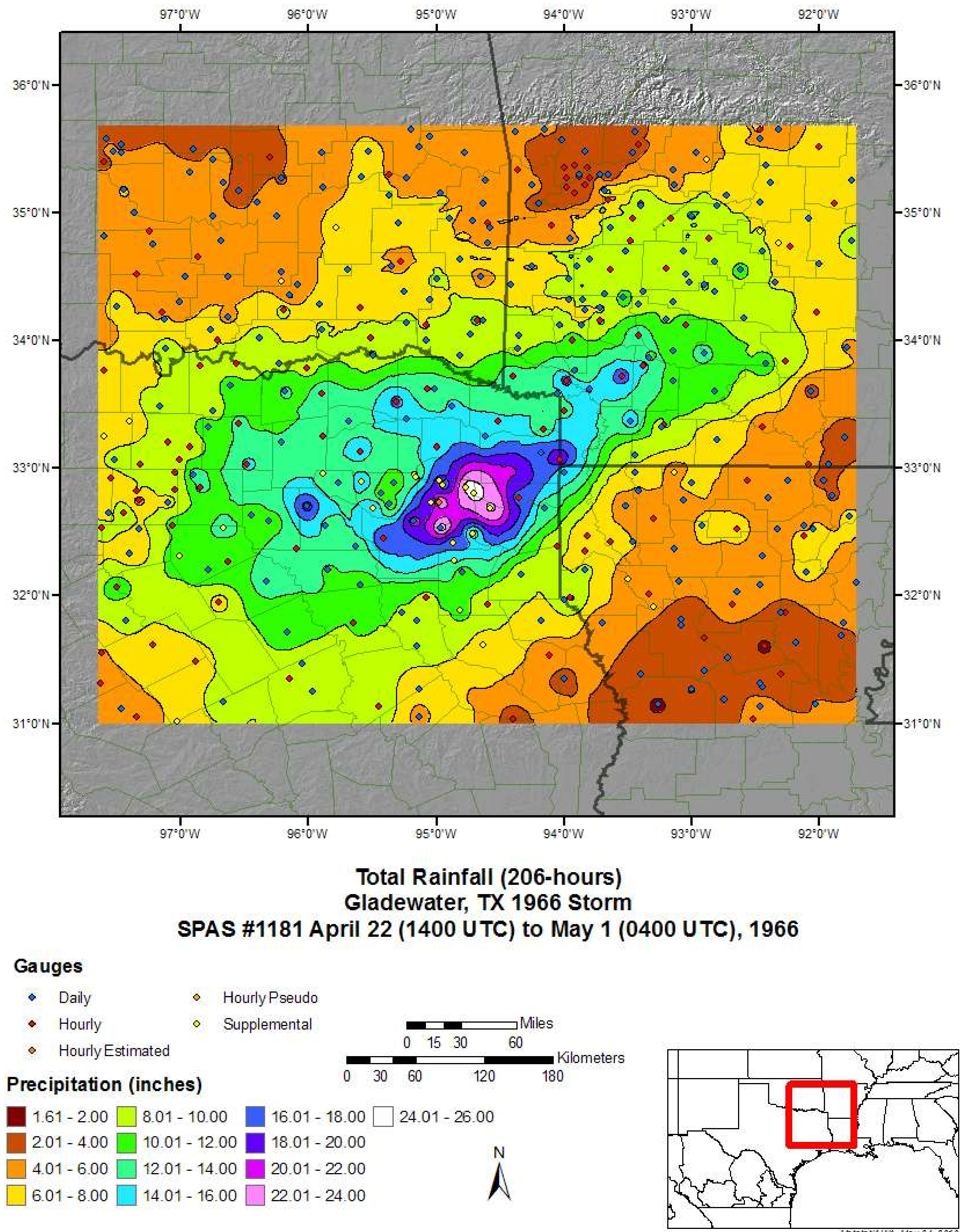
Appendix F: Table F.56: Depth-area-duration values for Gladewater, TX, April 27, 1966



Appendix F: Figure F.77: Depth-area-duration chart for Gladewater, TX, April 27, 1966



Appendix F: Figure F.78: Mass curve chart for Gladewater, TX, April 27, 1966



Appendix F: Figure F.79: Total storm isohyetal analysis for Gladewater, TX, April 27, 1966

Edgerton, MO, AWA 26

July 18, 1965

Storm Type: Frontal/MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	SPAS 1183-Edgerton, MO
Storm Date:	7/18-20/1965
AWA Analysis Date:	12/14/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	40.41 N	95.51 W
Storm Rep Dew Point Location	39.22 N	96.58 W
Transposition Dew Point Location	41.54 N	93.69 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SW @ 100	miles
Grid Point Elevation	350	feet
Storm Center Elevation	950	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	950	which subtracts	0.25	inches of precipitable water at	76.0 F	
The in-place storm elevation is	950	which subtracts	0.29	inches of precipitable water at	80.5 F	
The transposition storm elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place maximization factor is	1.24
The transposition factor is	1.00
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.23

Notes:

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	3.7	11.8	16.7	17.3	18.0	-	19.3	19.4	20.1	-
10 sq miles	3.5	11.1	15.4	16.5	17.6	-	19.0	19.1	19.7	-
100 sq miles	2.4	7.5	11.0	11.5	13.4	-	15.3	16.4	17.2	-
200 sq miles	1.8	6.2	9.2	9.9	12.7	-	14.2	15.4	16.2	-
500 sq miles	1.4	4.4	6.1	8.2	10.9	-	13.4	13.9	15.2	-
1000 sq miles	1.2	3.7	5.8	7.6	9.5	-	12.1	13.0	13.8	-
2000 sq miles	1.0	3.5	4.9	6.8	8.7	-	10.8	11.8	12.7	-
5000 sq miles	0.6	2.7	3.8	5.6	6.9	-	8.5	9.7	10.4	-
10000 sq miles	0.4	2.1	3.2	4.0	5.2	-	7.0	7.7	8.2	-
20000 sq miles	0.3	1.4	2.2	2.8	3.6	-	4.9	5.4	5.8	-

Adjusted Storm Depth-Area-Duration

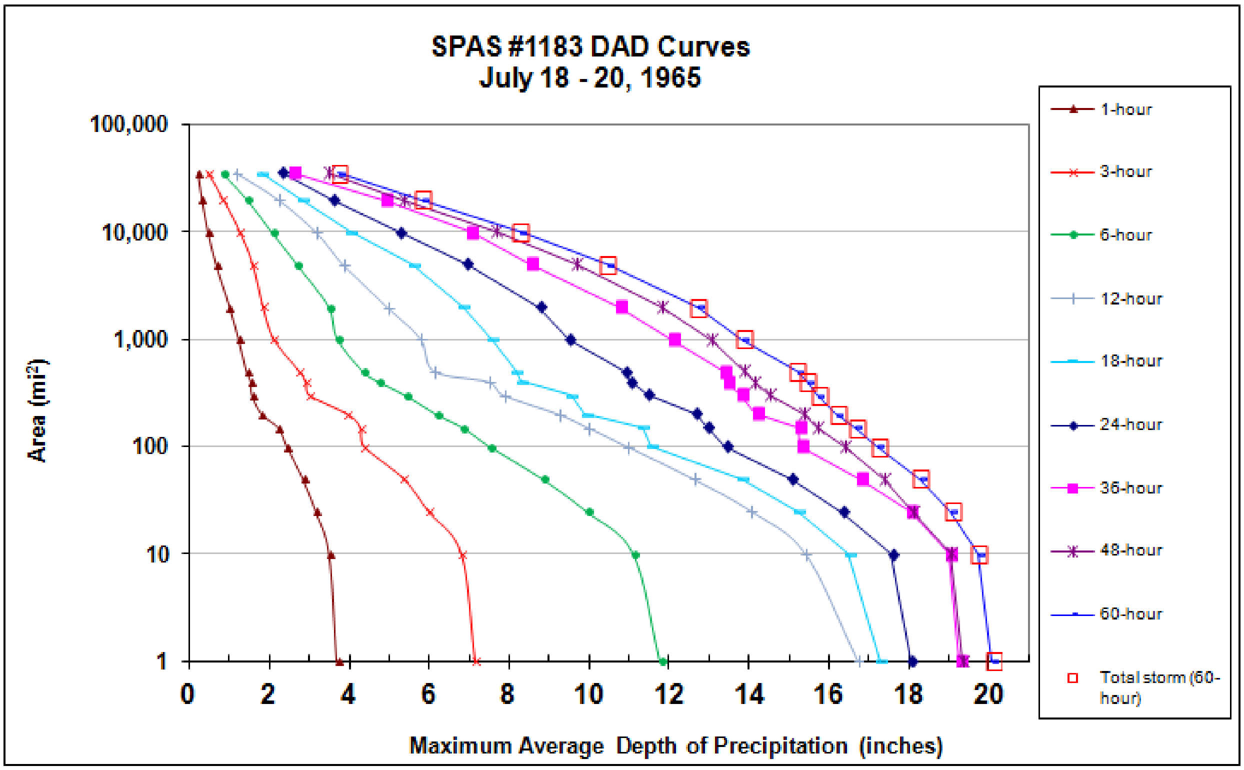
	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	4.5	14.5	20.6	21.3	22.2	-	23.7	23.8	24.7	-
10 sq miles	4.3	13.7	19.0	20.3	21.6	-	23.4	23.4	24.2	-
100 sq miles	3.0	9.2	13.5	14.2	16.5	-	18.8	20.2	21.2	-
200 sq miles	2.2	7.6	11.4	12.2	15.6	-	17.4	18.9	19.9	-
500 sq miles	1.7	5.4	7.5	10.0	13.4	-	16.4	17.1	18.7	-
1000 sq miles	1.5	4.6	7.1	9.3	11.7	-	14.9	16.0	17.0	-
2000 sq miles	1.2	4.3	6.1	8.4	10.8	-	13.2	14.5	15.6	-
5000 sq miles	0.8	3.3	4.7	6.9	8.5	-	10.5	11.9	12.8	-
10000 sq miles	0.5	2.5	3.9	4.9	6.4	-	8.6	9.4	10.1	-
20000 sq miles	0.4	1.8	2.7	3.5	4.4	-	6.0	6.6	7.1	-

Storm or Storm Center Name	**SPAS 1183-Edgerton, MO**	
Storm Date(s)	7/18-20/1965	
Storm Type	General Storm/MCC	
Storm Location	40.41 N	95.51 W
Storm Center Elevation	950	
Precipitation Total & Duration (10 sq mi)	20.76 inches in 60hrs, 18.59" in 24hrs	
Storm Representative Dew Point	76.0 F	24
Storm Representative Dew Point Location	39.22 N	96.58 W
Maximum Dew Point	80.5 F	
Moisture Inflow Vector	SW @ 100	
In-place Maximization Factor	**1.24**	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	41.54 N	93.69 W
Transposition Maximum Dew Point	80.5 F	
Transposition Adjustment Factor	**1.00**	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.23**	

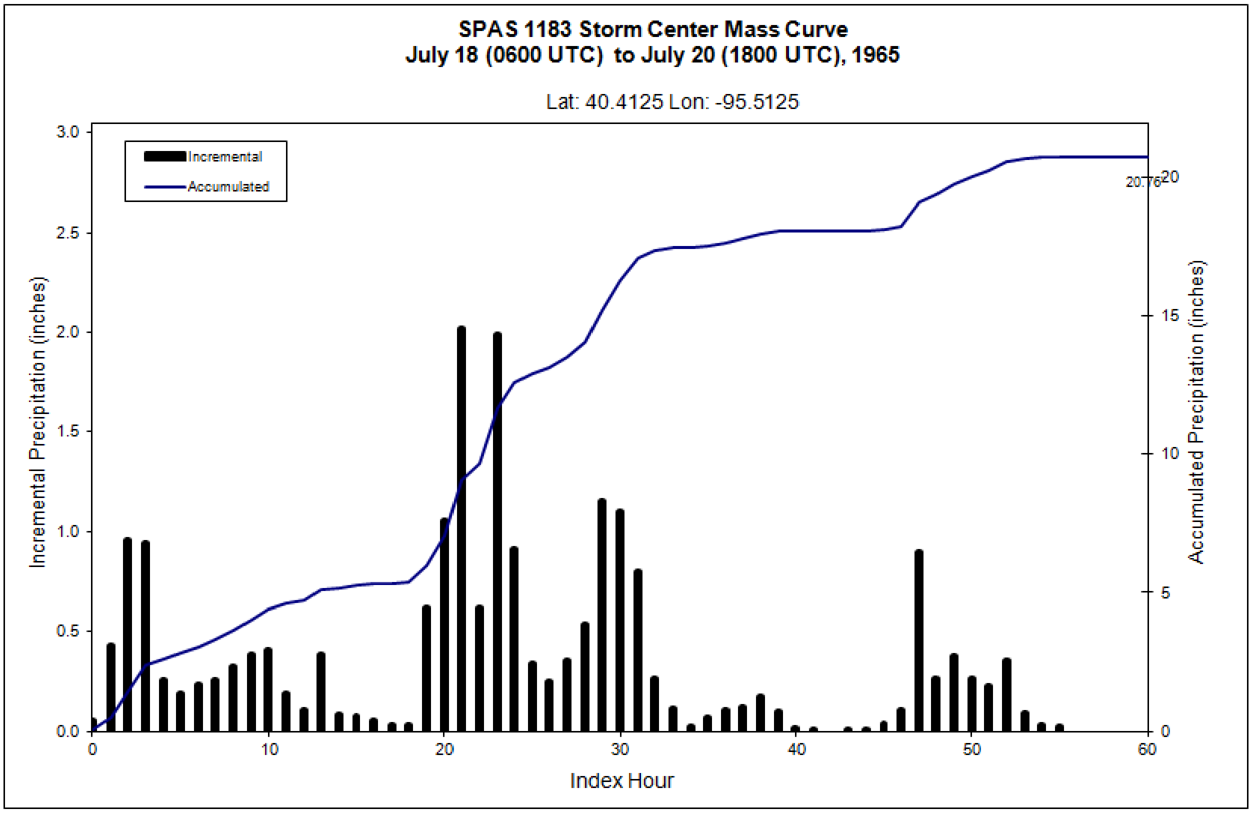
Appendix F: Table F.57: Storm spreadsheet for Edgerton, MO July 18, 1965

Storm 1183 - July 18, 1965 (0600 UTC) to July 20 (1800 UTC), 1965 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi^2)	1	3	6	12	18	24	36	48	60	Total
0.30	3.77	7.34	12.06	17.13	17.80	18.59	19.82	19.86	20.76	20.76
1	3.68	7.13	11.77	16.72	17.29	18.04	19.27	19.35	20.08	20.08
10	3.49	6.79	11.11	15.41	16.49	17.56	19.00	19.06	19.71	19.71
25	3.15	5.96	9.93	14.05	15.23	16.32	18.04	18.12	19.06	19.06
50	2.83	5.35	8.83	12.60	13.81	15.05	16.79	17.37	18.27	18.27
100	2.43	4.36	7.52	10.95	11.54	13.41	15.27	16.39	17.22	17.22
150	2.21	4.26	6.84	9.96	11.34	12.96	15.23	15.69	16.66	16.66
200	1.79	3.94	6.18	9.23	9.90	12.66	14.18	15.38	16.18	16.18
300	1.55	2.99	5.41	7.86	9.53	11.45	13.80	14.49	15.71	15.71
400	1.52	2.90	4.74	7.48	8.30	11.04	13.43	14.13	15.44	15.44
500	1.41	2.73	4.35	6.13	8.17	10.88	13.37	13.88	15.17	15.17
1,000	1.21	2.09	3.71	5.79	7.57	9.48	12.08	13.04	13.83	13.83
2,000	0.98	1.82	3.49	4.94	6.83	8.74	10.76	11.80	12.70	12.70
5,000	0.64	1.56	2.69	3.84	5.57	6.92	8.50	9.66	10.42	10.42
10,000	0.44	1.24	2.06	3.16	4.00	5.23	7.03	7.67	8.24	8.24
20,000	0.29	0.82	1.44	2.21	2.81	3.59	4.86	5.36	5.81	5.81
35,221	0.19	0.45	0.83	1.17	1.78	2.29	2.57	3.46	3.72	3.72

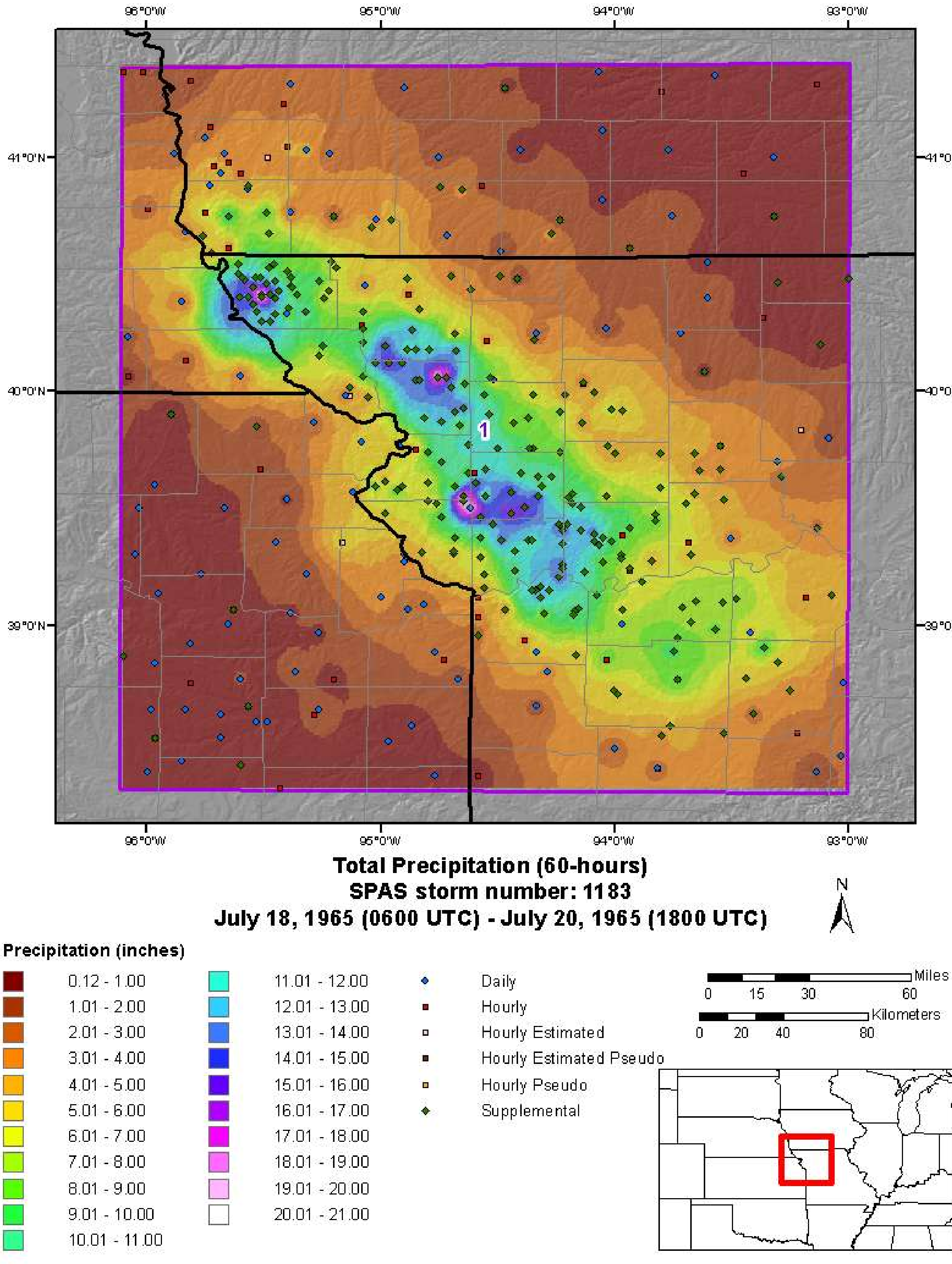
Appendix F: Table F.58: Depth-area-duration values for Edgerton, MO July 18, 1965



Appendix F: Figure F.80: Depth-area-duration chart for Edgerton, MO July 18, 1965



Appendix F: Figure F.81: Mass curve chart for Edgerton, MO July 18, 1965



Appendix F: Figure F.82: Total storm isohyetal analysis for Edgerton, MO July 18, 1965

Holly, CO, AWA 27

June 16, 1965

Storm Type: MCC

Grid Points Used: 5-6, 12, 15, 19-20

Storm Name:	SPAS 1293 Holly, CO Zone 1		
Storm Date:	6/14-18/1965		
AWA Analysis Date:	12/14/2013		

Storm Adjustment for ANO Grid Point 5

Temporal Transposition Date	1-Jul	
	Lat	Long
Storm center location	37.71 N	102.40 W
Storm Rep dew point location	33.50 N	100.00 W
Transposition dewpoint location	30.80 N	99.67 W
Basin location	35.00 N	102.00 W

Moisture Inflow Direction:	SSE @ 320	miles
Grid Point Elevation	3,700	feet
Storm Center Elevation	4,100	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	75.5 F	with total precipitable water above sea level of			2.92	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	4,100	which subtracts	0.94	inches of precipitable water at	75.5 F	
The in-place storm elevation is	4,100	which subtracts	1.04	inches of precipitable water at	78.5 F	
The transposition basin elevation at	3,700	which subtracts	0.97	inches of precipitable water at	79.0 F	
The inflow barrier/basin elevation height is	3,700	which subtracts	0.97	inches of precipitable water at	79.0 F	

The in-place storm maximization factor is	1.17
The transposition/elevation to basin factor is	1.06
The barrier adjustment factor is	1.00
The total adjustment factor is	1.25

Notes: DAD values taken from SPAS 1293 Zone 1. Storm representative dew point value was based on maximum 24-hr Td values between June 14-15, 1965 at KLBB, KABI, KFWH, KMWL.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	3.8	7.5	13.3	14.1	14.2	16.0	17.1	18.2	18.4	18.6
10 sq miles	3.8	7.3	13.3	14.1	14.2	16.0	17.1	18.2	18.4	18.6
100 sq miles	3.5	6.6	12.2	13.0	13.0	14.9	16.0	17.5	17.5	17.7
200 sq miles	3.1	5.8	10.8	11.5	11.5	13.4	14.8	16.3	16.3	16.6
500 sq miles	2.0	4.2	7.9	8.5	8.5	10.3	12.0	13.6	14.4	14.4
1000 sq miles	1.5	2.7	4.3	5.4	5.5	8.6	9.4	11.4	12.5	12.5
2000 sq miles	1.3	2.2	3.1	3.8	4.6	6.1	7.1	9.5	10.0	10.5
5000 sq miles	0.9	1.6	2.3	2.6	3.5	4.7	5.3	6.6	7.1	7.1
10000 sq miles	0.4	0.6	0.9	1.9	2.2	3.1	3.5	4.6	4.8	5.2
20000 sq miles	0.2	0.6	0.7	0.9	1.2	1.8	2.8	3.0	3.4	3.8

Adjusted Storm Depth-Area-Duration

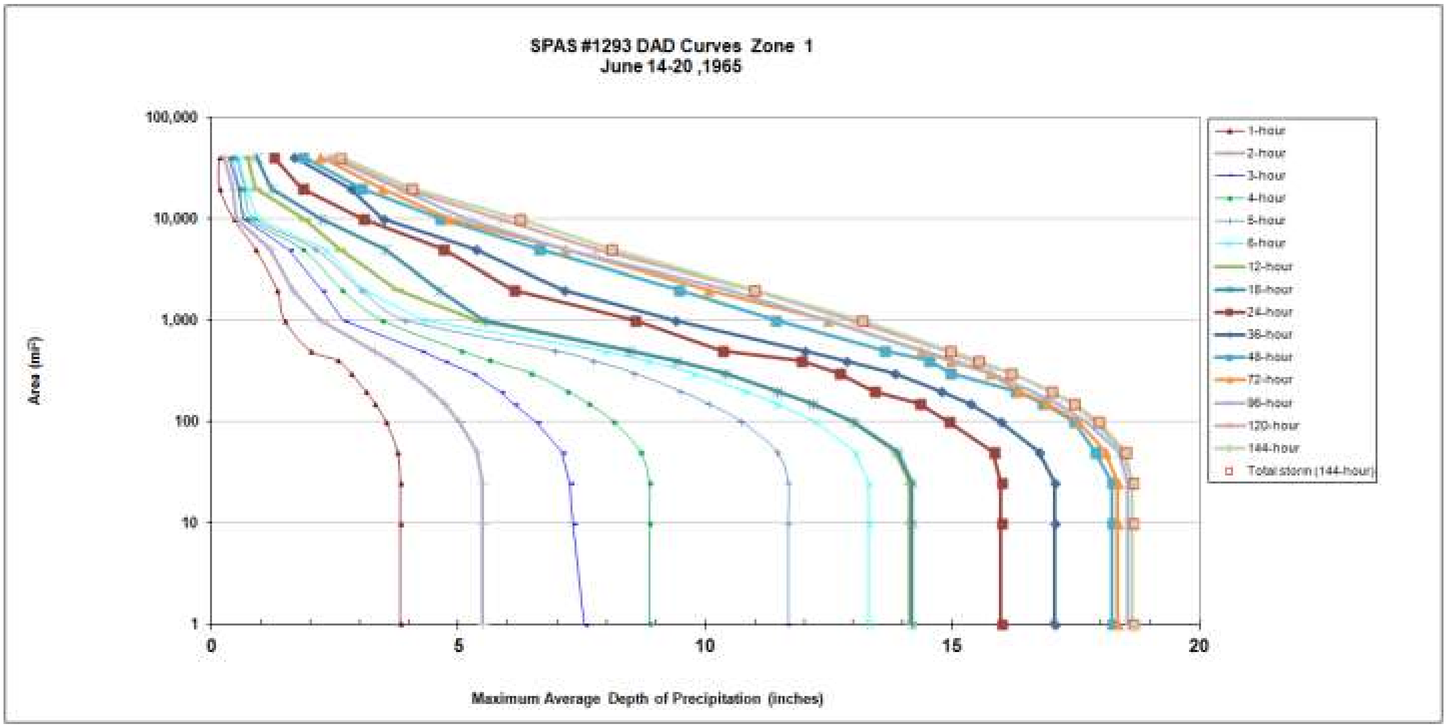
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	4.8	9.4	16.6	17.6	17.7	19.9	21.3	22.8	22.9	23.1
10 sq miles	4.8	9.1	16.6	17.6	17.7	19.9	21.3	22.8	22.9	23.1
100 sq miles	4.4	8.2	15.2	16.2	16.2	18.6	19.9	21.8	21.9	22.1
200 sq miles	3.9	7.3	13.5	14.3	14.3	16.7	18.4	20.3	20.4	20.7
500 sq miles	2.5	5.3	9.9	10.6	10.6	12.9	15.0	17.0	17.9	18.0
1000 sq miles	1.8	3.3	5.3	6.7	6.9	10.7	11.7	14.3	15.5	15.5
2000 sq miles	1.6	2.8	3.9	4.7	5.7	7.6	8.9	11.8	12.5	13.0
5000 sq miles	1.1	1.9	2.9	3.2	4.4	5.9	6.6	8.3	8.9	8.9
10000 sq miles	0.5	0.8	1.2	2.3	2.8	3.8	4.3	5.8	6.0	6.4
20000 sq miles	0.2	0.7	0.9	1.1	1.5	2.3	3.5	3.8	4.3	4.7

Storm or Storm Center Name	**SPAS 1293 Holly, CO Zone 1**			
Storm Date(s)	6/14-18/1965			
Storm Type	MCC			
Storm Location	37.71 N	102.40 W		
Storm Center Elevation	4,100			
Precipitation Total & Duration	19.18 Inches 120-hours			
Storm Representative Dewpoint	75.5 F	24		
Storm Representative Dewpoint Location	33.50 N	100.00 W	Jun	Jul
Maximum Dewpoint	78.5 F		78	79
Moisture Inflow Vector	SSE @ 320	Miles		
In-place Maximization Factor	**1.17**			
Temporal Transposition (Date)	1-Jul			
Transposition Dewpoint Location	30.80 N	99.67 W	Jun	Jul
Transposition Maximum Dewpoint	79.0 F		x	x
Transposition Adjustment Factor	**1.06**			
Average Basin Elevation	3,700			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	0.00			
Elevation Adjustment Factor	1			
Total Adjustment Factor	**1.25**			

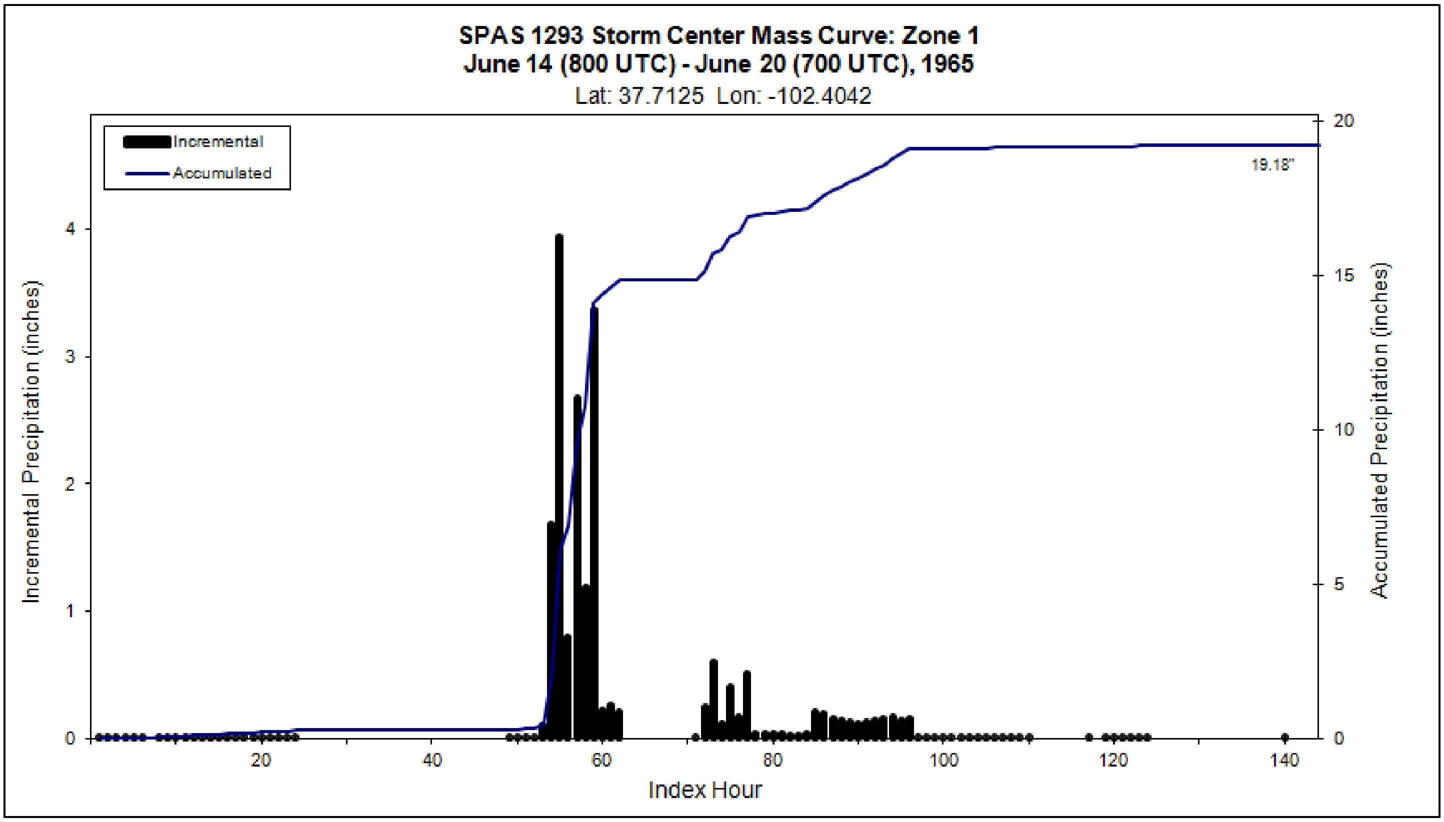
Appendix F: Table F.59: Storm spreadsheet for Holly, CO, June 16, 1965

SPAS 1293 - June 14 (800 UTC) - June 20 (700 UTC), 1965 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
	Duration (hours)														
Area (mi^2)	1	2	3	4	5	6	12	18	24	36	48	72	96	120	144	Total
0.3	3.94	5.65	7.72	9.1	11.98	13.66	14.52	14.55	16.45	17.55	18.8	18.9	19.09	19.18	19.18	19.18
1	3.81	5.5	7.54	8.86	11.67	13.3	14.14	14.17	15.98	17.06	18.24	18.35	18.55	18.65	18.65	18.65
10	3.81	5.5	7.31	8.86	11.67	13.3	14.14	14.17	15.98	17.06	18.24	18.35	18.55	18.65	18.65	18.65
25	3.81	5.49	7.24	8.86	11.67	13.3	14.14	14.17	15.98	17.06	18.24	18.35	18.55	18.65	18.65	18.65
50	3.76	5.37	7.08	8.68	11.44	13.04	13.86	13.89	15.82	16.74	17.9	18.09	18.36	18.47	18.5	18.50
100	3.52	5.02	6.57	8.13	10.71	12.21	12.97	12.99	14.91	15.96	17.45	17.54	17.7	17.89	17.95	17.95
150	3.3	4.71	6.11	7.62	10.04	11.44	12.15	12.16	14.32	15.34	16.83	16.91	17.12	17.43	17.45	17.45
200	3.11	4.44	5.84	7.18	9.47	10.8	11.45	11.45	13.4	14.75	16.28	16.33	16.6	16.98	16.99	16.99
300	2.81	4.01	5.28	6.46	8.54	9.75	10.38	10.4	12.7	13.81	14.96	15.75	15.79	16.17	16.18	16.18
400	2.54	3.62	4.7	5.61	7.72	8.81	9.38	9.39	11.93	12.84	14.53	14.96	15.03	15.4	15.51	15.51
500	1.99	3.27	4.23	5.06	6.96	7.94	8.46	8.46	10.33	11.99	13.63	14.36	14.41	14.86	14.93	14.93
1,000	1.47	2.2	2.67	3.45	3.92	4.28	5.38	5.52	8.56	9.37	11.43	12.46	12.46	12.96	13.17	13.17
2,000	1.32	1.64	2.23	2.64	3.03	3.09	3.76	4.6	6.11	7.11	9.45	10.04	10.45	10.93	10.98	10.98
5,000	0.88	1.19	1.55	1.83	2.09	2.3	2.59	3.5	4.69	5.33	6.63	7.13	7.13	7.76	8.09	8.09
10,000	0.44	0.5	0.64	0.73	0.85	0.93	1.86	2.22	3.06	3.47	4.64	4.81	5.16	5.83	6.23	6.23
20,000	0.16	0.44	0.55	0.56	0.66	0.71	0.89	1.21	1.82	2.8	3.03	3.44	3.78	3.84	4.05	4.05
40,556	0.15	0.25	0.35	0.4	0.49	0.54	0.74	0.92	1.25	1.66	1.86	2.2	2.37	2.47	2.6	2.60

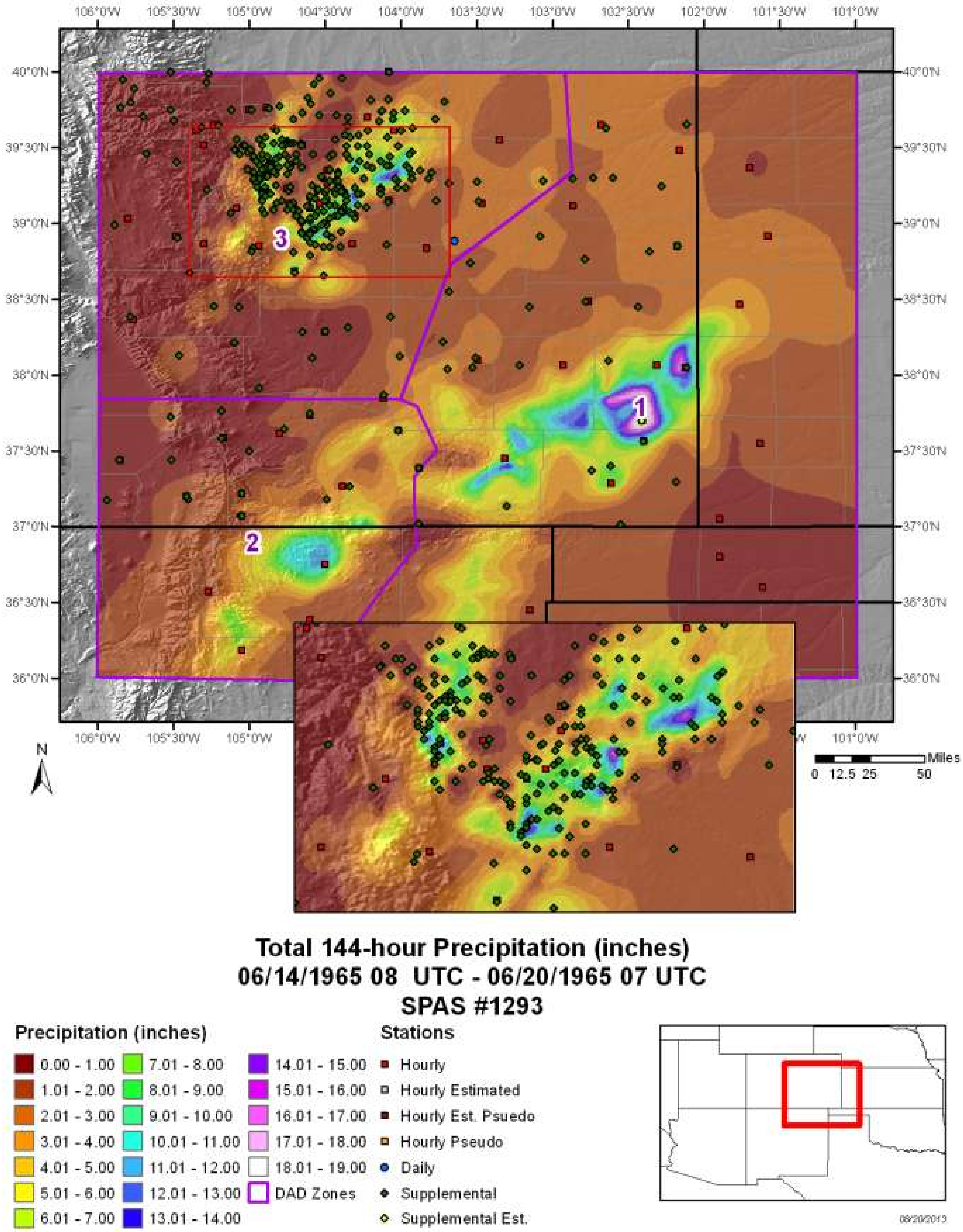
Appendix F: Table F.60: Depth-area-duration values for Holly, CO, June 16, 1965



Appendix F: Figure F.83: Depth-area-duration chart for Holly, CO, June 16, 1965



Appendix F: Figure F.84: Mass curve chart for Holly, CO, June 16, 1965



Appendix F: Figure F.85: Total storm isohyetal analysis for Holly, CO, June 16, 1965

Plum Creek, CO, AWA 28

June 15, 1965

Storm Type: MCC

Grid Points Used: 6, 13, 15, 21

Storm Name:	SPAS 1293 Plum Creek, CO Zone 3		**Storm Adjustment for ANO Grid Point 5**
Storm Date:	6/14-18/1965		
AWA Analysis Date:	12/14/2013		

Temporal Transposition Date 1-Jul

	Lat	Long
Storm center location	39.19 N	104.30 W
Storm Rep dew point location	33.50 N	100.00 W
Transposition dewpoint location	29.30 N	97.88 W
Basin location	35.00 N	102.00 W

Moisture Inflow Direction:	SE @ 460	miles
Grid Point Elevation	3,700	feet
Storm Center Elevation	6,220	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	75.5 F	with total precipitable water above sea level of			2.92	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The in-place storm elevation is	6,220	which subtracts	0.94	inches of precipitable water at	75.5 F	
The in-place storm elevation is	6,220	which subtracts	1.04	inches of precipitable water at	78.5 F	
The transposition basin elevation at	3,700	which subtracts	0.99	inches of precipitable water at	79.5 F	
The inflow barrier/basin elevation height is	3,700	which subtracts	0.99	inches of precipitable water at	79.5 F	

The in-place storm maximization factor is	1.17
The transposition/elevation to basin factor is	1.09
The barrier adjustment factor is	1.00
The total adjustment factor is	1.28

Notes: DAD values taken from SPAS 1293 Zone 1. Storm representative dew point value was based on maximum 24-hr Td values between June 14-15, 1965 at KLBB, KABI, KFWH, KMWL.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	6.5	7.7	11.7	12.7	13.0	13.3	13.5	13.6	15.9	15.9
10 sq miles	6.0	6.7	9.8	10.6	11.2	11.4	12.2	12.7	14.5	14.6
100 sq miles	3.8	4.5	6.3	8.2	8.2	8.4	9.5	9.9	12.0	12.1
200 sq miles	2.8	3.9	5.7	7.2	7.3	7.4	8.4	8.7	10.5	10.8
500 sq miles	2.0	2.7	4.0	5.5	5.9	6.0	7.1	7.4	8.8	8.8
1000 sq miles	1.3	1.8	2.8	4.3	4.4	4.5	5.8	6.2	7.4	7.4
2000 sq miles	0.7	1.0	1.8	3.0	3.2	3.3	3.8	4.8	5.9	5.9
5000 sq miles	0.4	0.6	1.0	1.4	1.5	1.6	2.8	2.8	4.1	4.2
10000 sq miles	0.2	0.4	0.7	0.8	0.9	1.3	1.9	2.3	2.7	2.8
20000 sq miles	0.1	0.2	0.4	0.6	0.7	0.8	1.1	1.3	1.6	1.7

Adjusted Storm Depth-Area-Duration

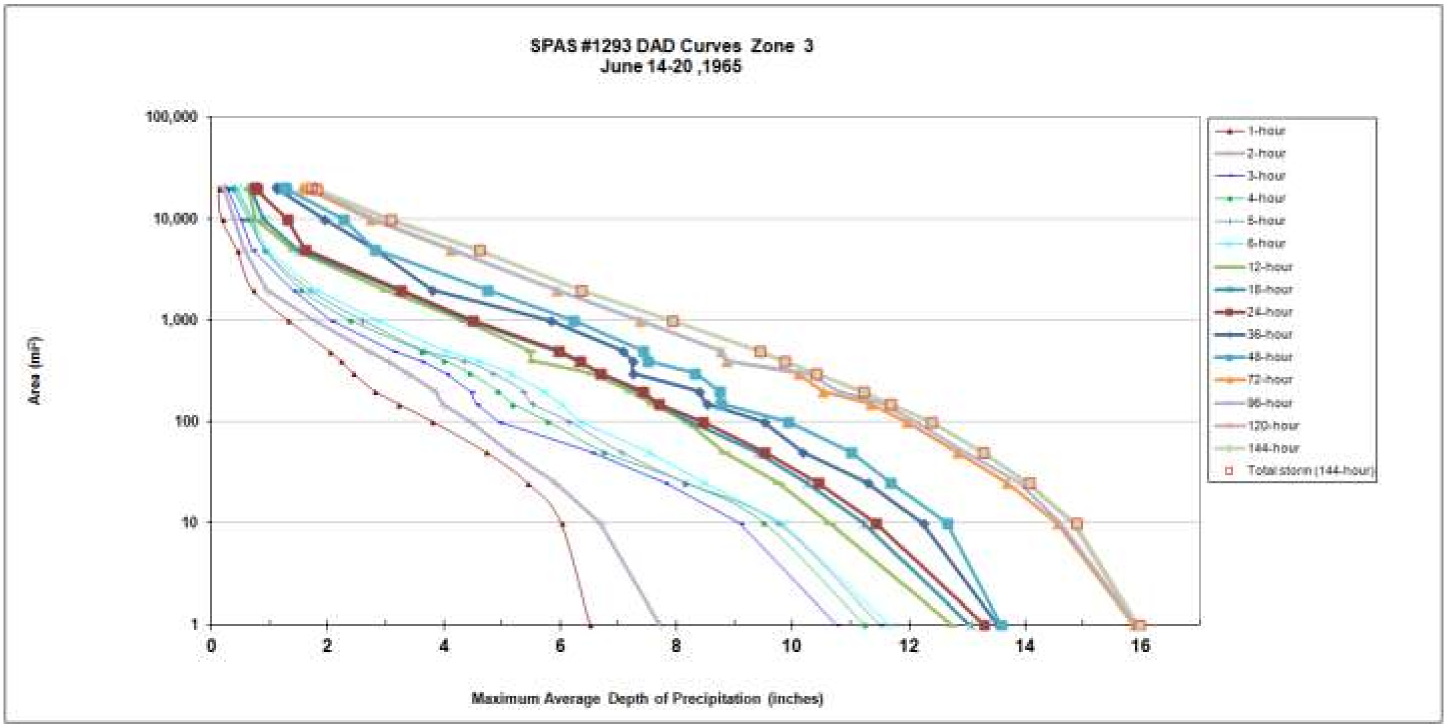
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours	96 Hours
1 sq miles	8.3	9.9	14.9	16.3	16.7	17.0	17.3	17.4	20.3	20.3
10 sq miles	7.7	8.5	12.6	13.6	14.3	14.6	15.6	16.2	18.6	18.7
100 sq miles	4.8	5.7	8.1	10.4	10.5	10.8	12.1	12.7	15.3	15.5
200 sq miles	3.6	4.9	7.3	9.2	9.4	9.5	10.7	11.2	13.4	13.8
500 sq miles	2.6	3.5	5.1	7.0	7.6	7.6	9.0	9.5	11.2	11.2
1000 sq miles	1.7	2.3	3.6	5.5	5.6	5.7	7.4	7.9	9.4	9.4
2000 sq miles	0.9	1.2	2.3	3.8	4.1	4.2	4.9	6.1	7.6	7.6
5000 sq miles	0.5	0.7	1.2	1.8	1.9	2.0	3.6	3.6	5.3	5.3
10000 sq miles	0.2	0.5	0.9	1.0	1.2	1.6	2.5	2.9	3.5	3.6
20000 sq miles	0.2	0.3	0.6	0.8	0.9	1.0	1.4	1.6	2.1	2.2

Storm or Storm Center Name	**SPAS 1293 Plum Creek, CO Zone 3**			
Storm Date(s)	6/14-18/1965			
Storm Type	MCC			
Storm Location	39.19 N	104.30 W		
Storm Center Elevation	6,220			
Precipitation Total & Duration	16.29 Inches 120-hours			
Storm Representative Dewpoint	75.5 F	24		
Storm Representative Dewpoint Location	33.50 N	100.00 W	Jun	Jul
Maximum Dewpoint	78.5 F		78	79
Moisture Inflow Vector	SE @ 460	Miles		
In-place Maximization Factor	**1.17**			
Temporal Transposition (Date)	1-Jul			
Transposition Dewpoint Location	29.30 N	97.88 W	Jun	Jul
Transposition Maximum Dewpoint	79.5 F		79	79.5
Transposition Adjustment Factor	**1.09**			
Average Basin Elevation	3,700			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	0.00			
Elevation Adjustment Factor	1			
Total Adjustment Factor	**1.28**			

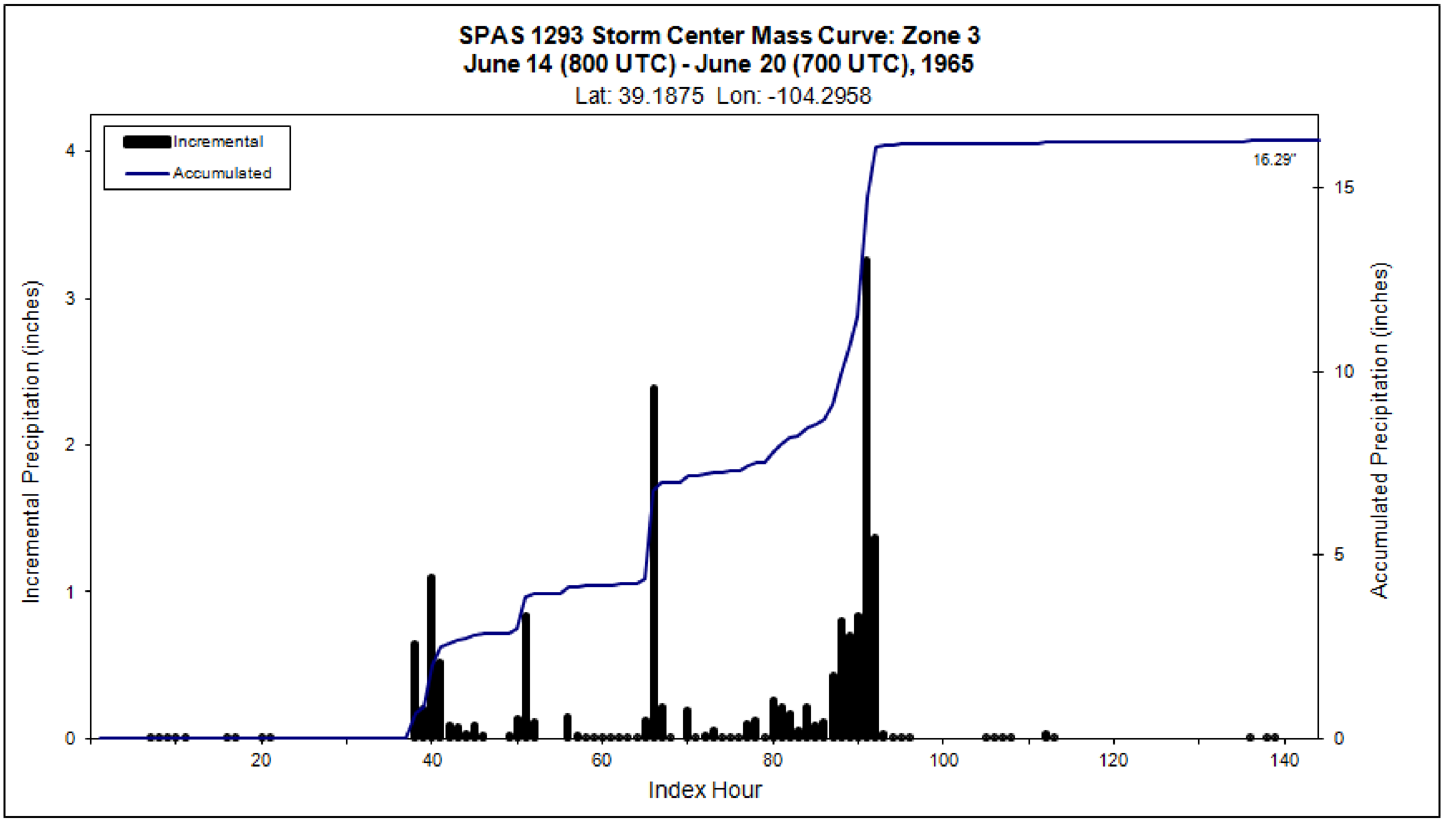
Appendix F: Table F.61: Storm spreadsheet for Plum Creek, CO, June 15, 1965

SPAS 1293 - June 14 (800 UTC) - June 20 (700 UTC), 1965 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
	Duration (hours)														
Area (mi²)	1	2	3	4	5	6	12	18	24	36	48	72	96	120	144	Total
0.3	6.64	8.06	10.98	11.46	11.76	11.86	12.99	13.31	13.56	13.81	13.86	16.19	16.25	16.27	16.29	16.29
1	6.5	7.71	10.75	11.23	11.51	11.66	12.72	13.04	13.28	13.53	13.58	15.86	15.91	15.93	15.95	15.95
10	6	6.68	9.09	9.5	9.74	9.83	10.63	11.21	11.42	12.23	12.65	14.54	14.6	14.81	14.86	14.86
25	5.43	5.9	7.79	8.14	8.14	8.46	9.75	10.23	10.43	11.28	11.68	13.68	13.89	14.03	14.04	14.04
50	4.71	5.13	6.52	6.74	7.04	7.52	8.82	9.38	9.51	10.17	11.01	12.83	12.96	13.24	13.26	13.26
100	3.79	4.45	4.94	5.78	6.14	6.33	8.17	8.24	8.44	9.5	9.91	11.96	12.11	12.35	12.37	12.37
150	3.2	3.98	4.56	5.18	5.52	6	7.58	7.67	7.68	8.51	8.75	11.34	11.55	11.67	11.67	11.67
200	2.8	3.85	4.46	4.92	5.36	5.71	7.2	7.34	7.42	8.39	8.73	10.51	10.79	11.18	11.21	11.21
300	2.43	3.37	4.03	4.44	4.84	5.15	6.52	6.68	6.68	7.24	8.32	10.1	10.24	10.38	10.39	10.39
400	2.21	3.03	3.6	4	4.34	4.59	5.52	6.29	6.32	7.24	7.49	8.86	8.86	9.83	9.85	9.85
500	2.01	2.7	3.12	3.6	3.66	4.01	5.48	5.91	5.96	7.07	7.41	8.75	8.75	9.4	9.41	9.41
1,000	1.31	1.77	2.06	2.38	2.59	2.84	4.34	4.42	4.49	5.82	6.22	7.37	7.37	7.91	7.91	7.91
2,000	0.7	0.95	1.4	1.54	1.67	1.8	2.99	3.2	3.25	3.8	4.75	5.92	5.92	6.33	6.34	6.34
5,000	0.43	0.57	0.7	0.91	0.91	0.95	1.4	1.47	1.6	2.81	2.81	4.11	4.15	4.55	4.6	4.60
10,000	0.17	0.39	0.51	0.63	0.69	0.72	0.76	0.9	1.29	1.94	2.27	2.73	2.79	3.02	3.07	3.07
20,000	0.12	0.22	0.28	0.35	0.39	0.44	0.63	0.68	0.76	1.12	1.27	1.62	1.74	1.79	1.79	1.79
20,732	0.12	0.21	0.27	0.35	0.39	0.42	0.63	0.67	0.74	1.11	1.25	1.56	1.67	1.7	1.7	1.70

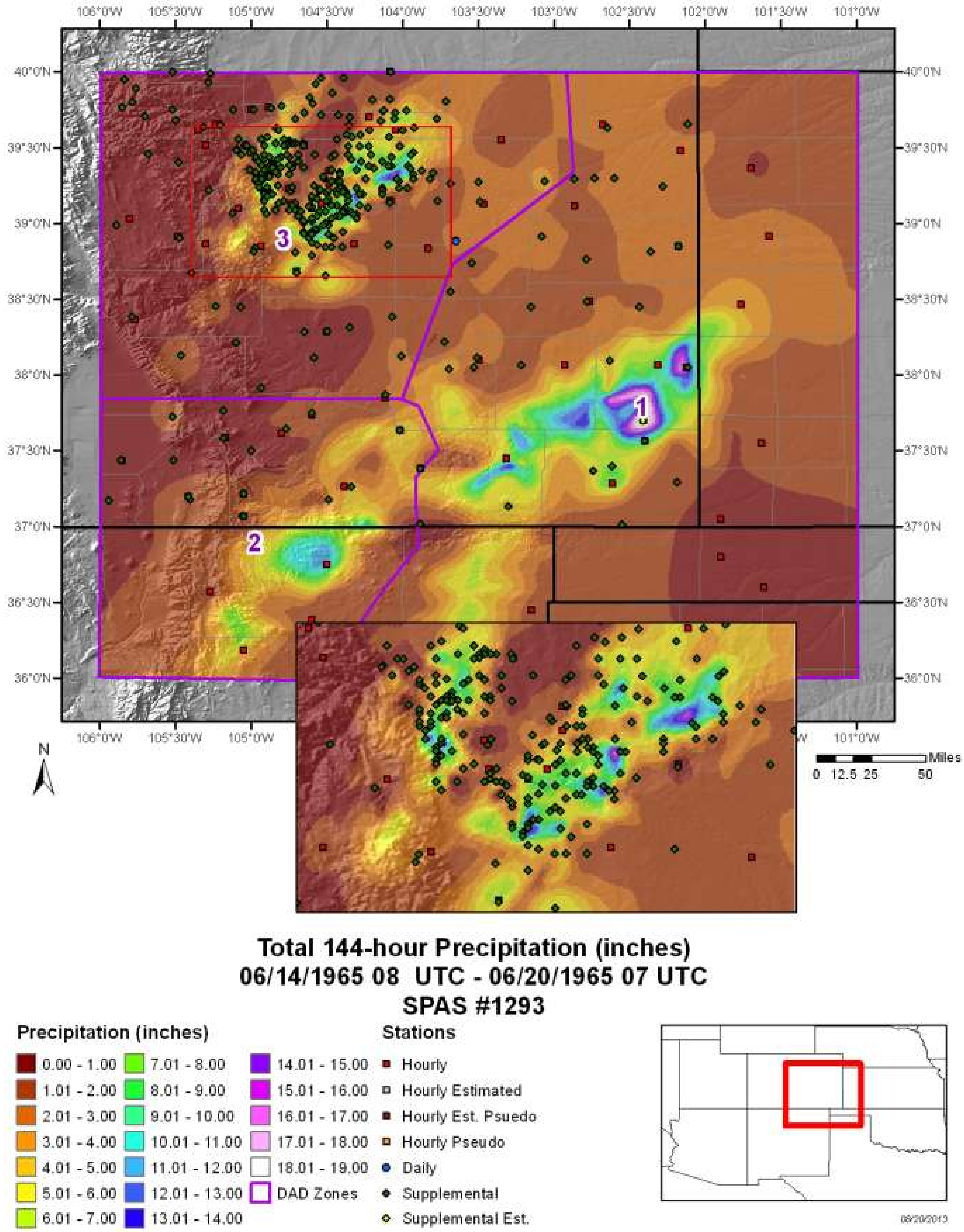
Appendix F: Table F.62: Depth-area-duration values for Plum Creek, CO, June 15, 1965



Appendix F: Figure F.86: Depth-area-duration chart for Plum Creek, CO, June 15, 1965



Appendix F: Figure F.87: Mass curve chart for Plum Creek, CO, June 15, 1965



Appendix F: Figure F.88: Total storm isohyetal analysis for Plum Creek, CO, June 15, 1965

College Hill, OH, AWA 30

June 3, 1963

Storm Type: MCC

Grid Points Used: 8

Storm Name:	College Hill, OH SPAS 1226	Storm Adjustment for ANO Grid Point 8
Storm Date:	6/3-5/1963	
AWA Analysis Date:	12/14/2013	

Temporal Transposition Date 15-Jun

	Lat	Long
Storm Center Location	40.09 N	81.65 W
Storm Rep Dew Point Location	39.20 N	83.00 W
Transposition Dew Point Location	42.84 N	93.99 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SW @ 95	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	68.5 F	with total precipitable water above sea level of			2.10	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place storm elevation is	1,000	which subtracts	0.21	inches of precipitable water at	68.5 F	
The in-place storm elevation is	1,000	which subtracts	0.27	inches of precipitable water at	76.5 F	
The transposition basin elevation at	1,200	which subtracts	0.28	inches of precipitable water at	78.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.28	inches of precipitable water at	78.0 F	

The in-place storm maximization factor is	1.48
The transposition/elevation to basin factor is	1.08
The barrier adjustment factor is	1.00
The total adjustment factor is	1.60

Notes: Storm representative dew point value was based on maximum 12hr Td values between June 4-5, 1963 at KLCK, KILN, and KHTS.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	2.5	5.6	10.5	15.1	17.1	17.6	17.7	17.7	-
10 sq miles	2.1	4.6	8.1	12.4	13.3	13.9	14.0	14.1	-
100 sq miles	1.4	2.9	5.5	7.8	8.6	8.7	9.7	9.9	-
200 sq miles	1.0	2.3	4.5	5.8	6.5	6.6	8.1	8.3	-
500 sq miles	0.6	1.6	2.2	3.7	4.4	5.3	5.7	6.6	-
1000 sq miles	0.5	1.3	2.2	3.3	3.4	3.4	5.1	5.2	-
2000 sq miles	0.4	0.5	1.0	2.3	3.2	3.3	4.3	4.5	-
5000 sq miles	0.2	0.4	0.7	1.1	1.3	1.7	2.9	3.0	-
10000 sq miles	0.1	0.2	0.5	0.8	1.1	1.3	1.6	1.7	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

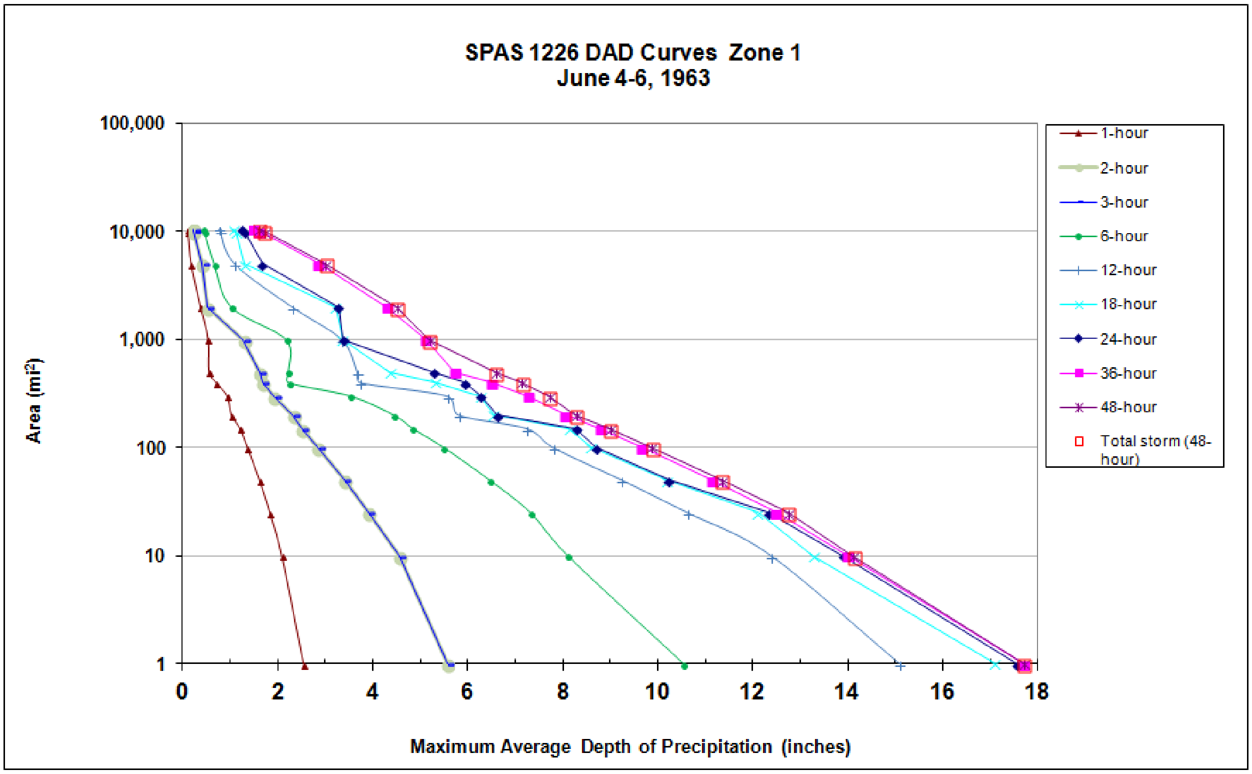
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.1	8.9	16.8	24.1	27.3	28.0	28.3	28.3	-
10 sq miles	3.3	7.3	12.9	19.8	21.2	22.2	22.4	22.5	-
100 sq miles	2.2	4.6	8.8	12.4	13.7	13.9	15.4	15.7	-
200 sq miles	1.6	3.7	7.1	9.3	10.4	10.6	12.9	13.2	-
500 sq miles	0.9	2.6	3.6	5.8	7.0	8.4	9.1	10.5	-
1000 sq miles	0.8	2.0	3.5	5.3	5.4	5.4	8.2	8.3	-
2000 sq miles	0.6	0.8	1.6	3.7	5.1	5.2	6.9	7.2	-
5000 sq miles	0.3	0.7	1.1	1.7	2.1	2.7	4.6	4.8	-
10000 sq miles	0.2	0.4	0.7	1.2	1.8	2.1	2.6	2.7	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**College Hill, OH SPAS 1226**	
Storm Date(s)	6/3-5/1963	
Storm Type	MCC	
Storm Location	40.09 N	81.65 W
Storm Center Elevation	1,000	
Precipitation Total & Duration	19.39 Inches 48-hours	
Storm Representative Dew Point	68.5 F	12
Storm Representative Dew Point Location	39.20 N	83.00 W
Maximum Dew Point	76.5 F	
Moisture Inflow Vector	SW @ 95	
In-place Maximization Factor	**1.48**	
Temporal Transposition (Date)	15-Jun	
Transposition Dew Point Location	42.84 N	93.99 W
Transposition Maximum Dew Point	78.0 F	
Transposition Adjustment Factor	**1.08**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.60**	

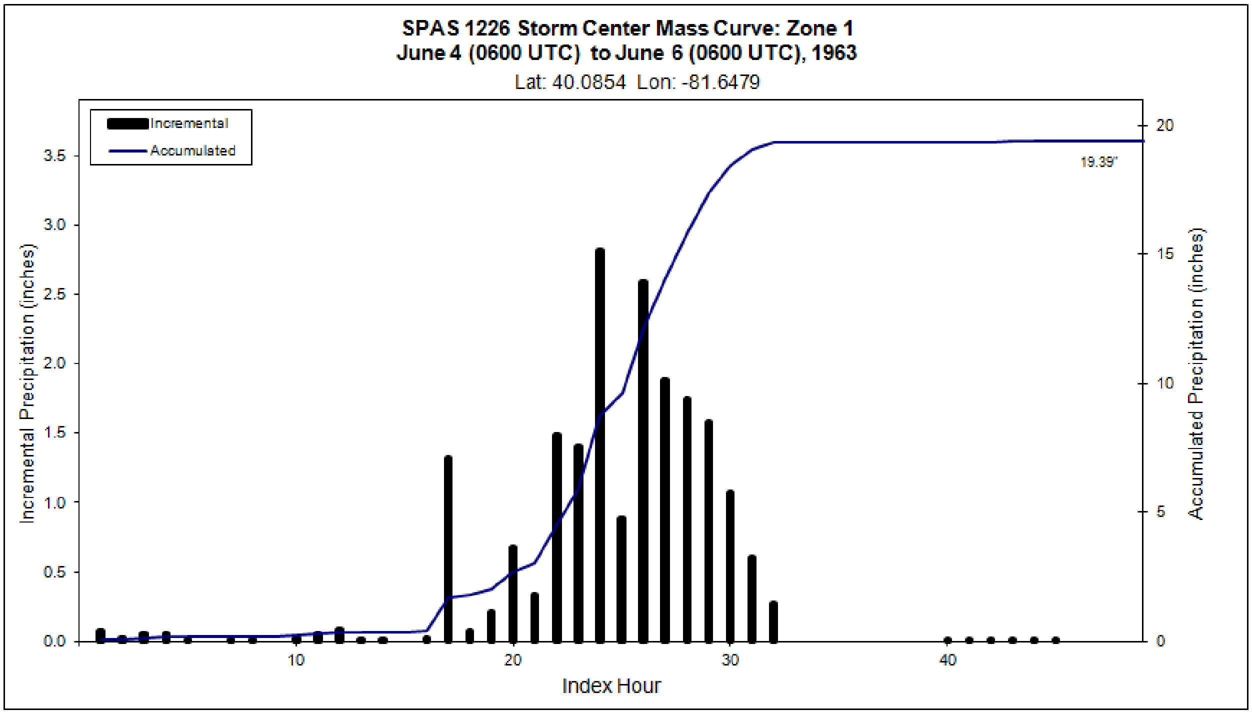
Appendix F: Table F.63: Storm spreadsheet for College Hill, OH, June 3, 1963

Storm 1226 - June 4 (0600 UTC) - June 6 (0600 UTC), 1963									
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)									
	Duration (hours)								
Area (mi^2)	1	3	6	12	18	24	36	48	Total
0.1	2.81	6.28	11.5	17.08	18.99	19.16	19.37	19.39	19.39
1	2.54	5.56	10.53	15.07	17.09	17.56	17.7	17.7	17.70
10	2.08	4.56	8.1	12.37	13.28	13.9	14	14.11	14.11
25	1.83	3.9	7.32	10.61	12.1	12.33	12.49	12.72	12.72
50	1.61	3.4	6.46	9.23	10.18	10.23	11.13	11.34	11.34
100	1.36	2.85	5.5	7.79	8.59	8.69	9.66	9.86	9.86
150	1.2	2.5	4.85	7.23	8.14	8.28	8.79	8.98	8.98
200	1.02	2.32	4.45	5.8	6.54	6.62	8.06	8.26	8.26
300	0.93	1.93	3.54	5.55	6.26	6.28	7.28	7.7	7.70
400	0.7	1.67	2.24	3.73	5.31	5.93	6.5	7.13	7.13
500	0.55	1.61	2.23	3.66	4.37	5.28	5.73	6.57	6.57
1,000	0.53	1.28	2.18	3.34	3.37	3.39	5.12	5.19	5.19
2,000	0.37	0.52	1.03	2.3	3.22	3.28	4.3	4.5	4.50
5,000	0.17	0.41	0.67	1.09	1.31	1.67	2.86	3	3.00
10,000	0.1	0.24	0.46	0.78	1.12	1.3	1.61	1.7	1.70
10,512	0.1	0.24	0.44	0.75	1.08	1.26	1.5	1.6	1.60

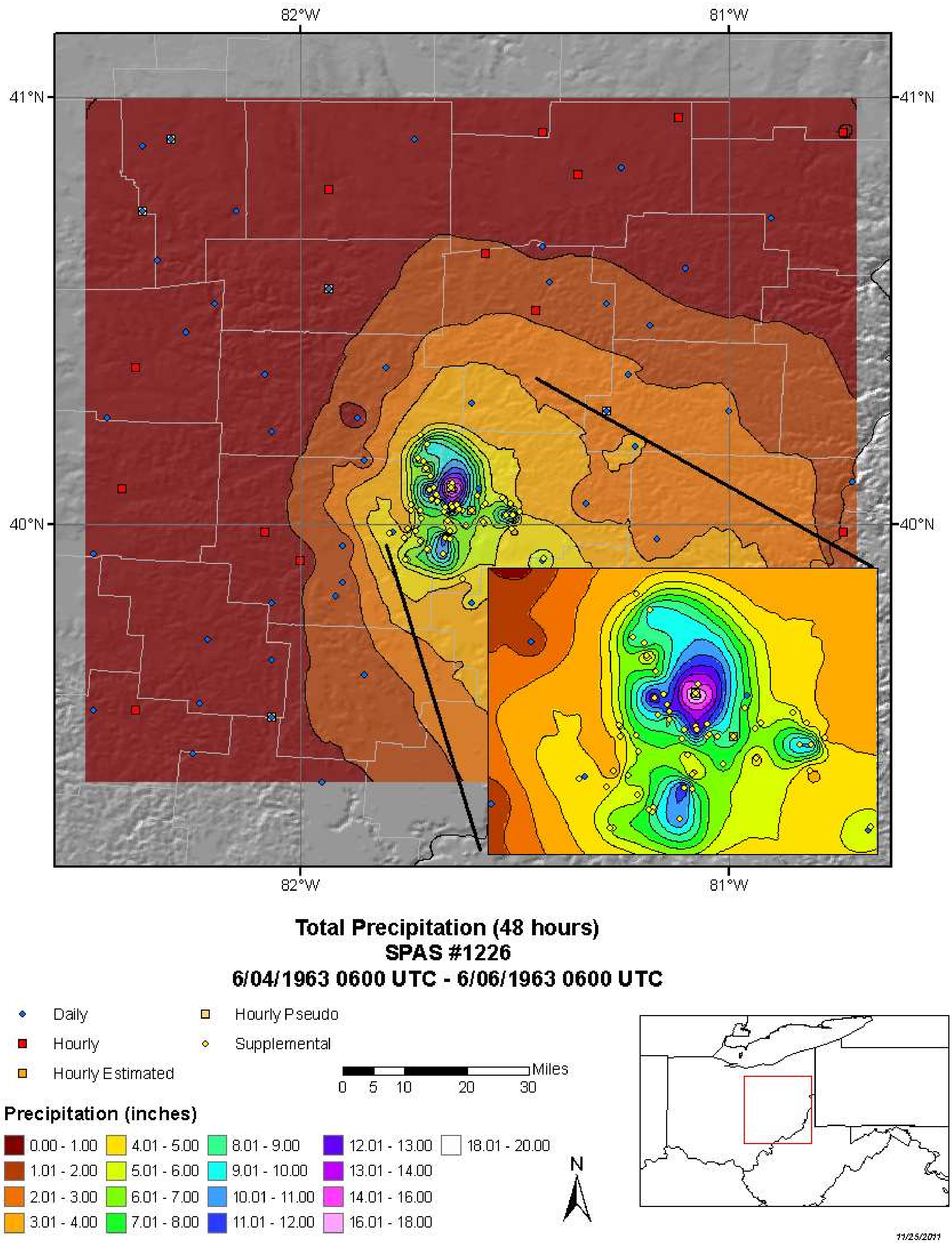
Appendix F: Table F.64: Depth-area-duration values for College Hill, OH June 3, 1963



Appendix F: Figure F.89: Depth-area-duration chart for College Hill, OH, June 3, 1963



Appendix F: Figure F.90: Mass curve chart for College Hill, OH, June 3, 1963



Appendix F: Figure F.91: Total storm isohyetal analysis for College Hill, OH June 1963

David City, NE, AWA 31

June 24, 1963

Storm Type: MCC

Grid Points Used:

Storm Name:	**SPAS 1030-David City, NE**	**Storm Adjustment for ANO Grid Point 2**
Storm Date:	**24-Jun-1963**	
AWA Analysis Date:	**12/14/2013**	

Temporal Transposition Date	**9-Jul**	
	Lat	**Long**
Storm Center Location	**41.23 N**	**97.11 W**
Storm Rep Dew Point Location	**39.41 N**	**94.83 W**
Transposition Dew Point Location	**40.91 N**	**90.24 W**
Grid Point Location	**34.50 N**	**95.50 W**

Moisture Inflow Direction	**SE @ 175**	miles
Grid Point Elevation	**550**	feet
Storm Center Elevation	**1,650**	feet
Storm Rep Analysis Duration	**6**	hours

The storm representative dew point is	**73.5 F**	with total precipitable water above sea level of			**2.67**	inches.
The in-place maximum dew point is	**81.0 F**	with total precipitable water above sea level of			**3.76**	inches.
The transpositioned maximum dew point is	**80.5 F**	with total precipitable water above sea level of			**3.68**	inches.
The in-place storm elevation is	**1,650**	which subtracts	**0.39**	inches of precipitable water at	**73.5 F**	
The in-place storm elevation is	**1,650**	which subtracts	**0.51**	inches of precipitable water at	**81.0 F**	
The transposition basin elevation at	**550**	which subtracts	**0.30**	inches of precipitable water at	**80.5 F**	
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**80.5 F**	

The in-place storm maximization factor is	**1.43**
The transposition/elevation to basin factor is	**1.04**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.49**

Notes: In place of 1.56 adjusted to 1.50 based on HMR 51 and 55A guidance. DAD values taken from SPAS 1030.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**3.9**	**14.1**	**15.6**	**15.9**	**16.0**	-	**16.0**	**16.0**	-	**16.0**
10 sq miles	**3.7**	**13.3**	**14.6**	**15.0**	**15.2**	-	**15.2**	**15.2**	-	**15.2**
100 sq miles	**3.0**	**11.2**	**12.7**	**13.1**	**13.2**	-	**13.2**	**13.2**	-	**13.2**
200 sq miles	**2.8**	**10.5**	**12.0**	**12.4**	**12.5**	-	**12.5**	**12.5**	-	**12.5**
500 sq miles	**2.4**	**9.0**	**10.4**	**10.8**	**10.8**	-	**10.8**	**10.9**	-	**10.9**
1000 sq miles	**2.0**	**7.8**	**9.0**	**9.4**	**9.5**	-	**9.5**	**9.5**	-	**9.5**
5000 sq miles	**0.9**	**4.2**	**5.9**	**6.6**	**6.8**	-	**6.9**	**6.9**	-	**6.9**
10000 sq miles	**0.6**	**2.6**	**4.1**	**4.6**	**4.9**	-	**4.9**	**5.0**	-	**5.0**
20000 sq miles	**0.4**	**1.5**	**2.4**	**2.9**	**3.1**	-	**3.1**	**3.1**	-	**3.1**

Adjusted Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**5.7**	**20.9**	**23.2**	**23.6**	**23.7**	-	**23.7**	**23.7**	-	**23.7**
10 sq miles	**5.5**	**19.8**	**21.8**	**22.3**	**22.5**	-	**22.6**	**22.6**	-	**22.5**
100 sq miles	**4.5**	**16.7**	**18.9**	**19.5**	**19.7**	-	**19.7**	**19.7**	-	**19.7**
200 sq miles	**4.2**	**15.5**	**17.8**	**18.4**	**18.6**	-	**18.6**	**18.6**	-	**18.6**
500 sq miles	**3.5**	**13.4**	**15.5**	**16.0**	**16.1**	-	**16.1**	**16.1**	-	**16.1**
1000 sq miles	**2.9**	**11.5**	**13.3**	**14.0**	**14.0**	-	**14.1**	**14.1**	-	**14.1**
5000 sq miles	**1.3**	**6.2**	**8.8**	**9.8**	**10.1**	-	**10.2**	**10.2**	-	**10.2**
10000 sq miles	**0.9**	**3.9**	**6.1**	**6.8**	**7.3**	-	**7.3**	**7.4**	-	**7.4**
20000 sq miles	**0.5**	**2.2**	**3.6**	**4.2**	**4.6**	-	**4.6**	**4.7**	-	**4.7**

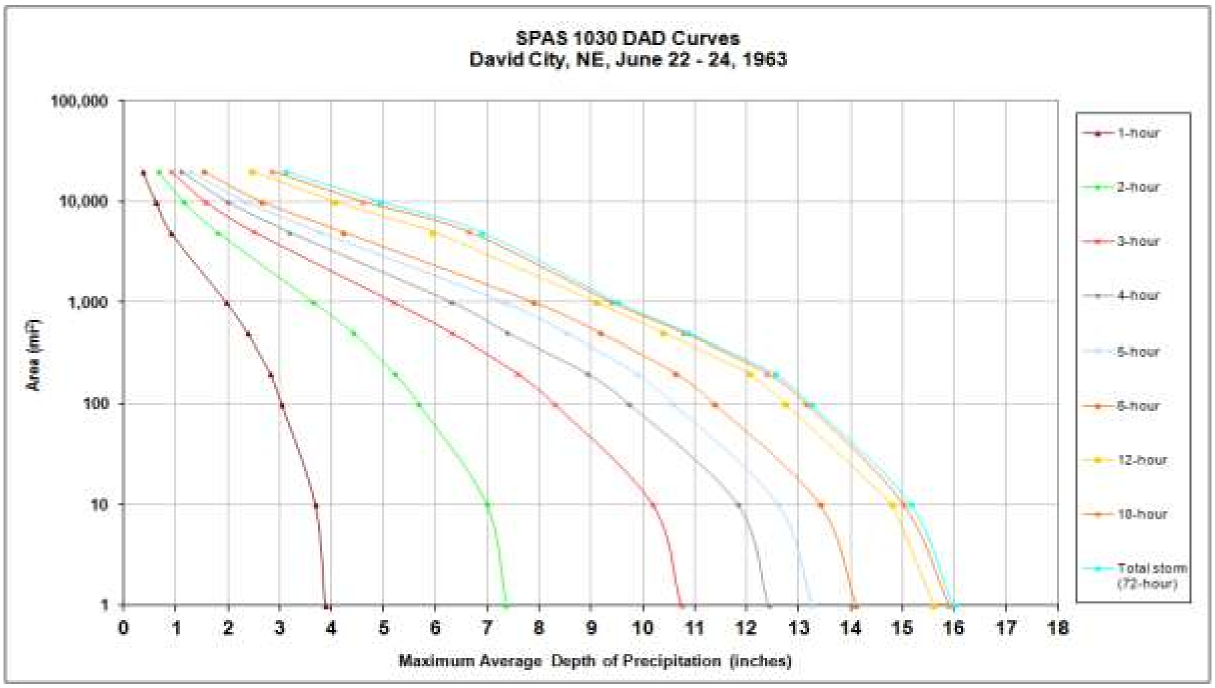
Storm or Storm Center Name	**SPAS 1030-David City, NE**			
Storm Date(s)	24-Jun-1963			
Storm Type	MCC			
Storm Location	41.23 N	97.11 W		
Storm Center Elevation	1,650			
Precipitation Total & Duration	16.50 Inches 24-hours USACE Bucket Survey Data			
Storm Representative Dew Point	73.5 F	6		
Storm Representative Dew Point Location	39.41 N	94.83 W		
Maximum Dew Point	81.0 F			
Moisture Inflow Vector	SE @ 175			
In-place Maximization Factor	**1.43**			
Temporal Transposition (Date)	9-Jul			
Transposition Dew Point Location	40.91 N	90.24 W	June	July
Transposition Maximum Dew Point	80.5 F		78.5	81
Transposition Adjustment Factor	**1.04**			
Grid Point Elevation	550			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.49**			

Appendix F: Table F.65: Storm spreadsheet for David City, NE June 24, 1963

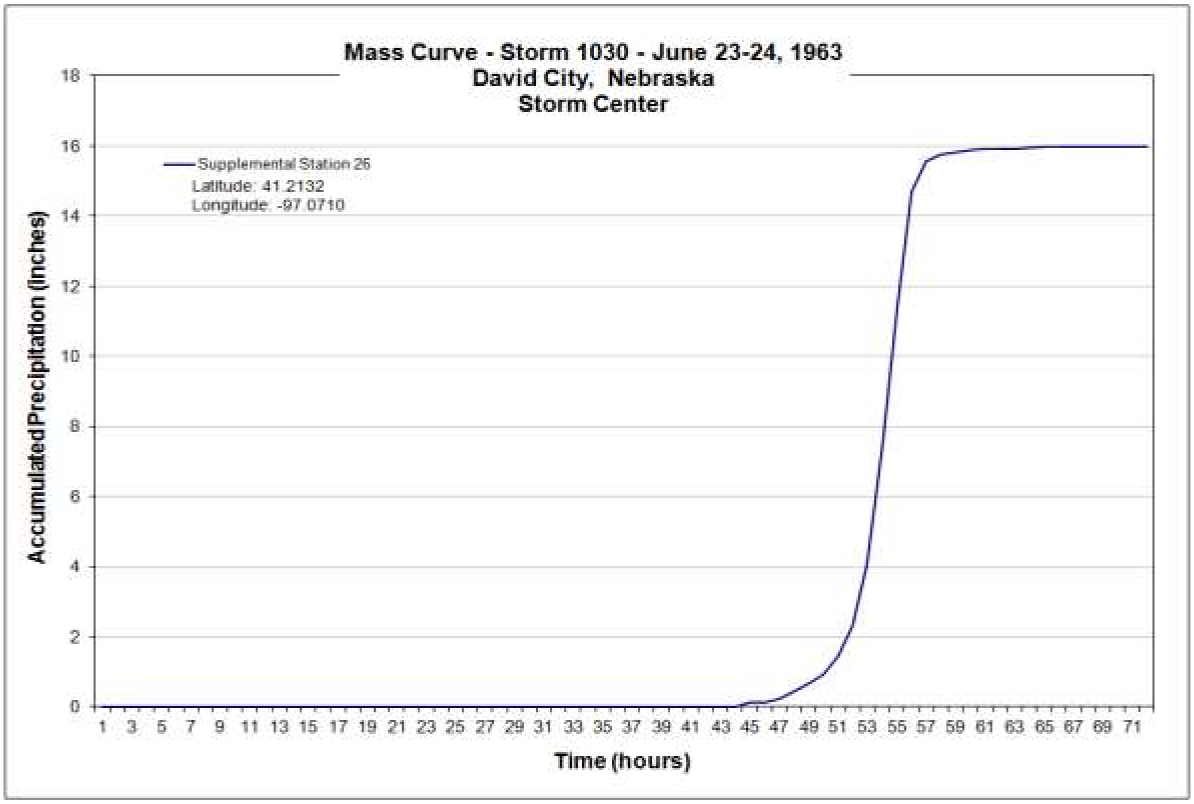
SPAS Storm 1030 - David City, NE, June 22 - 24, 1963
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)												
Area (mi^2)	1	2	3	4	5	6	12	18	24	36	48	72	total
1	3.87	7.36	10.73	12.40	13.26	14.10	15.61	15.90	15.98	15.98	15.98	15.98	15.98
10	3.68	6.98	10.18	11.82	12.60	13.40	14.80	15.02	15.15	15.13	15.13	15.16	15.16
100	3.03	5.68	8.28	9.72	10.59	11.37	12.75	13.14	13.23	13.23	13.23	13.23	13.23
200	2.81	5.21	7.57	8.91	9.87	10.63	12.07	12.39	12.49	12.49	12.50	12.52	12.52
500	2.37	4.41	6.30	7.38	8.52	9.17	10.39	10.79	10.82	10.84	10.86	10.87	10.87
1,000	1.96	3.65	5.19	6.31	7.32	7.89	9.10	9.39	9.45	9.47	9.48	9.51	9.51
5,000	0.89	1.80	2.50	3.18	3.77	4.22	5.96	6.64	6.80	6.83	6.87	6.87	6.87
10,000	0.61	1.15	1.56	1.99	2.35	2.65	4.07	4.60	4.84	4.91	4.92	4.93	4.93
20,000	0.36	0.66	0.89	1.09	1.27	1.53	2.46	2.85	3.04	3.09	3.10	3.10	3.10

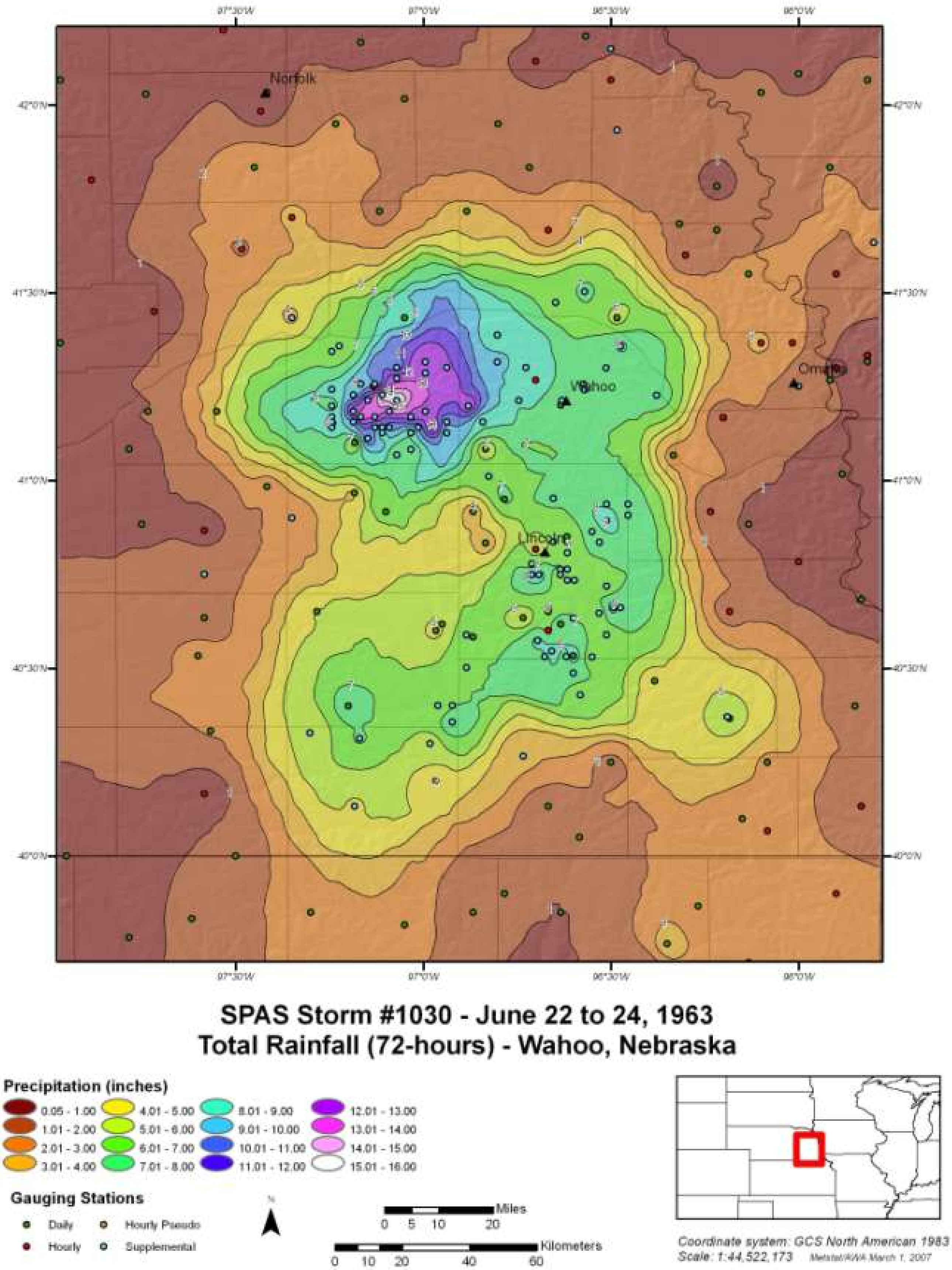
Appendix F: Table F.66: Depth-area-duration values David City, NE June 24, 1963



Appendix F: Figure C.92: Depth-area-duration chart for David City, NE June 24, 1963



Appendix F: Figure F.93: Mass curve chart for David City, NE June 24, 1963



Appendix F: Figure F.94: Total storm isohyetal analysis for David City, NE June 24, 1963

Ida Grove, IA, AWA 32

August 30, 1962

Storm Type: Frontal/MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	EPRI Storm 19 Ida Grove, IA		
Storm Date:	30-Aug-1962		
AWA Analysis Date:	12/14/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	15-Aug	
	Lat	Long
Storm Center Location	42.32 N	95.47 W
Storm Rep Dew Point Location	39.10 N	95.47 W
Transposition Dew Point Location	39.51 N	92.58 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 225	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,200	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	71.0 F	with total precipitable water above sea level of			2.36	inches.
The in-place maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,200	which subtracts	0.27	inches of precipitable water at	71.0 F	
The in-place storm elevation is	1,200	which subtracts	0.35	inches of precipitable water at	80.0 F	
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.50
The transposition/elevation to basin factor is	1.04
The barrier adjustment factor is	1.00
The total adjustment factor is	1.56

Notes: DAD values taken from EPRI Storm Number 19. Storm representative dew point value was based on average 24-hr Td values between August 30-31, 1962 at KGVW, KIXD, and KFOE. In place max factor held to 1.50 based on HMR guidance, calculated at 1.56.

Observed Storm Depth-Area-Duration

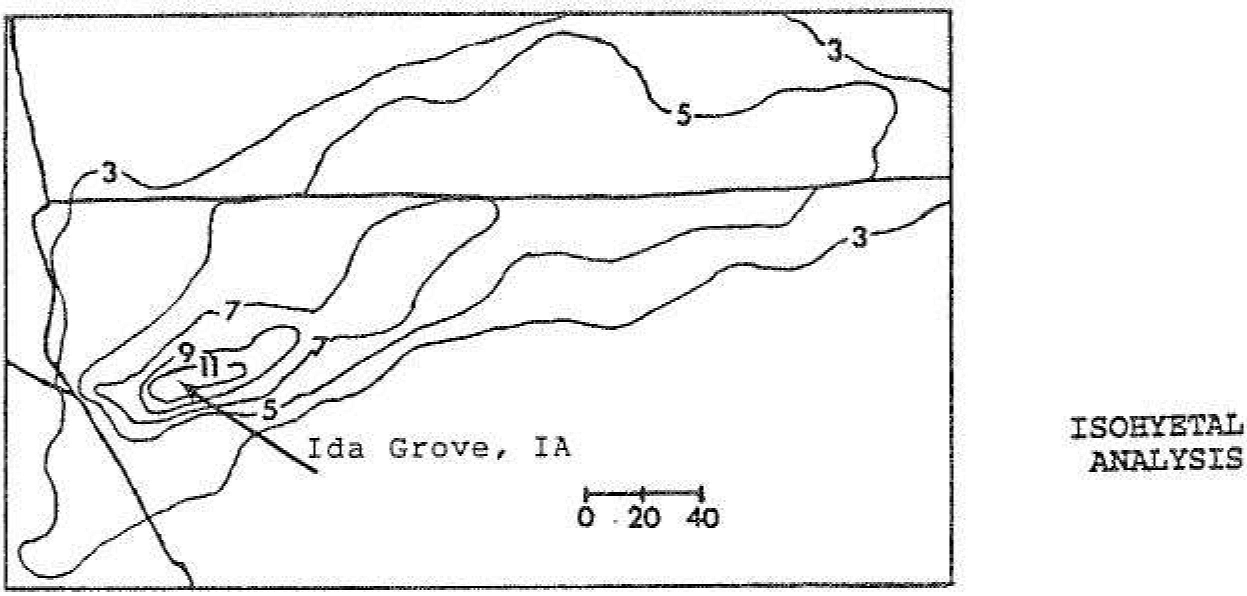
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	-	-	-	-	-	-	-	-	-
100 sq miles	5.7	8.0	-	12.2	-	12.9	-	-	-
200 sq miles	5.4	7.6	-	11.7	-	12.3	-	-	-
500 sq miles	4.8	7.0	-	10.8	-	11.3	-	-	-
1000 sq miles	4.2	6.3	-	9.8	-	10.3	-	-	-
5000 sq miles	2.6	4.3	-	7.0	-	7.6	-	-	-
10000 sq miles	2.1	3.5	-	5.8	-	6.6	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	-	-	-	-	-	-	-	-	-
100 sq miles	8.9	12.5	-	19.0	-	20.1	-	-	-
200 sq miles	8.4	11.9	-	18.3	-	19.2	-	-	-
500 sq miles	7.5	10.9	-	16.8	-	17.6	-	-	-
1000 sq miles	6.6	9.8	-	15.3	-	16.1	-	-	-
5000 sq miles	4.1	6.7	-	10.9	-	11.9	-	-	-
10000 sq miles	3.3	5.5	-	9.0	-	10.3	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	EPRI Storm 19 Ida Grove, IA	
Storm Date(s)	30-Aug-1962	
Storm Type	Synoptic	
Storm Location	42.32 N	95.47 W
Storm Center Elevation	1,200	
Precipitation Total & Duration	12.85 Inches 48-hours EPRI Storm Number 19	
Storm Representative Dewpoint	71.0 F	24
Storm Representative Dewpoint Location	39.10 N	95.47 W
Maximum Dewpoint	80.0 F	
Moisture Inflow Vector	S @ 225	
In-place Maximization Factor	1.50	
Temporal Transposition (Date)	15-Aug	
Transposition Dewpoint Location	39.51 N	92.58 W
Transposition Maximum Dewpoint	80.5 F	
Transposition Adjustment Factor	1.04	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.56	

Appendix F: Table F.67: Storm spreadsheet for Ida Grove, IA August 30, 1962



MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Miles	Duration of Rainfall in Hours 6	12	24	48
100	5.73	7.97	12.2	12.85
200	5.42	7.62	11.65	12.34
500	4.82	6.98	10.82	11.3
1000	4.18	6.25	9.78	10.32
5000	2.59	4.31	7.01	7.6
10000	2.1	3.51	5.82	6.58

Appendix F: Figure F.95 and Table F.68: Total storm isohyetal analysis and Depth-area-duration values for Ida Grove, IA August 30, 1962

Prague, NE, AWA 33

August 1, 1959

Storm Type: Frontal/MCC

Grid Points Used: 2-4, 8-11, 16-18

Storm Name:	SPAS 1031-Prague, NE	
Storm Date:	01-Aug-1959	
AWA Analysis Date:	12/21/2013	

Storm Adjustment for ANO Grid Point 2

Temporal Transposition Date	1-Aug	
	Lat	Long
Storm Center Location	41.36 N	96.88 W
Storm Rep Dew Point Location	39.22 N	95.71 W
Transposition Dew Point Location	40.59 N	91.39 W
Grid Point Location	34.500 N	95.50 W

Moisture Inflow Direction	SSE @ 160	miles
Grid Point Elevation	550	feet
Storm Center Elevation	1,500	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	72.5 F	with total precipitable water above sea level of			2.54	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	1,500	which subtracts	0.35	inches of precipitable water at	72.5 F	
The in-place storm elevation is	1,500	which subtracts	0.42	inches of precipitable water at	78.5 F	
The transposition basin elevation at	550	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place storm maximization factor is	1.35
The transposition/elevation to basin factor is	1.17
The barrier adjustment factor is	1.00
The total adjustment factor is	1.58

Notes: 12hr average taken from KMCK and KTOP from 8-1 8Z to 8-1 20Z. In-place maximization factor of 1.51, although a factor of 1.50 was adopted as the upper limit for this study through guidance from HMRs 55A and 51. DAD values taken from SPAS 1031.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	7.1	9.6	10.1	10.4	-	10.4	10.8	-	10.9
10 sq miles	6.8	9.3	9.7	10.0	-	10.0	10.5	-	10.5
100 sq miles	5.5	7.8	8.4	8.6	-	8.6	9.0	-	9.1
200 sq miles	5.0	7.3	7.9	8.3	-	8.3	8.7	-	8.7
500 sq miles	4.5	6.6	7.1	7.4	-	7.4	7.9	-	8.0
1000 sq miles	4.0	5.8	6.4	6.8	-	6.8	7.3	-	7.4
5000 sq miles	2.2	3.3	3.8	4.1	-	4.1	4.6	-	4.6
10000 sq miles	1.3	2.0	2.4	2.6	-	2.6	3.0	-	3.0
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	11.2	15.2	15.9	16.5	-	16.5	17.1	-	17.2
10 sq miles	10.7	14.6	15.3	15.8	-	15.8	16.6	-	16.6
100 sq miles	8.7	12.2	13.2	13.6	-	13.6	14.2	-	14.4
200 sq miles	7.9	11.6	12.5	13.0	-	13.1	13.7	-	13.8
500 sq miles	7.1	10.3	11.2	11.7	-	11.7	12.5	-	12.6
1000 sq miles	6.4	9.2	10.1	10.8	-	10.8	11.6	-	11.7
5000 sq miles	3.5	5.2	6.0	6.4	-	6.4	7.2	-	7.3
10000 sq miles	2.1	3.2	3.8	4.1	-	4.1	4.7	-	4.8
20000 sq miles	-	-	-	-	-	-	-	-	-

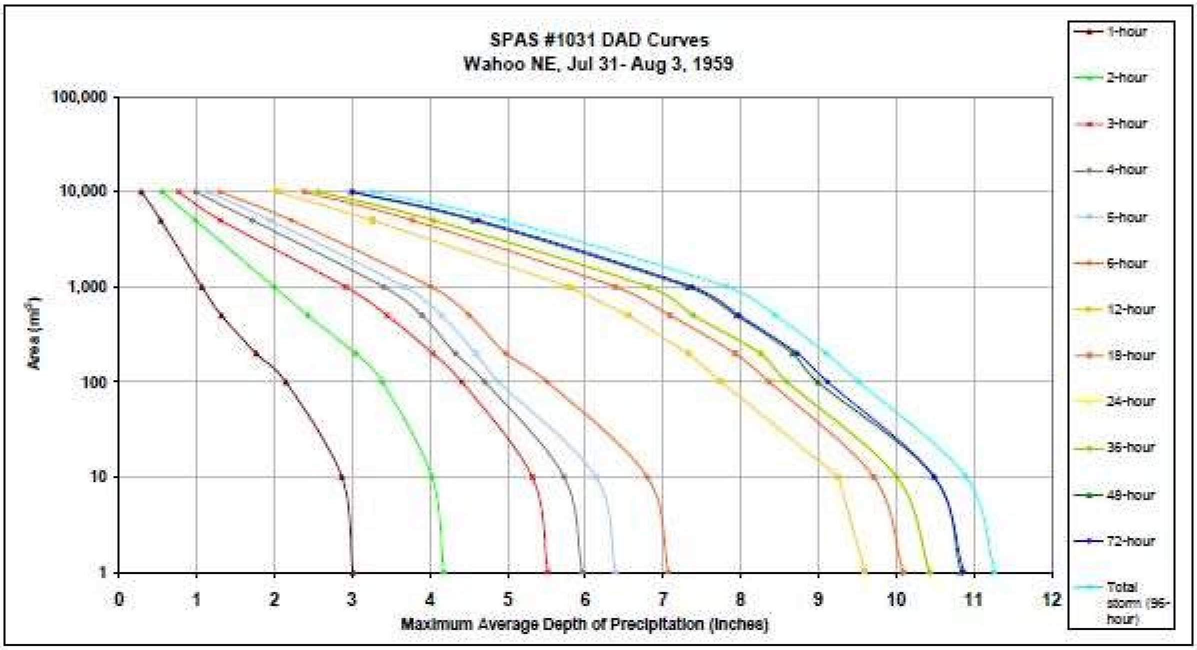
Storm or Storm Center Name	SPAS 1031-Prague, NE			
Storm Date(s)	1-Aug-1959			
Storm Type	MCC			
Storm Location	41.36 N	96.88 W		
Storm Center Elevation	1,500			
Precipitation Total & Duration	13.09 Inches 24-hours USACE Bucket Survey Data			
Storm Representative Dewpoint	72.5 F	12		
Storm Representative Dewpoint Location	39.22 N	95.71 W		
Maximum Dewpoint	78.5 F			
Moisture Inflow Vector	SSE @ 160			
In-place Maximization Factor	1.35			
Temporal Transposition (Date)	1-Aug		July	Aug
Transposition Dewpoint Location	40.59 N	91.39 W	81	80.5
Transposition Adjustment Factor	1.17			
Transposition Maximum Dewpoint	81.0 F			
Grid Point Elevation	550			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.58			

Appendix F: Table F.69: Storm spreadsheet for Prague, NE August 1, 1959

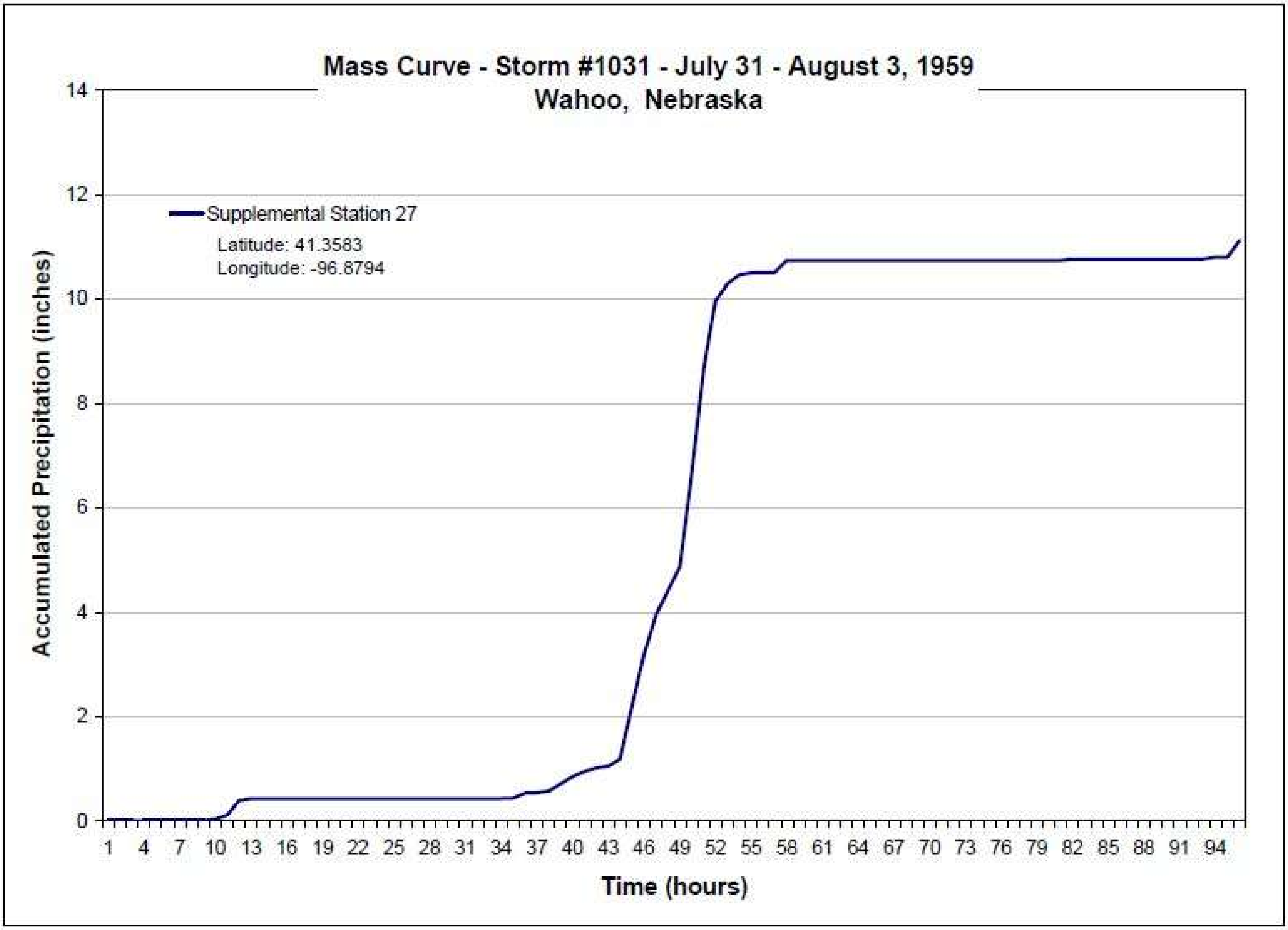
Storm 1031 - Wahoo NE, Jul 31 - Aug 3, 1959

MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

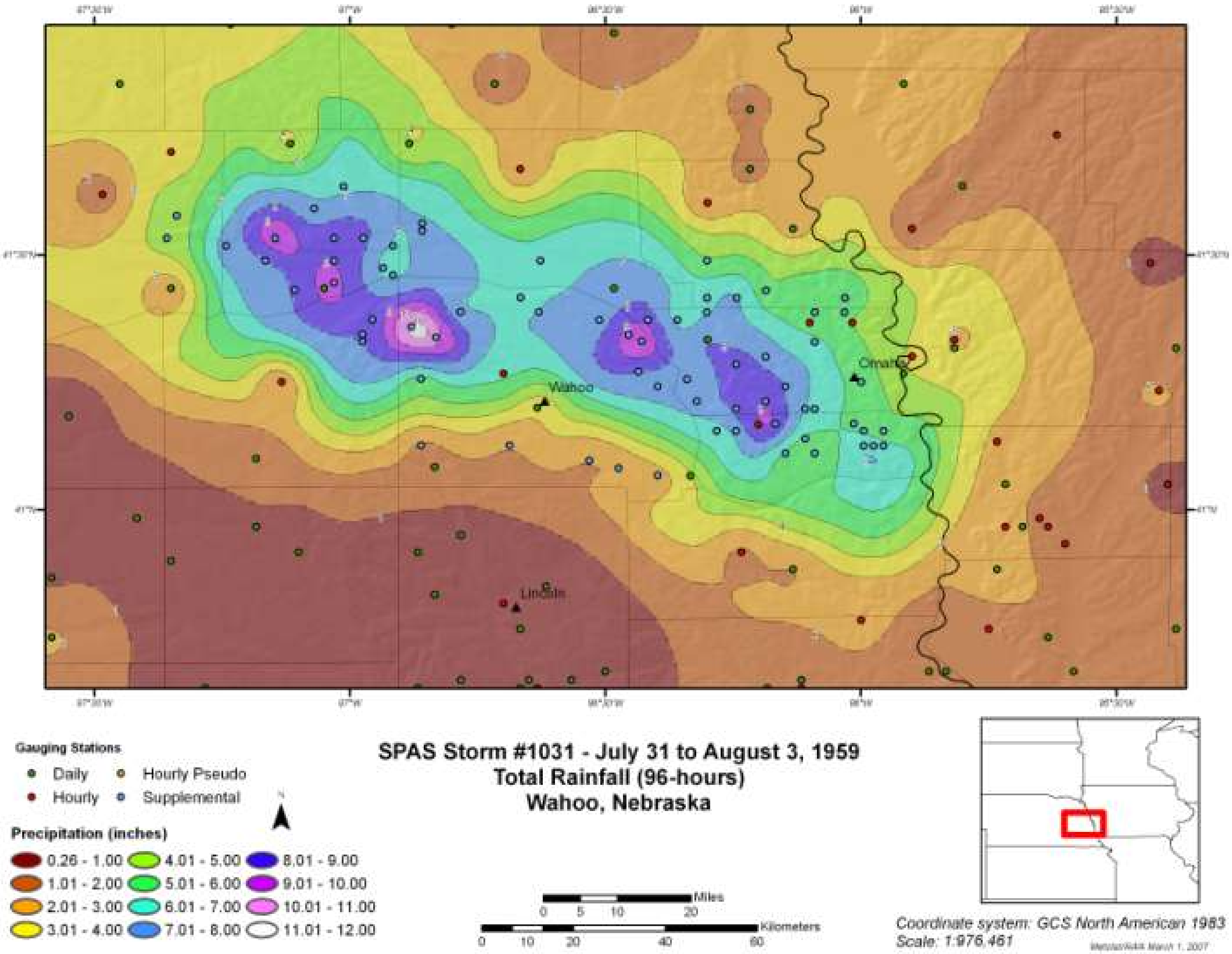
	Duration (hours)													
Area (mi^2)	1	2	3	4	5	6	12	18	24	36	48	72	96	total
1	3.01	4.18	5.52	5.96	6.39	7.07	9.60	10.09	10.43	10.43	10.83	10.87	11.27	11.27
10	2.87	4.03	5.32	5.73	6.14	6.80	9.26	9.71	10.01	10.01	10.49	10.49	10.90	10.90
100	2.15	3.39	4.41	4.71	4.89	5.51	7.75	8.37	8.60	8.60	8.99	9.12	9.52	9.52
200	1.77	3.05	4.04	4.33	4.59	4.98	7.33	7.93	8.25	8.26	8.67	8.73	9.10	9.10
500	1.32	2.43	3.45	3.90	4.15	4.51	6.55	7.09	7.39	7.39	7.94	7.98	8.45	8.45
1,000	1.07	2.00	2.92	3.41	3.68	4.02	5.80	6.39	6.82	6.82	7.32	7.38	7.83	7.83
5,000	0.54	0.99	1.31	1.72	1.95	2.22	3.27	3.78	4.05	4.05	4.56	4.63	4.96	4.96
10,000	0.29	0.56	0.77	0.99	1.15	1.30	2.04	2.39	2.57	2.57	2.99	3.01	3.27	3.27



Appendix F: Table F.70 and Figure F.96: Depth-area-duration values and Depth-area-duration chart for Prague, NE August 1, 1959



Appendix F: Figure F.97: Mass curve chart for Prague, NE August 1, 1959



Appendix F: Figure F.98: Total storm isohyetal analysis for Prague, NE August 1, 1959

Paris Waterworks, IN, AWA 34

June 27, 1957

Storm Type: Frontal/Tropical

Grid Points Used: 1-2, 8-9, 16

Storm Name:	**HMB-V18 Paris Waterworks, IN**		
Storm Date:	**6/27-28/1957**		
AWA Analysis Date:	**12/15/2013**		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	**13-Jul**	
	Lat	**Long**
Storm Center Location	**39.05 N**	**87.70 W**
Storm Rep Dew Point Location	**36.00 N**	**86.70 W**
Transposition Dew Point Location	**39.68 N**	**91.52 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction:	**SSE @ 215**	miles
Grid Point Elevation	**350**	feet
Storm Elevation	**500**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**74.0 F**	with total precipitable water above sea level of		**2.73**	inches.
The in-place maximum dew point is	**81.5 F**	with total precipitable water above sea level of		**3.84**	inches.
The transpositioned maximum dew point is	**81.0 F**	with total precipitable water above sea level of		**3.76**	inches.
The in-place storm elevation is	**500**	which subtracts	**0.12**	inches of precipitable water at	**74.0 F**
The in-place storm elevation is	**500**	which subtracts	**0.15**	inches of precipitable water at	**81.5 F**
The transposition basin elevation at	**350**	which subtracts	**0.30**	inches of precipitable water at	**81.0 F**
The Grid point/Inflow barrier height is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**81.0 F**

The in-place storm maximization factor is	**1.41**
The transposition/elevation to basin factor is	**0.94**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.33**

Notes: DAD values taken from EPRI Storm Number 18, HMB V-18. Storm representative Td value was based on maximum 12-hr Td values between June 27-28, 1957 at KBNA, and KMQY.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	-	-	-	-	-	-	-	-	
100 sq miles	**8.0**	**10.9**	-	**11.5**	-	-	-	-	-
200 sq miles	**7.6**	**10.3**	-	**11.1**	-	-	-	-	-
500 sq miles	**6.8**	**9.3**	-	**10.2**	-	-	-	-	-
1000 sq miles	**6.2**	**8.4**	-	**9.4**	-	-	-	-	-
5000 sq miles	**4.4**	**5.9**	-	**7.1**	-	-	-	-	-
10000 sq miles	**3.6**	**4.7**	-	**6.0**	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

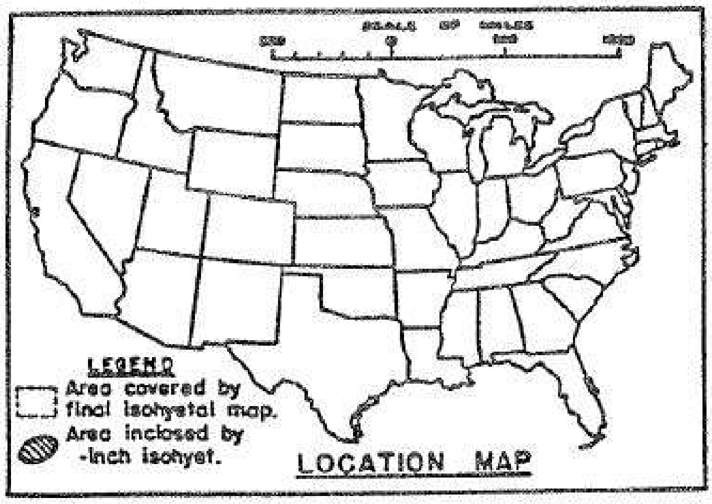
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	-	-	-	-	-	-	-	-	
100 sq miles	**10.6**	**14.4**	-	**15.2**	-	-	-	-	-
200 sq miles	**10.1**	**13.7**	-	**14.7**	-	-	-	-	-
500 sq miles	**9.0**	**12.3**	-	**13.5**	-	-	-	-	-
1000 sq miles	**8.2**	**11.1**	-	**12.5**	-	-	-	-	-
5000 sq miles	**5.8**	**7.8**	-	**9.4**	-	-	-	-	-
10000 sq miles	**4.8**	**6.2**	-	**8.0**	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**HMB-V18 Paris Waterworks, IN**	
Storm Date(s)	6/27-28/1957	
Storm Type	Synoptic	
Storm Location	39.05 N	87.70 W
Storm Center Elevation	500	
Precipitation Total & Duration	12.40 Inches 24-hours HMB V-18	
Storm Representative Td	74.0 F	12
Storm Representative Td Location	36.00 N	86.70 W
Maximum Td	81.5 F	
Moisture Inflow Vector	SSE @ 215	Miles
In-place Maximization Factor	**1.41**	
Temporal Transposition (Date)	13-Jul	
Transposition Td Location	39.68 N	91.52 W
Transposition Maximum Td	81.0 F	
Transposition Adjustment Factor	**0.94**	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.33**	

Appendix F: Table F.71: Storm spreadsheet for Paris Waterworks, IN June 27, 1957

STORM STUDIES – PERTINENT DATA SHEET



Storm of June 27-28, 1957
Assignment OMS-V18
Location ______
Study Prepared by: ______

Part I Reviewed by Hydromet. Sec. of Weather Bureau, ______
Part II Approved by Office, Chief of Engineers for distribution of factual data, ______
Remarks ______
39° 38'
87° 42'
739 ft

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary Isohyetal map, in ______ sheet scale ______

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data) ______
Form 5001-B (24-hour " ") ______
Form 5001-D (" " " ") ______
Miscl. precip. records, meteorological data, etc. ______
Form 5002 (Mass rainfall curves) ______

PART II

Final isohyetal maps, in ______ sheet scale ______

Data and computation sheets:

Form S-10 (Data from mass rainfall curves) ______
Form S-11 (Depth-area data from isohyetal map) ______
Form S-12 (Maximum depth-duration data) ______
Maximum duration-depth-area curves ______
Data relating to periods of maximum rainfall ______

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Miles	Duration of Rainfall in Hours											
	3	6	12	18	24	30	36	48	60	72	96	120
25	4.5	8.7	12.0		12.4							
50	4.3	8.3	11.5		12.0							
100	4.2	8.0	10.9		11.5							
200	4.0	7.6	10.3		11.1							
500	3.7	6.8	9.3		10.2							
1000	3.4	6.2	8.4		9.4							
2000	3.1	5.5	7.4		8.5							
5000	2.6	4.4	5.9		7.1							
10000	2.2	3.6	4.7		6.0							

Appendix F: Table F.72: Depth-area-duration values for Paris Waterworks, IN June 27, 1957

ISOHYETAL
ANALYSIS

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Miles	Duration of Rainfall in Hours 6	12	24
100	8	10.9	11.5
200	7.6	10.3	11.1
500	6.8	9.3	10.2
1000	6.2	8.4	9.4
5000	4.4	5.9	7.1
10000	3.6	4.7	6

SYNOPTIC
ANALYSIS

Table F.73 and Figure F.99: Depth-area-duration Table and synoptic analysis for Paris Waterworks, IN June 27, 1957

Lake Maloya, NM, AWA 35

May 19, 1955

Storm Type: Frontal

Grid Points Used: 7, 13-14, 21

Storm Name:	SPAS 1251 Lake Maloya, NM		
Storm Date:	05/17-05/21/1955		
AWA Analysis Date:	9/11/2012		

Storm Adjustment for ANO Grid Point 7

Temporal Transposition Date	5-Jun	
	Lat	Long
Storm center location	37.01 N	104.34 W
Storm Rep Td location	31.50 N	98.10 W
Transposition Td location	37.37 N	92.35 W
Grid Point location	36.00 N	105.50 W

Moisture Inflow Direction:	SE @ 520	miles
Grid Point Elevation	11,300	feet
Storm Center Elevation	7,900	feet
Storm Rep Analysis Duration	24	hours

The storm representative Td is	70.5 F	with total precipitable water above sea level of			2.31	inches.
The in-place maximum Td is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum Td is	65.0 F	with total precipitable water above sea level of			1.77	inches.
The in-place storm elevation is	7,900	which subtracts	1.34	inches of precipitable water at	70.5 F	
The in-place storm elevation is	7,900	which subtracts	1.73	inches of precipitable water at	78.0 F	
The transposition storm elevation at	11,300	which subtracts	xx	inches of precipitable water at	65.0 F	
The Grid point/inflow barrier height is	1,150	which subtracts	xx	inches of precipitable water at	65.0 F	

The in-place maximization factor is	1.62
The transposition factor is	#VALUE!
The elevation/barrier adjustment factor is	#VALUE!
The total adjustment factor is	#VALUE!

Notes: Storm representative dew point value was based on maximum 24-hr Td values for May 16-17 at KATT, KBSM, and KGRK. Calculated in-place max factor of 1.62, held to 1.50 based on HMR aguidance and previous AWA analyses.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	1.2	2.3	3.9	6.9	9.5	11.6	13.6	14.3	14.4
10 sq miles	1.2	2.3	3.9	6.8	9.5	11.3	13.6	14.3	14.3
100 sq miles	1.0	1.8	3.1	5.5	7.9	9.5	11.8	12.6	12.7
200 sq miles	0.9	1.7	2.7	4.8	6.7	8.0	10.4	11.4	11.5
500 sq miles	0.7	1.4	2.0	3.8	5.5	6.6	7.9	9.5	9.7
1000 sq miles	0.5	1.1	1.9	3.1	4.2	5.2	7.3	7.8	8.5
2000 sq miles	0.4	0.9	1.6	2.5	3.6	4.6	6.2	7.4	7.5
5000 sq miles	0.3	0.8	1.4	2.2	2.9	3.7	5.3	5.9	6.6
10000 sq miles	0.3	0.7	1.3	1.9	2.6	3.2	4.1	5.1	5.6
20000 sq miles	0.2	0.6	1.0	1.5	2.1	2.6	3.4	4.0	4.6

Adjusted Storm Depth-Area-Duration

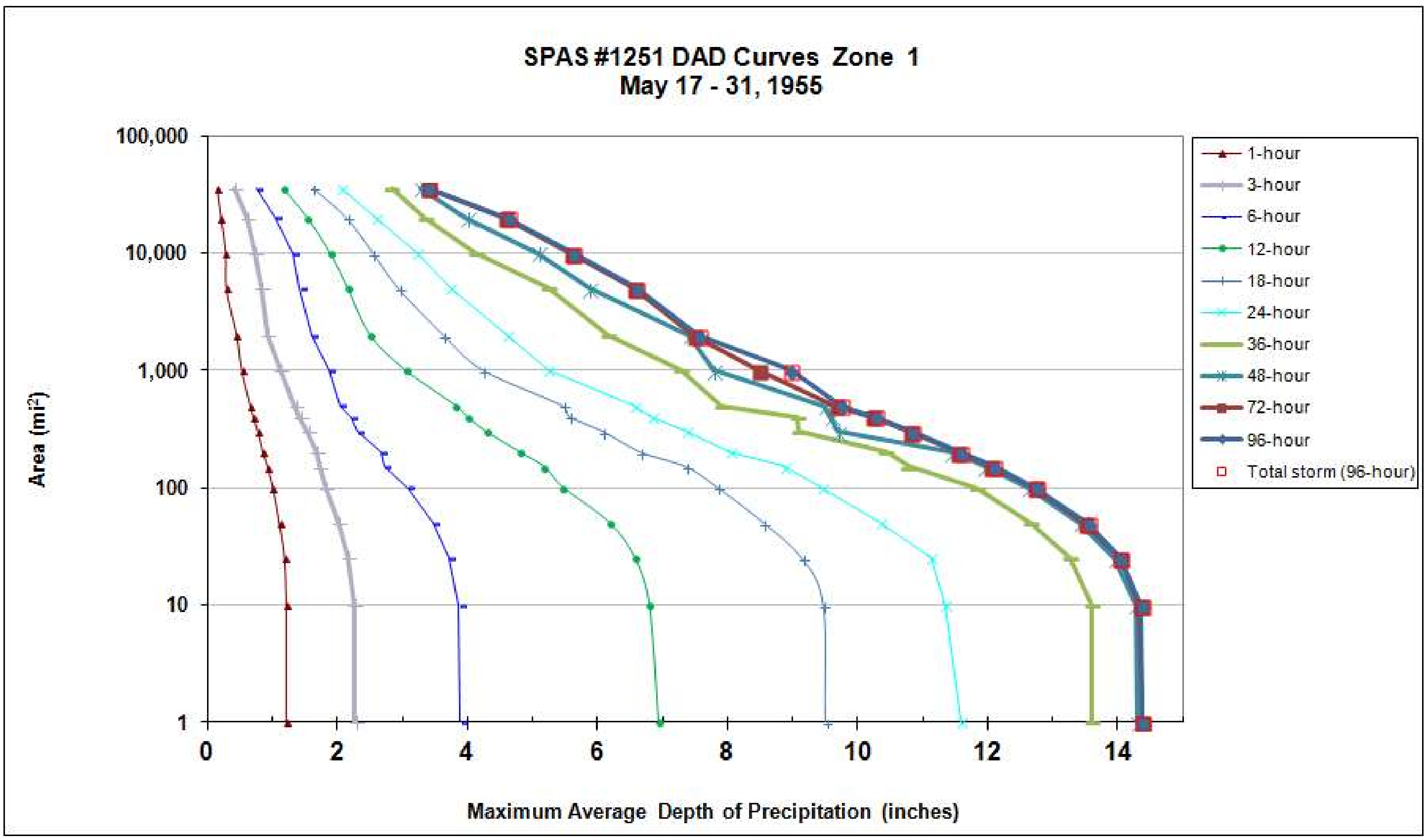
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
10 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
100 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
200 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
500 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
1000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
2000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
10000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
20000 sq miles	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Storm or Storm Center Name	SPAS 1251 Lake Maloya, NM				
Storm Date(s)	05/17-05/21/1955				
Storm Type	Synoptic				
Storm Location	37.01 N	104.34 W			
Storm Center Elevation	7900				
Precipitation Total & Duration	14.4 Inches	72			
Storm Representative Td	70.5 F	24			
Storm Representative Td Location	31.50 N	98.10 W	may	june	77.354839
In-place Maximum Td	78.0 F		76	79	
Moisture Inflow Vector	SE @ 520				
In-place Maximization Factor	1.62				
Temporal Transposition (Date)	5-Jun				
Transposition Td Location	37.37 N	92.35 W	may	june	
Transposition Maximum Td	65.0 F		75	79	
Transposition Adjustment Factor	#VALUE!				
Grid Point Elevation	11,300				
Highest Elevation in Basin	14,344				
Inflow Barrier Height	1,150				
Elevation Adjustment Factor	#VALUE!				
Total Adjustment Factor	#VALUE!				

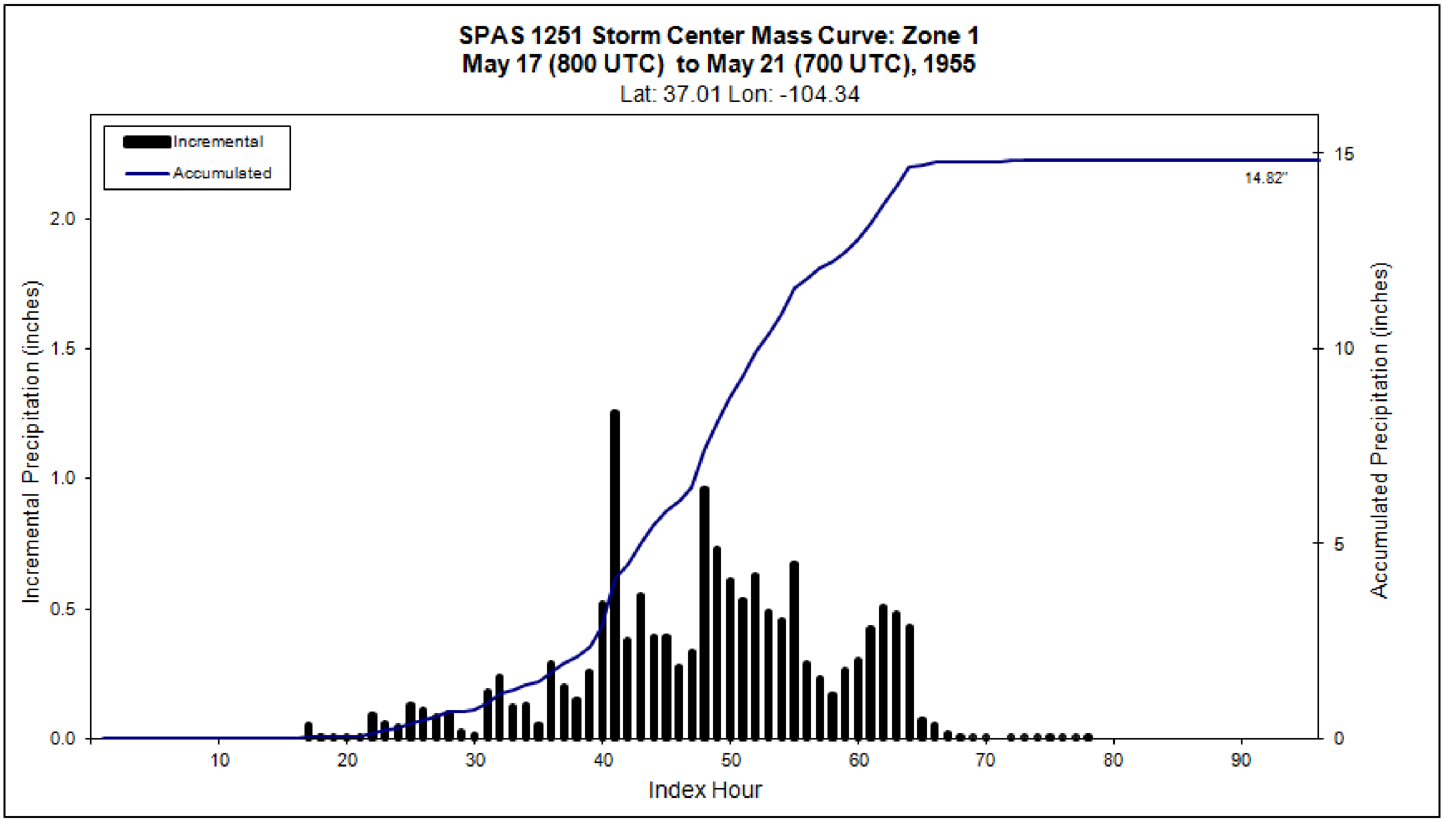
Appendix F: Table F.74: Storm spreadsheet for Lake Maloya, NM, May 19, 1955

SPAS 1251 - May 17 (800 UTC) - May 21 (700 UTC), 1955 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	Total
0.3	1.26	2.32	3.98	7.09	9.77	11.90	14.04	14.74	14.82	14.82	14.82
1	1.21	2.27	3.89	6.93	9.51	11.60	13.60	14.30	14.38	14.38	14.38
10	1.21	2.25	3.87	6.79	9.48	11.34	13.60	14.27	14.34	14.36	14.36
25	1.18	2.16	3.71	6.57	9.15	11.14	13.26	13.95	14.03	14.04	14.04
50	1.10	2.02	3.47	6.18	8.56	10.36	12.65	13.41	13.49	13.54	13.54
100	1.00	1.82	3.08	5.47	7.85	9.45	11.84	12.63	12.73	12.74	12.74
150	0.92	1.73	2.72	5.18	7.37	8.87	10.78	11.95	12.05	12.10	12.10
200	0.85	1.67	2.66	4.81	6.67	8.04	10.44	11.44	11.54	11.57	11.57
300	0.77	1.54	2.30	4.29	6.09	7.37	9.10	9.69	10.80	10.83	10.83
400	0.70	1.42	2.20	4.00	5.57	6.85	9.08	9.59	10.23	10.26	10.26
500	0.65	1.35	2.04	3.82	5.46	6.58	7.91	9.49	9.66	9.74	9.74
1,000	0.52	1.11	1.86	3.05	4.24	5.24	7.28	7.78	8.47	8.97	8.97
2,000	0.44	0.93	1.60	2.50	3.63	4.62	6.16	7.40	7.48	7.55	7.55
5,000	0.28	0.83	1.42	2.16	2.94	3.73	5.25	5.86	6.56	6.59	6.59
10,000	0.27	0.73	1.31	1.89	2.55	3.22	4.12	5.08	5.59	5.63	5.63
20,000	0.20	0.60	1.04	1.54	2.14	2.60	3.35	3.98	4.58	4.62	4.62
35,752	0.14	0.41	0.75	1.17	1.63	2.06	2.83	3.27	3.40	3.40	3.40

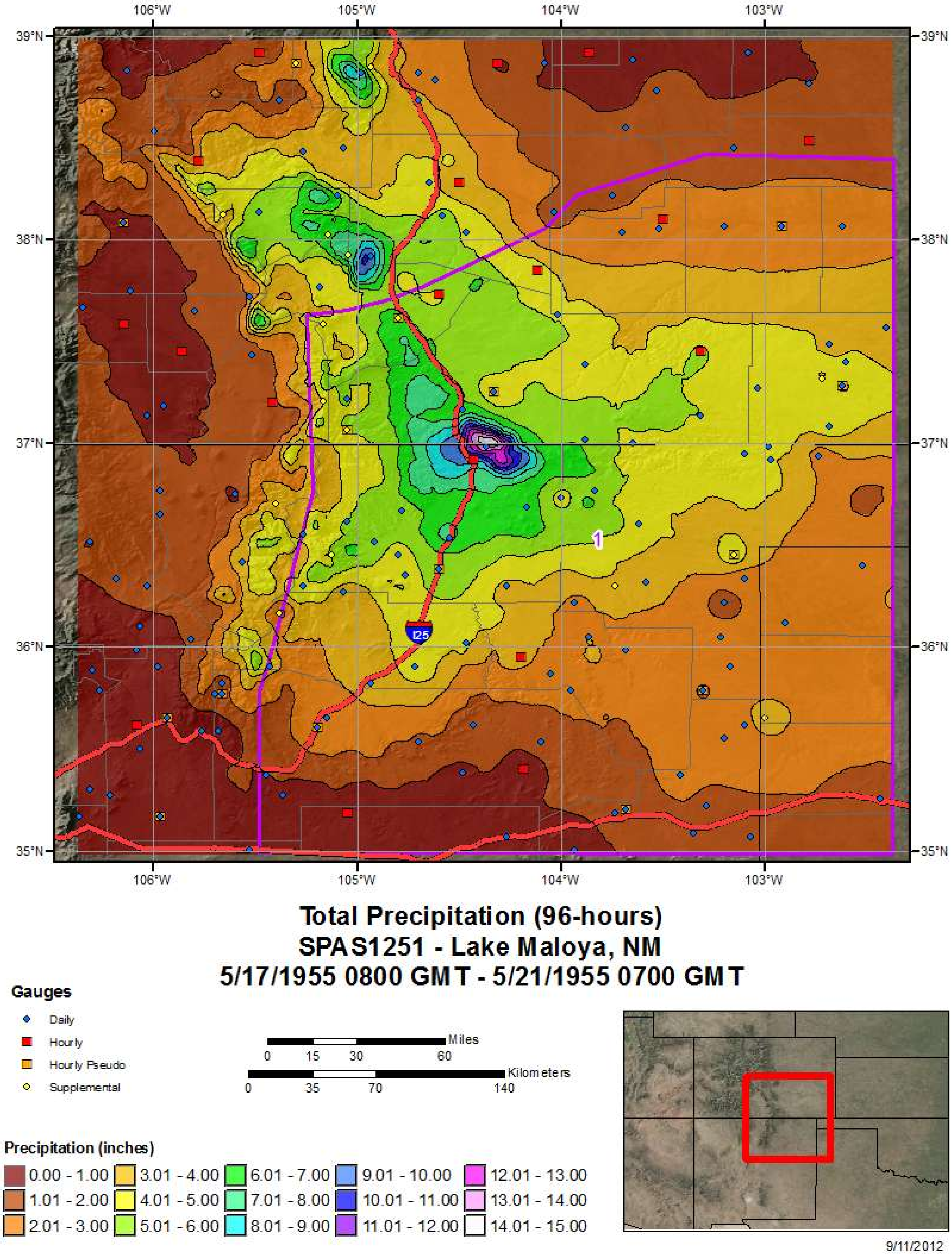
Appendix F: Table F.75: Depth-area-duration values for Lake Maloya, NM, May 19, 1955



Appendix F: Figure F.100: Depth-area-duration chart for Lake Maloya, NM, May 19, 1955



Appendix F: Figure F.101: Mass curve chart for Lake Maloya, NM, May 19, 1955



Appendix F: Figure F.102: Total storm isohyetal analysis Lake Maloya, NM, May 19, 1955

Ritter, IA, AWA 36

June 7, 1953

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	Ritter, IA		
Storm Date:	07-Jun-1953		
AWA Analysis Date:	12/15/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	30-Jun	
	Lat	Long
Storm Center Location	43.24 N	95.82 W
Storm Rep Dew Point Location	37.82 N	95.82 W
Transposition Dew Point Location	40.39 N	91.33 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 375	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,400	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The in-place maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The transpositioned maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	1,400	which subtracts	0.34	inches of precipitable water at	74.0 F	
The in-place storm elevation is	1,400	which subtracts	0.42	inches of precipitable water at	81.0 F	
The transposition basin elevation at	350	which subtracts	0.29	inches of precipitable water at	80.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	80.0 F	

The in-place storm maximization factor is	1.40
The transposition/elevation to basin factor is	0.99
The barrier adjustment factor is	1.00
The total adjustment factor is	1.38

Notes: DAD values taken from USACE MR 10-8 (HMB 20)

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	9.1	10.5	-	-	-	-	-	-	-
100 sq miles	7.4	9.4	-	-	-	-	-	-	-
200 sq miles	-	-	-	-	-	-	-	-	-
500 sq miles	6.5	8.5	-	-	-	-	-	-	-
1000 sq miles	6.1	7.9	-	-	-	-	-	-	-
5000 sq miles	4.4	5.9	-	-	-	-	-	-	-
10000 sq miles	3.5	4.8	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

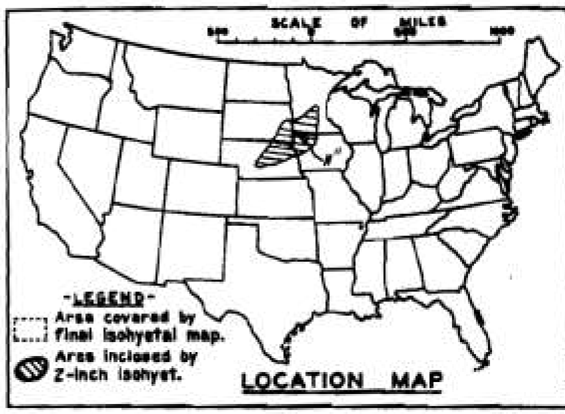
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	12.6	14.5	-	-	-	-	-	-	-
100 sq miles	10.2	13.0	-	-	-	-	-	-	-
200 sq miles	-	-	-	-	-	-	-	-	-
500 sq miles	9.0	11.8	-	-	-	-	-	-	-
1000 sq miles	8.4	10.9	-	-	-	-	-	-	-
5000 sq miles	6.1	8.2	-	-	-	-	-	-	-
10000 sq miles	4.8	6.6	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	Ritter, IA			
Storm Date(s)	7-Jun-1953			
Storm Type	MCS			
Storm Location	43.24 N	95.82 W		
Storm Center Elevation	1,400			
Precipitation Total & Duration	11.00 Inches 12-hours USACE MR 10-8 (HMB 20)			
Storm Representative Dew Point	74.0 F	6hr average, 7° added to USACE storm rep Td based on EPRI and Wanahoo guidance		
Storm Representative Dew Point Locat	37.82 N	95.82 W		
Maximum Dew Point	81.0 F			
Moisture Inflow Vecto	S @ 380 Miles			
In-place Maximization Factor	1.40			
Temporal Transposition (Date)	30-Jun			
Transposition Dew Point Location	40.39 N	91.33 W	June	July
Transposition Maximum Dew Point	80.0 F		78.5	81.5
Transposition Adjustment Factor	0.99			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	1.00			
Total Adjustment Fact	1.38			

Appendix F: Table F.76: Storm spreadsheet for Ritter, IA June 7, 1953

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 7 June 1953
Assignment MR 10-8 (HMB 20)
Location Iowa, Minn., S. Dak, Nebr.
Study Prepared by:
Omaha Dist.

Part I Reviewed by H. M. Sec. of Weather Bureau, ______
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, ______
Remarks: Center of Ritter, Iowa
Dew Pt. 67° Ref. Pt. 375S
Inplace adjustment 171%

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet , scale 1:500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	25
Form 5001-B (24-hour " ")	
Form 5001-D (" " " ")	5
Miscl. precip. records, meteorological data, etc. about	200
Form 5002 (Mass rainfall curves)	16

PART II

Final isohyetal maps, in sheet , scale 1:500,000

Data and computation sheets:

Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	3
Maximum duration-depth-area curves	
Data relating to periods of maximum rainfall	3

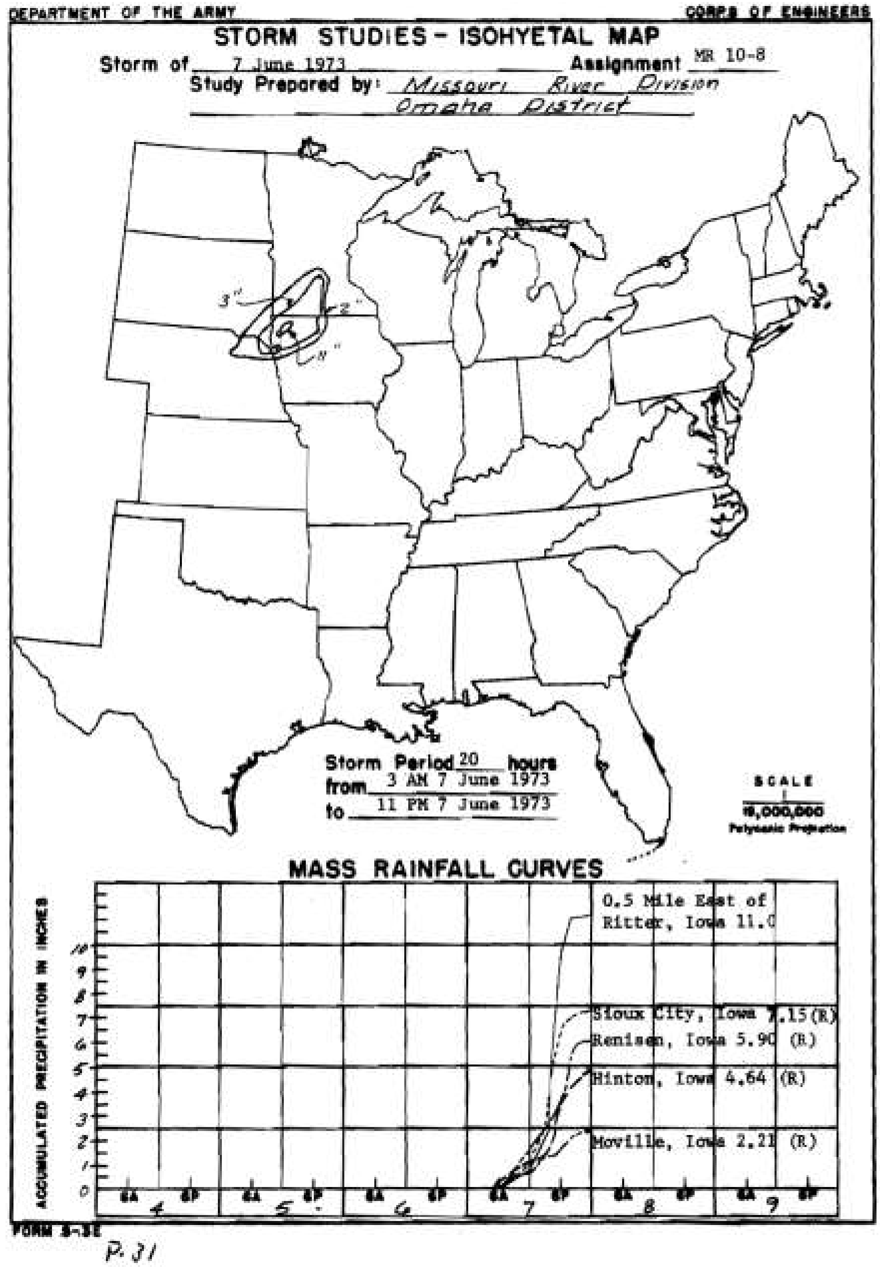
MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	20	24	30	36	48	60	72	96	120
10	9.2	10.5	11.0								
100	7.4	9.4	10.0								
200	7.1	9.1	9.7								
500	6.5	8.5	9.0								
1,000	6.1	7.9	8.4								
2,000	5.4	7.2	7.7								
5,000	4.4	5.9	6.5								
10,000	3.5	4.8	5.4								

Form S-2

P.30

Appendix F: Table F.77: Depth-area-duration values for Ritter, IA June 7, 1953



Appendix F: Figure F.103 and Figure F.104: Total storm isohyetal analysis and Mass curve chart for Ritter, IA June 7, 1953

Kelso, MO, AWA 37

August 11, 1952

Storm Type: MCC

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	**USACE UMV 3-30-Kelso, MO**		**Storm Adjustment for ANO Grid Point 1**
Storm Date:	**11-Aug-1952**		
AWA Analysis Date:	**12/15/2013**		

Temporal Transposition Date	**25-Jul**	
	Lat	**Long**
Storm Center Location	**37.19 N**	**89.55 W**
Storm Rep Dew Point Location	**35.17 N**	**89.50 W**
Transposition Dew Point Location	**40.71 N**	**92.53 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**S @ 140**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**500**	feet
Storm Rep Analysis Duration	**6**	hours

The storm representative dew point is	**76.5 F**	with total precipitable water above sea level of		**3.07**	inches.
The in-place maximum dew point is	**81.0 F**	with total precipitable water above sea level of		**3.75**	inches.
The transpositioned maximum dew point is	**81.5 F**	with total precipitable water above sea level of		**3.83**	inches.
The in-place storm elevation is	**500**	which subtracts	**0.14**	inches of precipitable water at	**76.5 F**
The in-place storm elevation is	**500**	which subtracts	**0.15**	inches of precipitable water at	**81.0 F**
The transposition basin elevation at	**350**	which subtracts	**0.31**	inches of precipitable water at	**81.5 F**
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.31**	inches of precipitable water at	**81.5 F**

The in-place storm maximization factor is	**1.23**
The transposition/elevation to basin factor is	**0.98**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.20**

Notes: DAD values taken from USACE UMV 3-30. Storm representative Td value was based on maximum 6-hr Td values between August 11, 1952 at KMEM, KNQA, KMKL, and KDYR.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
10 sq miles	**5.5**	**11.5**	**13.0**	-	-	-	-	-	-
100 sq miles	**4.2**	**10.4**	**11.9**	-	-	-	-	-	-
200 sq miles	**0.0**	**0.0**	**0.0**	-	-	-	-	-	-
500 sq miles	**2.9**	**7.4**	**8.7**	-	-	-	-	-	-
1000 sq miles	**2.3**	**5.7**	**6.9**	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

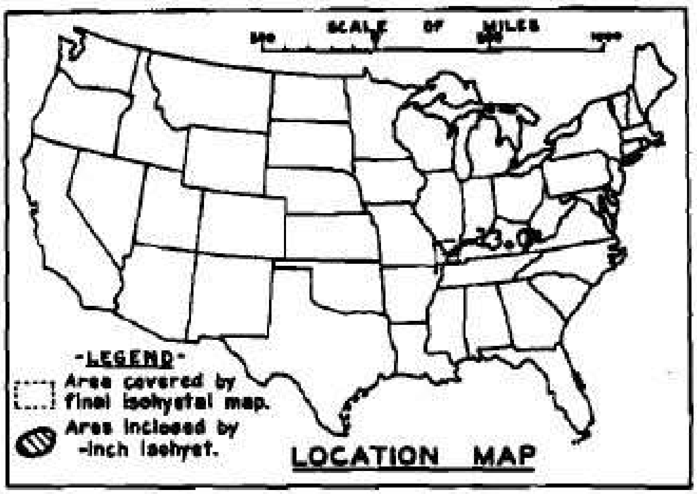
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
10 sq miles	**6.6**	**13.8**	**15.6**	-	-	-	-	-	-
100 sq miles	**5.1**	**12.5**	**14.3**	-	-	-	-	-	-
200 sq miles	**0.0**	**0.0**	**0.0**	-	-	-	-	-	-
500 sq miles	**3.5**	**8.9**	**10.5**	-	-	-	-	-	-
1000 sq miles	**2.8**	**6.9**	**8.3**	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE UMV 3-30-Kelso, MO**			
Storm Date(s)	11-Aug-1952			
Storm Type	MCC			
Storm Location	37.19 N	89.55 W		
Storm Center Elevation	500			
Precipitation Total & Duration	13.00 Inches 6-hours USACE UMV 3-30			
Storm Representative Td	76.5 F	6		
Storm Representative Td Location	35.17 N	89.50 W		
Maximum Td	81.0 F			
Moisture Inflow Vector	S @ 140	Miles		
In-place Maximization Factor	**1.23**			
Temporal Transposition (Date)	25-Jul			
Transposition Td Location	40.71 N	92.53 W	July	August
Transposition Maximum Td	81.5 F		82	81
Transposition Adjustment Factor	**0.98**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.20**			

Appendix F: Table F.78: Storm spreadsheet for Kelso, MO August 11, 1952

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 11-12 August 1952
Assignment UMV 3-30
Location SE Mo. and SW Ill.
Study Prepared by:
Lower Mississippi Valley Division
St. Louis District

Part I Reviewed by H. M. Sec. of Weather Bureau, 9/29/60
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 5/10/63
Remarks: Center at Kelso, Missouri. Dewpoint 75°F, 135 SSW.
Grid F-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	13
Form 5001-B (24-hour " ")	0
Form 5001-D (" " " ")	2
Miscl. precip. records, meteorological data, etc.	9
Form 5002 (Mass rainfall curves)	5

PART II

Final isohyetal maps, in 1 sheet, scale 1:500,000

Data and computation sheets:

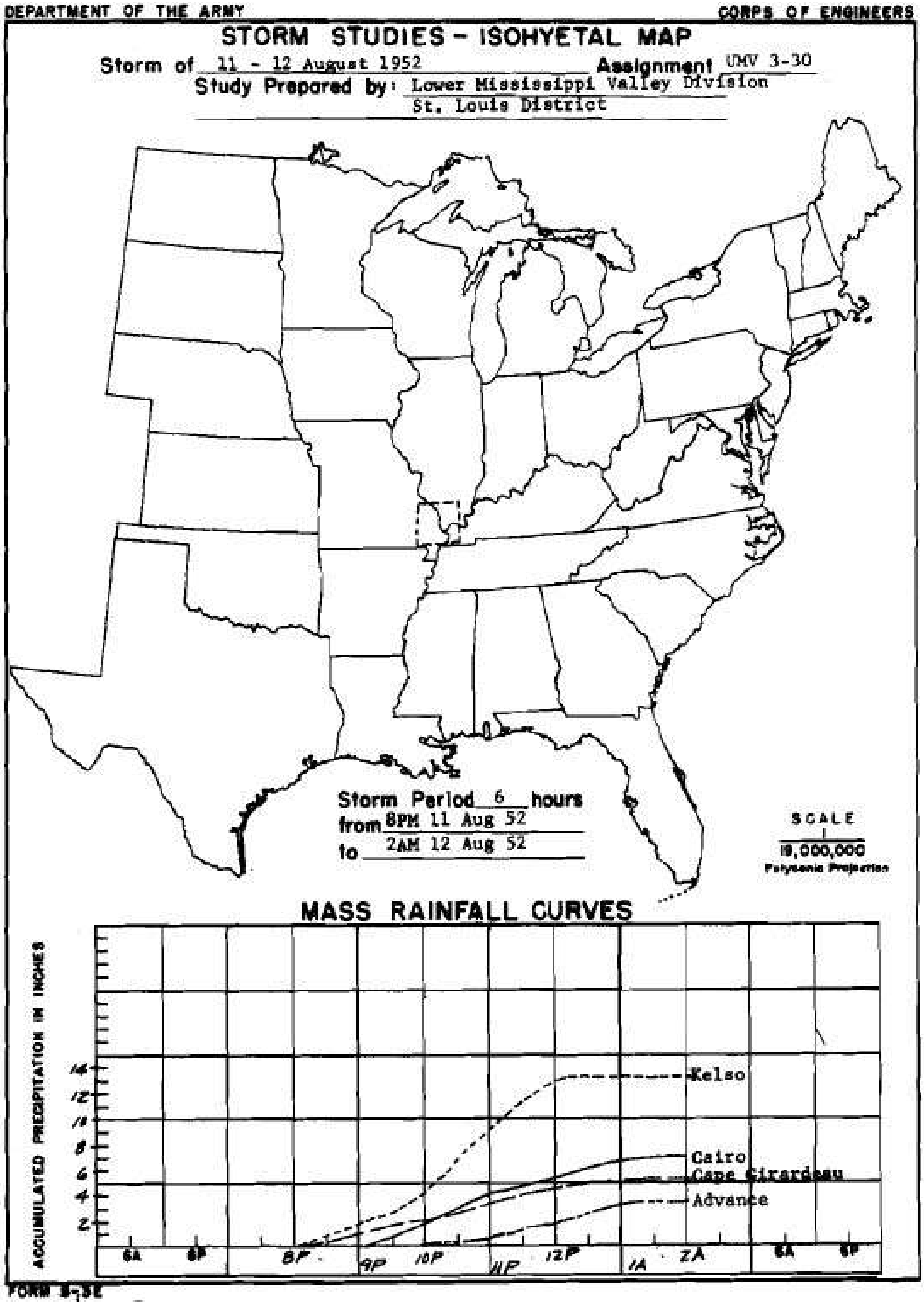
Form S-10 (Data from mass rainfall curves)	1
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	5
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	1	2	3	4	5	6				
10	5.5	9.1	11.5	12.9	13.0	13.0				
100	4.2	8.0	10.4	11.7	11.9	11.9				
500	2.9	5.5	7.4	8.0	8.6	8.7				
1,000	2.3	4.1	5.7	6.2	6.8	6.9				
1,730	1.7	3.1	4.3	4.9	5.4	5.5				

Form S-2

Appendix F: Table F.79: Depth-area-duration chart for Kelso, MO August 11, 1952



Appendix F: Figure F.105 and Figure F.106: Total storm isohyetal and Mass curve chart for Kelso, MO August 11, 1952

Council Grove, KS, AWA 38

July 9, 1951

Storm Type: Frontal

Grid Pints Used: 1-4, 8-11, 16-18

Storm Name:	MR 10-2-Council Grove, KS
Storm Date:	7/9-12/1951
AWA Analysis Date:	12/15/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	38.66 N	96.49 W
Storm Rep Dew Point Location	36.05 N	93.32 W
Transposition Dew Point Location	40.12 N	89.23 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SE @ 250	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,150	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	1,150	which subtracts	0.29	inches of precipitable water at	75.0 F	
The in-place storm elevation is	1,150	which subtracts	0.35	inches of precipitable water at	80.5 F	
The transposition basin elevation at	350	which subtracts	0.29	inches of precipitable water at	80.0 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	80.0 F	

The in-place storm maximization factor is	1.30
The transposition/elevation to basin factor is	0.99
The barrier adjustment factor is	1.00
The total adjustment factor is	1.29

Notes: DAD values taken from MR 10-2. Storm representative dew point value was based on maximum 24-hr Td values between July 9-10, 1951 at KFSM, KFYV, and KFLP.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	5.3	7.0	7.9	8.6	11.8	13.1	14.3	17.2	18.2
100 sq miles	4.7	6.4	7.4	7.9	10.6	12.4	13.8	16.3	17.5
200 sq miles	4.6	6.2	7.2	7.5	10.2	12.0	13.3	15.9	17.0
500 sq miles	4.3	5.8	6.7	7.0	9.5	11.3	12.4	15.0	16.2
1000 sq miles	4.0	5.5	6.3	6.6	9.0	10.5	11.5	14.2	15.5
2000 sq miles	3.8	5.1	5.9	6.2	8.3	9.6	10.5	13.1	14.6
5000 sq miles	3.4	4.5	5.1	5.4	7.2	8.4	9.3	11.7	13.0
10000 sq miles	2.9	3.9	4.4	4.8	6.2	7.3	8.2	10.4	11.4
20000 sq miles	2.4	3.2	3.7	4.1	5.1	6.1	6.9	8.6	9.4

Adjusted Storm Depth-Area-Duration

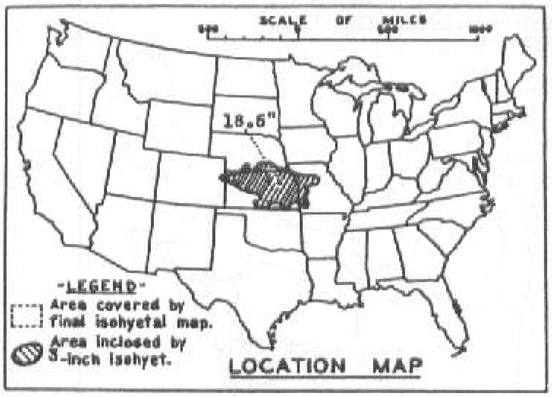
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	6.9	9.1	10.2	11.1	15.3	16.9	18.5	22.2	23.5
100 sq miles	6.1	8.3	9.6	10.2	13.7	16.0	17.8	21.1	22.6
200 sq miles	5.9	8.0	9.3	9.7	13.2	15.5	17.2	20.6	22.0
500 sq miles	5.6	7.5	8.7	9.1	12.3	14.6	16.0	19.4	20.9
1000 sq miles	5.2	7.1	8.1	8.5	11.6	13.6	14.9	18.4	20.0
2000 sq miles	4.9	6.6	7.6	8.0	10.7	12.4	13.6	16.9	18.9
5000 sq miles	4.4	5.8	6.6	7.0	9.3	10.9	12.0	15.1	16.8
10000 sq miles	3.7	5.0	5.7	6.2	8.0	9.4	10.6	13.4	14.7
20000 sq miles	3.1	4.1	4.8	5.3	6.6	7.9	8.9	11.1	12.2

Storm or Storm Center Name	**MR 10-2-Council Grove, KS**			
Storm Date(s)	7/9-12/1951			
Storm Type	General Storm			
Storm Location	38.66 N	96.49 W		
Storm Center Elevation	1150			
Precipitation Total & Duration (10 sq mi)	18.2 Inches in 72-hours			
Storm Representative Dew Point	75.0 F	24		
Storm Representative Dew Point Location	36.05 N	93.32 W	J	A
Maximum Dew Point	80.5 F		80.4	80.1
Moisture Inflow Vector	SE @ 250			
In-place Maximization Factor	**1.30**			
Temporal Transposition (Date)	15-Jul			
Transposition Dew Point Location	40.12 N	89.23 W		
Transposition Maximum Dew Point	80.0 F			
Transposition Adjustment Factor	**0.99**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.29**			

Appendix F: Table F.80: Storm spreadsheet for Council Grove, KS July 9, 1951

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 9-13 July 1951
Assignment MR 10-2
Location Kans., Nebr. Mo.
Study Prepared by:
Missouri River Division
Kansas City District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 10/29/51
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 12/10/52
Remarks: Center near Council Greve , Kans.
Dewpt. 73°F-Ref.Pt. 205 SSW
Grid F-16

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet , scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	78
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	2
Miscl. precip. records, meteorological data, etc.	151
Form 5002 (Mass rainfall curves)	61

PART II

Final isohyetal maps, in 1 sheet , scale 1: 1,000,000

Data and computation sheets:

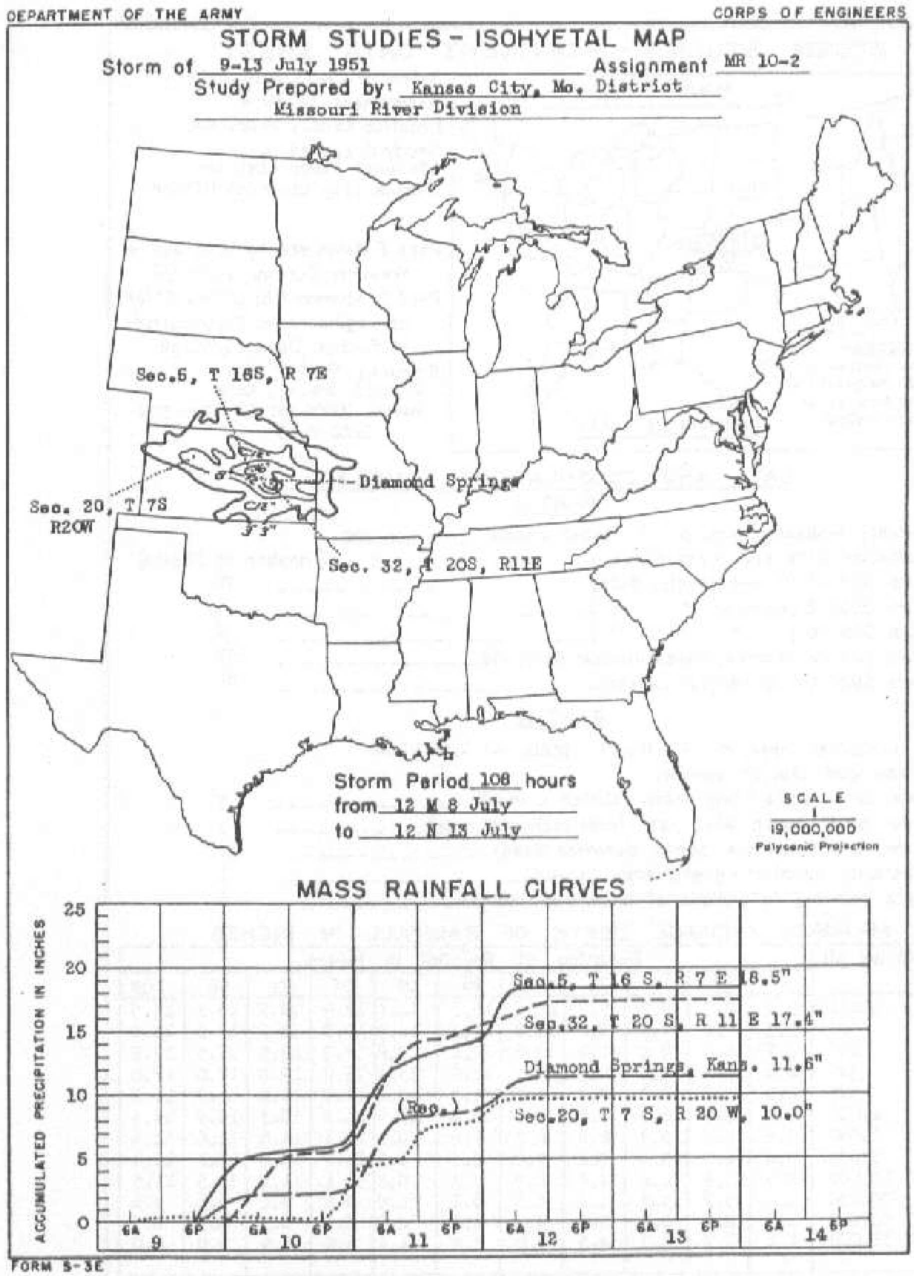
Form S-10 (Data from mass rainfall curves)	7
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	11
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	6

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	108
Max. Station	5.8	7.5	8.2	9.3	13.1	13.5	14.4	17.9	18.5	18.5	18.5
10	5.3	7.0	7.9	8.6	11.8	13.1	14.3	17.2	18.2	18.2	18.2
100	4.7	6.4	7.4	7.9	10.6	12.4	13.8	16.3	17.5	17.5	17.5
200	4.6	6.2	7.2	7.5	10.2	12.0	13.3	15.9	17.0	17.0	17.0
500	4.3	5.8	6.7	7.0	9.5	11.3	12.4	15.0	16.2	16.2	16.2
1,000	4.0	5.5	6.3	6.6	9.0	10.5	11.5	14.2	15.5	15.5	15.5
2,000	3.8	5.1	5.9	6.2	8.3	9.6	10.5	13.1	14.6	14.6	14.6
5,000	3.4	4.5	5.1	5.4	7.2	8.4	9.3	11.7	13.0	13.1	13.1
10,000	2.9	3.9	4.4	4.8	6.2	7.3	8.2	10.4	11.4	11.5	11.5
20,000	2.4	3.2	3.7	4.1	5.1	6.1	6.9	8.6	9.4	9.6	9.6
50,000	1.3	2.0	2.5	2.8	3.4	4.0	4.7	5.8	6.3	6.5	6.5
57,000	1.1	1.7	2.3	2.5	3.0	3.6	4.4	5.4	5.9	6.0	6.0

Form S-2

Appendix F: Table F.81: Depth-area-duration values for Council Grove, KS July 9, 1951



Appendix F: Figure F.107 and Figure F.108: Total storm isohyetal analysis and mass curve chart for Council Grove, KS July 9, 1951

Dumont, IA, AWA 39

June 25, 1951

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	USACE UMV 3-29-Dumont, IA
Storm Date:	25-Jun-1951
AWA Analysis Date:	12/15/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	10-Jul	
	Lat	Long
Storm Center Location	42.75 N	92.98 W
Storm Rep Dew Point Location	39.40 N	94.80 W
Transposition Dew Point Location	39.36 N	94.33 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 25	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	75.5 F	with total precipitable water above sea level of			2.92	inches.
The in-place maximum dew point is	81.5 F	with total precipitable water above sea level of			3.84	inches.
The transpositioned maximum dew point is	81.5 F	with total precipitable water above sea level of			3.84	inches.
The in-place storm elevation is	1,000	which subtracts	0.26	inches of precipitable water at	75.5 F	
The in-place storm elevation is	1,000	which subtracts	0.31	inches of precipitable water at	81.5 F	
The transposition basin elevation at	350	which subtracts	0.31	inches of precipitable water at	81.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.31	inches of precipitable water at	81.5 F	

The in-place storm maximization factor is	1.33
The transposition/elevation to basin factor is	1.00
The barrier adjustment factor is	1.00
The total adjustment factor is	1.33

Notes: DAD values taken from USACE UMV 3-29. Storm representative Td value was based on maximum 6-hr Td values between June 25, 1951 at KSTJ, KMKC, and KTOP.

Observed Storm Depth-Area-Duration

	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	6.8	9.4	12.0	-	-	-	-	-	-
10 sq miles	5.8	9.2	12.0	-	-	-	-	-	-
100 sq miles	4.4	7.7	10.0	-	-	-	-	-	-
200 sq miles	4.1	7.1	8.9	-	-	-	-	-	-
500 sq miles	3.6	6.1	7.5	-	-	-	-	-	-
1000 sq miles	3.2	5.3	6.6	-	-	-	-	-	-
5000 sq miles	2.1	3.5	4.4	-	-	-	-	-	-
10000 sq miles	1.6	2.7	3.5	-	-	-	-	-	-
20000 sq miles	1.2	1.9	2.5	-	-	-	-	-	-

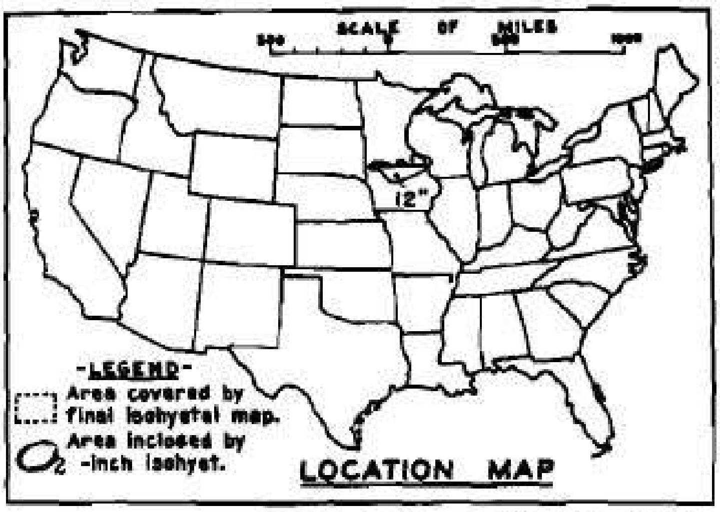
Adjusted Storm Depth-Area-Duration

	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	9.0	12.5	15.9	-	-	-	-	-	-
10 sq miles	7.7	12.2	15.9	-	-	-	-	-	-
100 sq miles	5.8	10.2	13.3	-	-	-	-	-	-
200 sq miles	5.4	9.4	11.8	-	-	-	-	-	-
500 sq miles	4.8	8.1	10.0	-	-	-	-	-	-
1000 sq miles	4.2	7.0	8.8	-	-	-	-	-	-
5000 sq miles	2.8	4.6	5.8	-	-	-	-	-	-
10000 sq miles	2.1	3.6	4.6	-	-	-	-	-	-
20000 sq miles	1.6	2.5	3.3	-	-	-	-	-	-

Storm or Storm Center Name	**USACE UMV 3-29-Dumont, IA**			
Storm Date(s)	25-Jun-1951			
Storm Type	MCC			
Storm Location	42.75 N	92.98 W		
Storm Center Elevation	1,000			
Precipitation Total & Duration	12.00 Inches 6-hours USACE UMV 3-29			
Storm Representative Dew Point	75.5 F	6		
Storm Representative Dew Point Location	39.40 N	94.80 W	Jun	Jul
Maximum Dew Point	81.5 F		79	82.5
Moisture Inflow Vector	SSW @ 250	Miles		
In-place Maximization Factor	**1.33**			
Temporal Transposition (Date)	10-Jul		Jun	Jul
Transposition Dew Point Location	39.36 N	94.33 W	79	82
Transposition Maximum Dew Point	81.5 F			
Transposition Adjustment Factor	**1.00**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.33**			

Appendix F: Table F.82: Storm spreadsheet for Dumont, IA June 25, 1951

STORM STUDIES - PERTINENT DATA SHEET



Storm of 25-26 June 1951
Assignment UMV 3-29
Location Iowa, Minnesota & Wisc.
Study Prepared by:
North Central Division
Rock Island District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 11-21-56
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 7-18-57
Remarks:
Center near Dumont, Iowa. Rep. Dewpoint 72°, Ref. Pt. 160 SW

DATA AND COMPUTATIONS COMPILED

Grid D-13

PART I

Preliminary isohyetal map, in 1 sheet , scale 1:1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	56
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	11
Miscl. precip. records, meteorological data, etc.	1
Form 5002 (Mass rainfall curves)	45

PART II

Final isohyetal maps, in 1 sheet , scale 1:500,000

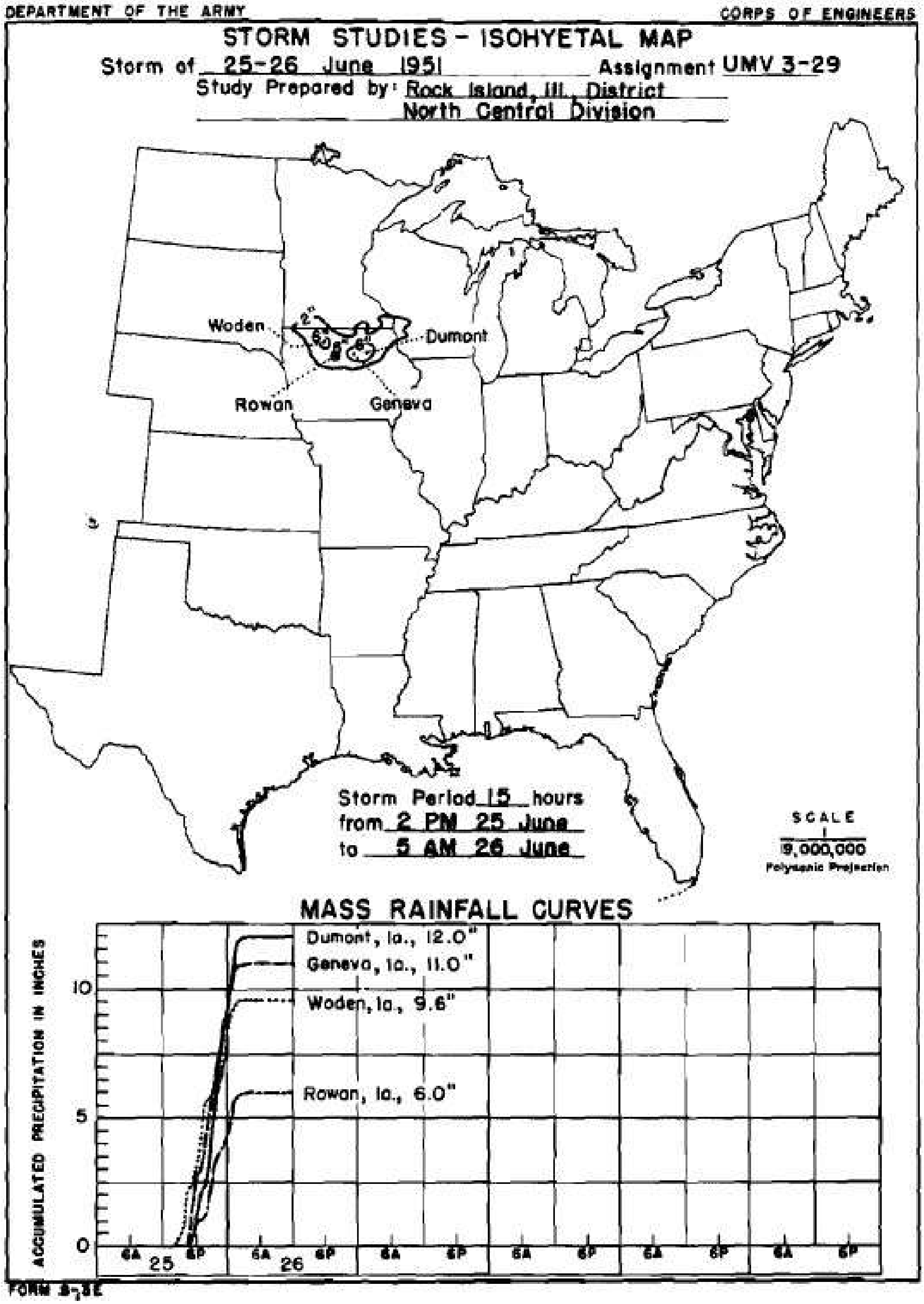
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	6
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	6
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	3	6	9	12	15					
Max.Station	6.8	9.4	11.6	12.0	12.0					
10	5.8	9.2	11.6	12.0	12.0					
100	4.4	7.7	9.7	10.0	10.0					
200	4.1	7.1	8.6	8.9	8.9					
500	3.6	6.1	7.3	7.5	7.6					
1000	3.2	5.3	6.4	6.6	6.6					
2000	2.7	4.5	5.4	5.6	5.7					
5000	2.1	3.5	4.2	4.4	4.5					
10000	1.6	2.7	3.3	3.5	3.6					
20000	1.2	1.9	2.3	2.5	2.6					

Form S-2

Appendix F: Table F.83: Depth-area-duration chart for Dumont, IA June 25, 1951



Appendix F: Figure F.109 and Figure F.110: Total storm isohyetal and Mass curve chart for Dumont, IA June 25, 1951

Holt, MO, AWA 40

June 18, 1947

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	USACE MR 8-20-Holt, MO
Storm Date:	6/18-22/1947
AWA Analysis Date:	12/15/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	5-Jul	
	Lat	Long
Storm Center Location	39.45 N	94.34 W
Storm Rep Dew Point Location	36.18 N	95.25 W
Transposition Dew Point Location	39.46 N	93.53 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 230	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place maximum dew point is	81.5 F	with total precipitable water above sea level of			3.84	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	1,000	which subtracts	0.28	inches of precipitable water at	79.0 F	
The in-place storm elevation is	1,000	which subtracts	0.30	inches of precipitable water at	81.5 F	
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place storm maximization factor is	1.12
The transposition/elevation to basin factor is	0.98
The barrier adjustment factor is	1.00
The total adjustment factor is	1.09

Notes: DAD values taken from USACE MR 8-20, 1sqmi amount taken from Holt, MO world record rainfall within the overall storm. Storm representative Td value was based on maximum 6-hr Td values between June 22-23, 1947 at KHRO and KTUL.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	12.0	12.0	12.0	12.0	-	12.0	14.4	-	16.6
10 sq miles	11.5	11.5	11.5	11.5	-	11.5	12.6	-	15.8
100 sq miles	7.9	7.9	7.9	7.9	-	7.9	9.3	-	12.9
200 sq miles	7.1	7.1	7.1	7.1	-	7.1	8.4	-	11.9
500 sq miles	6.3	6.3	6.3	6.3	-	6.3	7.4	-	10.6
1000 sq miles	5.6	5.6	5.6	5.6	-	5.6	6.6	-	9.6
5000 sq miles	3.5	3.7	3.7	3.7	-	3.7	4.6	-	6.7
10000 sq miles	2.6	2.9	3.0	3.0	-	3.0	3.7	-	5.4
20000 sq miles	1.8	2.1	2.2	2.2	-	2.2	3.1	-	4.4

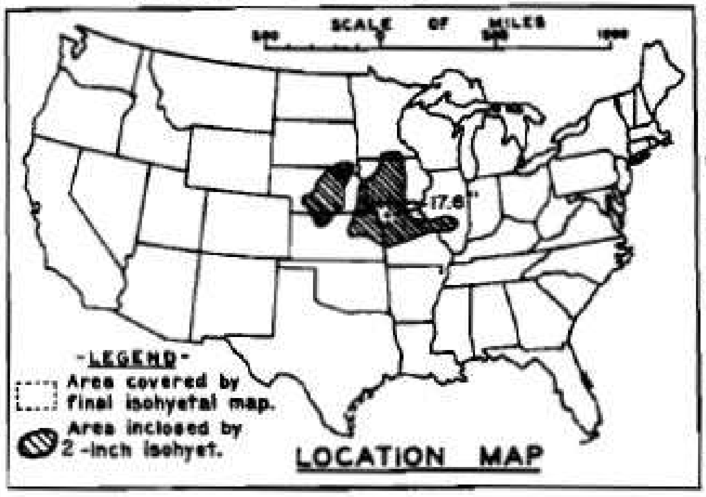
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	13.1	13.1	13.1	13.1	-	13.1	15.8	-	18.2
10 sq miles	12.6	12.6	12.6	12.6	-	12.6	13.8	-	17.3
100 sq miles	8.7	8.7	8.7	8.7	-	8.7	10.2	-	14.1
200 sq miles	7.8	7.8	7.8	7.8	-	7.8	9.2	-	13.0
500 sq miles	6.9	6.9	6.9	6.9	-	6.9	8.1	-	11.6
1000 sq miles	6.1	6.1	6.1	6.1	-	6.1	7.2	-	10.5
5000 sq miles	3.8	4.1	4.1	4.1	-	4.1	5.0	-	7.3
10000 sq miles	2.8	3.2	3.3	3.3	-	3.3	4.1	-	5.9
20000 sq miles	2.0	2.3	2.4	2.4	-	2.4	3.4	-	4.8

Storm or Storm Center Name	**USACE MR 8-20-Holt, MO**			
Storm Date(s)	6/18-22/1947			
Storm Type	MCC			
Storm Location	39.45 N	94.34 W		
Storm Center Elevation	1,000			
Precipitation Total & Duration	17.6 Inches 6-hours USACE MR 8-20			
Storm Representative Dew Point	79.0 F	6		
Storm Representative Dew Point Location	36.18 N	95.25 W		
Maximum Dew Point	81.5 F			
Moisture Inflow Vector	SSW @ 230	Miles		
In-place Maximization Factor	**1.12**			
Temporal Transposition (Date)	5-Jul			
Transposition Dew Point Location	39.46 N	93.53 W	June	July
Transposition Maximum Dew Point	81.0 F		79	82
Transposition Adjustment Factor	**0.98**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.09**			

Appendix F: Table F.84: Storm spreadsheet for Holt, MO June 18, 1947

STORM STUDIES – PERTINENT DATA SHEET



Storm of 18-23 June 1947
Assignment MR 8-20
Location Ill, Ia, Kans, Minn. Mo, Nebr, & S.Dak.
Study Prepared by:
Missouri River Division
Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 12/17/52
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 9/10/54
Remarks:
Center near Holt, Mo.
Dewpoint 75°, Ref. Pt. 140 S

DATA AND COMPUTATIONS COMPILED Grid E-14

PART I

Preliminary isohyetal map, in sheet, scale
Precipitation data and mass curves: (Number of Sheets)
Form 5001-C (Hourly precip. data)--
Form 5001-B (24-hour " ")--------
Form 5001-D (" " " ")--------
Miscl. precip. records, meteorological data, etc.
Form 5002 (Mass rainfall curves)----------------------

NOTE: This study was computed by the Regional Method which does not employ the Part I and Part II phases in their entirety.

PART II

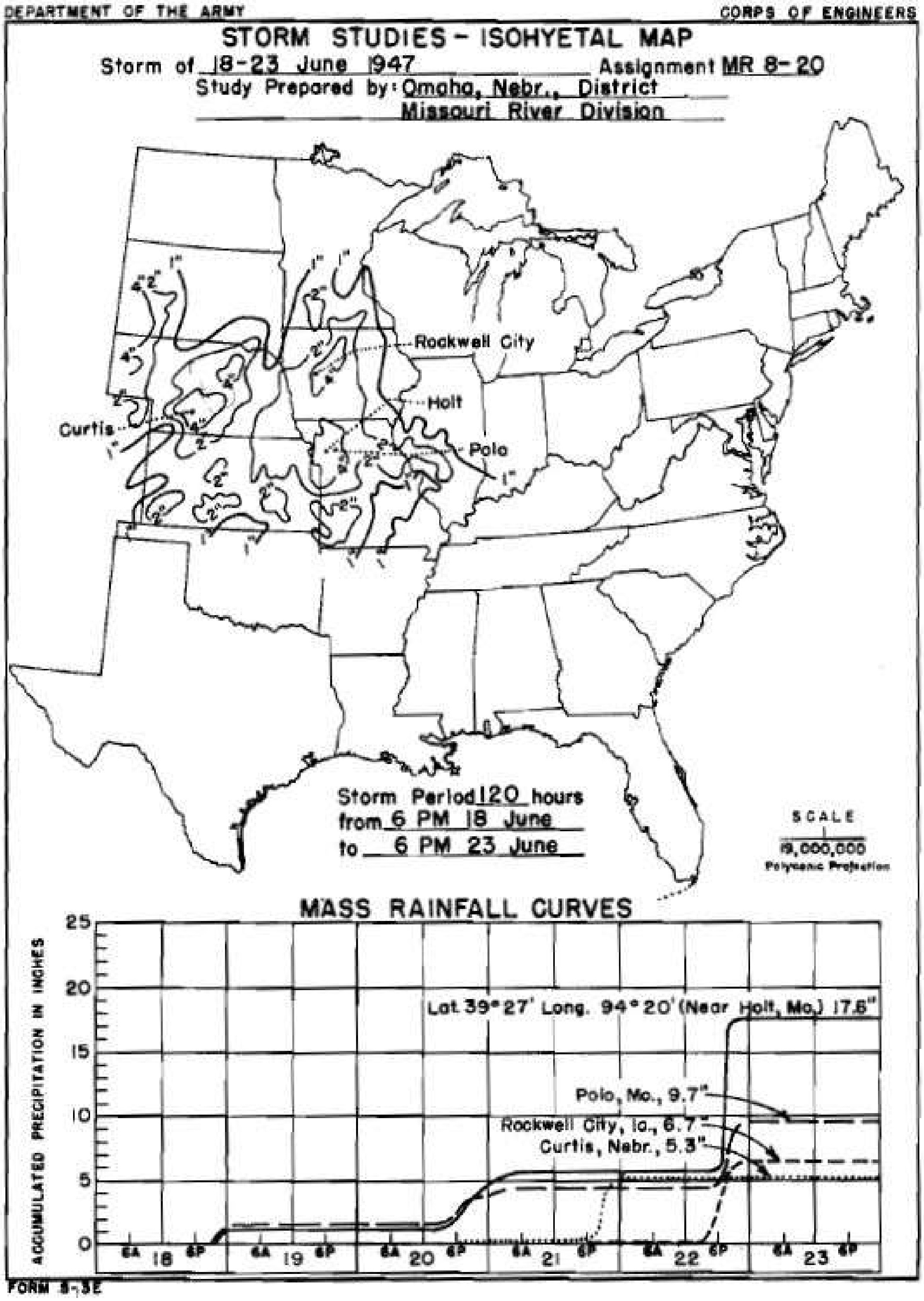
Final isohyetal maps, in 1 sheet, scale 1:100,000
Data and computation sheets:
Form S-10 (Data from mass rainfall curves)--------------- 9
Form S-11 (Depth-area data from isohyetal map)----------- 4
Form S-12 (Maximum depth-duration data)---------------- 7
Maximum duration-depth-area curves------------------ 1
Data relating to periods of maximum rainfall-------------

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	36	48	72	96	120		
Max.Station	12.0	12.0	12.0	12.0	12.0	14.4	16.6	16.9	17.6		
10	11.5	11.5	11.5	11.5	11.5	12.6	15.8	15.8	16.9		
100	7.9	7.9	7.9	7.9	7.9	9.3	12.9	12.9	14.1		
200	7.1	7.1	7.1	7.1	7.1	8.4	11.9	11.9	13.0		
500	6.3	6.3	6.3	6.3	6.3	7.4	10.6	10.6	11.6		
1000	5.6	5.6	5.6	5.6	5.6	6.6	9.6	9.6	10.5		
2000	4.9	4.9	4.9	4.9	4.9	5.7	8.4	8.4	9.3		
5000	3.5	3.7	3.7	3.7	3.7	4.6	6.7	6.7	7.3		
10000	2.6	2.9	3.0	3.0	3.0	3.7	5.4	5.4	5.9		
20000	1.8	2.1	2.2	2.2	2.2	3.1	4.4	4.6	4.9		
50000	1.2	1.4	1.5	1.6	1.9	2.5	3.2	3.5	3.6		
100000	0.8	1.0	[illegible]	1.4	1.6	2.1	2.7	2.9	3.0		
200000	0.5	0.7	[illegible]	1.1	1.4	1.7	2.1	2.2	2.3		
300000	0.3	0.5	0.6	0.7	0.9	1.2	1.5	1.6	1.8		

Form S-2

Appendix F: Table F.85: Depth-area-duration chart for Holt, MO June 18, 1947



Appendix F: Figure F.111 and Figure F.112: Total storm isohyetal and Mass curve chart for Holt, MO June 1947

Cole Camp, MO, AWA 41

August 12, 1946

Storm Type: Frontal

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	USACE MR 7-2A-Cole Camp, MO		
Storm Date:	8/12-15/1946		
AWA Analysis Date:	12/15/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	1-Aug	
	Lat	Long
Storm Center Location	38.46 N	93.20 W
Storm Rep Dew Point Location	32.55 N	93.00 W
Transposition Dew Point Location	36.82 N	92.37 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 410	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of		2.99	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of		3.68	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of		3.68	inches.
The in-place storm elevation is	1,000	which subtracts	0.26	inches of precipitable water at	76.0 F
The in-place storm elevation is	1,000	which subtracts	0.29	inches of precipitable water at	80.5 F
The transposition storm elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F
The Grid Point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F

The in-place maximization factor is	1.24
The transposition factor is	1.00
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.24

Notes: DAD values taken from HMR 51 DAD Table Storm Index N. 80-USACE MR 7-2B. Storm representative dew point value was based on maximum 24-hr Td values between August 10-11, 1946 at KBAD and KMLU.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.6	11.0	11.1	15.0	17.4	18.5	19.0	19.4	19.4
100 sq miles	9.0	9.9	10.0	13.4	16.0	17.0	18.3	18.6	18.6
200 sq miles	8.3	9.2	9.4	12.4	15.0	16.1	17.4	17.7	17.7
500 sq miles	7.0	7.9	8.0	10.4	12.9	14.1	15.5	15.9	15.9
1000 sq miles	5.5	6.6	7.0	8.3	10.9	12.0	13.7	14.1	14.1
2000 sq miles	4.2	5.5	6.3	6.8	9.4	10.4	11.8	12.3	12.3
5000 sq miles	3.3	4.7	5.6	5.9	7.8	8.6	9.6	10.0	10.1
10000 sq miles	2.8	4.2	5.0	5.4	6.5	7.2	8.1	8.4	8.7
20000 sq miles	2.3	3.4	4.2	4.5	5.1	5.7	6.6	6.9	7.2

Adjusted Storm Depth-Area-Duration

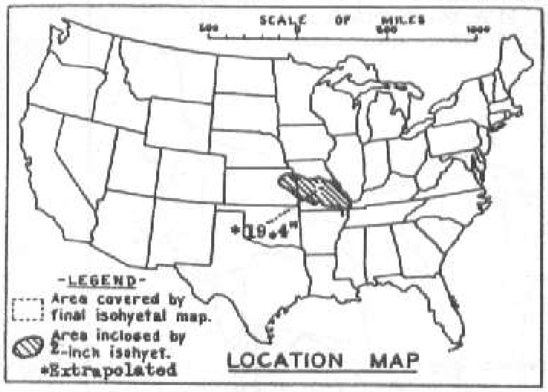
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	13.1	13.6	13.7	18.6	21.5	22.9	23.5	24.0	24.0
100 sq miles	11.1	12.3	12.4	16.6	19.8	21.0	22.7	23.0	23.0
200 sq miles	10.3	11.4	11.6	15.4	18.6	19.9	21.5	21.9	21.9
500 sq miles	8.7	9.8	9.9	12.9	16.0	17.5	19.2	19.7	19.7
1000 sq miles	6.8	8.2	8.7	10.3	13.5	14.9	17.0	17.5	17.5
2000 sq miles	5.2	6.8	7.8	8.4	11.6	12.9	14.6	15.2	15.2
5000 sq miles	4.1	5.8	6.9	7.3	9.7	10.6	11.9	12.4	12.5
10000 sq miles	3.5	5.2	6.2	6.7	8.0	8.9	10.0	10.4	10.8
20000 sq miles	2.8	4.2	5.2	5.6	6.3	7.1	8.2	8.5	8.9

Storm or Storm Center Name	USACE MR 7-2A-Cole Camp, MO			
Storm Date(s)	8/12-15/1946			
Storm Type	General Storm			
Storm Location	38.46 N	93.20 W		
Storm Center Elevation	1000			
Precipitation Total & Duration (10 sq mi)	19.40 Inches in 60-hours			
Storm Representative Dew Point	76.0 F	24		
Storm Representative Dew Point Location	32.55 N	93.00 W	Jul	Aug
Maximum Dew Point	80.5 F		80.5	80
Moisture Inflow Vector	S @ 410			
In-place Maximization Factor	1.24			
Temporal Transposition (Date)	1-Aug			
Transposition Dew Point Location	36.82 N	92.37 W	Jul	Aug
Transposition Maximum Dew Point	80.5 F		80.5	80.5
Transposition Adjustment Factor	1.00			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.24			

Appendix F: Table F.86: Storm spreadsheet for Cole Camp, MO August 12, 1946

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 12-15 August 1946
Assignment MR 7-2A
Location Kansas & Missouri
Study Prepared by:
Missouri River Division
Kansas City District

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/30/48
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/20/50
Remarks: Center near Cole Camp, Mo.
Dewpt. 74° - Ref. Pt. 140°S
Grid F-14

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	64
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	18
Miscl. precip. records, meteorological data, etc.	30
Form 5002 (Mass rainfall curves)	51

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

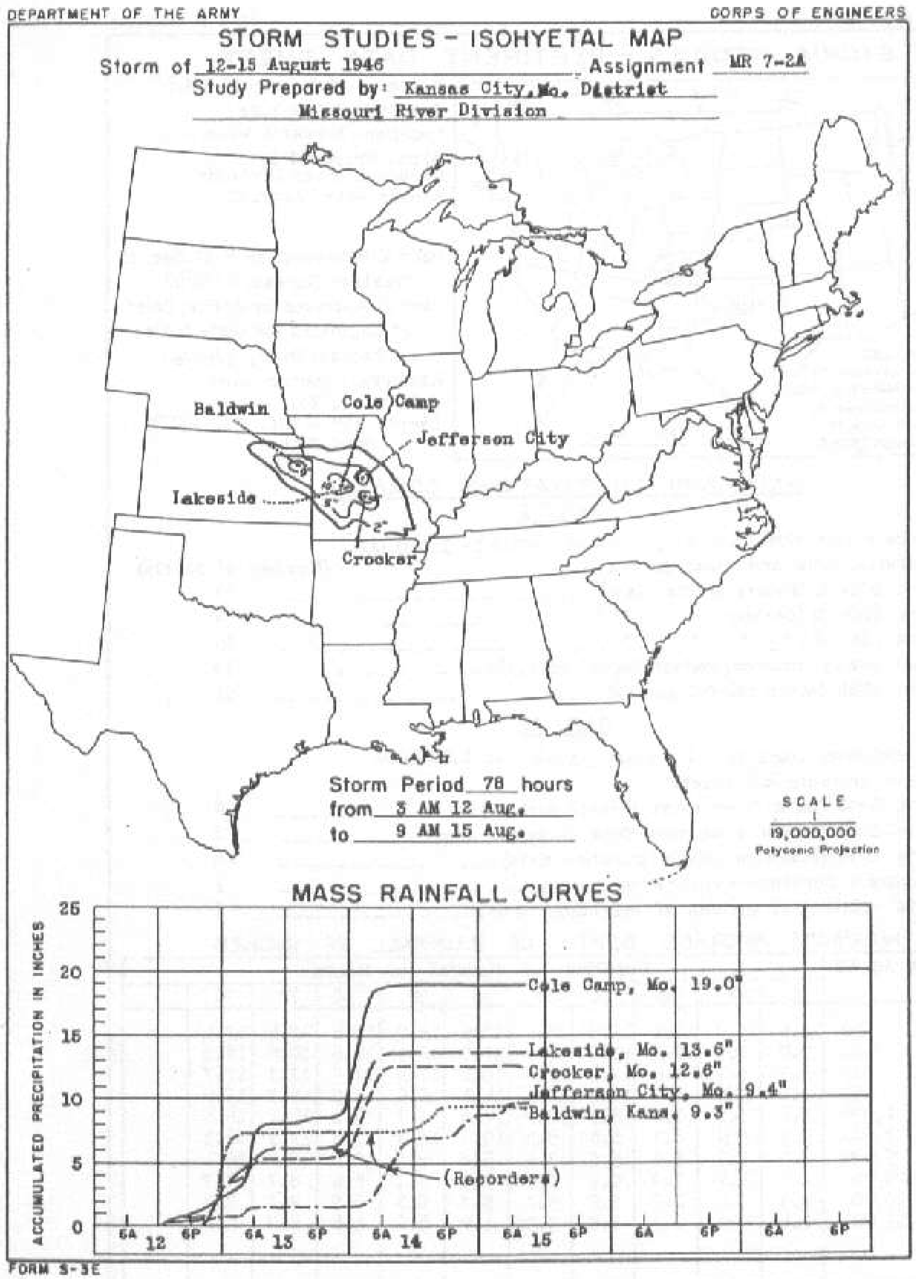
Form S-10 (Data from mass rainfall curves)	6
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	16
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	78
10	10.6	11.0	11.1	15.0	17.4	18.5	19.0	19.4	19.4	19.4
100	9.0	9.9	10.0	13.4	16.0	17.0	18.3	18.6	18.6	18.6
200	8.3	9.2	9.4	12.4	15.0	16.1	17.4	17.7	17.7	17.7
500	7.0	7.9	8.0	10.4	12.9	14.1	15.5	15.9	15.9	15.9
1,000	5.5	6.6	7.0	8.3	10.9	12.0	13.7	14.1	14.1	14.1
2,000	4.2	5.5	6.3	6.8	9.4	10.4	11.8	12.3	12.3	12.3
5,000	3.3	4.7	5.6	5.9	7.8	8.6	9.6	10.0	10.1	10.1
10,000	2.8	4.2	5.0	5.4	6.5	7.2	8.1	8.4	8.7	8.7
20,000	2.3	3.4	4.2	4.5	5.1	5.7	6.6	6.9	7.2	7.2
45,000	1.4	2.3	2.7	2.9	3.3	3.9	4.5	4.8	5.0	5.0

Form S-2

Appendix F: Table F.87: Depth-area-duration values for Cole Camp, MO August 12, 1946



Appendix F: Figure F.113 and Figure F.114: Isohyetal map and mass curve chart for Cole Camp, MO August 12, 1946

Collinsville, IL, AWA 42

August 12, 1946

Storm Type: Frontal

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	USACE MR 7-2B-Collinsville, IL	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	8/12-15/1946	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date	1-Aug	
	Lat	Long
Storm Center Location	38.67 N	89.98 W
Storm Rep Dew Point Location	32.55 N	93.00 W
Transposition Dew Point Location	36.61 N	95.75 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 455	miles
Grid Point Elevation	350	feet
Storm Center Elevation	500	feet
Storm Rep Analysis Duration	24	hours

The storm representative Td is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum Td is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum Td is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	500	which subtracts	0.13	inches of precipitable water at	76.0 F	
The in-place storm elevation is	500	which subtracts	0.16	inches of precipitable water at	80.5 F	
The transposition storm elevation at	350	which subtracts	0.29	inches of precipitable water at	80.0 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	80.0 F	

The in-place maximization factor is	1.23
The transposition factor is	0.94
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.16

Notes: DAD values taken from HMR 51 DAD Table Storm Index N. 80-USACE MR 7-2B. Storm representative dew point value was based on maximum 24-hr Td values between August 10-11, 1946 at KBAD and KMLU.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	6.4	10.2	12.6	12.7	14.1	18.0	18.1	18.6	18.7
10 sq miles	6.0	9.8	12.1	12.1	13.7	17.5	17.6	18.3	18.3
100 sq miles	5.6	8.8	10.9	11.1	13.2	16.6	16.7	17.5	17.6
200 sq miles	5.4	8.3	10.5	10.6	13.0	16.2	16.3	17.2	17.3
500 sq miles	5.2	7.7	9.7	9.9	12.8	15.5	15.6	16.7	16.9
1000 sq miles	4.9	7.0	8.9	9.0	12.6	14.7	14.8	15.9	16.0
2000 sq miles	4.3	6.1	7.6	7.8	11.2	13.3	13.4	14.3	14.3
5000 sq miles	3.3	4.8	5.9	6.0	8.6	10.4	10.6	11.3	11.4
10000 sq miles	2.4	3.7	4.5	4.6	6.6	8.0	8.2	8.7	8.8
20000 sq miles	1.5	2.5	3.1	3.2	4.6	5.6	5.8	6.0	6.1

Adjusted Storm Depth-Area-Duration

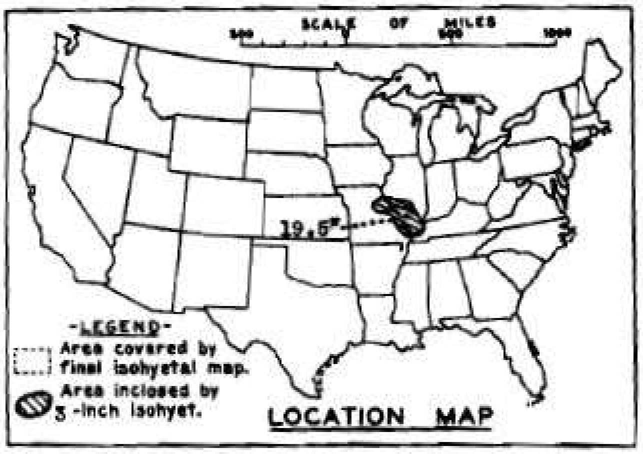
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	7.4	11.8	14.6	14.7	16.3	20.8	20.9	21.5	21.6
10 sq miles	6.9	11.3	14.0	14.0	15.9	20.3	20.4	21.2	21.2
100 sq miles	6.5	10.2	12.6	12.8	15.3	19.2	19.3	20.3	20.4
200 sq miles	6.2	9.6	12.2	12.3	15.0	18.7	18.9	19.9	20.0
500 sq miles	6.0	8.9	11.2	11.5	14.8	17.9	18.1	19.3	19.6
1000 sq miles	5.7	8.1	10.3	10.4	14.6	17.0	17.1	18.4	18.5
2000 sq miles	5.0	7.1	8.8	9.0	13.0	15.4	15.5	16.6	16.6
5000 sq miles	3.8	5.6	6.8	6.9	10.0	12.0	12.3	13.1	13.2
10000 sq miles	2.8	4.3	5.2	5.3	7.6	9.3	9.5	10.1	10.2
20000 sq miles	1.7	2.9	3.6	3.7	5.3	6.5	6.7	6.9	7.1

Storm or Storm Center Name	**USACE MR 7-2B-Collinsville, IL**			
Storm Date(s)	8/12-15/1946			
Storm Type	General Storm			
Storm Location	38.67 N	89.98 W		
Storm Center Elevation	500			
Precipitation Total & Duration (10 sq mi)	18.7 Inches in 72-hours			
Storm Representative Dew Point	76.0 F	24		
Storm Representative Dew Point Location	32.55 N	93.00 W	Jul	Aug
Maximum Dew Point	80.5 F		80.5	80
Moisture Inflow Vector	SSW @ 455			
In-place Maximization Factor	**1.23**			
Temporal Transposition (Date)	1-Aug			
Transposition Dew Point Location	36.61 N	95.75 W	Jul	Aug
Transposition Maximum Dew Point	80.0 F		80	80
Transposition Adjustment Factor	**0.94**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.16**			

Appendix F: Table F.88: Storm spreadsheet for Collinsville, IL August 12, 1946

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES – PERTINENT DATA SHEET



Storm of 12-16 August 1946
Assignment MR 7-2B
Location Mo.,Ill.,Ind. & Ky.
Study Prepared by: Upper Mississippi Valley Division St. Louis District

Part I Reviewed by H. M. Sec. of Weather Bureau, 3/8/49
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/20/50
Remarks: Center near Collinsville, Ill. Dewpt. 74° Ref. Pt. 225 S Grid F-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) 58
- Form 5001-B (24-hour " ") .... —
- Form 5001-D (" " " ") 16
- Miscl. precip. records, meteorological data, etc. 15
- Form 5002 (Mass rainfall curves) 44

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

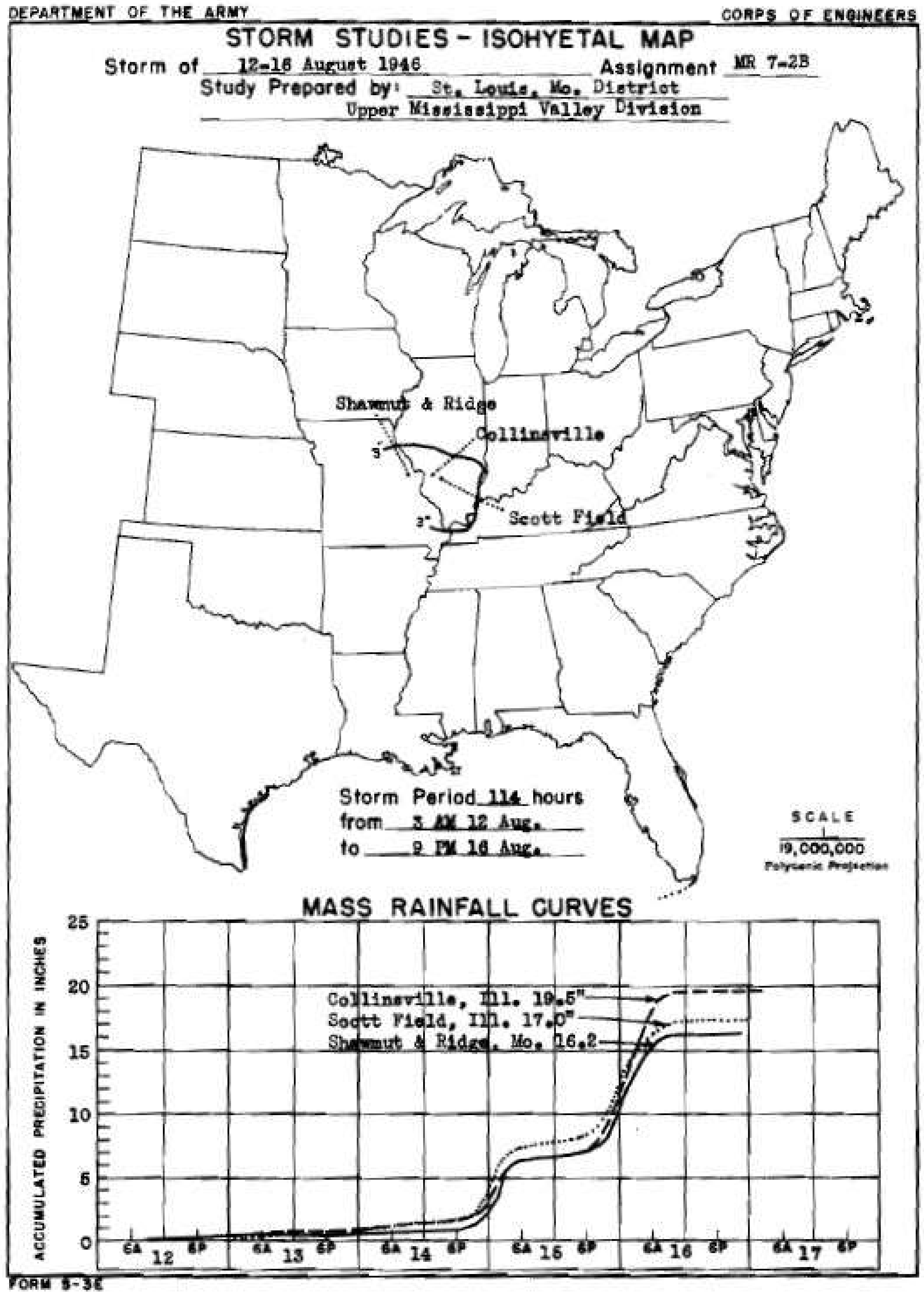
- Form S-10 (Data from mass rainfall curves) 5
- Form S-11 (Depth-area data from isohyetal map) 3
- Form S-12 (Maximum depth-duration data) 7
- Maximum duration-depth-area curves 1
- Data relating to periods of maximum rainfall 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	114
Max. Sta.	6.4	10.2	12.6	12.7	14.1	18.0	18.1	18.6	18.7	19.4	19.5
10	6.0	9.8	12.1	12.1	13.7	17.5	17.6	18.3	18.3	18.9	19.0
100	5.6	8.8	10.9	11.1	13.2	16.6	16.7	17.5	17.6	18.0	18.1
200	5.4	8.3	10.5	10.6	13.0	16.2	16.3	17.2	17.3	17.7	17.8
500	5.2	7.7	9.7	9.9	12.8	15.5	15.6	16.7	16.9	17.1	17.2
1,000	4.9	7.0	8.9	9.0	12.6	14.7	14.8	15.9	16.0	16.3	16.4
2,000	4.3	6.1	7.6	7.8	11.2	13.3	13.4	14.3	14.3	14.6	14.7
5,000	3.3	4.8	5.9	6.0	8.6	10.4	10.6	11.3	11.4	11.6	11.8
10,000	2.4	3.7	4.5	4.6	6.6	8.0	8.2	8.7	8.8	9.0	9.1
20,000	1.5	2.5	3.1	3.2	4.5	5.6	5.8	6.0	6.1	6.3	6.5
20,400	1.5	2.5	3.1	3.2	4.5	5.5	5.7	6.0	6.1	6.3	6.4

Form S-2

Appendix F: Table F.89: Depth-area-duration values for Collinsville, IL August 12, 1946



Appendix F: Figure F.115 and Figure F.116: Isohyetal map and mass curve chart for Collinsville, IL August 12, 1946

Stanton, NE, AWA 43

June 10, 1944

Storm Type: MCC

Grid Points Used: 2-4, 8-11, 16-18

Storm Name:	USACE MR-6-15-Stanton, NE	Storm Adjustment for ANO Grid Point 2
Storm Date:	6/10-11/1944	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date	25-Jun	
	Lat	Long
Storm Center Location	41.87 N	97.05 W
Storm Rep Dew Point Location	34.40 N	99.50 W
Transposition Dew Point Location	35.25 N	95.02 W
Grid Point Location	34.50 N	95.50 W

Moisture Inflow Direction	SSW @ 530	miles
Grid Point Elevation	550	feet
Storm Center Elevation	1,700	feet
Storm Rep Analysis Duration	6	feet

The storm representative dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum dew point is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,700	which subtracts	0.43	inches of precipitable water at	76.0 F	
The in-place storm elevation is	1,700	which subtracts	0.48	inches of precipitable water at	80.0 F	
The transposition basin elevation at	550	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.22
The transposition/elevation to basin factor is	1.08
The barrier adjustment factor is	1.00
The total adjustment factor is	1.32

Notes: DAD values taken from USACE Storm Studies MR 6-15. Storm representative Td value was based on maximum 6-hr Td values between June 10, 1944 at mid-point of KCDS, KLTS and KFDR.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	15.5	15.8	15.8	15.8	15.8	15.8	16.8	17.3	17.3
10 sq miles	13.4	15.3	15.3	15.3	15.3	15.3	16.2	16.4	16.7
100 sq miles	11.7	13.6	13.6	13.6	13.6	13.7	14.8	14.9	15.1
200 sq miles	11.1	12.9	12.9	12.9	12.9	13.1	14.1	14.3	14.4
500 sq miles	9.8	11.3	11.5	11.5	11.5	11.6	12.5	12.7	12.8
1000 sq miles	7.8	9.0	9.3	9.3	9.3	9.4	10.1	10.4	10.4
2000 sq miles	5.9	6.9	7.1	7.1	7.2	7.3	7.8	8.1	8.1
5000 sq miles	3.4	4.0	4.2	4.6	4.7	4.9	5.3	5.5	5.7
10000 sq miles	2.2	2.5	2.7	3.5	3.9	4.1	4.5	4.7	4.9
20000 sq miles	-	-	-	-	-	-	-	-	-

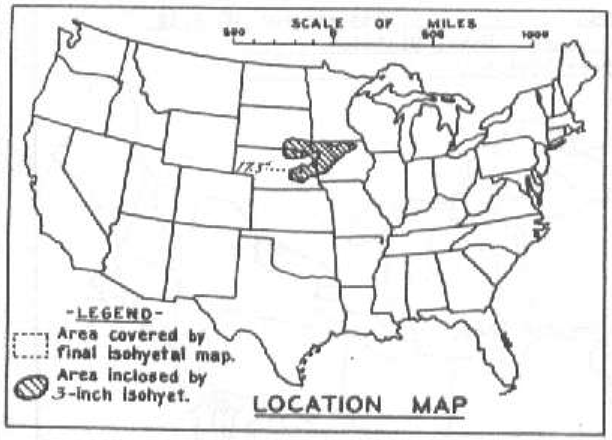
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	20.4	20.8	20.8	20.8	20.8	20.8	22.2	22.8	22.8
10 sq miles	17.7	20.2	20.2	20.2	20.2	20.2	21.4	21.6	22.0
100 sq miles	15.4	17.9	17.9	17.9	17.9	18.1	19.5	19.7	19.9
200 sq miles	14.6	17.0	17.0	17.0	17.0	17.3	18.6	18.9	19.0
500 sq miles	12.9	14.9	15.2	15.2	15.2	15.3	16.5	16.7	16.9
1000 sq miles	10.3	11.9	12.3	12.3	12.3	12.4	13.3	13.7	13.7
2000 sq miles	7.8	9.1	9.4	9.4	9.5	9.6	10.3	10.7	10.7
5000 sq miles	4.5	5.3	5.5	6.1	6.2	6.5	7.0	7.3	7.5
10000 sq miles	2.9	3.3	3.6	4.6	5.1	5.4	5.9	6.2	6.5
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	USACE MR-6-15-Stanton, NE			
Storm Date(s)	6/10-11/1944			
Storm Type	MCC			
Storm Location	41.87 N	97.05 W		
Storm Center Elevation	1,700			
Precipitation Total & Duration	17.3 Inches 60-hours USACE Storm Studies MR 6-15			
Storm Representative Td	76.0 F	6		
Storm Representative Td Location	34.40 N	99.50 W		
Maximum Td	80.0 F			
Moisture Inflow Vector	SSW @ 530			
In-place Maximization Factor	1.22			
Temporal Transposition (Date)	25-Jun			
Transposition Td Location	35.25 N	95.02 W	June	July
Transposition Maximum Td	80.5 F		79.5	82.5
Transposition Adjustment Factor	1.08			
Grid Point Elevation	550			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.32			

Appendix F: Table F.89: Storm spreadsheet for Stanton, NE June, 10, 1944

STORM STUDIES - PERTINENT DATA SHEET



LOCATION MAP

Storm of 10-13 June 1944
Assignment MR 6-15
Location Ia., Nebr., S. Dak.
Study Prepared by:
Missouri River Division
Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/7/46
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 2/10/48
Remarks: Center near Stanton, Nebr.
Dewpt. 70°- Ref. Pt. 125 SSE
Grid D-16

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:500,000
Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	56
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	19
Miscl. precip. records, meteorological data, etc.	11
Form 5002 (Mass rainfall curves)	34

PART II

Final isohyetal maps, in 1 sheet, scale 500,000
Data and computation sheets:

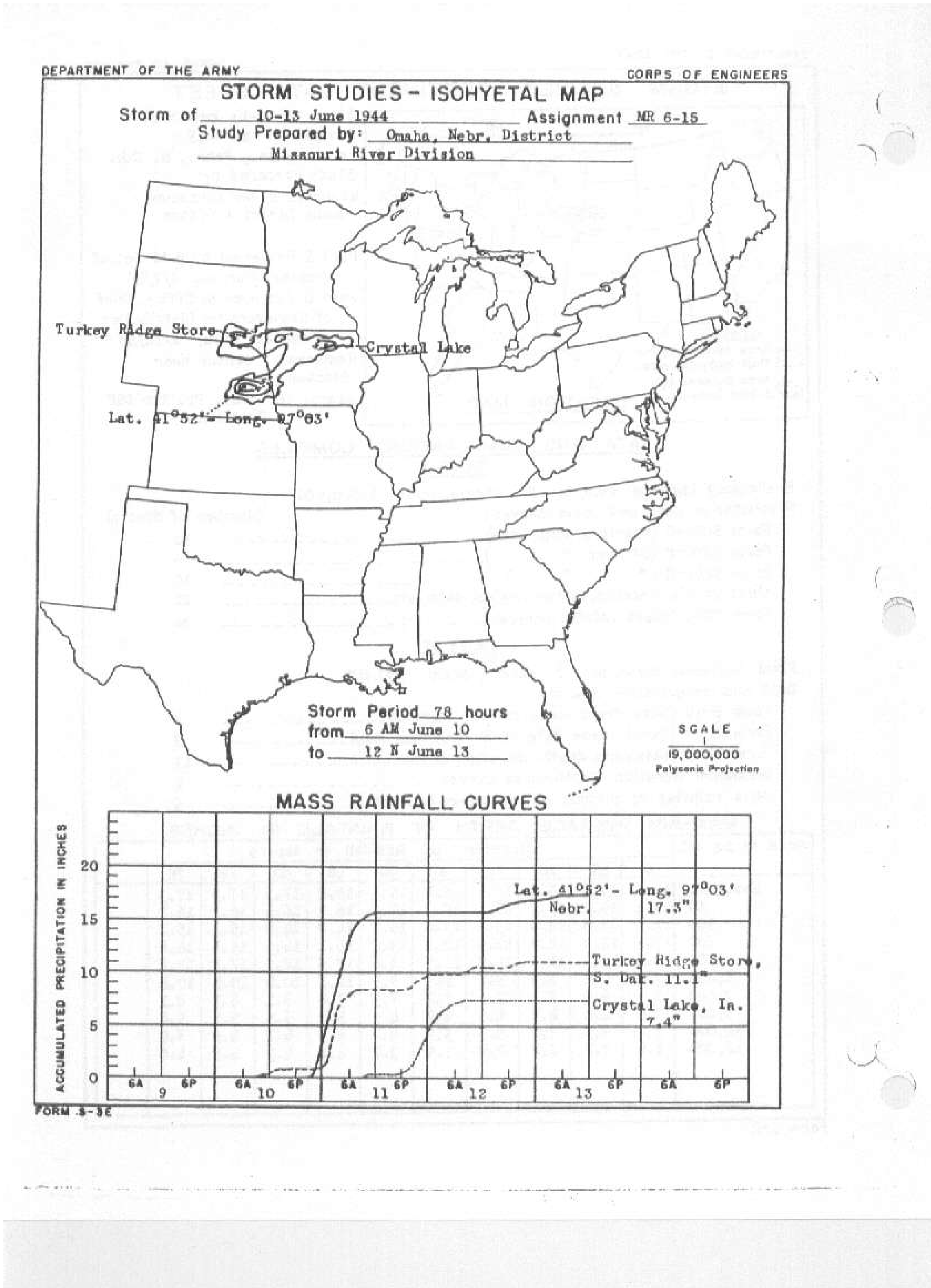
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	13
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	5

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	78
Max.Sta.	15.5	15.8	15.8	15.8	15.8	15.8	16.8	17.3	17.3	17.3
10	13.4	15.3	15.3	15.3	15.3	15.3	16.2	16.4	16.7	16.7
100	11.7	13.6	13.6	13.6	13.6	13.7	14.8	14.9	15.1	15.1
200	11.1	12.9	12.9	12.9	12.9	13.1	14.1	14.3	14.4	14.4
500	9.8	11.3	11.5	11.5	11.5	11.6	12.5	12.7	12.8	12.8
1,000	7.8	9.0	9.3	9.3	9.3	9.4	10.1	10.4	10.4	10.4
2,000	5.9	6.9	7.1	7.1	7.2	7.3	7.8	8.1	8.1	8.1
5,000	3.4	4.0	4.2	4.6	4.7	4.9	5.3	5.5	5.7	5.8
10,000	2.2	2.5	2.7	3.5	3.9	4.1	4.5	4.7	4.9	5.0
16,000	1.8	2.0	2.2	2.9	3.5	3.7	4.1	4.3	4.5	4.6

Form S-2

Appendix F: Table F.90: Depth-area-duration chart for Stanton, NE June 10, 1944



Appendix F: Figure F.117 and Figure F.118: Isohyetal map and mass curve chart for Stanton, NE June 10, 1944

Mounds, OK, AWA 44

May 16, 1943

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	**SW 2-21-Mounds, OK**		
Storm Date:	**5/15-20/1943**		
AWA Analysis Date:	**12/15/2013**		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	**1-Jun**	
	Lat	**Long**
Storm Center Location	**35.88 N**	**96.06 W**
Storm Rep Dew Point Location	**33.84 N**	**96.98 W**
Transposition Dew Point Location	**40.69 N**	**93.58 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**SSW @ 150**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**750**	feet
Storm Rep Analysis Duration	**6**	hours

The storm representative dew point is	**73.0 F**	with total precipitable water above sea level of			**2.60**	inches.
The in-place maximum dew point is	**78.5 F**	with total precipitable water above sea level of			**3.37**	inches.
The transpositioned maximum dew point is	**77.0 F**	with total precipitable water above sea level of			**3.14**	inches.
The in-place storm elevation is	**750**	which subtracts	**0.18**	inches of precipitable water at	**73.0 F**	
The in-place storm elevation is	**750**	which subtracts	**0.22**	inches of precipitable water at	**78.5 F**	
The transposition storm elevation at	**350**	which subtracts	**0.27**	inches of precipitable water at	**77.0 F**	
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.27**	inches of precipitable water at	**77.0 F**	

The in-place maximization factor is	**1.30**
The transposition factor is	**0.91**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.19**

Notes: Storm rep Td re-analyzed using hourly surface observations. KADM, KFWH, and KGVT used to derive the 6 hour average storm rep Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**15.9**	**16.7**	**16.7**	**16.7**	-	**16.7**	**16.7**	**16.7**	**16.7**
100 sq miles	**14.2**	**14.8**	**14.9**	**14.9**	-	**14.9**	**14.9**	**15.0**	**15.4**
200 sq miles	**13.0**	**13.5**	**13.9**	**13.9**	-	**13.9**	**13.9**	**13.9**	**14.4**
500 sq miles	**9.2**	**10.6**	**11.1**	**11.1**	-	**11.5**	**12.0**	**13.7**	**14.4**
1000 sq miles	**6.2**	**7.9**	**8.4**	**8.5**	-	**10.0**	**10.8**	**13.2**	**13.8**
2000 sq miles	**4.0**	**5.3**	**6.3**	**6.6**	-	**9.2**	**10.0**	**12.6**	**13.2**
5000 sq miles	**3.0**	**3.6**	**4.9**	**5.4**	-	**8.3**	**8.9**	**11.5**	**12.1**
10000 sq miles	**2.6**	**3.1**	**4.2**	**4.8**	-	**7.3**	**8.0**	**10.2**	**10.7**
20000 sq miles	**2.1**	**2.6**	**3.5**	**4.2**	-	**6.2**	**6.9**	**8.6**	**9.1**

Adjusted Storm Depth-Area-Duration

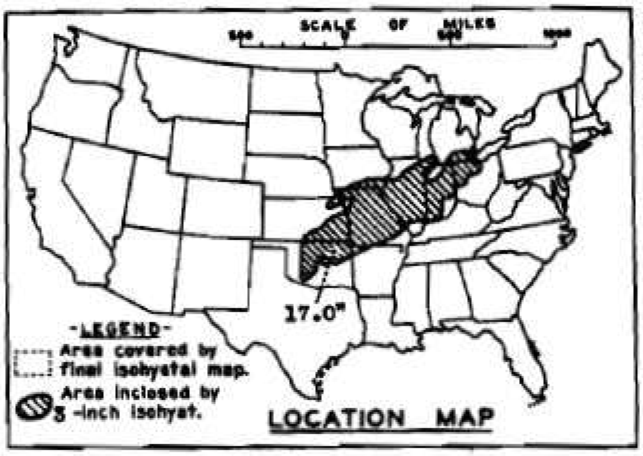
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**18.9**	**19.8**	**19.8**	**19.8**	-	**19.8**	**19.8**	**19.8**	**19.8**
100 sq miles	**16.8**	**17.6**	**17.7**	**17.7**	-	**17.7**	**17.7**	**17.8**	**18.3**
200 sq miles	**15.4**	**16.0**	**16.5**	**16.5**	-	**16.5**	**16.5**	**16.5**	**17.1**
500 sq miles	**10.9**	**12.6**	**13.2**	**13.2**	-	**13.6**	**14.2**	**16.2**	**17.1**
1000 sq miles	**7.4**	**9.4**	**10.0**	**10.1**	-	**11.9**	**12.8**	**15.7**	**16.4**
2000 sq miles	**4.7**	**6.3**	**7.5**	**7.8**	-	**10.9**	**11.9**	**14.9**	**15.7**
5000 sq miles	**3.6**	**4.3**	**5.8**	**6.4**	-	**9.8**	**10.6**	**13.6**	**14.4**
10000 sq miles	**3.1**	**3.7**	**5.0**	**5.7**	-	**8.7**	**9.5**	**12.1**	**12.7**
20000 sq miles	**2.5**	**3.1**	**4.2**	**5.0**	-	**7.4**	**8.2**	**10.2**	**10.8**

Storm or Storm Center Name	**SW 2-21-Mounds, OK**			
Storm Date(s)	5/15-20/1943			
Storm Type	MCC			
Storm Location	35.88 N	96.06 W		
Storm Center Elevation	750			
Precipitation Total & Duration (10 sq mi)	17.0 inches in 12 hours			
Storm Representative Td	73.0 F	6		
Storm Representative Td Location	33.84 N	96.98 W	May	June
In-place Maximum Td	78.5 F		77	79
Moisture Inflow Vector	SSW @ 150			
In-place Maximization Factor	**1.30**			
Temporal Transposition (Date)	1-Jun			
Transposition Dewpoint Location	40.69 N	93.58 W	May	June
Transposition Maximum Td	77.0 F		74.5	79
Transposition Adjustment Factor	**0.91**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.19**			

Appendix F: Table F.91: Storm spreadsheet for Mounds, OK May 16, 1943

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 12-20 May 1943
Assignment SW 2-21
Location Oklahoma to Great Lakes
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 10/9/46
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 8/15/49
Remarks: Center near Mounds, Okla.
Dewpt. 71° - Ref. Pt. 60 ESE
Grid G-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000
Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data)................ 531
- Form 5001-B (24-hour " ")................ --
- Form 5001-D (" " " ")................ 147
- Miscl. precip. records, meteorological data, etc................ 10
- Form 5002 (Mass rainfall curves)................ 251

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000
Data and computation sheets:

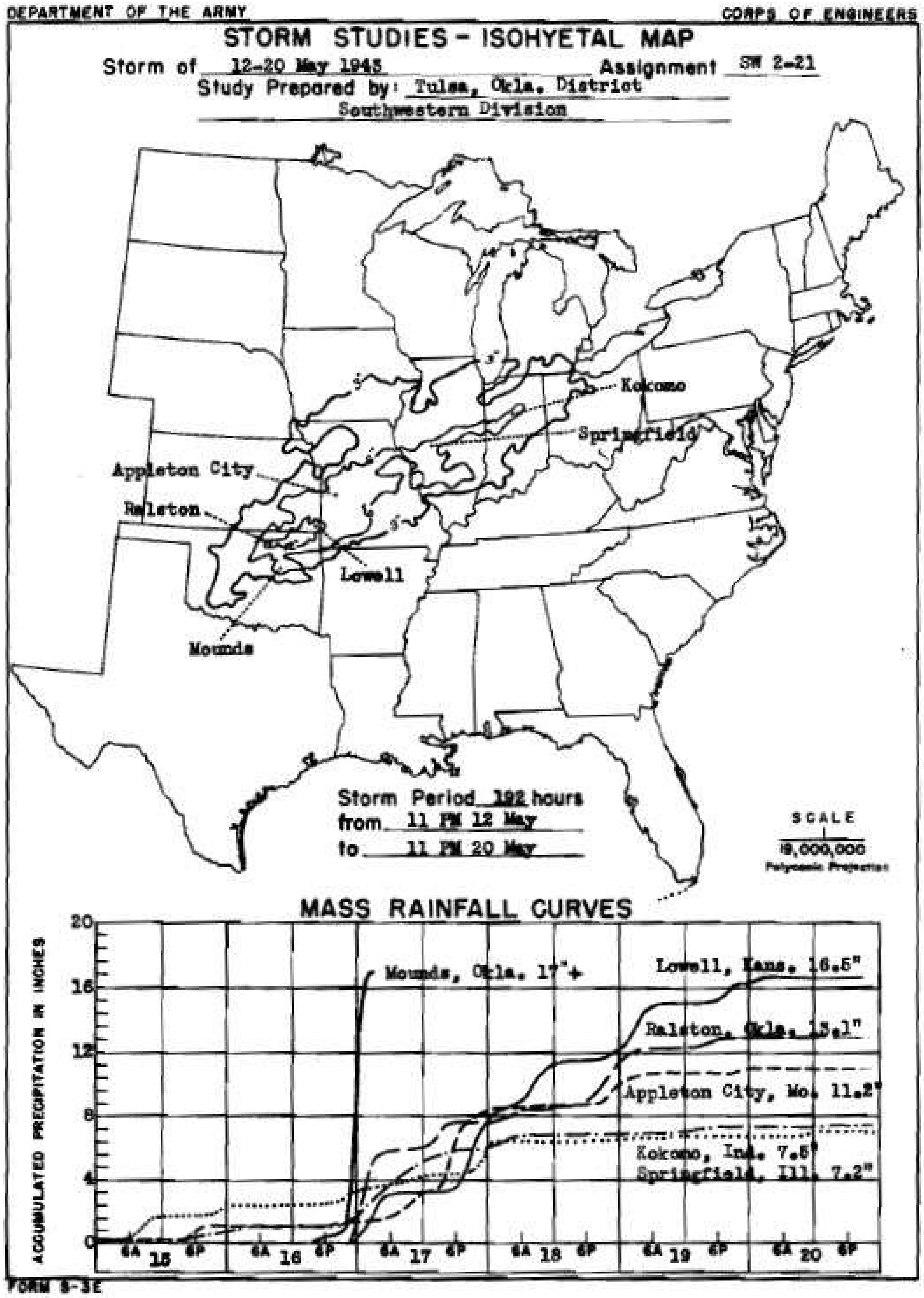
- Form S-10 (Data from mass rainfall curves)................ 44
- Form S-11 (Depth-area data from isohyetal map)................ 8
- Form S-12 (Maximum depth-duration data)................ 12
- Maximum duration-depth-area curves................ 1
- Data relating to periods of maximum rainfall................ 1

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	36	48	60	72	96	120	144/192
Max. Station	16.2	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
10	15.9	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.8	16.9	16.9
100	14.2	14.8	14.9	14.9	14.9	14.9	15.0	15.4	15.6	15.9	15.9
200	13.0	13.5	13.9	13.9	13.9	13.9	13.9	14.4	15.0	15.5	15.5
500	9.2	10.6	11.1	11.1	11.5	12.0	13.7	14.4	14.6	14.9	14.9
1,000	6.2	7.9	8.4	8.5	10.0	10.8	13.2	13.8	14.1	14.9	14.9
2,000	4.0	5.3	6.3	6.6	9.2	10.0	12.6	13.2	13.5	13.7	13.7
5,000	3.0	3.6	4.9	5.4	8.3	8.9	11.5	12.1	12.4	12.5	12.6
10,000	2.6	3.1	4.2	4.8	7.3	8.0	10.2	10.7	11.0	11.3	11.4
20,000	2.1	2.6	3.5	4.2	6.2	6.9	8.6	9.1	9.4	9.8	10.1
50,000	1.6	2.0	2.6	3.4	4.6	5.3	6.6	7.0	7.4	7.8	8.2
100,000	1.1	1.5	2.0	2.6	3.5	4.1	5.0	5.4	5.8	6.4	6.8
200,000	0.7	1.0	1.3	1.7	2.3	2.7	3.5	3.8	4.3	4.9	5.2

Form S-2

Appendix F: Table F.92: Depth-area-duration chart for Mounds, OK May 16, 1943



Appendix F: Figure F.119 and Figure F.120: Isohyetal map and mass curve chart for Mounds, OK May 16, 1943

Silver Lake, TX AWA 45

June 5, 1943

Storm Type: MCC

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	USACE SW 3-3-Silver Lake, TX	
Storm Date:	6/5-6/1943	**Storm Adjustment for ANO Grid Point 1**
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date 15-Jun

	Lat	Long
Storm center location	32.67 N	95.60 W
Storm Rep SST location	30.05 N	97.00 W
Transposition SST location	30.65 N	99.60 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	SSW @ 200	miles
Grid Point Elevation	350	feet
Storm Center Elevation	400	feet
Storm Rep Analysis Duration	6	hours

The storm representative SST is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum SST is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum SST is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	400	which subtracts	0.10	inches of precipitable water at	77.0 F	
The in-place storm elevation is	400	which subtracts	0.12	inches of precipitable water at	80.0 F	
The transposition storm elevation at	350	which subtracts	0.295	inches of precipitable water at	79.0 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.295	inches of precipitable water at	79.0 F	

The in-place maximization factor is	1.14
The transposition factor is	0.90
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.03

Notes: Storm rep Td re-analyzed using hourly surface observations at KBSM, KEFD, and KXKO for the 6 hour duration.

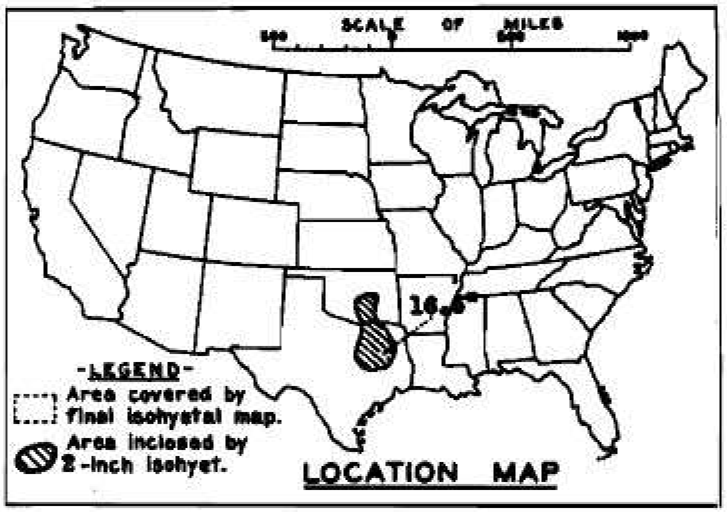
Observed Storm Depth-Area-Duration	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	14.2	16.5	16.5	16.5	16.5	16.5	16.5	-	-
100 sq miles	11.1	14.8	15.0	15.1	15.1	15.1	15.1	-	-
200 sq miles	9.7	14.1	14.3	14.6	14.6	14.6	14.6	-	-
500 sq miles	8.0	12.9	13.4	13.7	13.7	13.7	13.7	-	-
1000 sq miles	6.8	11.6	12.5	12.8	12.8	12.8	12.8	-	-
2000 sq miles	5.6	9.9	10.9	11.0	11.0	11.0	11.0	-	-
5000 sq miles	4.1	7.0	7.8	8.0	8.1	8.1	8.1	-	-
10000 sq miles	2.9	4.3	5.4	5.7	5.8	5.8	5.9	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	14.7	17.1	17.1	17.1	17.1	17.1	17.1	-	-
100 sq miles	11.5	15.3	15.5	15.6	15.6	15.6	15.6	-	-
200 sq miles	10.0	14.6	14.8	15.1	15.1	15.1	15.1	-	-
500 sq miles	8.3	13.3	13.9	14.2	14.2	14.2	14.2	-	-
1000 sq miles	7.0	12.0	12.9	13.2	13.2	13.2	13.2	-	-
2000 sq miles	5.8	10.2	11.3	11.4	11.4	11.4	11.4	-	-
5000 sq miles	4.2	7.2	8.1	8.3	8.4	8.4	8.4	-	-
10000 sq miles	3.0	4.4	5.6	5.9	6.0	6.0	6.1	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	USACE SW 3-3-Silver Lake, TX		
Storm Date(s)	6/5-6/1943		
Storm Type	MCC		
Storm Location	32.67 N	95.60 W	
Storm Center Elevation	400		
Precipitation Total & Duration (10 sq mi)	16.5 inches in 12 hours		
Storm Representative SST	77.0 F		
Storm Representative SST Location	30.05 N	97.00 W	J
In-place Maximum SST	80.0 F		80
Moisture Inflow Vector	SSW @ 200		
In-place Maximization Factor			
Temporal Transposition (Date)	15-Jun		
Transposition Dewpoint Location	30.65 N	99.60 W	J
Transposition Maximum SST	79.0 F		79
Transposition Adjustment Factor			
Grid Point Elevation	350		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	1.03		

Appendix F: Table F.92: Storm spreadsheet for Silver Lake, TX June 5, 1943

STORM STUDIES - PERTINENT DATA SHEET



Storm of 5-7 June 1943
Assignment SW 3-3
Location Texas & Oklahoma
Study Prepared by:
Southwestern Division
Fort Worth, Texas

Part I Reviewed by H. M. Sec. of Weather Bureau, 7/7/49
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/17/51
Remarks: Center at Silver Lake, Texas
Dewpt. 75°- Ref. Pt. 230 S
Grid I-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	15
Form 5001-B (24-hour " ")	0
Form 5001-D (" " " ")	8
Miscl. precip. records, meteorological data, etc.	9
Form 5002 (Mass rainfall curves)	23

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

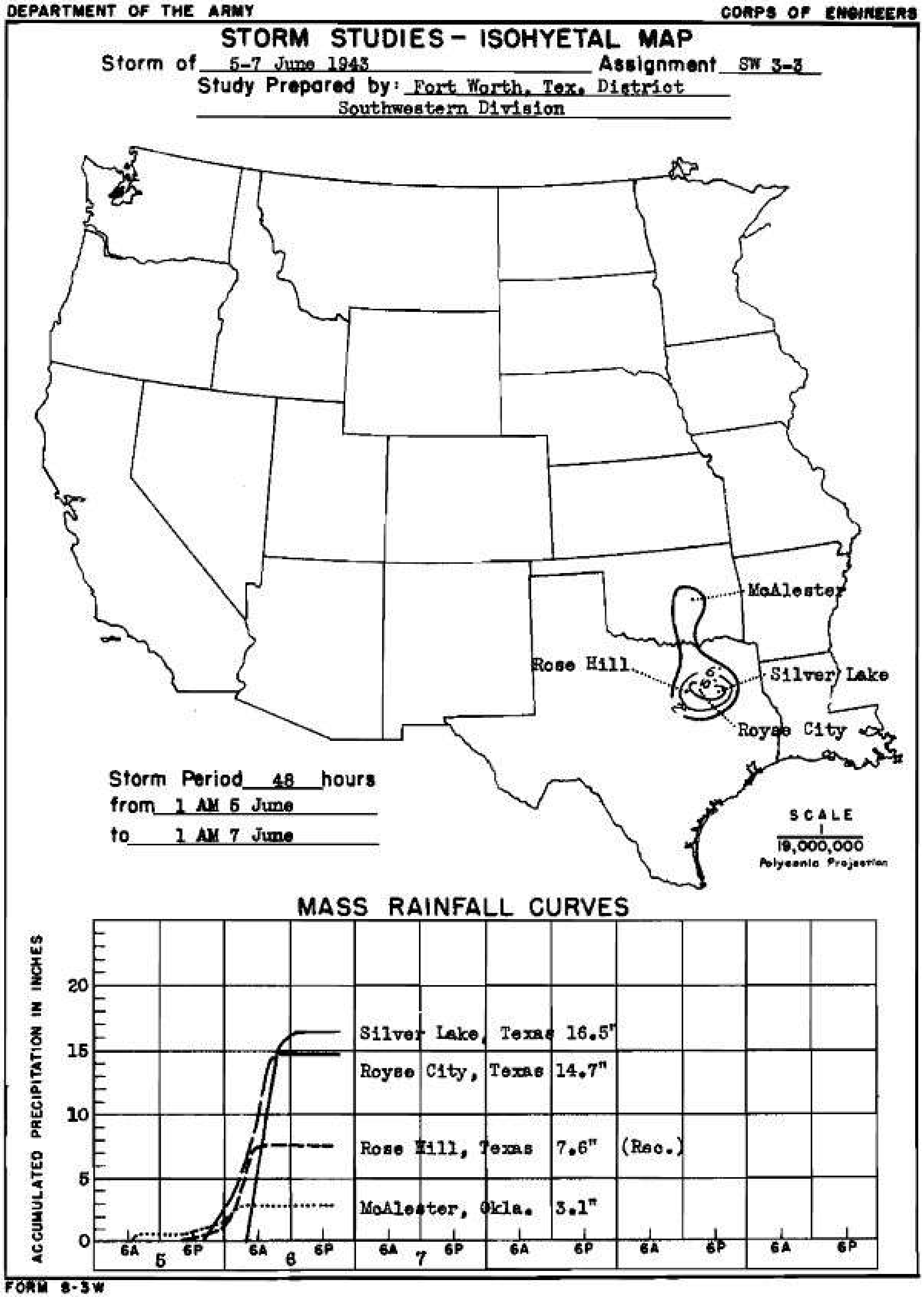
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	2
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48				
10	14.2	16.5	16.5	16.5	16.5	16.5	16.5				
100	11.1	14.8	15.0	15.1	15.1	15.1	15.1				
200	9.7	14.1	14.3	14.6	14.6	14.6	14.6				
500	8.0	12.9	13.4	13.7	13.7	13.7	13.7				
1000	6.8	11.6	12.5	12.8	12.8	12.8	12.8				
2000	5.6	9.9	10.9	11.0	11.0	11.0	11.0				
5000	4.1	7.0	7.8	8.0	8.1	8.1	8.1				
10,000	2.9	4.3	5.4	5.7	5.8	5.8	5.9				
16,000	2.0	3.2	3.7	4.0	4.1	4.1	4.2				

Form S-2

Appendix F: Table F.93: Depth-area-duration chart for Silver Lake, TX June 5, 1943



Appendix F: Figure F.121 and Figure F.122: Total storm isohyetal and mass curve chart for Silver Lake, TX June 5, 1943

Warner, OK, AWA 46

May 6, 1943

Storm Type: Frontal

Grid Points Used: 1-3, 8-10, 16-17

Storm Name:	SW 2-20-Warner, OK	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	5/6-10/1943	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date 24-May

	Lat	Long
Storm Center Location	35.49 N	95.31 W
Storm Rep Dew Point Location	33.20 N	95.00 W
Transposition Dew Point Location	40.44 N	92.24 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 160	miles
Grid Point Elevation	350	feet
Storm Center Elevation	600	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	72.0 F	with total precipitable water above sea level of		2.47	inches.
The in-place maximum dew point is	77.0 F	with total precipitable water above sea level of		3.14	inches.
The transpositioned maximum dew point is	74.0 F	with total precipitable water above sea level of		2.73	inches.
The in-place storm elevation is	600	which subtracts	0.14	inches of precipitable water at	72.0 F
The in-place storm elevation is	600	which subtracts	0.16	inches of precipitable water at	77.0 F
The transposition storm elevation at	350	which subtracts	0.24	inches of precipitable water at	74.0 F
The Grid point/inflow barrier height is	1,000	which subtracts	0.24	inches of precipitable water at	74.0 F

The in-place maximization factor is	1.28
The transposition factor is	0.84
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.07

Notes: Added 2° to the USACE storm rep Td based on EPRI, Nebraska, and TRWD guidance for a synoptic storm going from 12hr persisting to average Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	10.0	12.5	15.0	17.6	20.0	21.8	24.6	25.0	25.0
10 sq miles	9.9	12.3	14.6	17.2	19.5	21.5	24.4	24.9	24.9
100 sq miles	8.7	10.8	12.4	14.9	17.1	19.3	21.8	22.5	22.5
200 sq miles	7.4	9.5	11.4	13.8	16.0	18.3	20.6	21.3	21.3
500 sq miles	5.4	7.6	10.0	12.3	14.5	16.7	18.6	19.4	19.4
1000 sq miles	4.3	6.3	9.0	11.1	13.3	15.4	17.1	18.0	18.0
2000 sq miles	3.6	5.4	8.0	9.9	12.1	14.0	15.5	16.5	16.5
5000 sq miles	3.0	4.5	6.8	8.3	10.5	12.1	13.4	14.4	14.4
10000 sq miles	2.6	3.9	5.8	7.2	9.1	10.4	11.7	12.6	12.6
20000 sq miles	2.1	3.3	4.9	6.1	7.6	8.7	10.0	10.7	10.8

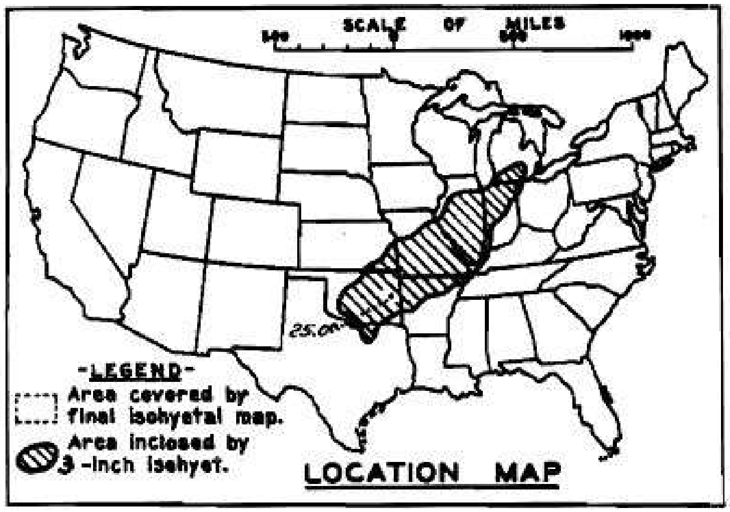
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	10.7	13.4	16.0	18.8	21.4	23.3	26.3	26.7	26.7
10 sq miles	10.6	13.1	15.6	18.4	20.8	23.0	26.1	26.6	26.6
100 sq miles	9.3	11.5	13.3	15.9	18.3	20.6	23.3	24.0	24.0
200 sq miles	7.9	10.2	12.2	14.7	17.1	19.6	22.0	22.8	22.8
500 sq miles	5.8	8.1	10.7	13.1	15.5	17.8	19.9	20.7	20.7
1000 sq miles	4.6	6.7	9.6	11.9	14.2	16.5	18.3	19.2	19.2
2000 sq miles	3.8	5.8	8.5	10.6	12.9	15.0	16.6	17.6	17.6
5000 sq miles	3.2	4.8	7.3	8.9	11.2	12.9	14.3	15.4	15.4
10000 sq miles	2.8	4.2	6.2	7.7	9.7	11.1	12.5	13.5	13.5
20000 sq miles	2.2	3.5	5.2	6.5	8.1	9.3	10.7	11.4	11.5

Storm or Storm Center Name	**SW 2-20-Warner, OK**			
Storm Date(s)	5/6-10/1943			
Storm Type	General Storm			
Storm Location	35.49 N	95.31 W		
Storm Center Elevation	600			
Precipitation Total & Duration (10 sq mi)	24.00 inches in 12 hours			
Storm Representative Td	72.0 F	24		
Storm Representative Td Location	33.20 N	95.00 W	May	June
In-place Maximum Td	77.0 F		75.9	79.3
Moisture Inflow Vector	S @ 160			
In-place Maximization Factor	**1.28**			
Temporal Transposition (Date)	24-May			
Transposition Dewpoint Location	40.44 N	92.24 W	May	June
Transposition Maximum Td	74.0 F		72.5	77.5
Transposition Adjustment Factor	**0.84**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.07**			

Appendix F: Table F.94: Storm spreadsheet for Warner, OK May 6, 1943

STORM STUDIES - PERTINENT DATA SHEET



Storm of 6-12 May 1943
Assignment SW 2-20
Location N.Texas to Great Lakes
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 4-14-45
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 7-17-47
Remarks: Center at Warner, Oklahoma
Dewpt. 70° - Ref. Pt. 225 SSE Grid G-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	553
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	178
Miscl. precip. records, meteorological data, etc.	80
Form 5002 (Mass rainfall curves)	281

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

Data and computation sheets:

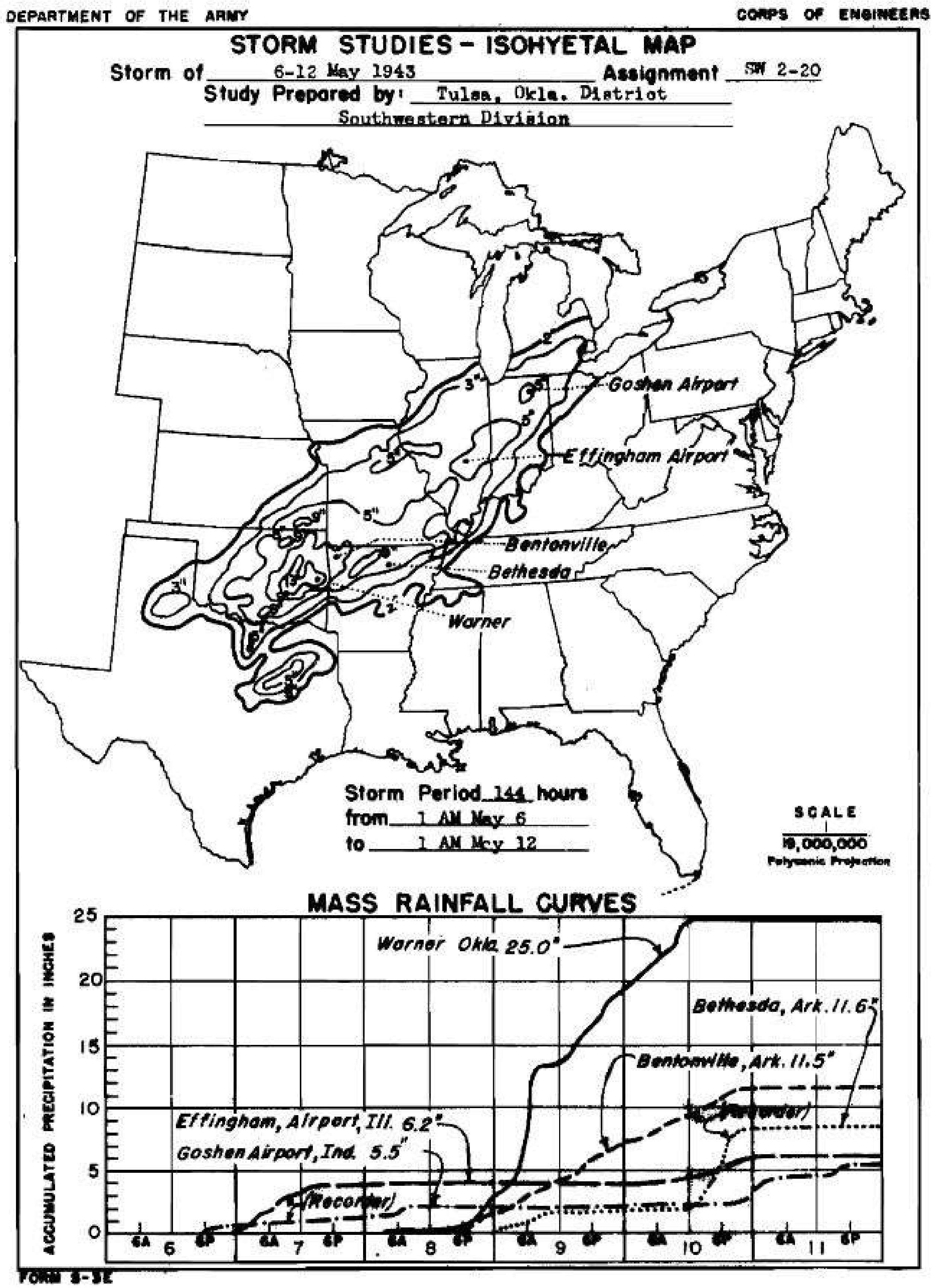
Form S-10 (Data from mass rainfall curves)	42
Form S-11 (Depth-area data from isohyetal map)	12
Form S-12 (Maximum depth-duration data)	12
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	96	120/144
Max. Station	10.0	12.5	15.0	17.6	20.0	21.8	24.6	25.0	25.0	25.0	25.0
10	9.9	12.3	14.6	17.2	19.5	21.5	24.4	24.9	24.9	24.9	24.9
100	8.7	10.8	12.4	14.9	17.1	19.3	21.8	22.5	22.5	22.5	22.5
200	7.4	9.5	11.4	13.8	16.0	18.3	20.6	21.3	21.3	21.3	21.3
500	5.4	7.6	10.0	12.3	14.5	16.7	18.6	19.4	19.4	19.4	19.4
1,000	4.3	6.3	9.0	11.1	13.3	15.4	17.1	18.0	18.0	18.0	18.0
2,000	3.6	5.4	8.0	9.9	12.1	14.0	15.5	16.5	16.5	16.5	16.5
5,000	3.0	4.5	6.8	8.3	10.5	12.1	13.4	14.4	14.4	14.4	14.4
10,000	2.6	3.9	5.8	7.2	9.1	10.4	11.7	12.6	12.6	12.8	12.8
20,000	2.1	3.3	4.9	6.1	7.6	8.7	10.0	10.7	10.8	11.1	11.1
50,000	1.6	2.5	3.7	4.6	5.7	6.5	7.7	8.1	8.3	8.8	8.9
100,000	1.1	1.9	2.7	3.4	4.2	4.9	5.8	6.2	6.4	7.0	7.3
212,000	0.6	1.1	1.7	2.2	2.6	3.0	3.7	4.2	4.4	5.0	5.5

Form S-2

Appendix F: Table F.95: Depth-area-duration chart for Warner, OK May 6, 1943



Appendix F: Figure F.123 and Figure F.124: Total storm isohyetal and mass curve chart for Warner, OK May 6, 1943

Rancho Grande, NM, AWA 47

August 29, 1942

Storm Type: Tropical

Grid Points Used: 6, 13

Storm Name:	Rancho Grande, NM USACE 2-29	**Storm Adjustment for ANO Grid Point 6**
Storm Date:	8/29-9/1/1942	
AWA Analysis Date:	12/21/2013	

Temporal Transposition Date	15-Aug	
	Lat	Long
Storm center location	34.95 N	105.10 W
Storm Rep dew point location	33.50 N	103.35 W
Transposition dewpoint location	33.05 N	102.75 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	SE @ 140	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	5,600	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	5,600	which subtracts	1.16	inches of precipitable water at	74.0 F	
The in-place storm elevation is	5,600	which subtracts	1.33	inches of precipitable water at	78.5 F	
The transposition basin elevation at	4,400	which subtracts	1.12	inches of precipitable water at	79.0 F	
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.12	inches of precipitable water at	79.0 F	

The in-place storm maximization factor is	1.30
The transposition/elevation to basin factor is	1.14
The barrier adjustment factor is	1.00
The total adjustment factor is	1.48

Notes: DAD values taken from SW 2-29. Storm representative dew point value was based on maximum 24-hr Td values between August 28-29, 1942 at KROW and KREE.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	3.2	5.9	7.0	7.9	8.0	8.0	8.0	8.0	8.0
100 sq miles	2.7	5.2	6.7	7.6	7.9	8.0	8.0	8.0	8.0
200 sq miles	2.6	5.1	6.7	7.6	7.8	8.0	8.0	8.0	8.0
500 sq miles	2.4	4.7	6.5	7.4	7.6	7.7	7.8	7.8	7.8
1000 sq miles	2.3	4.2	6.1	6.8	7.1	7.2	7.2	7.2	7.2
2000 sq miles	2.1	4.0	4.9	5.8	6.3	6.4	6.4	6.4	6.5
5000 sq miles	1.9	3.6	4.5	5.5	5.8	6.0	6.0	6.0	6.1
10000 sq miles	1.7	3.2	4.0	4.9	5.3	5.5	5.5	5.5	5.7
20000 sq miles	1.4	2.6	3.3	4.0	4.4	4.5	4.5	4.5	4.7

Adjusted Storm Depth-Area-Duration

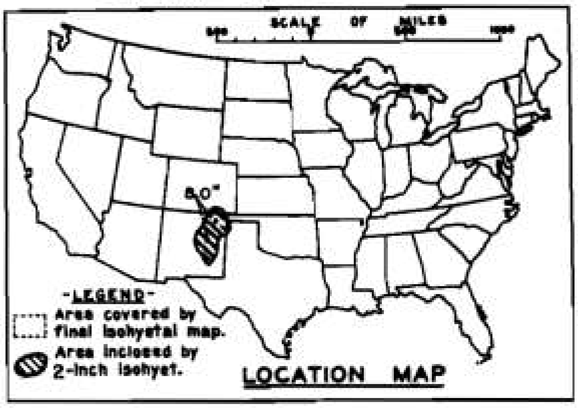
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	4.7	8.7	10.3	11.7	11.8	11.8	11.8	11.8	11.8
100 sq miles	4.0	7.7	9.9	11.2	11.7	11.8	11.8	11.8	11.8
200 sq miles	3.8	7.5	9.9	11.2	11.5	11.8	11.8	11.8	11.8
500 sq miles	3.5	6.9	9.6	10.9	11.2	11.4	11.5	11.5	11.5
1000 sq miles	3.4	6.2	9.0	10.0	10.5	10.6	10.6	10.6	10.6
2000 sq miles	3.1	5.9	7.2	8.6	9.3	9.5	9.5	9.5	9.6
5000 sq miles	2.8	5.3	6.6	8.1	8.6	8.9	8.9	8.9	9.0
10000 sq miles	2.5	4.7	5.9	7.2	7.8	8.1	8.1	8.1	8.4
20000 sq miles	2.1	3.8	4.9	5.9	6.5	6.6	6.6	6.6	6.9

Storm or Storm Center Name	**Rancho Grande, NM USACE 2-29**	
Storm Date(s)	8/29-9/1/1942	
Storm Type	Remnant Tropical	
Storm Location	34.95 N	105.10 W
Storm Center Elevation	5,600	
Precipitation Total & Duration	8.00 Inches 30-hours	
Storm Representative Dewpoint	74.0 F	24
Storm Representative Dewpoint Location	33.50 N	103.35 W
Maximum Dewpoint	78.5 F	
Moisture Inflow Vector	SE @ 140	
In-place Maximization Factor	**1.30**	
Temporal Transposition (Date)	15-Aug	
Transposition Dewpoint Location	33.05 N	102.75 W
Transposition Maximum Dewpoint	79.0 F	
Transposition Adjustment Factor	**1.14**	
Grid Point Elevation	4,400	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	xx	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.48**	

Appendix F: Table F.96: Storm spreadsheet for Rancho Grande, NM August, 29, 1942

DEPARTMENT OF THE ARMY | CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 29 Aug - 1 Sept 1942
Assignment SW 2-29
Location New Mex.; Colo.
Study Prepared by:
Southwestern Division
Albuquerque District

Part I Reviewed by H. M. Sec. of Weather Bureau, 9/9/49
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 7/22/58
Remarks: Center at Maxwell & Rancho Grande, New Mexico
Dew pt. 74° Ret. pt. 250 SSE
Grid G-19

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:1,300,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	46
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	45
Miscl. precip. records, meteorological data, etc.	19
Form 5002 (Mass rainfall curves)	55

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

Data and computation sheets:

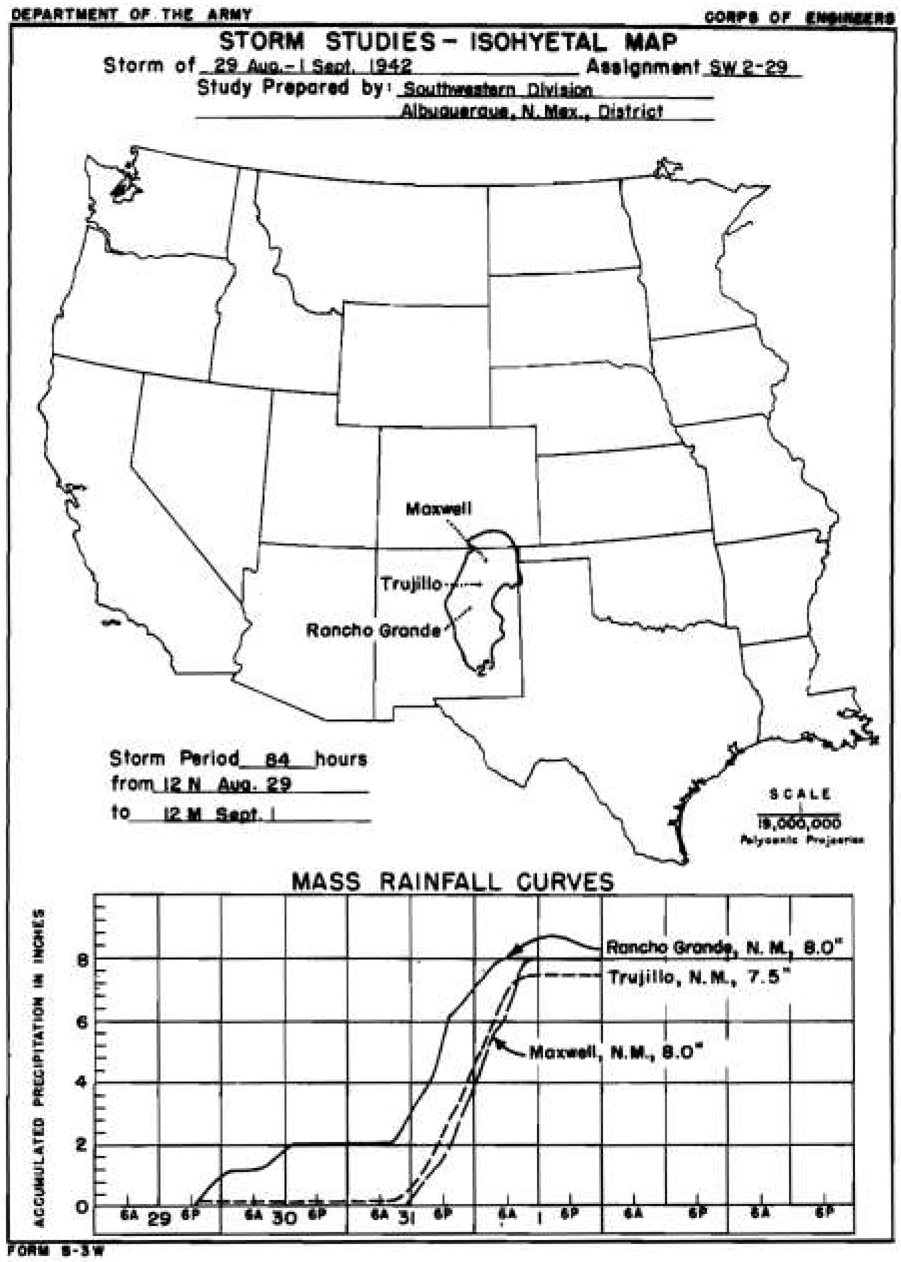
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	9
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	84
10	3.2	5.9	7.0	7.9	8.0	8.0	8.0	8.0	8.0	8.0
100	2.7	5.2	6.7	7.6	7.9	8.0	8.0	8.0	8.0	8.0
200	2.6	5.1	6.7	7.6	7.8	8.0	8.0	8.0	8.0	8.0
500	2.4	4.7	6.5	7.4	7.6	7.7	7.8	7.8	7.8	7.8
1000	2.3	4.2	6.1	6.8	7.1	7.2	7.2	7.2	7.2	7.3
2000	2.1	4.0	4.9	5.8	6.3	6.4	6.4	6.4	6.5	6.6
5000	1.9	3.6	4.5	5.5	5.8	6.0	6.0	6.0	6.1	6.3
10000	1.7	3.2	4.0	4.9	5.3	5.5	5.5	5.5	5.7	5.9
20,000	1.4	2.6	3.3	4.0	4.4	4.5	4.5	4.5	4.7	4.8
35,600	1.0	1.8	2.5	3.0	3.4	3.6	3.6	3.6	3.8	3.9

Form S-2

Appendix F: Table F.97: Depth-area-duration values for Rancho Grande, NM August, 29, 1942



Appendix F: Figure F.125 and Figure F.126: Total storm isohyetal analysis Mass curve chart for Rancho Grande, NM August, 29, 1942

Hayward, WI, AWA 48

August 28, 1941

Storm Type: MCC

Grid Points Used: 8-11, 16-18

Storm Name:	UMV 1-22-Hayward, WI
Storm Date:	8/28-30/1941
AWA Analysis Date:	12/15/2013

Storm Adjustment for For ANO Grid Point 8

Temporal Transposition Date 15-Aug

	Lat	Long
Storm Center Location	46.01 N	91.48 W
Storm Rep Dew Point Location	42.99 N	89.78 W
Transposition Dew Point Location	39.71 N	90.96 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SSE @ 225	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,200	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	73.0 F	with total precipitable water above sea level of			2.60	inches.
The in-place maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,200	which subtracts	0.28	inches of precipitable water at	73.0 F	
The in-place storm elevation is	1,200	which subtracts	0.34	inches of precipitable water at	79.0 F	
The transposition basin elevation at	1,200	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.30
The transposition/elevation to basin factor is	1.09
The barrier adjustment factor is	1.00
The total adjustment factor is	1.42

Notes: DAD values taken from USACE UMV 1-22. Storm representative dew point value was based on adding 2°F to the USACE analyzed storm rep Td following EPRI, Nebraska, and TRWD studies.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	8.5	11.5	12.4	12.4	13.3	13.8	14.4	15.0	15.0
100 sq miles	8.1	11.0	11.8	11.8	12.7	13.3	13.8	14.3	14.5
200 sq miles	7.8	10.6	11.3	11.3	12.3	13.0	13.4	13.9	14.1
500 sq miles	6.8	9.5	10.2	10.3	11.2	12.0	12.5	12.9	13.1
1000 sq miles	5.6	8.2	9.0	9.1	10.0	10.9	11.5	11.9	12.0
2000 sq miles	4.3	6.9	7.7	7.9	8.8	9.7	10.4	10.8	10.9
5000 sq miles	3.0	5.2	5.9	6.3	7.2	8.1	8.9	9.3	9.5
10000 sq miles	2.1	3.8	4.6	5.1	5.9	6.0	7.8	8.2	8.4
20000 sq miles	1.5	2.7	3.4	3.8	4.7	5.5	6.5	7.1	7.3

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	12.0	16.3	17.6	17.6	18.9	19.6	20.4	21.3	21.3
100 sq miles	11.5	15.6	16.7	16.7	18.0	18.9	19.6	20.3	20.6
200 sq miles	11.1	15.0	16.0	16.0	17.4	18.4	19.0	19.7	20.0
500 sq miles	9.6	13.5	14.5	14.6	15.9	17.0	17.7	18.3	18.6
1000 sq miles	7.9	11.6	12.8	12.9	14.2	15.4	16.3	16.9	17.0
2000 sq miles	6.1	9.8	10.9	11.2	12.5	13.7	14.7	15.3	15.4
5000 sq miles	4.3	7.4	8.4	8.9	10.2	11.5	12.6	13.2	13.5
10000 sq miles	3.0	5.4	6.5	7.2	8.4	8.5	11.1	11.6	11.9
20000 sq miles	2.1	3.8	4.8	5.4	6.7	7.8	9.2	10.1	10.3

Storm or Storm Center Name	UMV 1-22-Hayward, WI		
Storm Date(s)	8/28-30/1941		
Storm Type	Synoptic		
Storm Location	46.01 N	91.48 W	
Storm Center Elevation	1,200		
Precipitation Total & Duration	15.00 Inches 72-hours USACE UMV 1-22		
Storm Representative Dew Point	73.0 F	24	
Storm Representative Dew Point Location	42.99 N	89.78 W	
Maximum Dew Point	79.0 F		Aug
Moisture Inflow Vector	SSE @ 225		78.5
In-place Maximization Factor	1.30		
Temporal Transposition (Date)	15-Aug		
Transposition Dew Point Location	39.71 N	90.96 W	
Transposition Maximum Dew Point	80.5 F		
Transposition Adjustment Factor	1.09		
Grid Point Elevation	1,200		
Highest Elevation in Basin	14,344		
Inflow Barrier Height	1,000		
Elevation Adjustment Factor	1.00		
Total Adjustment Factor	1.42		

Appendix F: Table F.98: Storm spreadsheet for Hayward, WI August 28, 1941

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET

LOCATION MAP

Storm of August 28 - 31, 1941
Assignment U M V 1 - 22
Location Northern Wisconsin and Minn.
Study Prepared by:
Upper Mississippi Valley Division
St. Paul District Office
Part I Reviewed by H. M. Sec. of Weather Bureau, 3/24/42
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 4/11/45
Remarks: Center at: Haywood and Moose Lake, Wisc.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 4 sheet, scale 1 : 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	33
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	14
Miscl. precip. records, meteorological data, etc.	3
Form 5002 (Mass rainfall curves)	42

PART II

Final isohyetal maps, in 1 sheet, scale 1,000,000

Data and computation sheets:

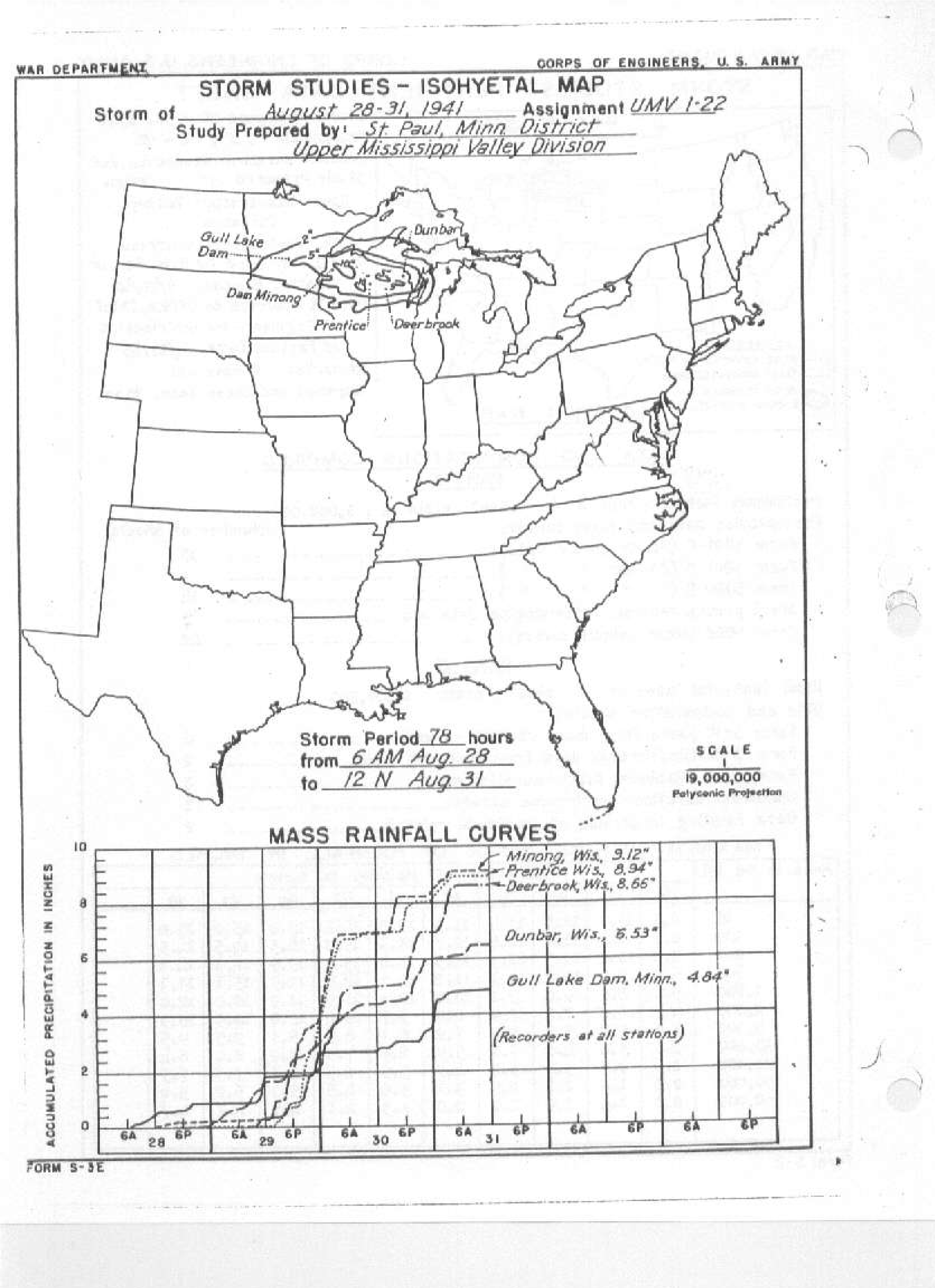
Form S-10 (Data from mass rainfall curves)	6
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	8
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	78	
10	8.5	11.5	12.4	12.4	13.3	13.8	14.4	15.0	15.0	15.0	
100	8.1	11.0	11.8	11.8	12.7	13.3	13.8	14.3	14.5	14.5	
200	7.8	10.6	11.3	11.3	12.3	13.0	13.4	13.9	14.1	14.1	
500	6.8	9.5	10.2	10.3	11.2	12.0	12.5	12.9	13.1	13.1	
1,000	5.6	8.2	9.0	9.1	10.0	10.9	11.5	11.9	12.0	12.0	
2,000	4.3	6.9	7.7	7.9	8.8	9.7	10.4	10.8	10.9	10.9	
5,000	3.0	5.2	5.9	6.3	7.2	8.1	8.9	9.3	9.5	9.5	
10,000	2.1	3.8	4.6	5.1	5.9	6.8	7.8	8.2	8.4	8.4	
20,000	1.5	2.7	3.4	3.8	4.7	5.5	6.5	7.1	7.3	7.3	
50,000	0.9	1.6	2.1	2.5	3.1	3.6	4.5	5.1	5.2	5.2	
60,000	0.8	1.4	1.9	2.2	2.8	3.3	4.1	4.5	4.7	4.7	

Form S-2

Appendix F: Table F.99: Depth-area-duration values for Hayward, WI August 28, 1941



Appendix F: Figure F.127 and Figure F.128: Total storm isohyetal analysis and mass curve chart for Hayward, WI August 28, 1941

McColleum Ranch, NM, AWA 49

September 20, 1941

Storm Type: Frontal

Grid Points Used: 6, 13

Storm Name:	McColleum Ranch, NM USACE GM	**Storm Adjustment for ANO Grid Point 6**	
Storm Date:	9/20-23/1941		
AWA Analysis Date:	12/15/2013		

Temporal Transposition Date	5-Sep	
	Lat	Long
Storm center location	32.17 N	104.73 W
Storm Rep dew point location	29.53 N	98.41 W
Transposition dewpoint location	31.80 N	98.03 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	ESE @ 415	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	5,783	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The transpositioned maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place storm elevation is	5,783	which subtracts	1.32	inches of precipitable water at	77.0 F	
The in-place storm elevation is	5,783	which subtracts	1.40	inches of precipitable water at	79.0 F	
The transposition basin elevation at	4,400	which subtracts	1.09	inches of precipitable water at	78.0 F	
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.09	inches of precipitable water at	78.0 F	

The in-place storm maximization factor is	1.12
The transposition/elevation to basin factor is	1.08
The barrier adjustment factor is	1.00
The total adjustment factor is	1.21

Notes: DAD values taken from GM 5-19. Storm representative dew point value was based on maximum 24-hr Td values between Sept 17-19, 1941 at KRND and KSKF. Values were selected in region where temperature did not vary more than a 1-degree over a large area.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	10.1	11.2	11.5	12.1	16.3	16.9	18.7	21.0	21.2
100 sq miles	5.9	8.3	8.7	9.0	10.1	11.7	13.0	14.7	15.0
200 sq miles	5.2	7.3	7.8	8.1	8.4	9.7	10.8	12.4	12.7
500 sq miles	4.4	6.2	6.8	6.9	7.2	7.9	9.1	10.2	10.5
1000 sq miles	3.8	5.5	6.1	6.3	6.4	7.1	8.3	9.4	9.6
2000 sq miles	3.3	4.8	5.5	5.6	5.8	6.4	7.5	8.6	8.8
5000 sq miles	2.6	3.9	4.6	4.8	5.1	5.6	6.6	7.5	7.8
10000 sq miles	2.0	3.2	4.0	4.2	4.5	4.9	5.9	6.7	7.0
20000 sq miles	1.5	2.6	3.3	3.7	4.0	4.4	5.2	5.9	6.2

Adjusted Storm Depth-Area-Duration

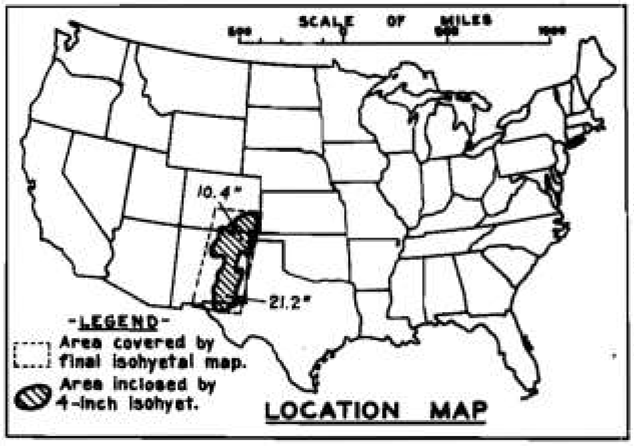
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	12.2	13.5	13.9	14.6	19.7	20.4	22.6	25.4	25.6
100 sq miles	7.1	10.0	10.5	10.9	12.2	14.1	15.7	17.8	18.1
200 sq miles	6.3	8.8	9.4	9.8	10.2	11.7	13.1	15.0	15.4
500 sq miles	5.3	7.5	8.2	8.3	8.7	9.5	11.0	12.3	12.7
1000 sq miles	4.6	6.6	7.4	7.6	7.7	8.6	10.0	11.4	11.6
2000 sq miles	4.0	5.8	6.6	6.8	7.0	7.7	9.1	10.4	10.6
5000 sq miles	3.1	4.7	5.6	5.8	6.2	6.8	8.0	9.1	9.4
10000 sq miles	2.4	3.9	4.8	5.1	5.4	5.9	7.1	8.1	8.5
20000 sq miles	1.8	3.1	4.0	4.5	4.8	5.3	6.3	7.1	7.5

Storm or Storm Center Name	**McColleum Ranch, NM USACE GM 5-19**			
Storm Date(s)	9/20-23/1941			
Storm Type	Synoptic			
Storm Location	32.17 N	104.73 W		
Storm Center Elevation	5,783			
Precipitation Total & Duration	21.2 Inches 78-hours			
Storm Representative Dewpoint	77.0 F	24		
Storm Representative Dewpoint Location	29.53 N	98.41 W	Aug	Sept
Maximum Dewpoint	79.0 F		79.84	77.73
Moisture Inflow Vector	ESE @ 415			
In-place Maximization Factor	**1.12**			
Temporal Transposition (Date)	5-Sep			
Transposition Dewpoint Location	31.80 N	98.03 W	Aug	Sept
Transposition Maximum Dewpoint	78.0 F		79.84	77.73
Transposition Adjustment Factor	**1.08**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.21**			

Appendix F: Table F.100: Storm spreadsheet for McColleum Ranch, NM September 20, 1941

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of September 20-23, 1941
Assignment GM 5-19
Location New Mexico
Study Prepared by:
Southwestern Division,
Galveston District Office.

Part I Reviewed by H. M. Sec. of Weather Bureau, 7/9/43
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/27/44
Remarks: Center at Dave McColleum Ranch, N. Mex.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:1,000,000
Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) ---------- 64
- Form 5001-B (24-hour " ") ---------- -
- Form 5001-D (" " " ") ---------- 26
- Miscl. precip. records, meteorological data, etc. ---------- 19
- Form 5002 (Mass rainfall curves) ---------- 76

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000
Data and computation sheets:

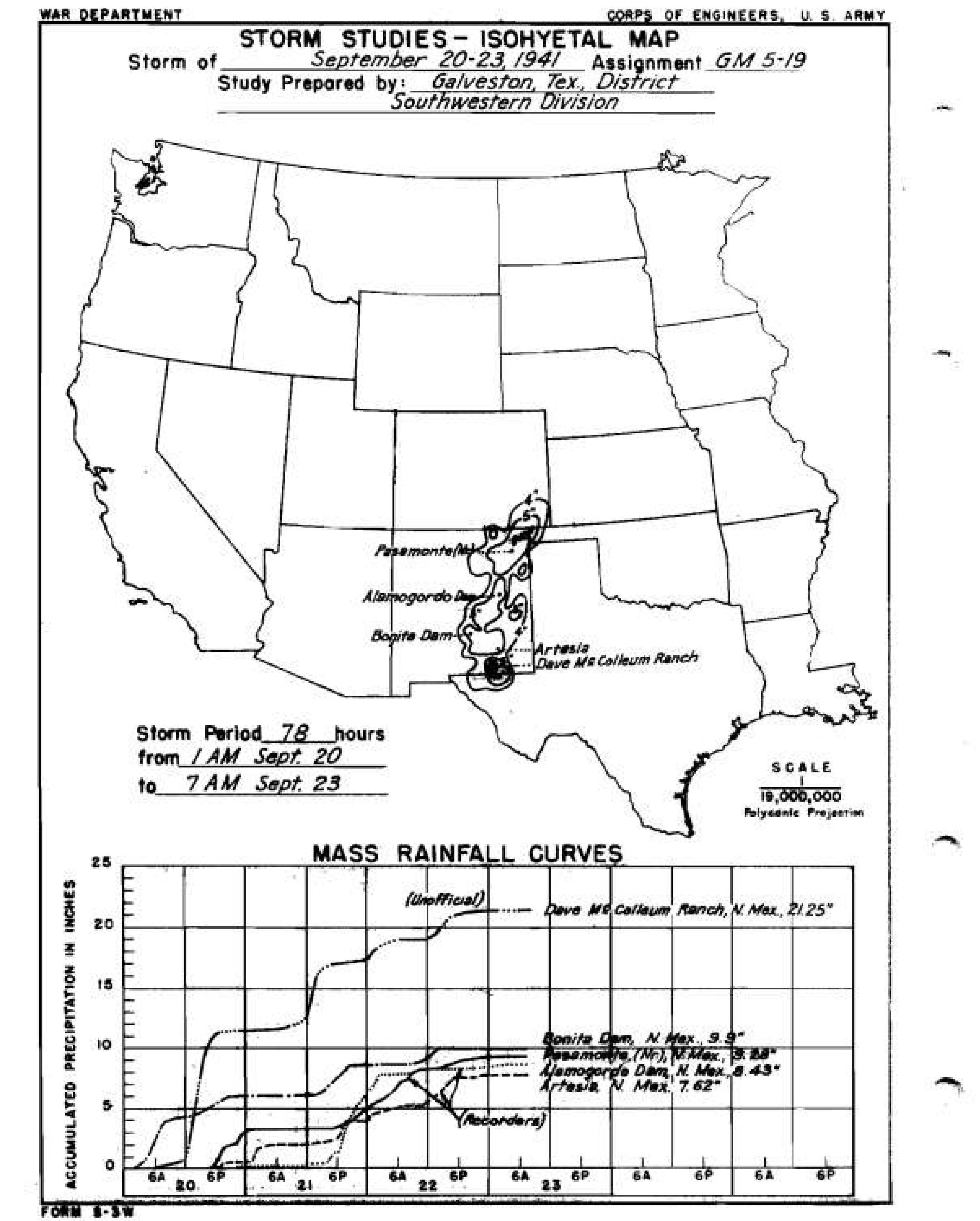
- Form S-10 (Data from mass rainfall curves) ---------- 4
- Form S-11 (Depth-area data from isohyetal map) ---------- 2
- Form S-12 (Maximum depth-duration data) ---------- 18
- Maximum duration-depth-area curves ---------- 1
- Data relating to periods of maximum rainfall ---------- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	78		
10	10.1	11.2	11.5	12.1	16.3	16.9	18.7	21.0	21.2		
100	5.9	8.3	8.7	9.0	10.1	11.7	13.0	14.7	15.0		
200	5.2	7.3	7.8	8.1	8.4	9.7	10.8	12.4	12.7		
500	4.4	6.2	6.8	6.9	7.2	7.9	9.1	10.2	10.5		
1,000	3.8	5.5	6.1	6.3	6.4	7.1	8.3	9.4	9.6		
2,000	3.3	4.8	5.5	5.6	5.8	6.4	7.5	8.6	8.8		
5,000	2.6	3.9	4.6	4.8	5.1	5.6	6.6	7.5	7.8		
10,000	2.0	3.2	4.0	4.2	4.5	4.9	5.9	6.7	7.0		
20,000	1.5	2.6	3.3	3.7	4.0	4.4	5.2	5.9	6.2		
38,000	1.1	2.0	2.7	3.2	3.6	3.9	4.6	5.4	5.5		

Form S-2

Appendix F: Table F.101: Depth-area-duration values for McColleum Ranch, NM September 20, 1941



Appendix F: Figure F.129 and Figure F.130: Total storm isohyetal analysis Mass curve chart for McColleum Ranch, NM September 20, 1941

Prairieview, NM, AWA 50

May 20, 1941

Storm Type: Frontal

Grid Points Used: 5-6, 12

Storm Name:	Prairieveiew, NM USACE GM 5-18	Storm Adjustment for ANO Grid Point 6
Storm Date:	5/20-25/1941	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date	5-Jun	
	Lat	Long
Storm center location	33.12 N	103.20 W
Storm Rep dew point location	29.50 N	98.43 W
Transposition dewpoint location	30.87 N	99.65 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	SE @ 375	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	3,855	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	73.0 F	with total precipitable water above sea level of			2.60	inches.
The in-place maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum dew point is	77.5 F	with total precipitable water above sea level of			3.22	inches.
The in-place storm elevation is	3,855	which subtracts	0.82	inches of precipitable water at	73.0 F	
The in-place storm elevation is	3,855	which subtracts	0.97	inches of precipitable water at	78.0 F	
The transposition basin elevation at	4,400	which subtracts	1.07	inches of precipitable water at	77.5 F	
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.05	inches of precipitable water at	77.5 F	

The in-place storm maximization factor is	1.30
The transposition/elevation to basin factor is	0.92
The barrier adjustment factor is	1.01
The total adjustment factor is	1.22

Notes: DAD values taken from GM 5-18. Storm representative dew point value was based on maximum 24-hr Td values between May 19-22, 1941 at KRND and KSKF. Values were selected in region where temperature did not vary more than a 1-degree over a large area.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	3.8	4.8	6.0	6.5	6.9	7.0	7.4	7.4	8.4
100 sq miles	3.0	4.0	5.2	6.3	6.7	6.8	6.9	7.0	8.1
200 sq miles	2.7	3.7	4.7	6.0	6.4	6.6	6.7	6.9	8.0
500 sq miles	2.3	3.3	4.1	5.4	5.8	6.1	6.4	6.7	7.7
1000 sq miles	2.1	3.0	3.7	4.9	5.3	5.7	6.1	6.4	7.5
2000 sq miles	1.8	2.7	3.2	4.3	4.7	5.2	5.7	6.1	7.2
5000 sq miles	1.4	2.2	2.7	3.5	3.9	4.4	5.0	5.6	6.6
10000 sq miles	1.2	1.9	2.2	2.9	3.2	3.7	4.4	5.0	5.9
20000 sq miles	0.9	1.5	1.8	2.3	2.6	3.0	3.7	4.3	5.1

Adjusted Storm Depth-Area-Duration

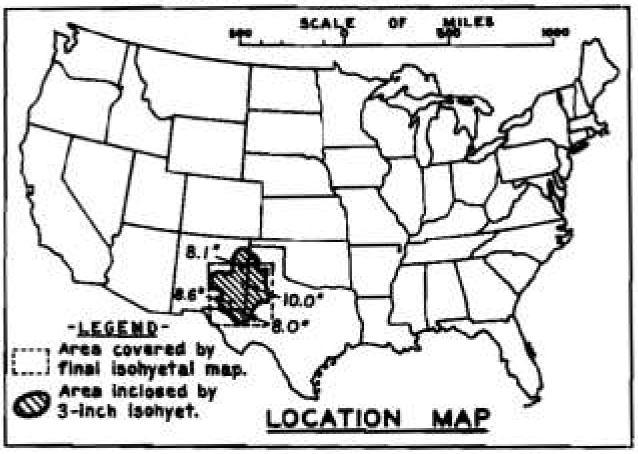
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	4.6	5.8	7.3	7.9	8.4	8.5	9.0	9.0	10.2
100 sq miles	3.7	4.9	6.3	7.7	8.2	8.3	8.4	8.5	9.9
200 sq miles	3.3	4.5	5.7	7.3	7.8	8.0	8.2	8.4	9.7
500 sq miles	2.8	4.0	5.0	6.6	7.1	7.4	7.8	8.2	9.4
1000 sq miles	2.6	3.7	4.5	6.0	6.5	6.9	7.4	7.8	9.1
2000 sq miles	2.2	3.3	3.9	5.2	5.7	6.3	6.9	7.4	8.8
5000 sq miles	1.7	2.7	3.3	4.3	4.8	5.4	6.1	6.8	8.0
10000 sq miles	1.5	2.3	2.7	3.5	3.9	4.5	5.4	6.1	7.2
20000 sq miles	1.1	1.8	2.2	2.8	3.2	3.7	4.5	5.2	6.2

Storm or Storm Center Name	Prairieveiew, NM USACE GM 5-18			
Storm Date(s)	5/20-25/1941			
Storm Type	Synoptic			
Storm Location	33.12 N	103.20 W		
Storm Center Elevation	3,855			
Precipitation Total & Duration	10.0 Inches 108-hours			
Storm Representative Dewpoint	73.0 F	24		
Storm Representative Dewpoint Location	29.50 N	98.43 W	May	June
Maximum Dewpoint	78.0 F		77.05	79.01
Moisture Inflow Vector	SE @ 375			
In-place Maximization Factor	1.30			
Temporal Transposition (Date)	5-Jun			
Transposition Dewpoint Location	30.87 N	99.65 W	May	June
Transposition Maximum Dewpoint	77.5 F		75.5	78.5
Transposition Adjustment Factor	0.92			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	1.01			
Total Adjustment Factor	1.22			

Appendix F: Table F.102: Storm spreadsheet for Prairieview, NM May 20, 1941

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of May 20-25, 1941
Assignment GM 5-18
Location Texas and New Mexico
Study Prepared by:
Southwestern Division
Galveston District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 7/18/43
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 2/18/44
Remarks: Center at Prairieview, New Mexico

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	76
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	26
Miscl. precip. records, meteorological data, etc. (Hydrologic Network Special Supp.)	10
Form 5002 (Mass rainfall curves)	78

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

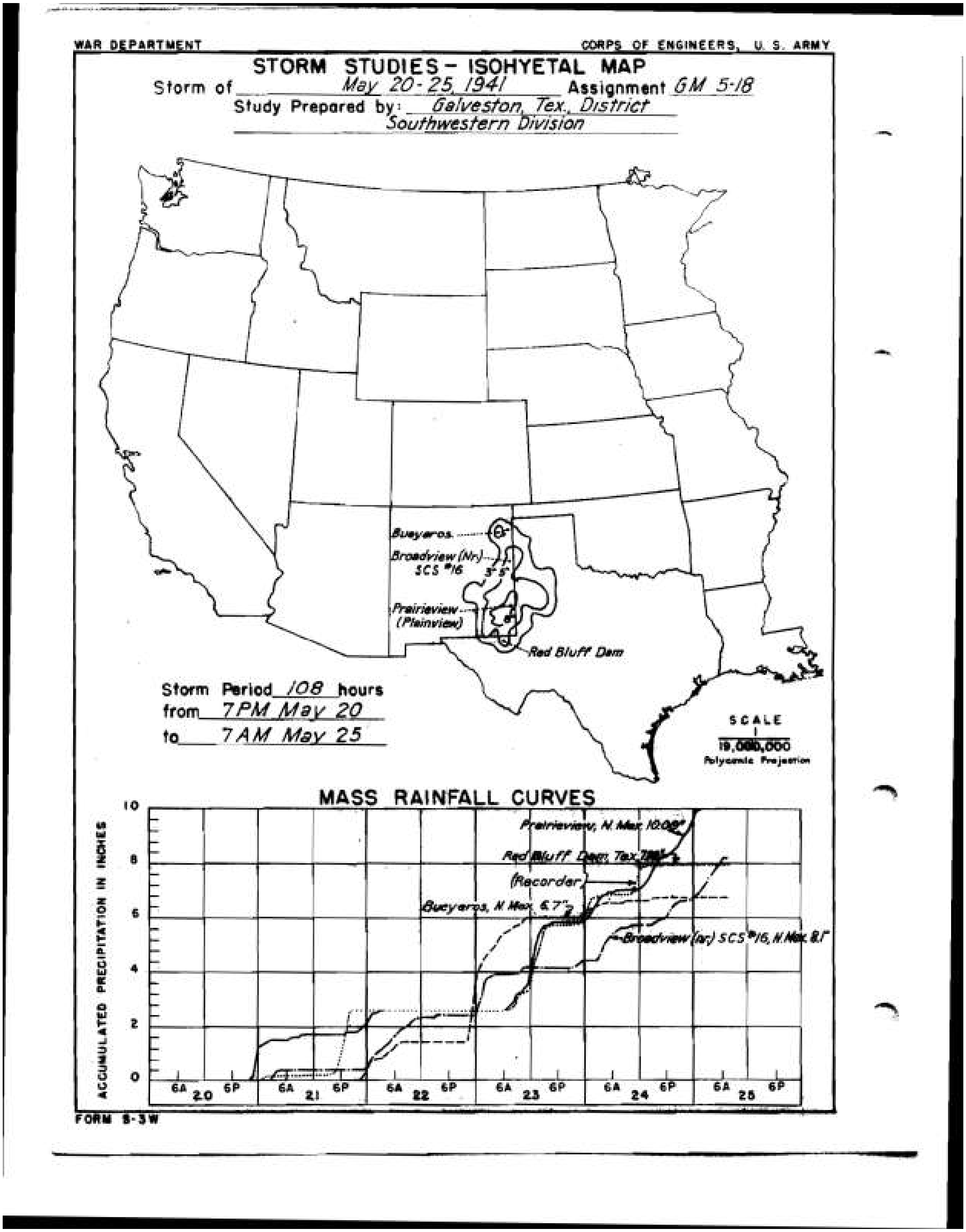
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	15
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	108
10	3.8	4.8	6.0	6.5	6.9	7.0	7.4	7.4	8.4	9.3	10.0
100	3.0	4.0	5.2	6.3	6.7	6.8	6.9	7.0	8.1	9.0	9.6
200	2.7	3.7	4.7	6.0	6.4	6.6	6.7	6.9	8.0	8.8	9.5
500	2.3	3.3	4.1	5.4	5.8	6.1	6.4	6.7	7.7	8.6	9.2
1,000	2.1	3.0	3.7	4.9	5.3	5.7	6.1	6.4	7.5	8.4	9.0
2,000	1.8	2.7	3.2	4.3	4.7	5.2	5.7	6.1	7.2	8.1	8.7
5,000	1.4	2.2	2.7	3.5	3.9	4.4	5.0	5.6	6.6	7.6	8.2
10,000	1.2	1.9	2.2	2.9	3.2	3.7	4.4	5.0	5.9	7.0	7.6
20,000	0.9	1.5	1.8	2.3	2.6	3.0	3.7	4.3	5.1	6.2	6.7
44,000	0.6	1.1	1.3	1.5	1.8	2.1	2.7	3.4	3.9	4.9	5.2

Form S-?

Appendix F: Table F.103: Depth-area-duration values for Prairieview, NM May 20, 1941



Appendix F: Figure F.131 and Figure F.132: Total storm isohyetal analysis and mass curve chart for Prairieview, NM May 20, 1941

Grant Township, NE, AWA 51

June 3, 1940

Storm Type: MCC

Grid Points Used: 2-4, 8-11, 16-18

Storm Name:	USACE MR 4-5-Grant Township,	**Storm Adjustment for ANO Grid Point 2**
Storm Date:	June 3, 1940	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date	18-Jun				
	Lat	Long			
Storm Center Location	42.24 N	96.59 W	Moisture Inflow Direction	S @ 120	miles
Storm Rep Dew Point Location	40.51 N	96.59 W	Grid Point Elevation	550	feet
Transposition Dew Point Location	41.00 N	92.58 W	Storm Center Elevation	1,400	feet
Grid Point Location	34.50 N	95.50 W	Storm Rep Analysis Duration	6	hours

The storm representative dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The in-place maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The transpositioned maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	1,400	which subtracts	0.34	inches of precipitable water at	74.0 F	
The in-place storm elevation is	1,400	which subtracts	0.39	inches of precipitable water at	79.0 F	
The transposition storm elevation at	550	which subtracts	0.28	inches of precipitable water at	79.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.28	inches of precipitable water at	79.0 F	

The in-place maximization factor is	1.28
The transposition factor is	1.04
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.32

Notes: DAD values taken from USACE Storm Studies MR 4-5. Storm representative dew point value was based on adding 7° to the USACE analysis using EPRI, Nebraska, and TRWD guidance.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	13.0	13.0	13.0	-	-	-	-	-	-
100 sq miles	10.6	11.7	11.7	-	-	-	-	-	-
200 sq miles	9.6	11.2	11.2	-	-	-	-	-	-
500 sq miles	8.3	10.2	10.3	-	-	-	-	-	-
1000 sq miles	7.2	8.9	9.0	-	-	-	-	-	-
2000 sq miles	6.0	7.5	7.6	-	-	-	-	-	-
5000 sq miles	4.2	5.5	5.7	-	-	-	-	-	-
10000 sq miles	3.1	4.4	4.6	-	-	-	-	-	-
20000 sq miles	2.1	3.3	3.5	-	-	-	-	-	-

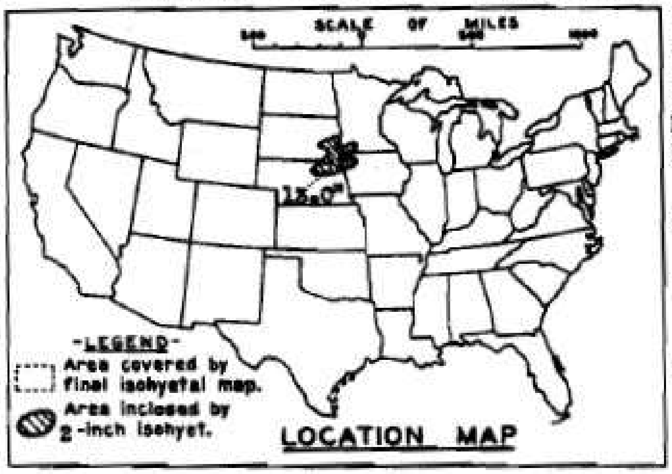
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	17.2	17.2	17.2	-	-	-	-	-	-
100 sq miles	14.0	15.5	15.5	-	-	-	-	-	-
200 sq miles	12.7	14.8	14.8	-	-	-	-	-	-
500 sq miles	11.0	13.5	13.6	-	-	-	-	-	-
1000 sq miles	9.5	11.8	11.9	-	-	-	-	-	-
2000 sq miles	7.9	9.9	10.0	-	-	-	-	-	-
5000 sq miles	5.6	7.3	7.5	-	-	-	-	-	-
10000 sq miles	4.1	5.8	6.1	-	-	-	-	-	-
20000 sq miles	2.8	4.4	4.6	-	-	-	-	-	-

Storm or Storm Center Name	**USACE MR 4-5-Grant Township, NE**	
Storm Date(s)	3-Jun-1940	
Storm Type	MCC	
Storm Location	42.24 N	96.59 W
Storm Center Elevation	1,400	
Precipitation Total & Duration (10 sq mi)	13.00 Inches 6-hours USACE Storm Studies MR 4-5	
Storm Representative Dew Point	74.0 F	6
Storm Representative Dew Point Location	40.51 N	96.59 W
Maximum Dew Point	79.0 F	
Moisture Inflow Vector	S @ 120	
In-place Maximization Factor	**1.28**	
Temporal Transposition (Date)	18-Jun	
Transposition Dew Point Location	41.00 N	92.58 W
Transposition Maximum Dew Point	79.0 F	
Transposition Adjustment Factor	**1.04**	
Grid Point Elevation	550	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.32**	

Appendix F: Table F.104: Storm spreadsheet for Grant Township, NE June 3, 1940

STORM STUDIES - PERTINENT DATA SHEET



Storm of 3-4 June 1940
Assignment MR 4-5
Location Nebr., Ia., Minn.
Study Prepared by:
Missouri River Division
Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 11/15/50
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 12/11/52
Remarks: Center at Grant Township, Nebr.
Dewpt. 63°F - Ref. Pt. 120 S.
Grid D-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	9
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	8
Miscl. precip. records, meteorological data, etc.	12
Form 5002 (Mass rainfall curves)	24

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

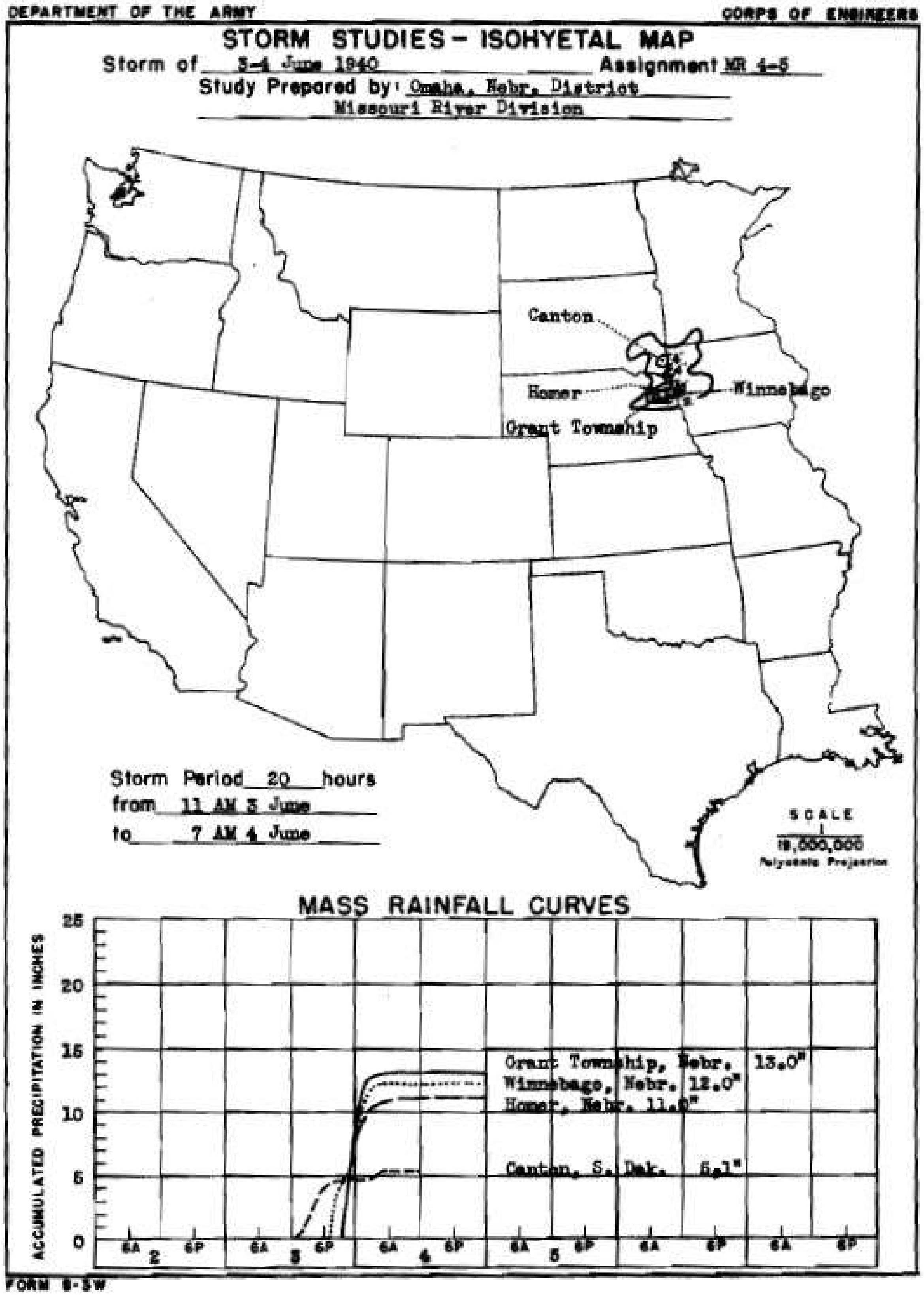
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	7
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	7

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	3	6	9	12	15	18	20				
10	8.3	13.0	13.0	13.0	13.0	13.0	13.0				
100	6.4	10.6	11.7	11.7	11.7	11.7	11.7				
200	5.5	9.6	11.1	11.2	11.2	11.2	11.2				
500	4.5	8.3	10.0	10.2	10.3	10.3	10.3				
1,000	3.8	7.2	8.8	8.9	9.0	9.0	9.0				
2,000	3.2	6.0	7.3	7.5	7.6	7.6	7.6				
5,000	2.4	4.2	5.3	5.5	5.7	5.7	5.7				
10,000	1.8	3.1	4.0	4.4	4.6	4.6	4.6				
20,000	1.2	2.1	2.8	3.3	3.5	3.5	3.5				

Form S-2

Appendix F: Table F.105: Depth-area-duration values for Grant Township, NE June 3, 1940



Appendix F: Figure F.133 and Figure F.134: Total storm isohyetal analysis and mass curve chart for Grant Township, NE June 3, 1940

Hallett, OK AWA 52

September 2, 1940

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	**USACE SW 2-18-Hallett, OK**	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	**9/2-4/1940**	
AWA Analysis Date:	**12/15/2013**	

Temporal Transposition Date	**17-Aug**	
	Lat	**Long**
Storm Center Location	**36.23 N**	**96.57 W**
Storm Rep Dew Point Location	**32.90 N**	**93.15 W**
Transposition Dew Point Location	**39.39 N**	**89.86 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**SE @ 300**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**900**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**77.5 F**	with total precipitable water above sea level of			**3.22**	inches.
The in-place maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.52**	inches.
The transpositioned maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.52**	inches.
The in-place storm elevation is	**900**	which subtracts	**0.25**	inches of precipitable water at	**77.5 F**	
The in-place storm elevation is	**900**	which subtracts	**0.27**	inches of precipitable water at	**80.0 F**	
The transposition storm elevation at	**350**	which subtracts	**0.29**	inches of precipitable water at	**80.0 F**	
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.29**	inches of precipitable water at	**80.0 F**	

The in-place maximization factor is	**1.09**
The transposition factor is	**0.99**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.09**

Notes: Reanalyzed the storm rep Td using hourly surface obs in the region. Used KBAD, Shreveprot, LA to derive the 6 hour average storm rep Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**18.4**	**23.4**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	-	-
100 sq miles	**14.7**	**19.2**	**19.4**	**19.6**	**19.7**	**19.8**	**19.8**	-	-
200 sq miles	**12.5**	**17.6**	**17.8**	**18.0**	**18.1**	**18.2**	**18.3**	-	-
500 sq miles	**9.7**	**15.4**	**15.6**	**15.7**	**15.8**	**16.1**	**16.2**	-	-
1000 sq miles	**7.9**	**13.3**	**13.4**	**13.6**	**13.7**	**14.0**	**14.1**	-	-
2000 sq miles	**6.2**	**10.3**	**10.5**	**10.7**	**10.9**	**11.1**	**11.3**	-	-
5000 sq miles	**4.3**	**7.3**	**7.4**	**7.5**	**7.7**	**7.8**	**7.9**	-	-
10000 sq miles	**3.0**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**	**5.8**	-	-
20000 sq miles	**2.0**	**3.9**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	-	-

Adjusted Storm Depth-Area-Duration

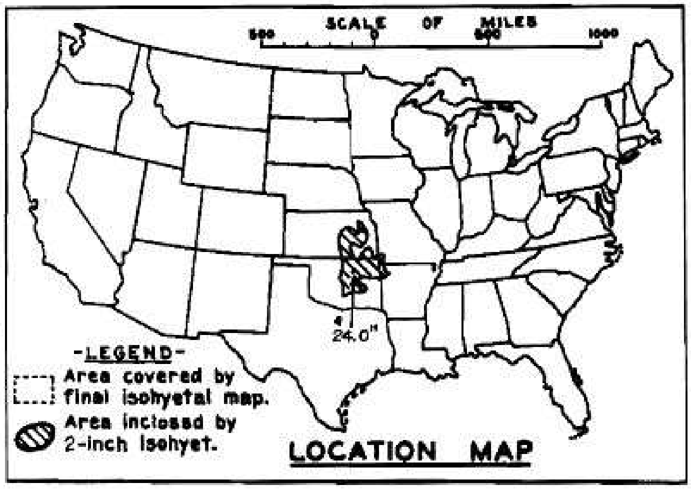
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**20.0**	**25.4**	**25.6**	**25.6**	**25.6**	**25.6**	**25.6**	-	-
100 sq miles	**16.0**	**20.8**	**21.1**	**21.3**	**21.4**	**21.5**	**21.5**	-	-
200 sq miles	**13.6**	**19.1**	**19.3**	**19.5**	**19.7**	**19.8**	**19.9**	-	-
500 sq miles	**10.5**	**16.7**	**16.9**	**17.0**	**17.2**	**17.5**	**17.6**	-	-
1000 sq miles	**8.6**	**14.4**	**14.5**	**14.8**	**14.9**	**15.2**	**15.3**	-	-
2000 sq miles	**6.7**	**11.2**	**11.4**	**11.6**	**11.8**	**12.1**	**12.3**	-	-
5000 sq miles	**4.7**	**7.9**	**8.0**	**8.1**	**8.4**	**8.5**	**8.6**	-	-
10000 sq miles	**3.3**	**5.8**	**5.9**	**6.0**	**6.1**	**6.2**	**6.3**	-	-
20000 sq miles	**2.2**	**4.2**	**4.5**	**4.6**	**4.7**	**4.8**	**4.9**	-	-

Storm or Storm Center Name	**USACE SW 2-18-Hallett, OK**			
Storm Date(s)	9/2-4/1940			
Storm Type	MCC			
Storm Location	36.23 N	96.57 W		
Storm Center Elevation	900			
Precipitation Total & Duration (10 sq mi)	24.00 inches in 12 hours			
Storm Representative Dew Point	77.5 F	12		
Storm Representative Dew Point Location	32.90 N	93.15 W	A	
Maximum Dew Point	80.0 F		79.5	
Moisture Inflow Vector	SE @ 300			
In-place Maximization Factor	**1.09**			
Temporal Transposition (Date)	17-Aug			
Transposition Dew Point Location	39.39 N	89.86 W	A	S
Transposition Maximum Dew Point	80.0 F		80.5	76
Transposition Adjustment Factor	**0.99**			
Grid Point Elevation	350			
Highest Elevation in Basin	**14,344**			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.09**			

Appendix F: Table F.106: Storm spreadsheet for Hallett, OK September 2, 1940

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of September 2 - 6, 1940
Assignment S W 2 - 18
Location Okla. Kans. Mo. & Ark.
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/18/41
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/25/43
Remarks: Centers at; Hallett, Okla. and Lebo, Kans.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheet, scale 1 : 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	38
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	23
Miscl. precip. records, meteorological data, etc.	1
Form 5002 (Mass rainfall curves)	49

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

Data and computation sheets:

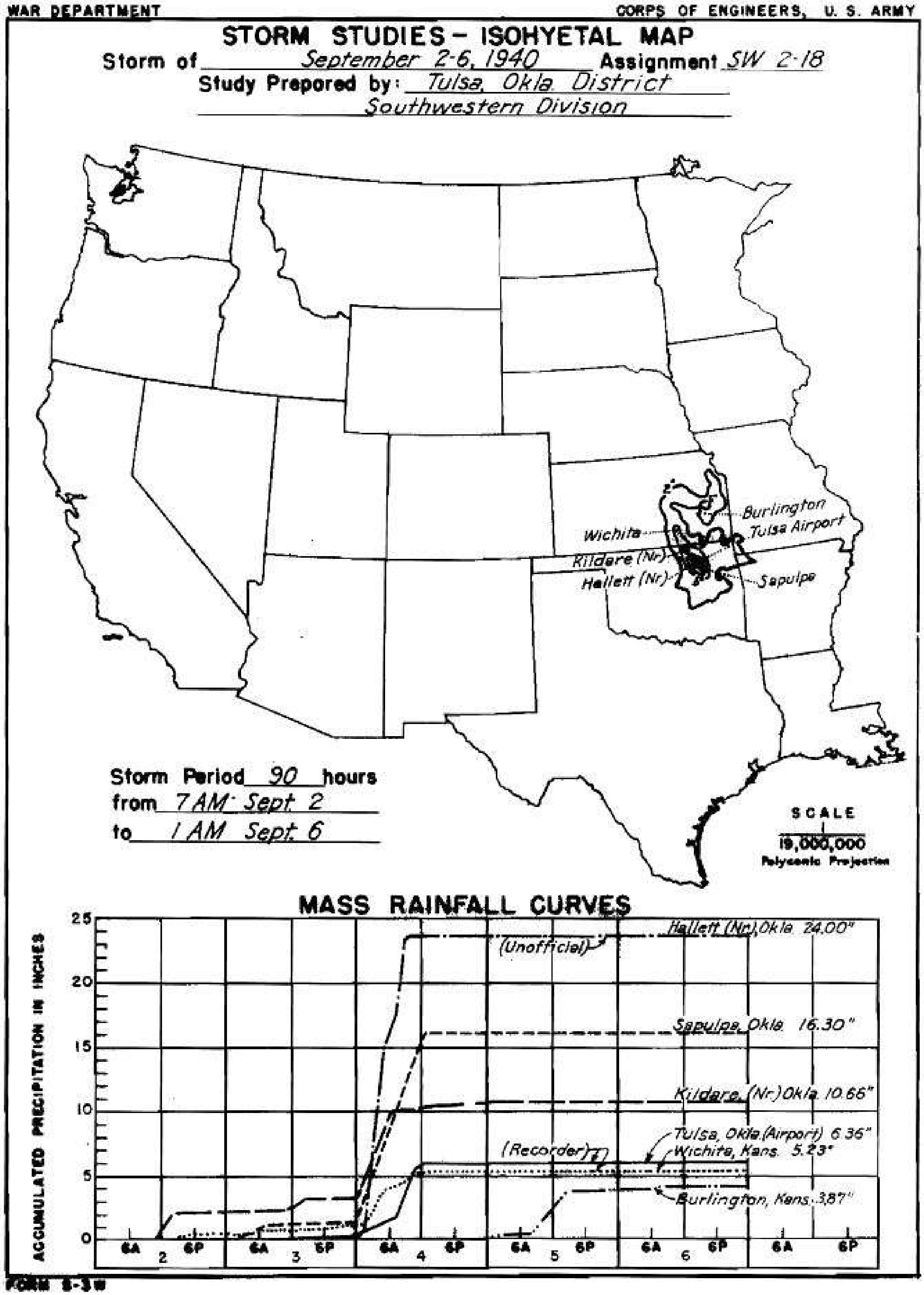
Form S-10 (Data from mass rainfall curves)	9
Form S-11 (Depth-area data from isohyetal map)	3
Form S-12 (Maximum depth-duration data)	11
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	54	90		
Max. Station	18.9	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0		
10	18.4	23.4	23.6	23.6	23.6	23.6	23.6	23.6	23.6		
100	14.7	19.2	19.4	19.6	19.7	19.8	19.8	19.8	19.8		
200	12.5	17.6	17.8	18.0	18.1	18.2	18.3	18.3	18.3		
500	9.7	15.4	15.6	15.7	15.8	16.1	16.2	16.2	16.2		
1,000	7.9	13.3	13.4	13.6	13.7	14.0	14.1	14.1	14.1		
2,000	6.2	10.3	10.5	10.7	10.9	11.1	11.3	11.3	11.3		
5,000	4.3	7.3	7.4	7.5	7.7	7.8	7.9	8.0	8.0		
10,000	3.0	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.9		
15,000	2.4	4.4	4.5	4.7	4.7	4.8	4.9	5.1	5.1		
20,000	2.0	3.9	4.1	4.2	4.3	4.4	4.5	4.6	4.6		

Form S-2

Appendix F: Table F.107: Depth-area-duration values for Hallett, OK September 2, 1940



Appendix F: Figure F.135 and Figure F.136: Total storm isohyetal analysis and mass curve chart for Hallett, OK September 2, 1940

Hempstead, TX AWA 53

November 22, 1940

Storm Type: Frontal/MCC

Grid Points Used: 1-3, 8-10

Storm Name:	USACE GM 5-13-Hempstead, TX			
Storm Date:	11/22-25/1940			
AWA Analysis Date:	12/15/2013			

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	5-Nov	
	Lat	Long
Storm center location	30.13 N	96.13 W
Storm Rep SST location	30.15 N	94.05 W
Transposition SST location	33.30 N	96.05 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	E @ 125	miles
Grid Point Elevation	350	feet
Storm Center Elevation	200	feet
Storm Rep Analysis Duration	24	hours

The storm representative SST is	72.0 F	with total precipitable water above sea level of			2.47	inches.
The in-place maximum SST is	74.5 F	with total precipitable water above sea level of			2.79	inches.
The transpositioned maximum SST is	71.5 F	with total precipitable water above sea level of			2.42	inches.
The in-place storm elevation is	200	which subtracts	0.05	inches of precipitable water at	72.0 F	
The in-place storm elevation is	200	which subtracts	0.05	inches of precipitable water at	74.5 F	
The transposition storm elevation at	350	which subtracts	0.24	inches of precipitable water at	71.5 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.24	inches of precipitable water at	71.5 F	

The in-place maximization factor is	1.13
The transposition factor is	0.80
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	0.90

Notes: Added 2° to the USACE storm rep Td based on EPRI and Nebraska guidance for a synoptic storm going from 12hr persisting to average Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	9.0	10.5	16.0	18.6	20.2	20.4	20.6	20.8	21.1
100 sq miles	7.5	10.0	14.6	17.6	19.1	19.3	19.5	19.7	20.2
200 sq miles	7.0	9.7	13.6	16.8	18.4	18.7	18.9	19.1	19.6
500 sq miles	6.4	9.2	12.2	15.5	17.0	17.6	17.8	18.2	18.7
1000 sq miles	5.8	8.6	11.1	14.2	15.6	16.3	16.7	17.5	18.0
2000 sq miles	5.0	7.6	10.0	12.7	14.0	14.8	15.7	16.7	17.3
5000 sq miles	3.8	6.0	8.4	10.6	11.7	12.4	14.1	16.4	16.1
10000 sq miles	3.0	4.8	7.0	8.8	9.7	10.5	12.8	14.3	14.8
20000 sq miles	2.0	3.6	5.3	6.7	7.6	8.7	11.0	12.5	13.0

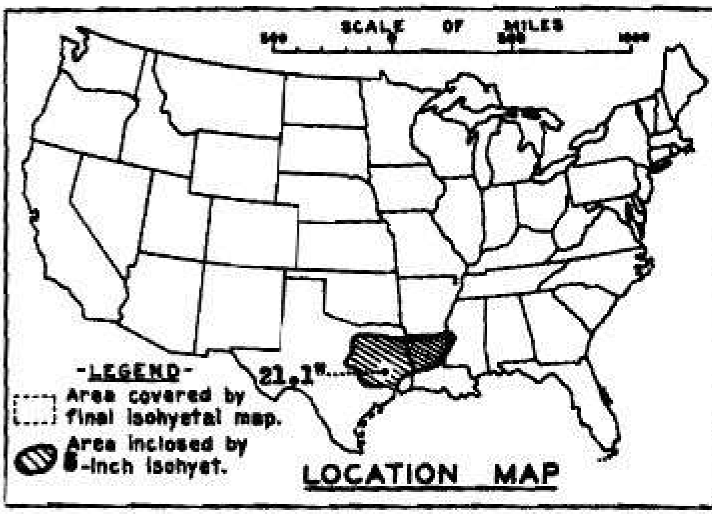
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	8.1	9.5	14.4	16.8	18.2	18.4	18.6	18.8	19.1
100 sq miles	6.8	9.0	13.2	15.9	17.2	17.4	17.6	17.8	18.2
200 sq miles	6.3	8.8	12.3	15.2	16.6	16.9	17.1	17.2	17.7
500 sq miles	5.8	8.3	11.0	14.0	15.3	15.9	16.1	16.4	16.9
1000 sq miles	5.2	7.8	10.0	12.8	14.1	14.7	15.1	15.8	16.3
2000 sq miles	4.5	6.9	9.0	11.5	12.6	13.4	14.2	15.1	15.6
5000 sq miles	3.4	5.4	7.6	9.6	10.6	11.2	12.7	14.8	14.5
10000 sq miles	2.7	4.3	6.3	7.9	8.8	9.5	11.6	12.9	13.4
20000 sq miles	1.8	3.3	4.8	6.0	6.9	7.9	9.9	11.3	11.7

Storm or Storm Center Name	USACE GM 5-13-Hempstead, TX			
Storm Date(s)	11/22-25/1940			
Storm Type	MCC			
Storm Location	30.13 N	96.13 W		
Storm Center Elevation	200			
Precipitation Total & Duration (10 sq mi)	21.1 inches in 72 hours, 18.6" in 24 hours			
Storm Representative SST	72.0 F			
Storm Representative SST Location	30.15 N	94.05 W	O	N
In-place Maximum SST	74.5 F		76.5	73
Moisture Inflow Vector	E @ 125			
In-place Maximization Factor				
Temporal Transposition (Date)	5-Nov			
Transposition Dewpoint Location	33.30 N	96.05 W	O	N
Transposition Maximum SST	71.5 F		75	70
Transposition Adjustment Factor				
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height				
Elevation Adjustment Factor				
Total Adjustment Factor	0.90			

Appendix F: Table F.108: Storm spreadsheet for Hempstead, TX November 22, 1940

STORM STUDIES - PERTINENT DATA SHEET



Storm of 22-25 November 1940
Assignment GM 5-13
Location Texas, Louisiana & Miss
Study Prepared by:
Southwestern Division
Galveston District

Part I Reviewed by H. M. Sec. of Weather Bureau, 3-17-47
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3-20-50
Remarks: Center at Hempstead, Texas
Dewpt. 70^{o}-Ref. Pt. 125 E
Grid. J-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	109
Form 5001-B (24-hour " ")	127
Form 5001-D (" " " ")	0
Miscl. precip. records, meteorological data, etc.	24
Form 5002 (Mass rainfall curves)	127

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

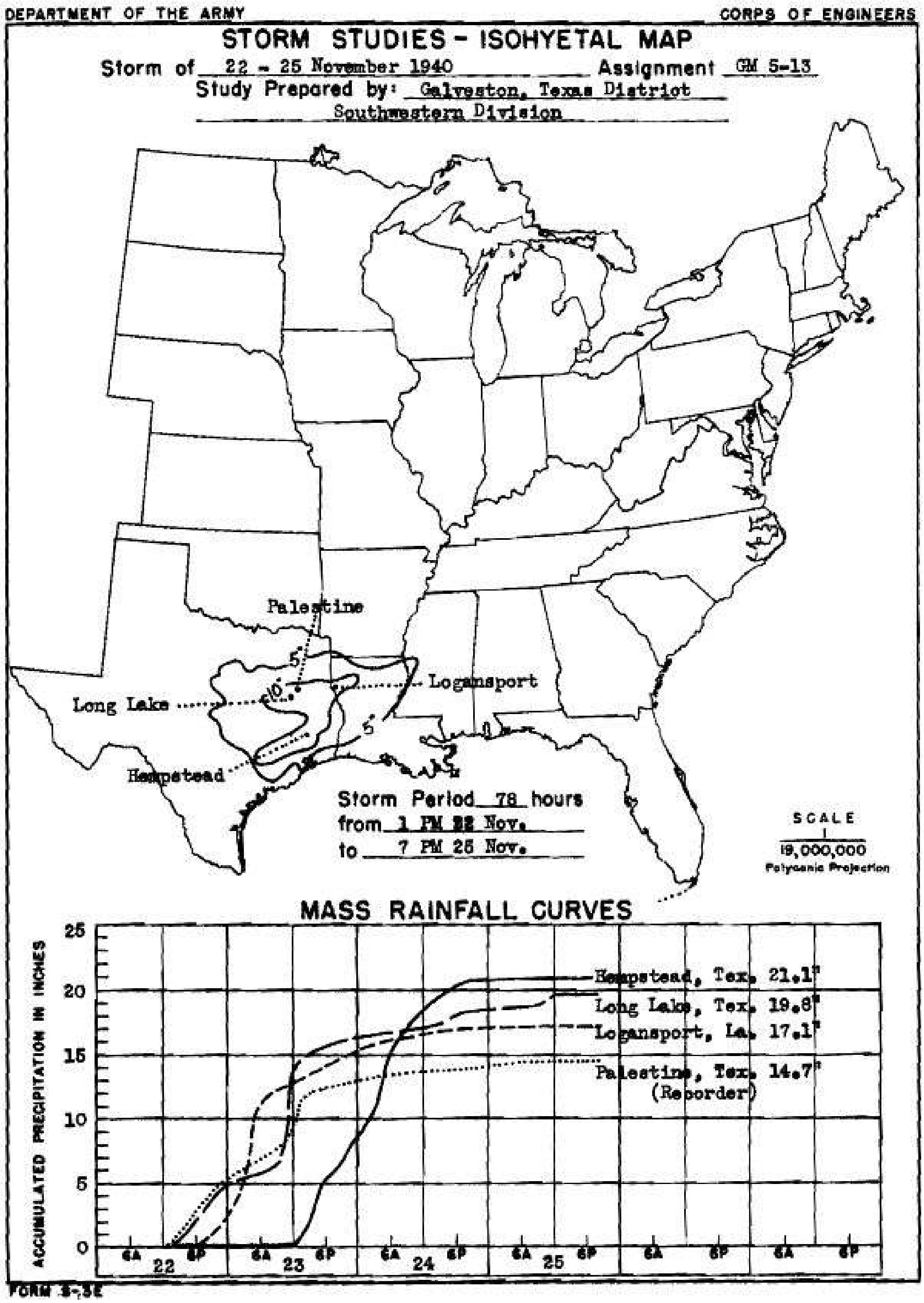
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	8
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	15
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	78
10	9.0	10.5	16.0	18.6	20.2	20.4	20.6	20.8	21.1	21.1
100	7.5	10.0	14.6	17.6	19.1	19.3	19.5	19.7	20.2	20.2
200	7.0	9.7	13.6	16.8	18.4	18.7	18.9	19.1	19.6	19.7
500	6.4	9.2	12.2	15.5	17.0	17.6	17.8	18.2	18.7	18.8
1,000	5.8	8.6	11.1	14.2	15.6	16.3	16.7	17.5	18.0	18.1
2,000	5.0	7.6	10.0	12.7	14.0	14.8	15.7	16.7	17.3	17.5
5,000	3.8	6.0	8.4	10.6	11.7	12.4	14.1	16.4	16.1	16.3
10,000	3.0	4.8	7.0	8.8	9.7	10.5	12.8	14.3	14.8	15.1
20,000	2.0	3.6	5.3	6.7	7.6	8.7	11.0	12.5	13.0	13.2
50,000	1.2	2.4	3.4	4.4	5.3	6.3	8.0	9.2	9.9	10.0
78,000	1.0	1.9	2.8	3.6	4.4	5.2	6.6	7.8	8.4	8.5

Form S-2

Appendix F: Table F.109: Depth-area-duration values for Hempstead, TX November 22, 1940



Appendix F: Figure F.137 and Figure F.138: Total storm isohyetal analysis and mass curve chart for Hempstead, TX November 22, 1940

Index, AR, AWA 54

June 30, 1940

Storm Type: MCC

Grid Points Used: 13-, 8-10, 16-17

Storm Name:	USACE LMV 4-25-Index, AR
Storm Date:	30-Jun-1940
AWA Analysis Date:	12/15/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	33.55 N	94.04 W
Storm Rep Dew Point Location	32.50 N	93.67 W
Transposition Dew Point Location	41.68 N	92.15 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSE @ 75	miles
Grid Point Elevation	350	feet
Storm Center Elevation	300	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	300	which subtracts	0.08	inches of precipitable water at	77.0 F	
The in-place storm elevation is	300	which subtracts	0.09	inches of precipitable water at	81.0 F	
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place storm maximization factor is	1.20
The transposition/elevation to basin factor is	0.94
The barrier adjustment factor is	1.00
The total adjustment factor is	1.13

Notes: DAD values taken from USACE LMV 4-25. Storm representative dew point value was based on maximum 12hr Td values between June 30-July 1, 1940 at KBAD.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	8.5	10.4	10.9	10.9	11.2	11.5	11.5	-	-
100 sq miles	8.4	9.8	10.2	10.2	10.7	11.3	11.3	-	-
200 sq miles	8.3	9.5	9.9	10.0	10.4	10.9	11.0	-	-
500 sq miles	7.8	8.9	9.4	9.6	9.8	10.3	10.4	-	-
1000 sq miles	7.3	8.2	8.8	9.1	9.3	9.6	9.8	-	-
2000 sq miles	6.4	7.2	7.8	8.1	8.5	8.7	9.0	-	-
5000 sq miles	4.8	5.7	6.1	6.4	7.1	7.4	7.7	-	-
10000 sq miles	3.5	4.5	4.8	5.1	5.8	6.2	6.5	-	-
20000 sq miles	2.3	3.3	3.4	3.8	4.4	5.0	6.2	-	-

Adjusted Storm Depth-Area-Duration

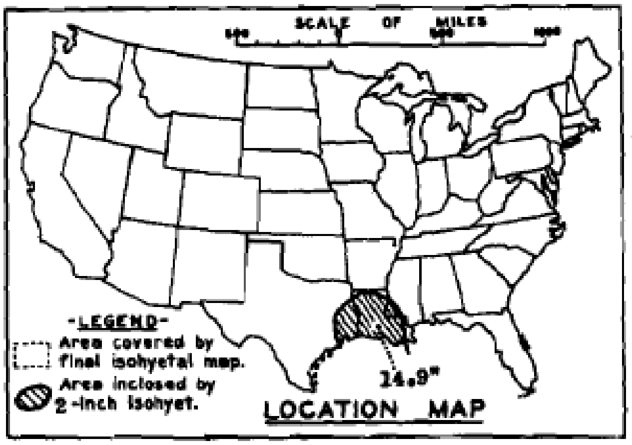
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	9.6	11.8	12.3	12.3	12.7	13.0	13.0	-	-
100 sq miles	9.5	11.1	11.5	11.5	12.1	12.8	12.8	-	-
200 sq miles	9.4	10.7	11.2	11.3	11.8	12.3	12.4	-	-
500 sq miles	8.8	10.1	10.6	10.9	11.1	11.6	11.8	-	-
1000 sq miles	8.3	9.3	10.0	10.3	10.5	10.9	11.1	-	-
2000 sq miles	7.2	8.1	8.8	9.2	9.6	9.8	10.2	-	-
5000 sq miles	5.4	6.4	6.9	7.2	8.0	8.4	8.7	-	-
10000 sq miles	4.0	5.1	5.4	5.8	6.6	7.0	7.3	-	-
20000 sq miles	2.6	3.7	3.8	4.3	5.0	5.7	7.0	-	-

Storm or Storm Center Name	**USACE LMV 4-25-Index, AR**	
Storm Date(s)	30-Jun-1940	
Storm Type	MCC	
Storm Location	33.55 N	94.04 W
Storm Center Elevation	300	
Precipitation Total & Duration	11.5 Inches 36-hours USACE LMV 4-25	
Storm Representative Dewpoint	77.0 F	12
Storm Representative Dewpoint Location	32.50 N	93.67 W
Maximum Dewpoint	81.0 F	
Moisture Inflow Vector	SSE @ 75	
In-place Maximization Factor	**1.20**	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	41.68 N	92.15 W
Transposition Maximum Dewpoint	81.0 F	
Transposition Adjustment Factor	**0.94**	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.13**	

Appendix F: Table F.110: Storm spreadsheet for Index, AR June 30, 1940

DEPARTMENT OF THE ARMY | CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 26-31 May 1941
Assignment LMV 4-28
Location Louisiana
Study Prepared by:
Lower Miss. Valley Div.
New Orleans District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 5/29/47
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 2/8/51
Remarks: Center at Jennings, La.
Dewpt. 73° Ref. Pt. 50 SW
Grid J-13

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) 56
- Form 5001-B (24-hour " ") ..... —
- Form 5001-D (" " " ") 22
- Miscl. precip. records, meteorological data, etc. ..... —
- Form 5002 (Mass rainfall curves) 39

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

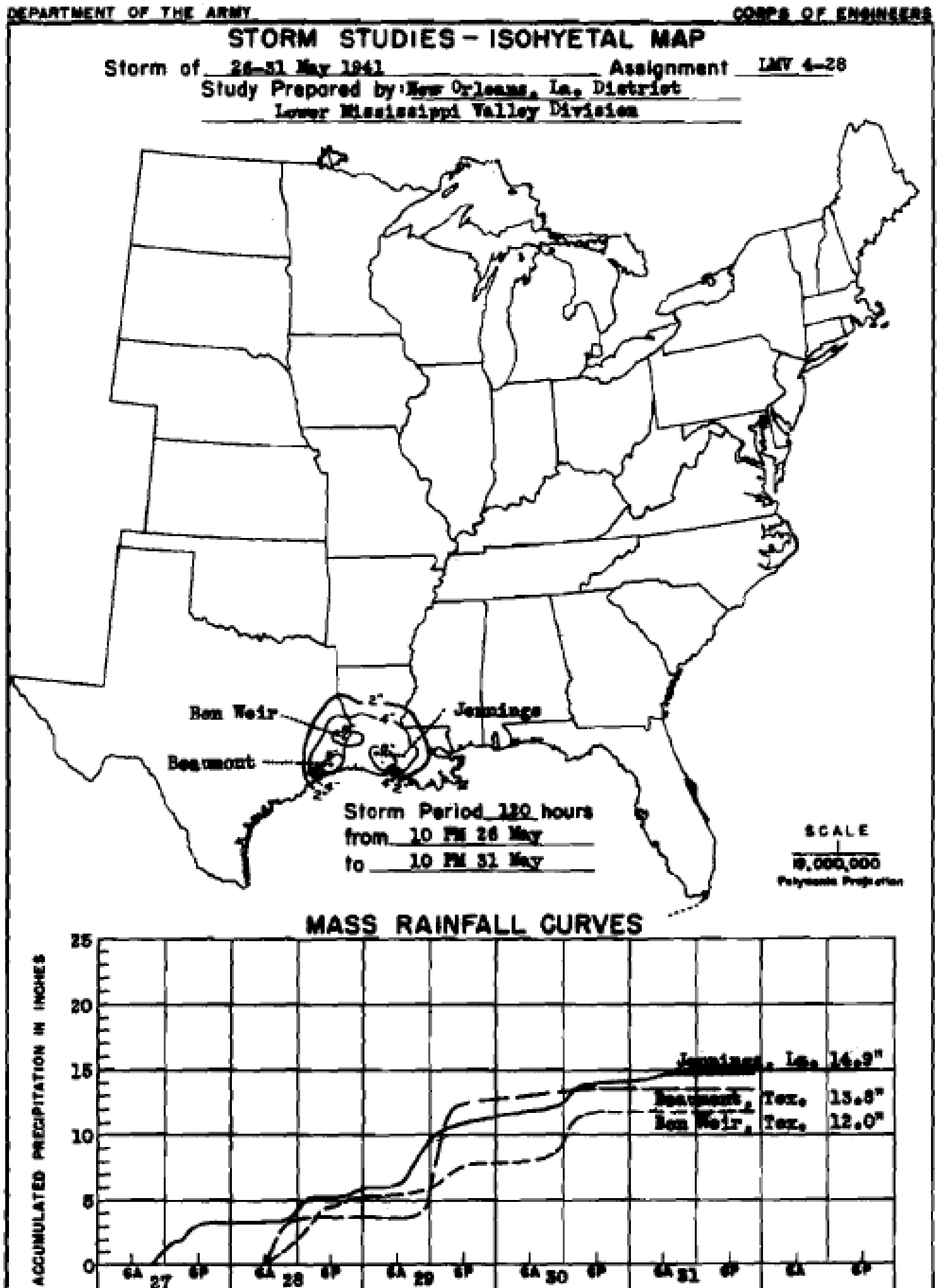
- Form S-10 (Data from mass rainfall curves) 6
- Form S-11 (Depth-area data from isohyetal map) 1
- Form S-12 (Maximum depth-duration data) 6
- Maximum duration-depth-area curves 1
- Data relating to periods of maximum rainfall 3

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	120
10	8.0	8.7	8.9	9.1	9.6	12.3	12.5	13.4	13.4	14.9	14.9
100	7.1	7.6	7.8	8.0	8.5	10.5	11.2	11.9	12.0	13.4	13.4
200	6.8	7.2	7.3	7.5	8.0	9.8	10.5	11.1	11.3	12.8	12.9
500	6.0	6.2	6.4	6.6	7.1	8.6	9.2	9.9	10.1	11.9	12.0
1,000	5.1	5.3	5.5	5.6	6.2	7.2	7.9	8.8	9.4	10.9	11.3
2,000	4.0	4.2	4.5	4.6	5.3	5.9	7.1	8.3	8.7	10.0	10.5
5,000	2.1	2.7	3.3	3.6	4.6	5.0	6.4	7.6	8.0	8.9	9.3
10,000	1.4	2.0	2.9	3.2	4.3	4.6	5.6	6.9	7.1	8.0	8.2
20,000	1.1	1.7	2.4	2.7	3.6	3.9	4.6	5.8	6.1	6.6	6.8
50,000	0.7	1.2	1.5	1.8	2.4	2.7	3.1	3.9	4.4	4.7	4.8
54,000	0.7	1.1	1.4	1.7	2.3	2.6	2.9	3.7	4.1	4.5	4.6

Form S-2

Appendix F: Table F.111: Depth-area-duration values for Index, AR June 30, 1940



Appendix F: Figure F.139 and Figure F.140: Total storm isohyetal analysis and mass curve chart for Index, AR June 30, 1940

Elbert, CO, AWA 55

May 30, 1935

Storm Type: MCC

Grid Points Used: 6, 13, 15, 21

Storm Name:	SPAS 1295 Cherry Creek-Elbert, C
Storm Date:	5/29-31/1935
AWA Analysis Date:	12/15/2013

Storm Adjustment for ANO Grid Point 6

Temporal Transposition Date	30-May	
	Lat	Long
Storm center location	39.24 N	104.49 W
Storm Rep dew point location	33.05 N	99.80 W
Transposition dewpoint location	28.33 N	100.03 W
Basin location	34.50 N	104.00 W

Moisture Inflow Direction:	SSE @ 500	miles
Basin Ave. Elevation	4,400	feet
Storm Center Elevation	6,800	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The in-place maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	6,800	which subtracts	1.48	inches of precipitable water at	76.5 F	
The in-place storm elevation is	6,800	which subtracts	1.56	inches of precipitable water at	78.0 F	
The transposition basin elevation at	4,400	which subtracts	1.12	inches of precipitable water at	79.0 F	
The inflow barrier/basin elevation height is	4,400	which subtracts	1.12	inches of precipitable water at	79.0 F	

The in-place storm maximization factor is	1.09
The transposition/elevation to basin factor is	1.34
The barrier adjustment factor is	1.00
The total adjustment factor is	1.46

Notes: DAD values taken from SPAS 1295 Zone 1. Storm representative dew point value was based on maximum average 6-hr Td values between May 29-30, 1935 at KABI and KSPS.

Observed Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	18 Hours	24 Hours
1 sq miles	5.8	10.1	13.0	14.1	14.3	17.4	23.0	23.3	23.3
10 sq miles	5.5	9.6	12.1	13.2	13.4	16.3	21.2	21.2	21.2
100 sq miles	3.7	6.7	8.5	9.3	9.3	10.6	14.8	15.0	15.0
200 sq miles	3.1	5.8	7.0	7.7	7.7	7.9	12.4	12.5	12.5
500 sq miles	2.6	4.5	5.3	5.7	5.7	6.2	9.5	9.5	9.5
1000 sq miles	2.1	3.5	4.1	4.1	4.5	4.8	5.7	5.7	5.7
2000 sq miles	1.6	2.8	3.2	3.4	3.6	3.8	5.3	5.4	5.4
5000 sq miles	0.9	1.3	1.4	1.6	1.7	2.1	2.5	2.5	2.5
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	18 Hours	24 Hours
1 sq miles	8.5	14.8	19.1	20.6	20.9	25.4	33.6	34.1	34.1
10 sq miles	8.0	14.0	17.8	19.3	19.6	23.8	31.0	31.0	31.0
100 sq miles	5.4	9.8	12.5	13.6	13.6	15.6	21.6	22.0	22.0
200 sq miles	4.6	8.5	10.2	11.2	11.3	11.6	18.2	18.4	18.4
500 sq miles	3.8	6.6	7.8	8.3	8.4	9.1	13.9	13.9	13.9
1000 sq miles	3.1	5.1	6.0	6.0	6.6	7.1	8.4	8.4	8.4
2000 sq miles	2.3	4.1	4.6	5.0	5.2	5.6	7.8	7.8	7.8
5000 sq miles	1.3	1.9	2.1	2.3	2.5	3.1	3.6	3.6	3.6
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**SPAS 1295 Cherry Creek-Elbert, CO Zone 1**			
Storm Date(s)	5/29-31/1935			
Storm Type	Convective			
Storm Location	39.24 N	104.49 W		
Storm Center Elevation	6,800			
Precipitation Total & Duration	24.0 Inches 18-hours			
Storm Representative Dewpoint	76.5 F	6		
Storm Representative Dewpoint Location	33.05 N	99.80 W	May	June
Maximum Dewpoint	78.0 F		76.5	79
Moisture Inflow Vector	SSE @ 500	Miles		
In-place Maximization Factor	**1.09**			
Temporal Transposition (Date)	30-May			
Transposition Dewpoint Location	28.33 N	100.03 W	May	June
Transposition Maximum Dewpoint	79.0 F		78	79.5
Transposition Adjustment Factor	1.46			
Average Basin Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.46**			

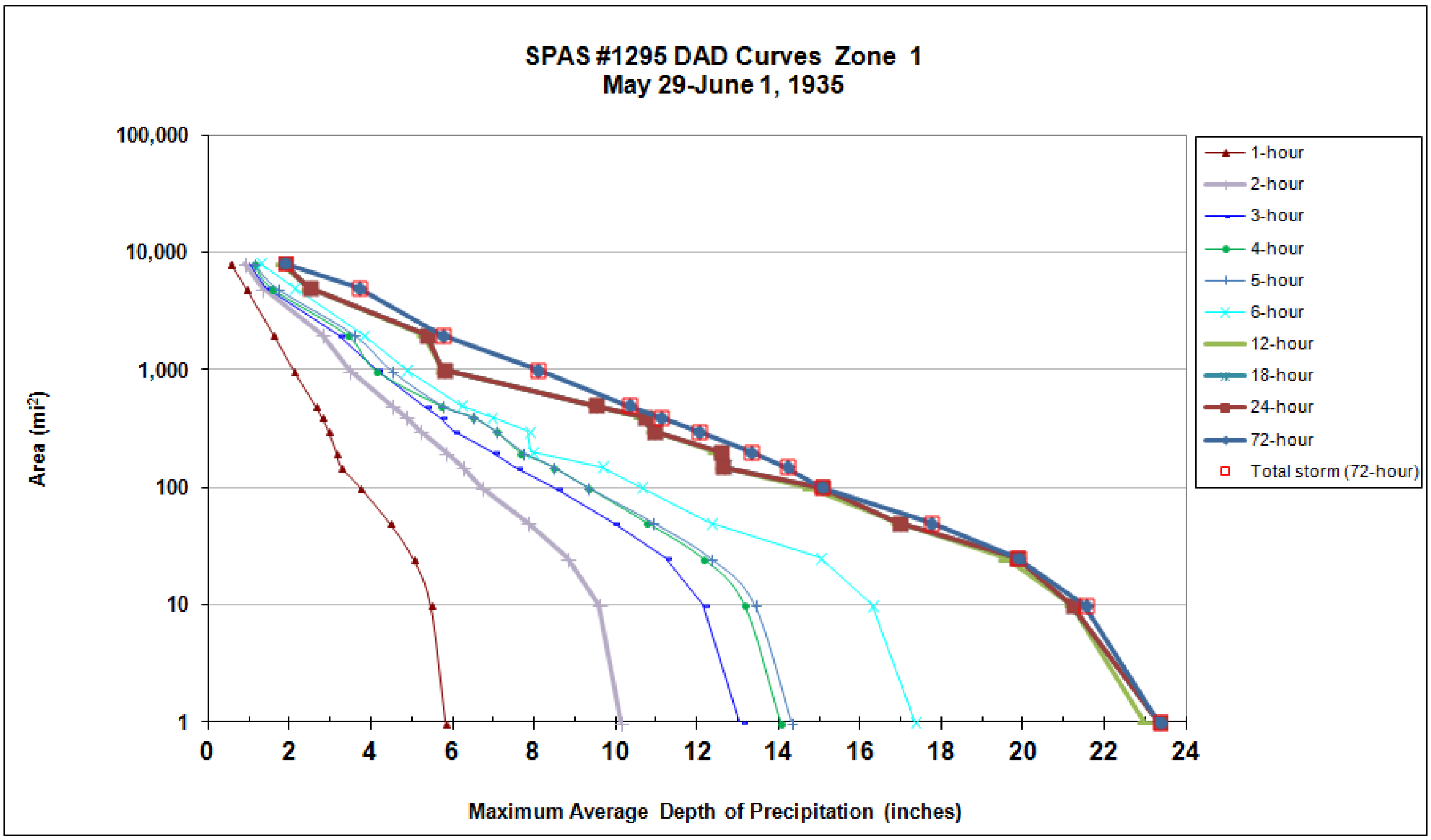
Appendix F: Table F.112: Storm spreadsheet for Cherry Creek-Elbert, CO May 30, 1935

SPAS 1295 - May 29 (800 UTC) - June 1 (700 UTC), 1935

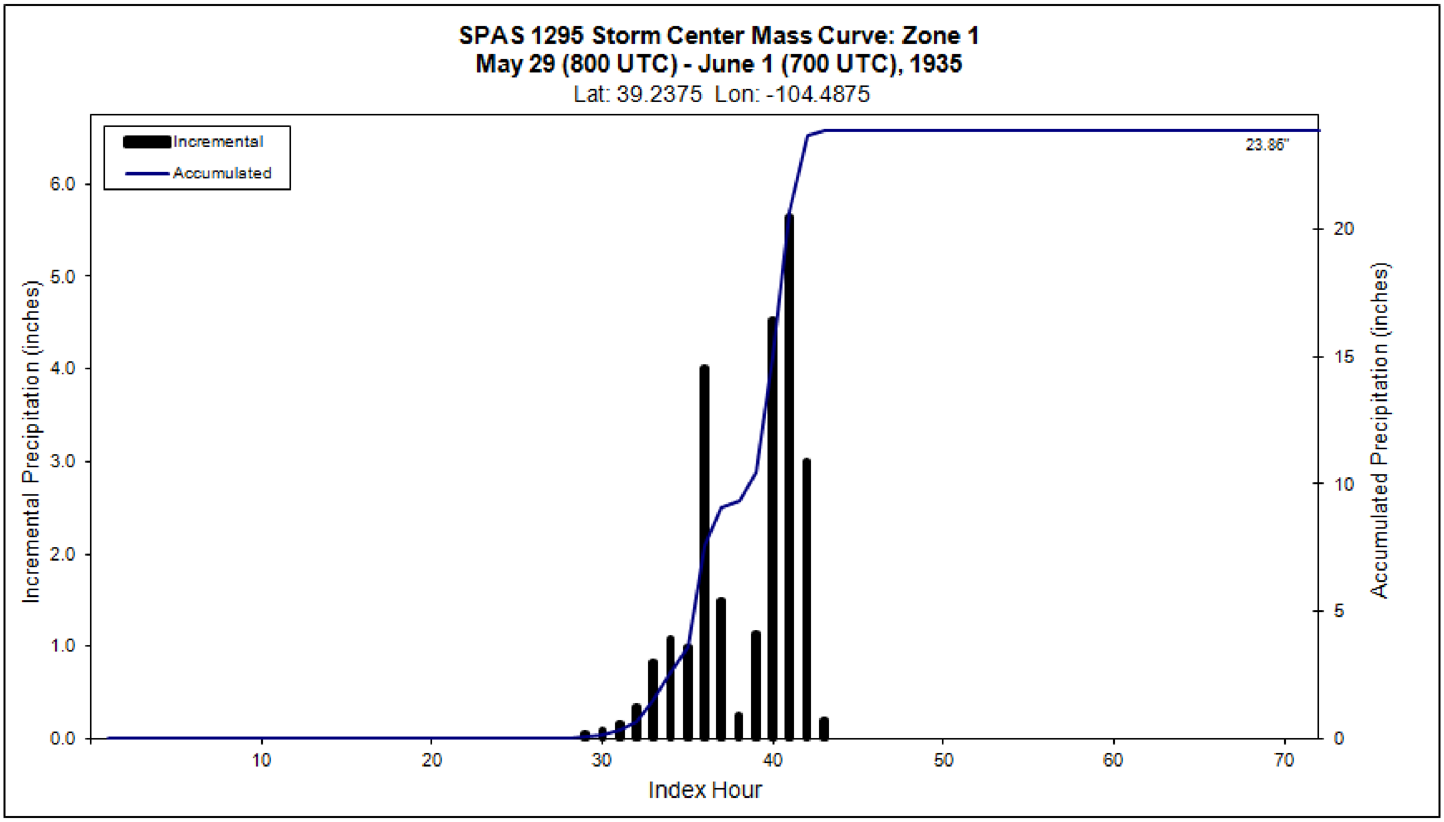
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)										
Area (mi^2)	1	2	3	4	5	6	12	18	24	72	Total
0.3	5.99	10.46	13.33	14.39	14.66	17.83	23.53	23.86	23.86	23.86	**23.86**
1	5.83	10.14	13.04	14.05	14.31	17.35	22.97	23.32	23.32	23.32	**23.32**
10	5.46	9.59	12.14	13.16	13.4	16.29	21.18	21.18	21.18	21.51	**21.51**
25	5.02	8.83	11.2	12.13	12.31	15	19.54	19.81	19.81	19.82	**19.82**
50	4.44	7.83	9.93	10.76	10.91	12.31	16.92	16.92	16.92	17.72	**17.72**
100	3.72	6.71	8.52	9.31	9.31	10.63	14.75	15.04	15.04	15.04	**15.04**
150	3.26	6.27	7.55	8.45	8.45	9.67	12.6	12.6	12.6	14.17	**14.17**
200	3.14	5.83	6.95	7.66	7.73	7.93	12.41	12.54	12.54	13.3	**13.30**
300	2.95	5.19	6	7.06	7.06	7.85	10.92	10.92	10.92	12	**12.00**
400	2.78	4.85	5.68	6.47	6.47	6.94	10.58	10.68	10.68	11.08	**11.08**
500	2.62	4.5	5.3	5.69	5.73	6.2	9.49	9.49	9.49	10.29	**10.29**
1,000	2.09	3.47	4.1	4.1	4.49	4.84	5.73	5.74	5.74	8.06	**8.06**
2,000	1.6	2.81	3.17	3.4	3.58	3.8	5.3	5.35	5.35	5.7	**5.70**
5,000	0.92	1.33	1.42	1.55	1.69	2.09	2.45	2.45	2.45	3.66	**3.66**
8,125	0.54	0.9	1.03	1.13	1.14	1.27	1.81	1.85	1.86	1.86	**1.86**

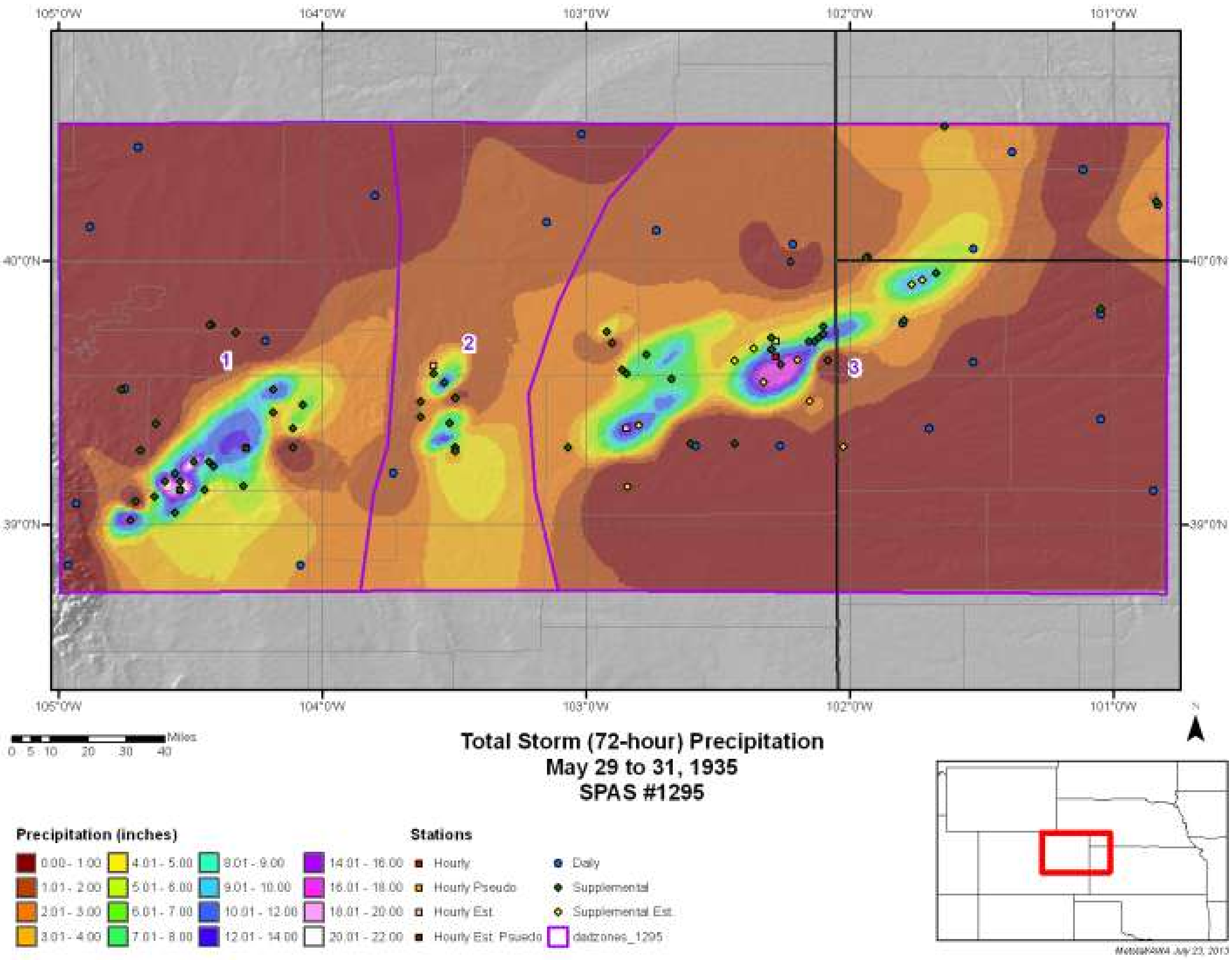
Appendix F: Table F.113: Depth-area-duration values for Cherry Creek-Elbert, CO May 30, 1935



Appendix F: Figure F.141: Depth-area-duration chart for Cherry Creek-Elbert, CO May 30, 1935



Appendix F: Figure F.142: Mass curve chart for Cherry Creek-Elbert, CO May 30, 1935



Appendix F: Figure F.143 Total storm isohyetal analysis Cherry Creek-Elbert, CO May 30, 1935

Hale, CO, AWA 56

May 30, 1935

Storm Type: MCC

Grid Points Used: 5-6, 12, 15, 19-20

Storm Name:	SPAS 1295 DAD Zone 3 Hale, CO		
Storm Date:	5/30/1935		**Storm Adjustment for ANO Grid Point 6**
AWA Analysis Date:	12/15/2013		

Temporal Transposition Date	30-May	
	Lat	Long
Storm center location	39.61 N	102.26 W
Storm Rep dew point location	33.05 N	99.80 W
Transposition dewpoint location	28.00 N	102.15 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	SSE @ 475	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	3,700	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The in-place maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	3,700	which subtracts	0.89	inches of precipitable water at	76.5 F	
The in-place storm elevation is	3,700	which subtracts	0.94	inches of precipitable water at	78.0 F	
The transposition basin elevation at	4,400	which subtracts	1.12	inches of precipitable water at	79.0 F	
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.12	inches of precipitable water at	79.0 F	

The in-place storm maximization factor is	1.08
The transposition/elevation to basin factor is	0.99
The barrier adjustment factor is	1.00
The total adjustment factor is	1.07

Notes: DAD values taken from SPAS 1295 Zone 3. Storm representative dew point value was based on maximum 6-hr average Td values between May 29-30, 1935 at KABI and KSPS. Values were selected in region where temperature did not vary more than a 1-degree over a large area.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	9.1	17.6	17.6	17.6	17.6	17.6	-	-	-
10 sq miles	9.1	17.6	17.6	17.6	17.6	17.6	-	-	-
100 sq miles	7.4	14.9	14.9	14.9	14.9	14.9	-	-	-
200 sq miles	6.1	12.7	12.7	12.7	12.7	12.7	-	-	-
500 sq miles	4.4	9.8	10.2	10.2	10.2	10.2	-	-	-
1000 sq miles	2.7	7.6	8.4	8.4	8.4	8.4	-	-	-
2000 sq miles	1.8	5.7	6.1	6.4	6.4	6.4	-	-	-
5000 sq miles	1.1	2.8	3.8	3.8	3.8	3.9	-	-	-
10000 sq miles	0.7	2.1	2.6	2.7	2.7	2.8	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

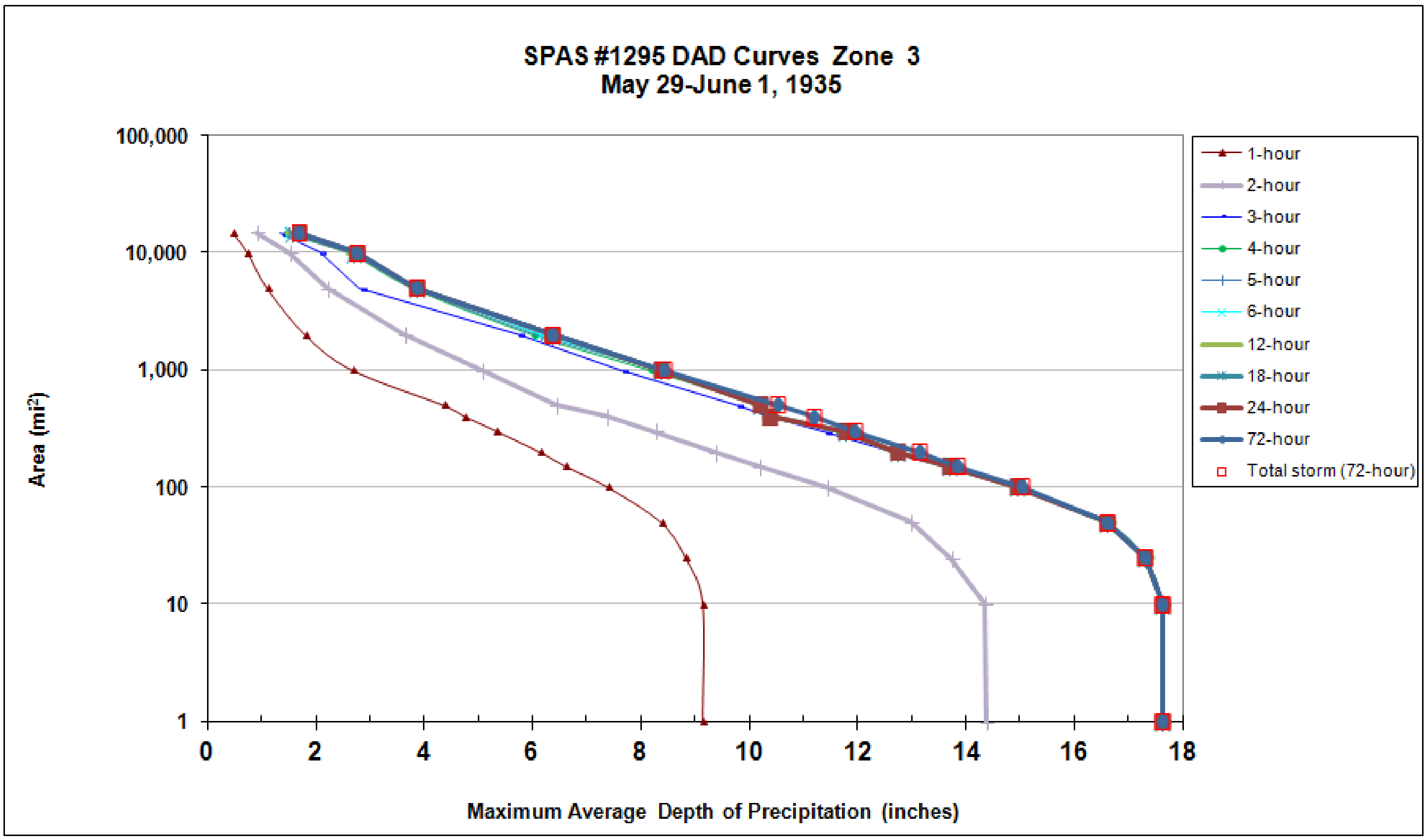
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	9.7	18.8	18.8	18.8	18.8	18.8	-	-	-
10 sq miles	9.7	18.8	18.8	18.8	18.8	18.8	-	-	-
100 sq miles	7.9	15.9	15.9	15.9	15.9	15.9	-	-	-
200 sq miles	6.5	13.5	13.5	13.6	13.6	13.6	-	-	-
500 sq miles	4.6	10.4	10.9	10.9	10.9	10.9	-	-	-
1000 sq miles	2.8	8.1	8.9	8.9	8.9	8.9	-	-	-
2000 sq miles	1.9	6.1	6.5	6.8	6.8	6.8	-	-	-
5000 sq miles	1.2	3.0	4.1	4.1	4.1	4.1	-	-	-
10000 sq miles	0.8	2.2	2.8	2.8	2.8	2.9	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**SPAS 1295 DAD Zone 3 Hale, CO**			
Storm Date(s)	5/30/1935			
Storm Type	Convective			
Storm Location	39.61 N	102.26 W		
Storm Center Elevation	3,700			
Precipitation Total & Duration	18.00 Inches 3-hours			
Storm Representative Dewpoint	76.5 F	6	May	June
Storm Representative Dewpoint Location	33.05 N	99.80 W	76.5	79
Maximum Dewpoint	78.0 F			
Moisture Inflow Vector	SSE @ 475			
In-place Maximization Factor	**1.08**			
Temporal Transposition (Date)	30-May		May	June
Transposition Dewpoint Location	28.00 N	102.15 W	78	79.5
Transposition Maximum Dewpoint	79.0 F			
Transposition Adjustment Factor	**0.99**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.07**			

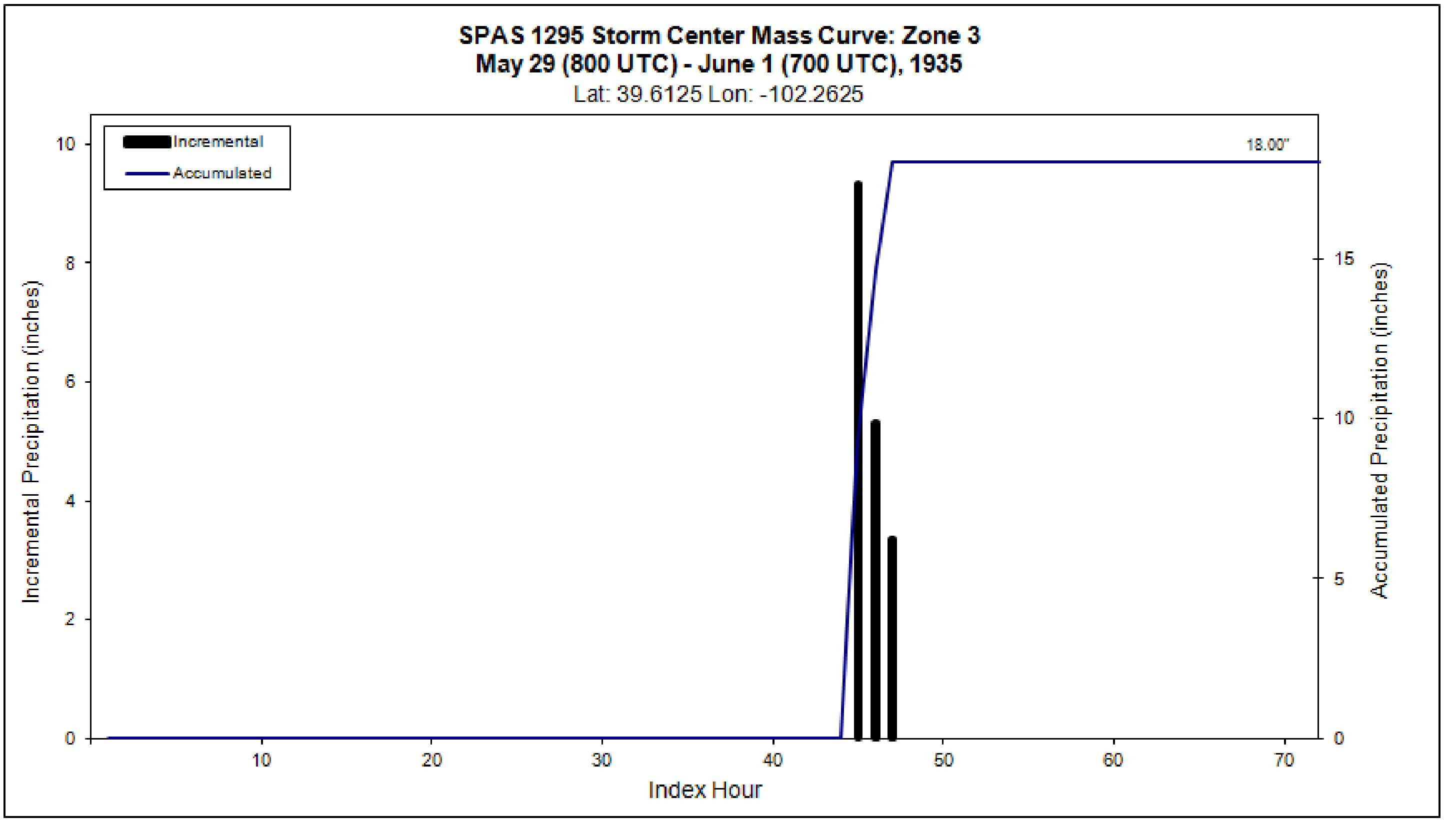
Appendix F: Table F.114: Storm spreadsheet for Hale, CO May 30, 1935

SPAS 1295 - May 29 (800 UTC) - June 1 (700 UTC), 1935 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi²)	1	2	3	4	5	6	12	18	24	72	Total
0.3	9.33	14.64	18	18	18	18	18	18	18	18	**18.00**
1	9.13	14.37	17.62	17.62	17.62	17.62	17.62	17.62	17.62	17.62	**17.62**
10	9.13	14.35	17.62	17.62	17.62	17.62	17.62	17.62	17.62	17.62	**17.62**
25	8.81	13.72	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	**17.30**
50	8.36	12.98	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	**16.60**
100	7.38	11.42	14.92	14.92	14.92	14.92	14.92	14.92	14.92	15.01	**15.01**
150	6.61	10.18	13.62	13.66	13.69	13.69	13.69	13.69	13.69	13.82	**13.82**
200	6.12	9.36	12.65	12.66	12.69	12.7	12.71	12.71	12.71	13.12	**13.12**
300	5.33	8.25	11.39	11.63	11.75	11.75	11.75	11.75	11.75	11.93	**11.93**
400	4.75	7.37	10.33	10.37	10.37	10.37	10.37	10.37	10.37	11.18	**11.18**
500	4.35	6.44	9.76	10.19	10.19	10.19	10.19	10.19	10.19	10.52	**10.52**
1,000	2.66	5.06	7.62	8.17	8.35	8.35	8.37	8.37	8.37	8.4	**8.40**
2,000	1.79	3.62	5.71	6.01	6.11	6.11	6.35	6.35	6.35	6.36	**6.36**
5,000	1.09	2.21	2.79	3.79	3.84	3.84	3.84	3.84	3.85	3.85	**3.85**
10,000	0.73	1.5	2.06	2.6	2.64	2.64	2.67	2.67	2.75	2.75	**2.75**
14,854	0.46	0.9	1.35	1.45	1.48	1.48	1.56	1.56	1.68	1.68	**1.68**

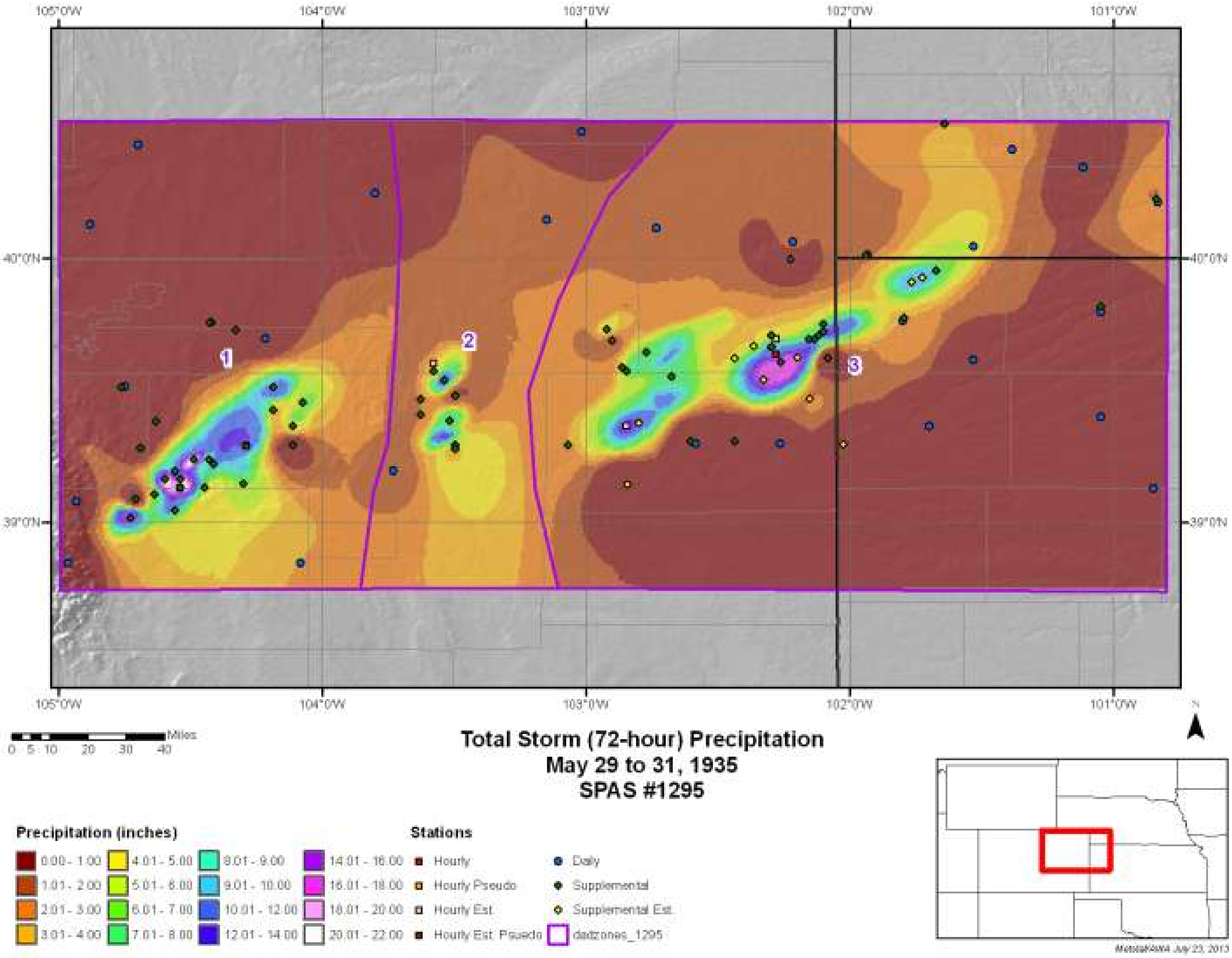
Appendix F: Table F.115: Depth-area-duration values for Hale, CO May 30, 1935



Appendix F: Figure F.144: Total storm isohyetal analysis for Hale, CO May 30, 1935



Appendix F: Figure F.145: Mass curve chart for Hale, CO May 30, 1935



Appendix F: Figure F.146 Total storm isohyetal analysis Hale, CO May 30, 1935

Cheyenne, OK, AWA 57

April 3, 1934

Storm Type: MCC

Grid Points Used: 8, 10-11, 16-18

Storm Name:	USACE SW 2-11-Cheyenne, OK
Storm Date:	03-Apr-1934
AWA Analysis Date:	12/16/2013

Storm Adjustment for ANO Grid Point 8

Temporal Transposition Date: 15-Apr

	Lat	Long
Storm Center Location	35.61 N	99.67 W
Storm Rep Dew Point Location	33.04 N	96.62 W
Transposition Dew Point Location	40.13 N	89.25 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SE @ 250	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,990	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	71.0 F	with total precipitable water above sea level of			2.36	inches.
The in-place maximum dew point is	73.0 F	with total precipitable water above sea level of			2.60	inches.
The transpositioned maximum dew point is	67.0 F	with total precipitable water above sea level of			1.95	inches.
The in-place storm elevation is	1,990	which subtracts	0.42	inches of precipitable water at	71.0 F	
The in-place storm elevation is	1,990	which subtracts	0.45	inches of precipitable water at	73.0 F	
The transposition basin elevation at	1,200	which subtracts	0.19	inches of precipitable water at	67.0 F	
The Grid Point/Inflow barrier height is	1,000	which subtracts	0.19	inches of precipitable water at	67.0 F	

The in-place storm maximization factor is	1.11
The transposition/elevation to basin factor is	0.82
The barrier adjustment factor is	1.00
The total adjustment factor is	0.91

Notes: DAD values taken from USACE Storm Studies SW 2-11. Added 7° to storm rep Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	17.3	20.8	21.3	-	-	-	-	-	-
100 sq miles	14.4	17.1	17.7	-	-	-	-	-	-
200 sq miles	13.3	15.7	16.4	-	-	-	-	-	-
500 sq miles	11.5	13.5	14.0	-	-	-	-	-	-
1000 sq miles	9.1	10.7	11.1	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

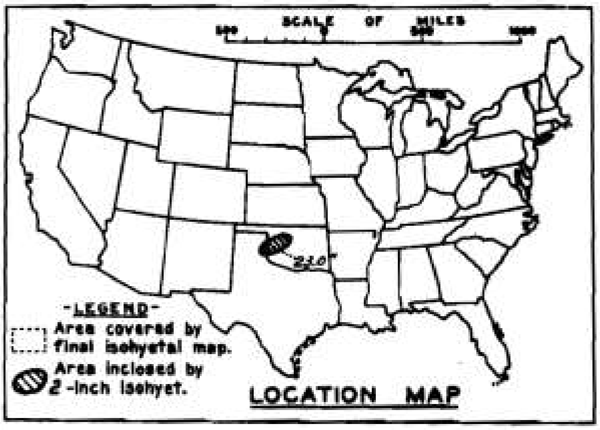
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	15.7	18.9	19.3	-	-	-	-	-	-
100 sq miles	13.1	15.5	16.1	-	-	-	-	-	-
200 sq miles	12.1	14.2	14.9	-	-	-	-	-	-
500 sq miles	10.4	12.2	12.7	-	-	-	-	-	-
1000 sq miles	8.3	9.7	10.1	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	USACE SW 2-11-Cheyenne, OK	
Storm Date(s)	4/3/34	
Storm Type	MCC	
Storm Location	35.61 N	99.67 W
Storm Center Elevation	1,990	
Precipitation Total & Duration	23.00 Inches 12-hours USACE Storm Studies SW 2-11	
Storm Representative Dew Point	71.0 F	12hr average added 7°F to Td as accepted by EPRI Michigan Wisconsin study
Storm Representative Dew Point Location	33.04 N	96.62 W
Maximum Dew Point	73.0 F	
Moisture Inflow Vector	SE @ 250	
In-place Maximization Factor	1.11	
Temporal Transposition (Date)	15-Apr	
Transposition Dew Point Location	40.13 N	89.25 W
Transposition Maximum Dew Point	67.0 F	
Transposition Adjustment Factor	0.82	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	0.91	

Appendix F: Table F.116: Storm spreadsheet for Cheyenne, OK April 3, 1934

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES – PERTINENT DATA SHEET



Storm of 3-4 April 1934
Assignment SW 2-11
Location Oklahoma and Texas
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 7/22/46
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 8/19/47
Remarks: Center near Cheyenne, Oklahoma
Dewpt. 64°- Ref. Pt. 250 SE
Grid G-17

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:250,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	2
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	7
Miscl. precip. records, meteorological data, etc. (Supplemental Folder)	112
Form 5002 (Mass rainfall curves)	21

PART II

Final isohyetal maps, in 1 sheet, scale 1:250,000

Data and computation sheets:

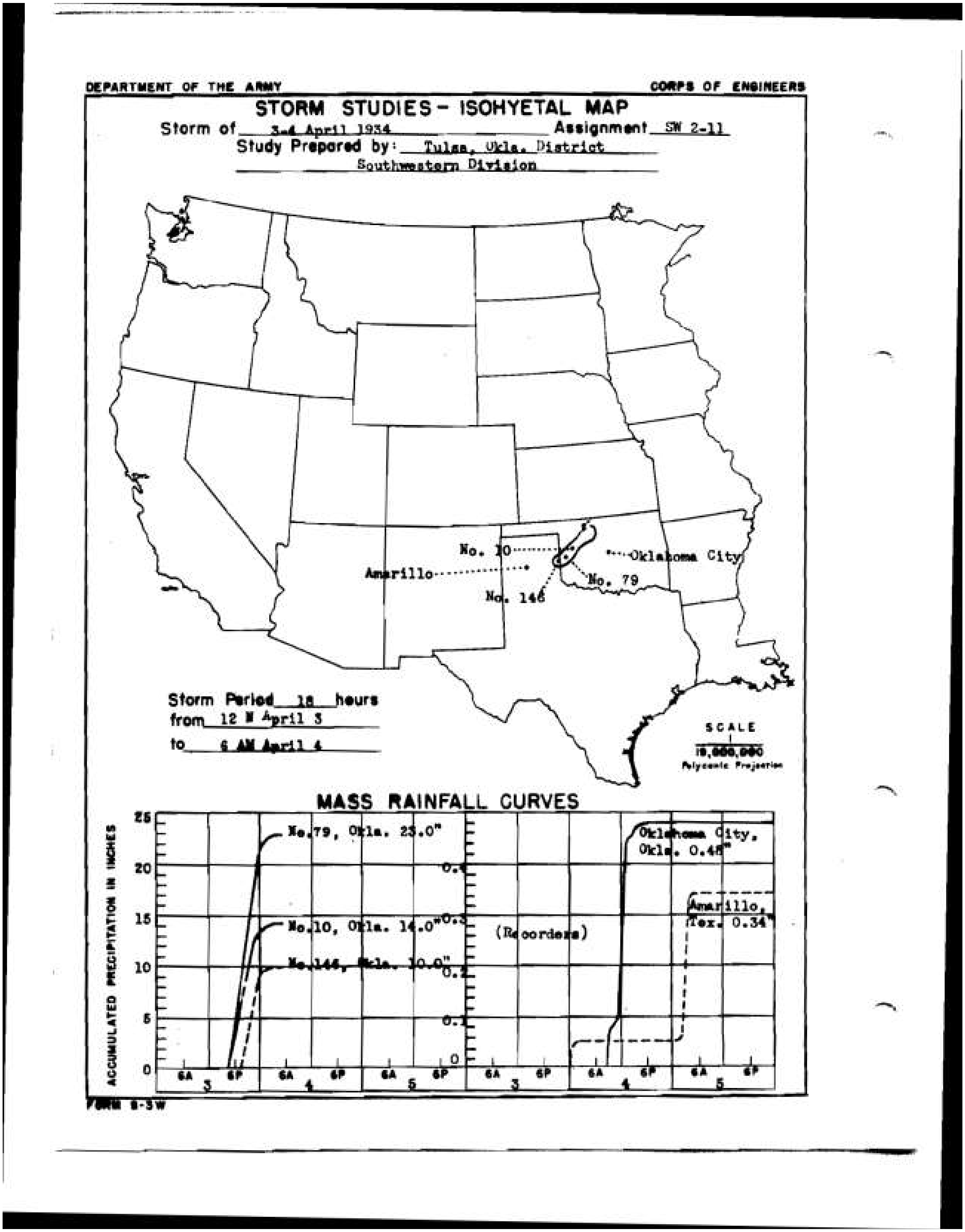
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	4
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	1

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18								
Max. Station	20.0	23.0	23.0								
10	17.3	20.8	21.3								
100	14.4	17.1	17.7								
200	13.3	15.7	16.4								
500	11.5	13.5	14.0								
1,000	9.1	10.7	11.1								
2,000	6.2	7.3	7.5								
2,200	5.8	6.9	7.1								

Form S-2

Appendix F: Table F.117: Depth-area-duration values for Cheyenne, OK April 3, 1934



Appendix F: Figure F.147 and Figure F.148: Total storm isohyetal analysis and mass curve chart for Cheyenne, OK April 3, 1934

Fairfield, TX, AWA 58

August 30, 1932

Storm Type: MCC

Grid Points Used: 1-3, 8-10

Storm Name:	USACE GM 5-16A-Fairfield, TX	Storm Adjustment for ANO Grid Point 1
Storm Date:	9/3-5/1932	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	20-Aug	
	Lat	Long
Storm center location	31.73 N	96.17 W
Storm Rep SST location	27.00 N	97.55 W
Transposition SST location	28.60 N	99.60 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	S @ 340	miles
Grid Point Elevation	350	feet
Storm Center Elevation	450	feet
Storm Rep Analysis Duration	12	hours

The storm representative SST is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum SST is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The transpositioned maximum SST is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	450	which subtracts	0.12	inches of precipitable water at	76.0 F	
The in-place storm elevation is	450	which subtracts	0.135	inches of precipitable water at	79.0 F	
The transposition storm elevation at	350	which subtracts	0.295	inches of precipitable water at	79.0 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.295	inches of precipitable water at	79.0 F	

The in-place maximization factor is	1.15
The transposition factor is	0.95
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.10

Notes: USACE states an inflow of South @ 340 miles for the storm rep dew point location, however, this would be over the Gulf of Mexico, more likely this is an overgeneralization of the inflow vector and the location of the storm rep was from the Corpus Christi area.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.0	13.8	16.4	18.3	18.9	19.3	19.5	-	19.5
100 sq miles	8.2	12.8	15.9	18.0	18.4	18.5	18.7	-	18.7
200 sq miles	7.6	12.4	15.5	17.4	17.9	17.9	18.1	-	18.1
500 sq miles	6.9	11.8	14.6	16.2	16.6	16.6	16.8	-	16.8
1000 sq miles	6.3	11.0	13.6	14.8	15.0	15.1	15.2	-	15.2
2000 sq miles	5.8	9.8	11.9	12.8	13.0	13.1	13.1	-	13.2
5000 sq miles	4.2	6.5	8.1	8.8	9.7	10.0	10.3	-	10.4
10000 sq miles	2.5	4.3	5.4	6.4	7.4	7.8	8.3	-	8.4
20000 sq miles	1.6	2.7	3.7	4.5	5.3	5.9	5.9	-	6.6

Adjusted Storm Depth-Area-Duration

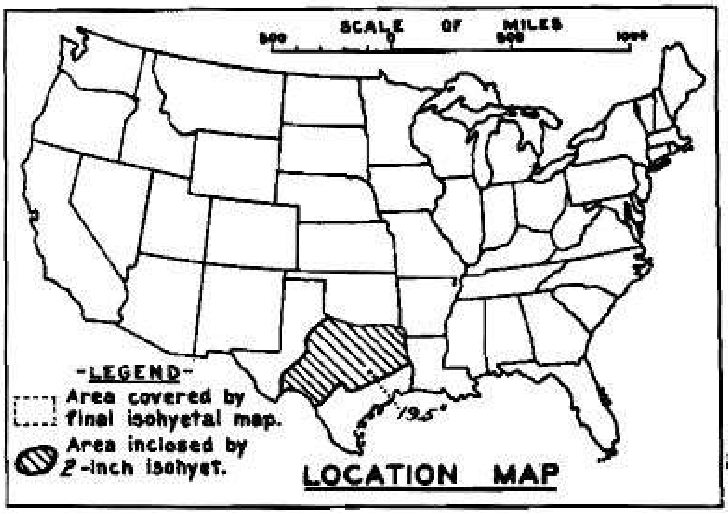
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	11.0	15.1	18.0	20.1	20.7	21.1	21.4	-	21.4
100 sq miles	9.0	14.0	17.4	19.7	20.2	20.3	20.5	-	20.5
200 sq miles	8.3	13.6	17.0	19.1	19.6	19.6	19.8	-	19.8
500 sq miles	7.6	12.9	16.0	17.8	18.2	18.2	18.4	-	18.4
1000 sq miles	6.9	12.1	14.9	16.2	16.4	16.5	16.7	-	16.7
2000 sq miles	6.4	10.7	13.0	14.0	14.2	14.4	14.4	-	14.5
5000 sq miles	4.6	7.1	8.9	9.6	10.6	11.0	11.3	-	11.4
10000 sq miles	2.7	4.7	5.9	7.0	8.1	8.5	9.1	-	9.2
20000 sq miles	1.8	3.0	4.1	4.9	5.8	6.5	6.5	-	7.2

Storm or Storm Center Name	USACE GM 5-16A-Fairfield, TX			
Storm Date(s)	9/3-5/1932			
Storm Type	MCC			
Storm Location	31.73 N	96.17 W		
Storm Center Elevation	450			
Precipitation Total & Duration (10 sq mi)	19.5 inches in 48 hours, 18.3" in 24 hours			
Storm Representative SST	76.0 F			
Storm Representative SST Location	27.00 N	97.55 W	A	S
In-place Maximum SST	79.0 F		79	79
Moisture Inflow Vector	S @ 340			
In-place Maximization Factor				
Temporal Transposition (Date)	20-Aug			
Transposition Dewpoint Location	28.60 N	99.60 W	A	S
Transposition Maximum SST	79.0 F		79	78
Transposition Adjustment Factor				
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height				
Elevation Adjustment Factor				
Total Adjustment Factor	1.10			

Appendix F: Table F.118: Storm spreadsheet for Fairfield, TX August 30, 1932

DEPARTMENT OF THE ARMY — CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 30 Aug-5 Sept 1932
Assignment GM 5-16A
Location Texas
Study Prepared by:
Southwestern Division
Galveston District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 5-22-44
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 12/2/47
Remarks: Centers at Fairfield and near Rock Springs, Texas
Dewpt. 76° - Ref. Pt. 340 S Grid I-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	20
Form 5001-B (24-hour " ")	79
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	16
Form 5002 (Mass rainfall curves)	53

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

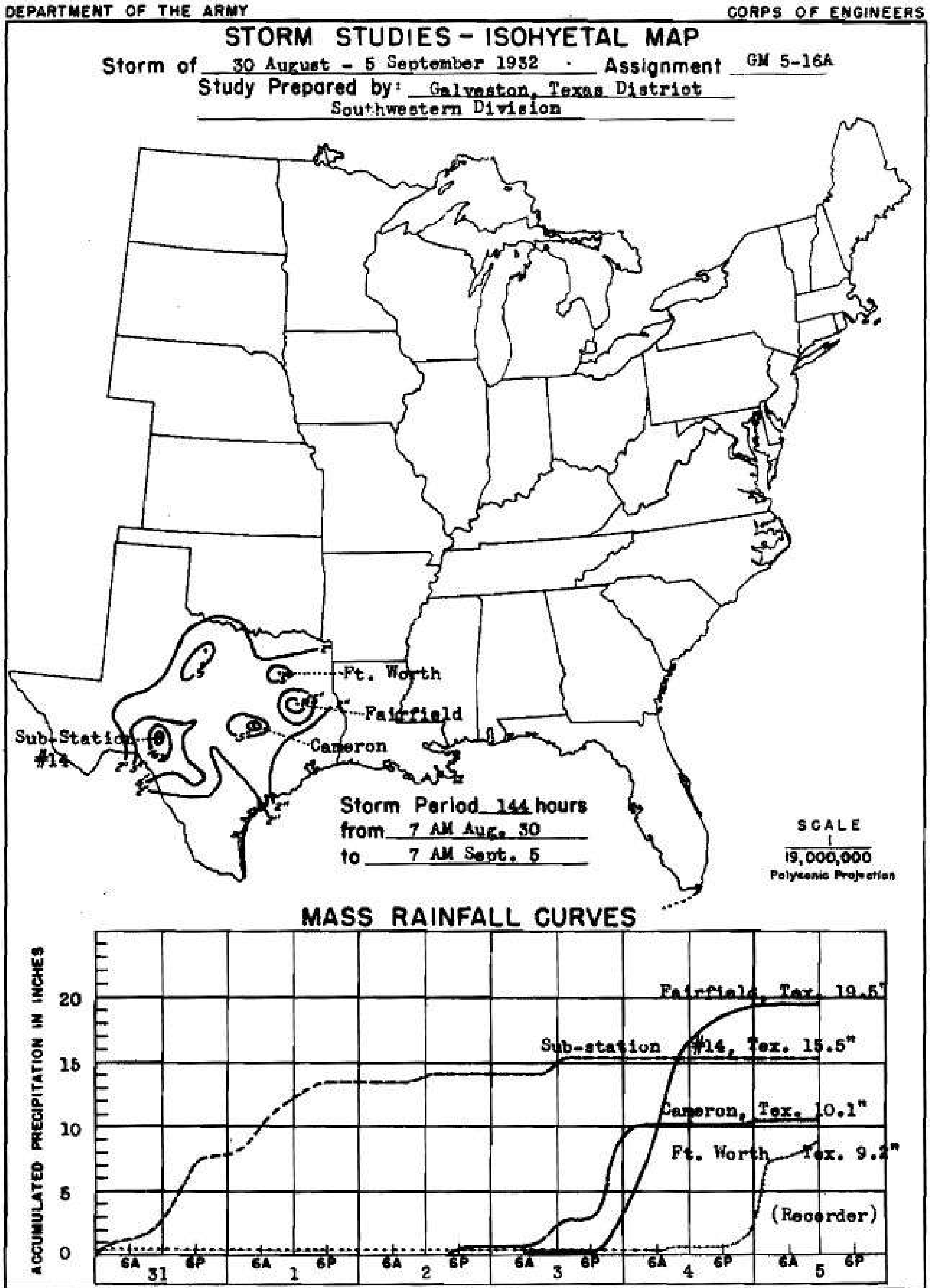
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	5
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	72	96	120	144
10	10.0	13.8	16.4	18.3	18.9	19.3	19.5	19.5	19.5	19.5	19.5
100	8.2	12.8	15.9	18.0	18.4	18.5	18.7	18.7	18.7	18.7	18.7
200	7.6	12.4	15.5	17.4	17.9	17.9	18.1	18.1	18.1	18.1	18.1
500	6.9	11.8	14.6	16.2	16.6	16.6	16.8	16.8	16.8	16.8	16.8
1,000	6.3	11.0	13.6	14.8	15.0	15.1	15.2	15.2	15.2	15.2	15.2
2,000	5.8	9.8	11.9	12.8	13.0	13.1	13.1	13.2	13.5	13.6	13.7
5,000	4.2	6.5	8.1	8.8	9.7	10.0	10.3	10.4	10.8	11.3	11.6
10,000	2.5	4.3	5.4	6.4	7.4	7.8	8.3	8.4	8.8	9.3	9.7
20,000	1.6	2.7	3.7	4.5	5.3	5.9	6.4	6.6	7.0	7.5	7.9
50,000	0.7	1.3	2.0	2.5	3.0	3.6	4.3	4.7	5.0	5.3	5.8
116,000	0.4	0.7	-1.0	1.3	1.5	1.7	1.9	2.3	3.0	3.9	4.4

Form S-2

Appendix F: Table F.119: Depth-area-duration values for Fairfield, TX August 30, 1932



Appendix F: Figure F.149 and Figure F.150: Total storm isohyetal analysis and mass curve chart for Fairfield, TX August 30, 1932

Porter, NM, AWA 59

October 9, 1930

Storm Type: Frontal/Tropical

Grid Points Used: 5-6, 12-13

Storm Name:	Porter, NM USACE SW 2-6	**Storm Adjustment for ANO Grid Point 6**
Storm Date:	10/9-12/1930	
AWA Analysis Date:	12/21/2013	

Temporal Transposition Date 25-Sep

	Lat	Long
Storm center location	35.20 N	103.28 W
Storm Rep dew point location	31.25 N	98.75 W
Transposition dewpoint location	31.95 N	97.95 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	SE @ 380	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	4,120	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	73.0 F	with total precipitable water above sea level of			2.60	inches.
The in-place maximum dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The transpositioned maximum dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place storm elevation is	4,120	which subtracts	0.86	inches of precipitable water at	73.0 F	
The in-place storm elevation is	4,120	which subtracts	0.99	inches of precipitable water at	77.0 F	
The transposition basin elevation at	4,400	which subtracts	1.05	inches of precipitable water at	77.0 F	
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.05	inches of precipitable water at	77.0 F	

The in-place storm maximization factor is	1.24
The transposition/elevation to basin factor is	0.97
The barrier adjustment factor is	1.00
The total adjustment factor is	1.20

Notes: DAD values taken from SW 2-6. Added 2°F to USACE storm rep to convert ot average maximum Td climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	5.7	6.3	8.5	9.9	9.9	9.9	9.9	9.9	-
100 sq miles	5.3	5.9	7.6	9.1	9.1	9.1	9.1	9.1	-
200 sq miles	5.1	5.7	7.2	8.7	8.7	8.7	8.7	8.7	-
500 sq miles	4.6	5.3	6.5	7.9	8.0	8.0	8.0	8.0	-
1000 sq miles	4.1	4.9	6.0	7.2	7.3	7.4	7.4	7.4	-
2000 sq miles	3.6	4.4	5.4	6.5	6.6	6.7	6.8	6.8	-
5000 sq miles	2.9	3.7	4.6	5.4	5.5	5.8	5.9	5.9	-
10000 sq miles	2.3	3.2	3.9	4.5	4.7	5.1	5.2	5.2	-
20000 sq miles	1.7	2.5	3.2	3.6	3.9	4.3	4.4	4.4	-

Adjusted Storm Depth-Area-Duration

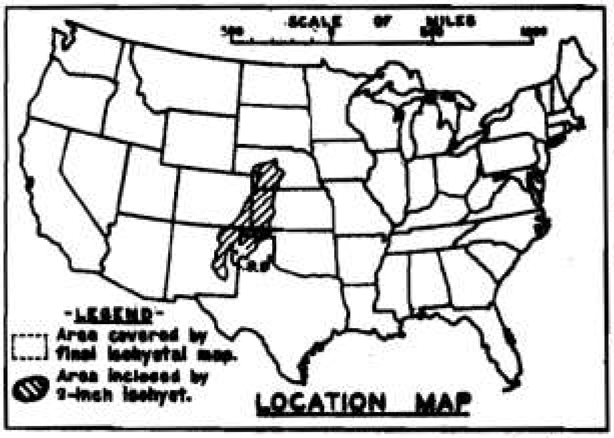
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	6.8	7.6	10.2	11.9	11.9	11.9	11.9	11.9	-
100 sq miles	6.4	7.1	9.1	10.9	10.9	10.9	10.9	10.9	-
200 sq miles	6.1	6.8	8.6	10.5	10.5	10.5	10.5	10.5	-
500 sq miles	5.5	6.4	7.8	9.5	9.6	9.6	9.6	9.6	-
1000 sq miles	4.9	5.9	7.2	8.6	8.8	8.9	8.9	8.9	-
2000 sq miles	4.3	5.3	6.5	7.8	7.9	8.0	8.2	8.2	-
5000 sq miles	3.5	4.4	5.5	6.5	6.6	7.0	7.1	7.1	-
10000 sq miles	2.8	3.8	4.7	5.4	5.6	6.1	6.2	6.2	-
20000 sq miles	2.0	3.0	3.8	4.3	4.7	5.2	5.3	5.3	-

Storm or Storm Center Name	**Porter, NM USACE SW 2-6**			
Storm Date(s)	10/9-12/1930			
Storm Type	Synoptic			
Storm Location	35.20 N	103.28 W		
Storm Center Elevation	4,120			
Precipitation Total & Duration	9.90 Inches 60-hours			
Storm Representative Dewpoint	73.0 F	24	DRT, AUS, FTW, ABI	
Storm Representative Dewpoint Location	31.25 N	98.75 W		
Maximum Dewpoint	77.0 F			
Moisture Inflow Vector	SE @ 380		Sept	Oct
In-place Maximization Factor	**1.24**		77.5	76
Temporal Transposition (Date)	25-Sep			
Transposition Dewpoint Location	31.95 N	97.95 W		
Transposition Maximum Dewpoint	77.0 F			
Transposition Adjustment Factor	**0.97**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	4,400			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.20**			

Appendix F: Table F.120: Storm spreadsheet for Porter, NM October 9, 1930

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of 9-12 October 1930
Assignment S W 2 - 6
Location N.M., Colo., Kans., Nebr., Tex., & Okla.
Study Prepared by: Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 5/6/43
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/26/45
Remarks: Center at: Porter, New Mexico

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:1,000,000
Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) ---------- 2
- Form 5001-B (24-hour " ") ---------- -
- Form 5001-D (" " " ") ---------- 6
- Miscl. precip. records, meteorological data, etc. ---------- 1
- Form 5002 (Mass rainfall curves) ---------- 12

PART II

Final isohyetal maps, in 1 sheet , scale 1:1,000,000
Data and computation sheets:

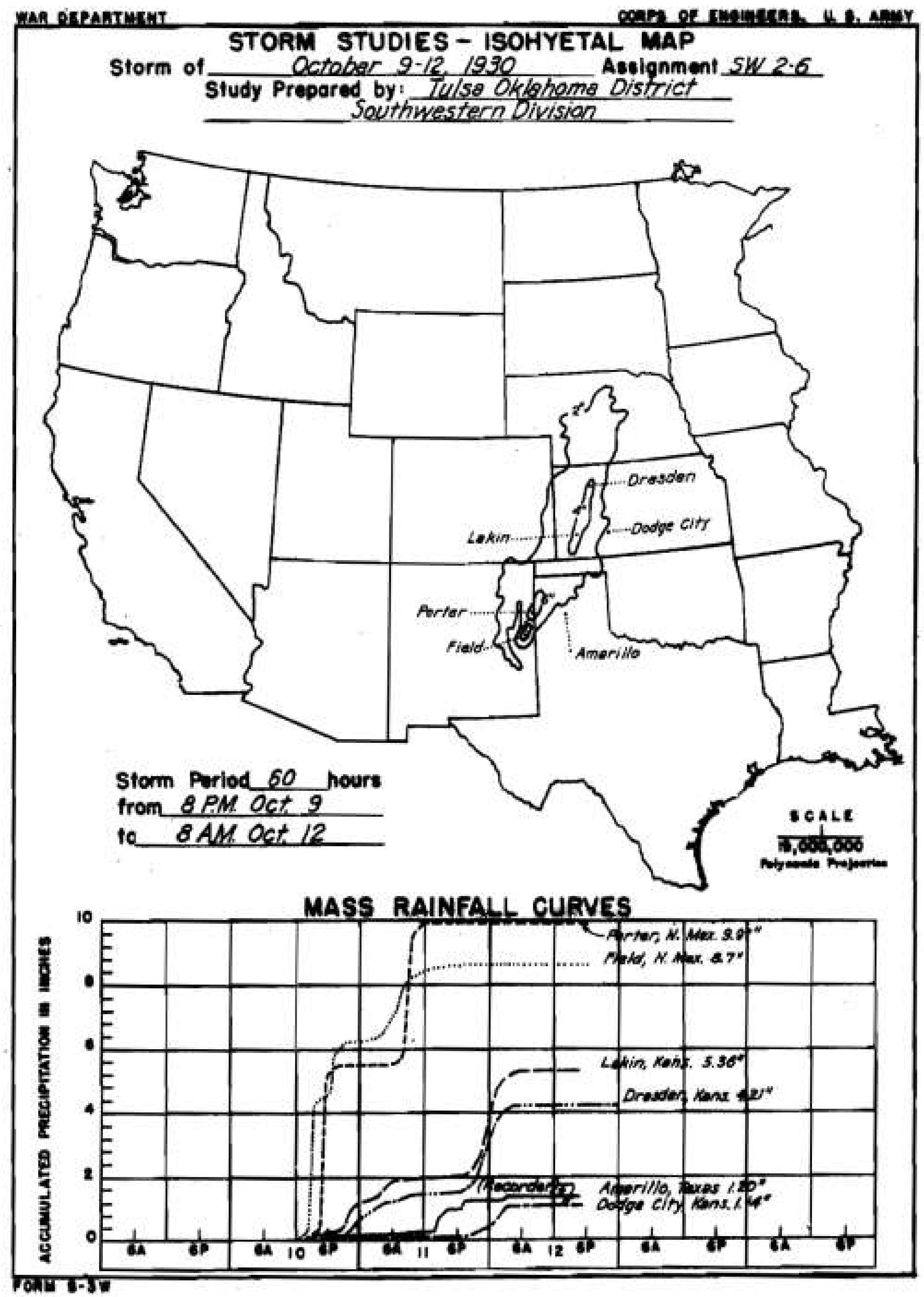
- Form S-10 (Data from mass rainfall curves) ---------- 5
- Form S-11 (Depth-area data from isohyetal map) ---------- 2
- Form S-12 (Maximum depth-duration data) ---------- 6
- Maximum duration-depth-area curves ---------- 1
- Data relating to periods of maximum rainfall ---------- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6.	12	18	24	30	36	48	60			
10	5.7	6.3	8.5	9.9	9.9	9.9	9.9	9.9			
100	5.3	5.9	7.6	9.1	9.1	9.1	9.1	9.1			
200	5.1	5.7	7.2	8.7	8.7	8.7	8.7	8.7			
500	4.6	5.3	6.5	7.9	8.0	8.0	8.0	8.0			
1,000	4.1	4.9	6.0	7.2	7.3	7.4	7.4	7.4			
2,000	3.6	4.4	5.4	6.5	6.6	6.7	6.8	6.8			
5,000	2.9	3.7	4.6	5.4	5.5	5.8	5.9	5.9			
10,000	2.3	3.2	3.9	4.5	4.7	5.1	5.2	5.2			
20,000	1.7	2.5	3.2	3.6	3.9	4.3	4.4	4.4			
27,700	1.1	2.1	2.8	3.1	3.5	4.0	4.1	4.1			

Form S-2

Appendix F: Table F.121: Depth-area-duration values for Porter, NM October 9, 1930



Appendix F: Figure F.151 and Figure F.152: Total storm isohyetal analysis and mass curve chart for Porter, NM October 9, 1930

Boyden, IA, AWA 60, MR 4-24

September 17, 1926

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	Boyden, IA MR4-24	**Storm Adjustment for ANO Grid Point 1**	
Storm Date:	17-Sep-1926		
AWA Analysis Date:	12/21/2013		

Temporal Transposition Date: 3-Sep

	Lat	Long
Storm Center Location	43.19 N	96.01 W
Storm Rep Dew Point Location	40.85 N	94.75 W
Transposition Dew Point Location	40.39 N	91.33 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSE @ 175	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,400	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	77.5 F	with total precipitable water above sea level of			3.22	inches.
The in-place storm elevation is	1,400	which subtracts	0.37	inches of precipitable water at	77.0 F	
The in-place storm elevation is	1,400	which subtracts	0.39	inches of precipitable water at	78.5 F	
The transposition basin elevation at	350	which subtracts	0.28	inches of precipitable water at	77.5 F	
The Grid Point/inflow barrier height is	350	which subtracts	0.28	inches of precipitable water at	77.5 F	

The in-place storm maximization factor is	1.07
The transposition/elevation to basin factor is	0.99
The barrier adjustment factor is	1.00
The total adjustment factor is	1.06

Notes: DAD values taken from USACE MR 4-24. Storm representative dew point value was based on adding 7° to the USACE analysis following standard guidance.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	18.4	23.8	24.0	24.0	24.0	24.0	24.0	-	-
10 sq miles	15.1	20.7	21.7	21.7	21.7	21.7	21.7	-	-
100 sq miles	12.8	17.1	17.8	17.8	17.8	17.8	17.8	-	-
200 sq miles	11.7	15.8	16.6	16.6	16.6	16.6	16.6	-	-
500 sq miles	9.4	12.6	13.3	13.3	13.3	13.3	13.3	-	-
1000 sq miles	7.5	10.1	10.4	10.6	10.6	10.6	10.6	-	-
2000 sq miles	5.9	8.0	8.2	8.6	8.6	8.6	8.6	-	-
5000 sq miles	4.1	6.3	6.4	6.6	6.6	6.6	6.6	-	-
10000 sq miles	3.0	5.2	5.4	5.5	5.6	5.6	5.6	-	-
20000 sq miles	2.1	4.1	4.3	4.4	4.6	4.8	4.9	-	-

Adjusted Storm Depth-Area-Duration

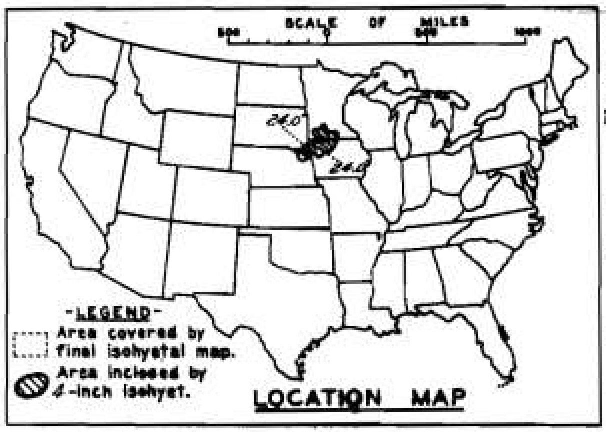
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	19.5	25.2	25.4	25.4	25.4	25.4	25.4	-	-
10 sq miles	16.0	21.9	23.0	23.0	23.0	23.0	23.0	-	-
100 sq miles	13.6	18.1	18.9	18.9	18.9	18.9	18.9	-	-
200 sq miles	12.4	16.7	17.6	17.6	17.6	17.6	17.6	-	-
500 sq miles	10.0	13.4	14.1	14.1	14.1	14.1	14.1	-	-
1000 sq miles	7.9	10.7	11.0	11.2	11.2	11.2	11.2	-	-
2000 sq miles	6.3	8.5	8.7	9.1	9.1	9.1	9.1	-	-
5000 sq miles	4.3	6.7	6.8	7.0	7.0	7.0	7.0	-	-
10000 sq miles	3.2	5.5	5.7	5.8	5.9	5.9	5.9	-	-
20000 sq miles	2.2	4.3	4.6	4.7	4.9	5.1	5.2	-	-

Storm or Storm Center Name	**Boyden, IA MR4-24**			
Storm Date(s)	17-Sep-1926			
Storm Type	MCC			
Storm Location	43.19 N	96.01 W		
Storm Center Elevation	1,400			
Precipitation Total & Duration	24.00 Inches 18-hours USACE Storm Studies MR 4-24			
Storm Representative Dewpoint	77.0 F	12		
Storm Representative Dewpoint Location	40.85 N	94.75 W	Aug	Sep
Maximum Dewpoint	78.5 F		81	76
Moisture Inflow Vector	SSE @ 175			
In-place Maximization Factor	**1.07**			
Temporal Transposition (Date)	3-Sep			
Transposition Dewpoint Location	40.39 N	91.33 W	Aug	Sep
Transposition Maximum Dewpoint	77.5 F		80.5	76
Transposition Adjustment Factor	**0.99**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	N/A			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.06**			

Appendix F: Table F.122: Storm spreadsheet for Boyden, IA September 17, 1926

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 17-19 September 1926
Assignment MR 4-24
Location Ia,Minn,Nebr.S.D. & Wisc
Study Prepared by:
Missouri River Division
Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/5/47
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 12/23/47
Remarks: Centers near Boyden & Maurice, Ia.
Dewpt. 70° - Ref. Pt. 175 SSE Grid C-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:500,000

Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) 8
- Form 5001-B (24-hour " ") .... -
- Form 5001-D (" " " ") 11
- Miscl. precip. records, meteorological data, etc. 29
- Form 5002 (Mass rainfall curves) 27

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

Data and computation sheets:

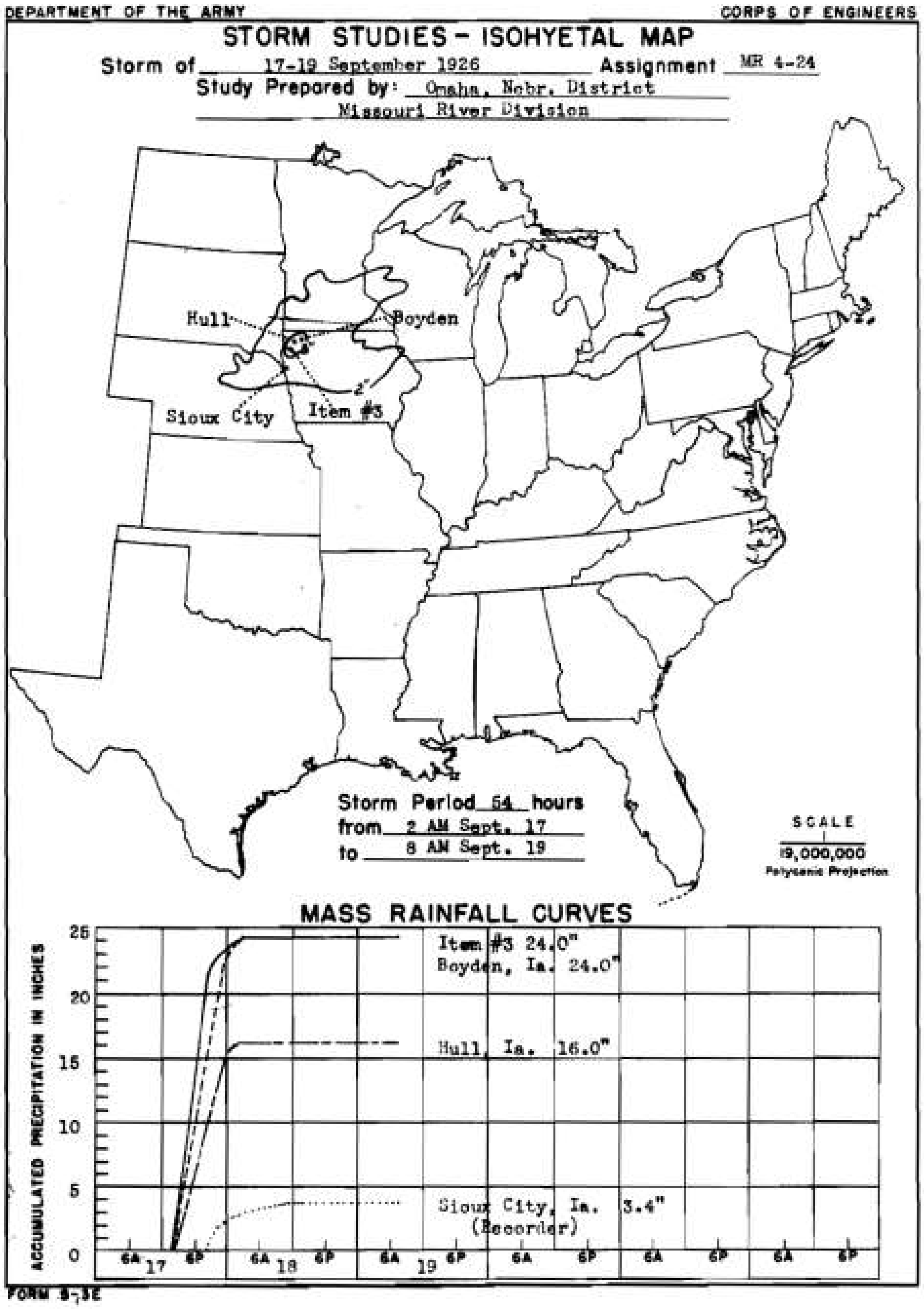
- Form S-10 (Data from mass rainfall curves) 3
- Form S-11 (Depth-area data from isohyetal map) 2
- Form S-12 (Maximum depth-duration data) 17
- Maximum duration-depth-area curves 1
- Data relating to periods of maximum rainfall 7

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours							
	6	12	18	24	30	36	48	54
Max.Station	18.4	23.8	24.0	24.0	24.0	24.0	24.0	24.0
10	15.1	20.7	21.7	21.7	21.7	21.7	21.7	21.7
100	12.8	17.1	17.8	17.8	17.8	17.8	17.8	17.8
200	11.7	15.8	16.6	16.6	16.6	16.6	16.6	16.6
500	9.4	12.6	13.3	13.3	13.3	13.3	13.3	13.3
1,000	7.5	10.1	10.4	10.6	10.6	10.6	10.6	10.6
2,000	5.9	8.0	8.2	8.6	8.6	8.6	8.6	8.6
5,000	4.1	6.3	6.4	6.6	6.6	6.6	6.6	6.6
10,000	3.0	5.2	5.4	5.5	5.6	5.6	5.6	5.6
20,000	2.1	4.1	4.3	4.4	4.6	4.8	4.9	4.9
50,000	1.4	2.7	2.9	3.0	3.2	3.6	3.8	3.8
63,000	1.2	2.4	2.6	2.7	2.9	3.3	3.5	3.5

Form S-2

Appendix F: Table F.123: Depth-area-duration values for Boyden, IA September 17, 1926



Appendix F: Figure F.153 and Figure F.154: Total storm isohyetal analysis and mass curve chart for Boyden, IA September 17, 1926

Neosho Falls, KS, AWA 61

September 12, 1926

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	USACE SW 2-1-Neosha Falls, KS	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	11-Sep-1926	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	25-Aug	
	Lat	Long
Storm Center Location	38.08 N	95.70 W
Storm Rep Dew Point Location	31.35 N	93.80 W
Transposition Dew Point Location	36.00 N	90.58 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSE @ 475	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The in-place storm elevation is	1,000	which subtracts	0.25	inches of precipitable water at	75.0 F	
The in-place storm elevation is	1,000	which subtracts	0.28	inches of precipitable water at	80.5 F	
The transposition basin elevation at	350	which subtracts	0.29	inches of precipitable water at	79.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	79.5 F	

The in-place storm maximization factor is	1.31
The transposition/elevation to basin factor is	0.95
The barrier adjustment factor is	1.00
The total adjustment factor is	1.24

Notes: DAD values taken from USACE SW 2-1. Storm representative dew point value was based on maximum 6-hr Td values between September 1, 1926 at WBAN 93936 and 12945.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	13.6	13.8	14.0	14.0	14.0	14.0	14.0	14.0	14.0
10 sq miles	13.4	13.7	13.9	13.9	13.9	13.9	13.9	13.9	13.9
100 sq miles	12.2	12.5	12.7	12.7	12.7	12.7	12.7	12.7	12.7
200 sq miles	11.4	11.7	11.9	12.0	12.0	12.0	12.0	12.0	12.0
500 sq miles	9.5	10.0	10.2	10.2	10.2	10.2	10.2	10.2	10.2
1000 sq miles	7.9	8.5	8.8	8.8	8.8	8.8	8.8	8.8	8.8
2000 sq miles	6.4	7.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3
5000 sq miles	4.3	5.1	5.3	5.3	5.3	5.3	5.3	5.5	5.5
10000 sq miles	2.9	3.8	3.9	4.0	4.0	4.0	4.2	4.3	4.4
20000 sq miles	1.7	2.6	2.7	2.8	2.8	2.8	2.9	3.3	3.5

Adjusted Storm Depth-Area-Duration

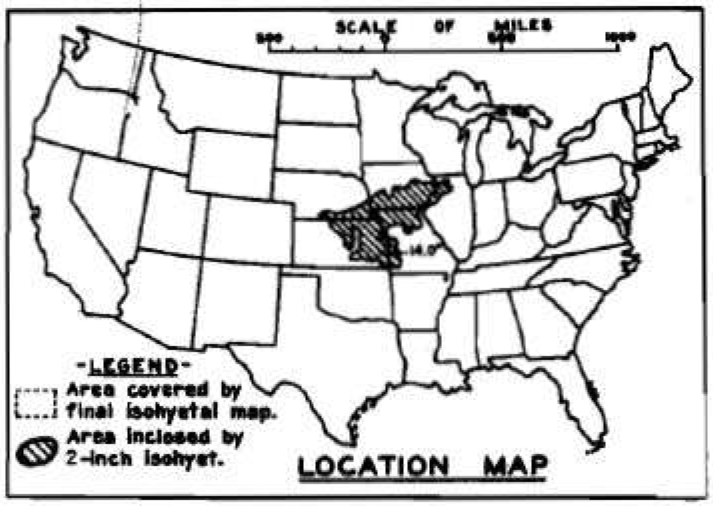
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	16.9	17.1	17.4	17.4	17.4	17.4	17.4	17.4	17.4
10 sq miles	16.6	17.0	17.3	17.3	17.3	17.3	17.3	17.3	17.3
100 sq miles	15.2	15.5	15.8	15.8	15.8	15.8	15.8	15.8	15.8
200 sq miles	14.2	14.5	14.8	14.9	14.9	14.9	14.9	14.9	14.9
500 sq miles	11.8	12.4	12.7	12.7	12.7	12.7	12.7	12.7	12.7
1000 sq miles	9.8	10.6	10.9	10.9	10.9	10.9	10.9	10.9	10.9
2000 sq miles	8.0	8.8	9.1	9.1	9.1	9.1	9.1	9.1	9.1
5000 sq miles	5.3	6.3	6.6	6.6	6.6	6.6	6.6	6.8	6.8
10000 sq miles	3.6	4.7	4.8	5.0	5.0	5.0	5.2	5.3	5.5
20000 sq miles	2.1	3.2	3.4	3.5	3.5	3.5	3.6	4.1	4.3

Storm or Storm Center Name	**USACE SW 2-1-Neosha Falls, KS**			
Storm Date(s)	9/11/26			
Storm Type	MCC-Thunderstorm Complex			
Storm Location	38.08 N	95.70 W		
Storm Center Elevation	1,000			
Precipitation Total & Duration	14.00 Inches 18-hours			
Storm Representative Dewpoint	75.0 F	6		
Storm Representative Dewpoint Location	31.35 N	93.80 W	Aug	Sep
Maximum Dewpoint	80.5 F		79.5	78.5
Moisture Inflow Vector	SSE @ 475			
In-place Maximization Factor	**1.31**			
Temporal Transposition (Date)	25-Aug			
Transposition Dewpoint Location	36.00 N	90.58 W	Aug	Sep
Transposition Maximum Dewpoint	79.5 F		81	77
Transposition Adjustment Factor	**0.95**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.24**			

Appendix F: Table F.124: Storm spreadsheet for Neosho Falls, KS September 12, 1926

WAR DEPARTMENT — CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of September 11-16, 1926
Assignment S W 2 - 1
Location Kans. Nebr. Iowa Mo.
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 1/31/41
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 6/5/45
Remarks: Center near Neosho Falls, Kans.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 2,500,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	8
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	6
Miscl. precip. records, meteorological data, etc.	2
Form 5002 (Mass rainfall curves)	17

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

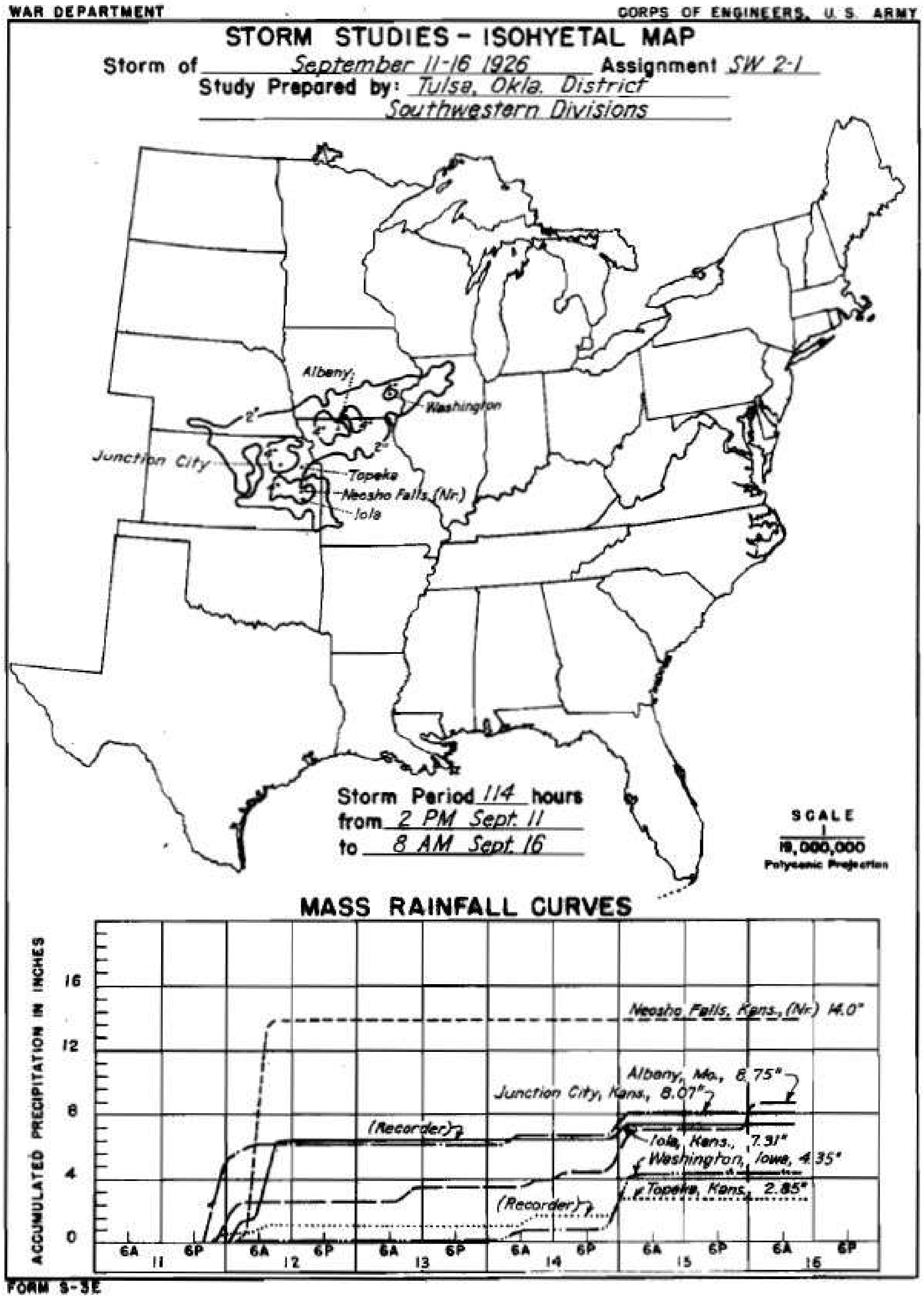
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	10
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	6
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	114
Max. Station	13.6	13.8	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
10	13.4	13.7	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
100	12.2	12.5	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
200	11.4	11.7	11.9	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
500	9.5	10.0	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.4	10.4
1,000	7.9	8.5	8.8	8.8	8.8	8.8	8.8	8.8	8.8	9.0	9.0
2,000	6.4	7.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.6	7.6
5,000	4.3	5.1	5.3	5.3	5.3	5.3	5.3	5.5	5.5	5.8	5.8
10,000	2.9	3.8	3.9	4.0	4.0	4.0	4.2	4.3	4.4	5.0	5.0
20,000	1.7	2.6	2.7	2.8	2.8	2.8	2.9	3.3	3.5	4.4	4.5
30,000	1.2	2.0	2.1	2.2	2.2	2.2	2.3	2.8	3.0	4.1	4.2

Form S-2

Appendix F: Table F.125: Depth-area-duration values for Neosho Falls, KS September 12, 1926



Appendix F: Figure F.155 and Figure F.156: Total storm isohyetal analysis and mass curve chart for Neosho Falls, KS September 12, 1926

Penrose, CO, AWA 62

June 2, 1921

Storm Type: MCC

Grid Points Used: 6, 13, 15, 21

Storm Name:	SPAS 1294 Penrose, CO		**Storm Adjustment for ANO Grid Point 6**
Storm Date:	6/3-4/1921		
AWA Analysis Date:	12/16/2013		

Temporal Transposition Date	20-Jun	
	Lat	Long
Storm center location	38.46 N	105.07 W
Storm Rep dew point location	34.25 N	100.10 W
Transposition dewpoint location	36.35 N	100.05 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	SE @ 400	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	5,544	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	74.0 F	with total precipitable water above sea level of		2.73	inches.
The in-place maximum dew point is	79.5 F	with total precipitable water above sea level of		3.52	inches.
The transpositioned maximum dew point is	79.5 F	with total precipitable water above sea level of		3.52	inches.
The in-place storm elevation is	5,544	which subtracts	1.14	inches of precipitable water at	74.0 F
The in-place storm elevation is	5,544	which subtracts	1.38	inches of precipitable water at	79.5 F
The transposition basin elevation at	4,400	which subtracts	1.14	inches of precipitable water at	79.5 F
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.14	inches of precipitable water at	79.5 F

The in-place storm maximization factor is	1.35
The transposition/elevation to basin factor is	1.11
The barrier adjustment factor is	1.00
The total adjustment factor is	1.50

Notes: DAD values taken from SPAS 1294. Storm rep Td added 7° to the USACE analyzed 12-hr persisting Td.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	3.0	8.1	10.3	11.3	11.9	11.9	-	-	-
10 sq miles	3.0	8.1	10.3	11.3	11.9	11.9	-	-	-
100 sq miles	2.8	7.6	9.6	10.4	10.8	10.8	-	-	-
200 sq miles	2.7	7.3	9.3	10.0	10.3	10.3	-	-	-
500 sq miles	2.6	7.0	8.9	9.8	10.0	10.0	-	-	-
1000 sq miles	2.4	6.7	8.4	9.2	9.7	9.7	-	-	-
2000 sq miles	2.2	6.1	7.7	8.4	8.9	8.9	-	-	-
5000 sq miles	1.6	5.0	6.2	6.8	7.1	7.1	-	-	-
10000 sq miles	1.2	4.0	5.0	5.5	5.8	5.8	-	-	-
20000 sq miles	1.1	2.9	4.1	4.4	4.5	4.5	-	-	-

Adjusted Storm Depth-Area-Duration

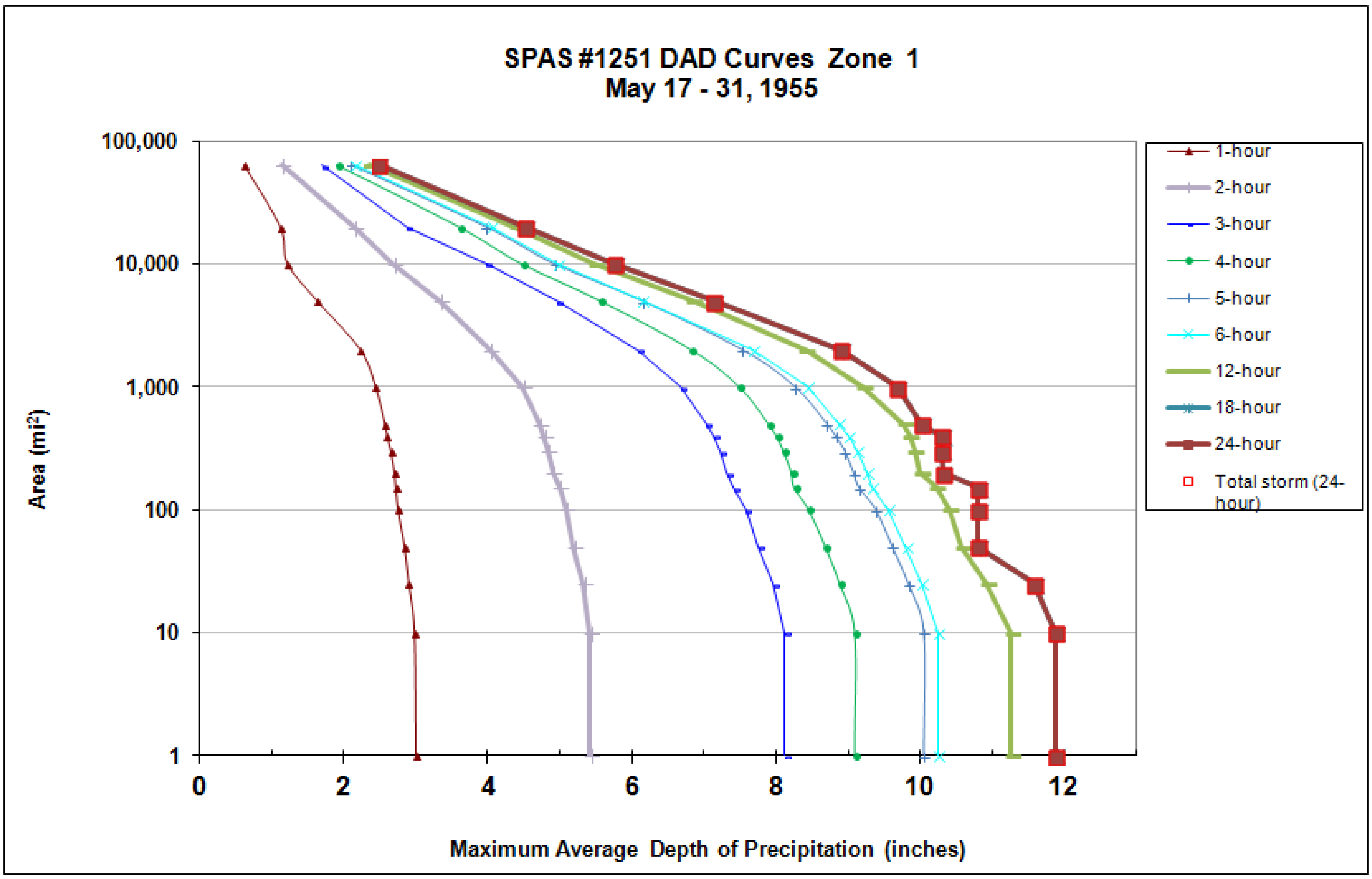
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.5	12.2	15.3	16.9	17.8	17.8	-	-	-
10 sq miles	4.5	12.2	15.3	16.9	17.8	17.8	-	-	-
100 sq miles	4.1	11.3	14.3	15.6	16.2	16.2	-	-	-
200 sq miles	4.0	11.0	13.9	15.0	15.4	15.4	-	-	-
500 sq miles	3.8	10.5	13.3	14.6	15.0	15.0	-	-	-
1000 sq miles	3.7	10.0	12.6	13.8	14.5	14.5	-	-	-
2000 sq miles	3.3	9.1	11.5	12.6	13.3	13.3	-	-	-
5000 sq miles	2.4	7.4	9.2	10.2	10.7	10.7	-	-	-
10000 sq miles	1.8	6.0	7.4	8.2	8.6	8.6	-	-	-
20000 sq miles	1.7	4.3	6.1	6.6	6.8	6.8	-	-	-

Storm or Storm Center Name	**SPAS 1294 Penrose, CO**			
Storm Date(s)	6/3-4/1921			
Storm Type	Convective			
Storm Location	38.46 N	105.07 W		
Storm Center Elevation	5,544			
Precipitation Total & Duration	12.20 Inches 18-hours			
Storm Representative Dewpoint	74.0 F	6	June	July
Storm Representative Dewpoint Location	34.25 N	100.10 W	79	81.5
Maximum Dewpoint	79.5 F			
Moisture Inflow Vector	SE @ 400			
In-place Maximization Factor	**1.35**			
Temporal Transposition (Date)	20-Jun		June	July
Transposition Dewpoint Location	36.35 N	100.05 W	79	81
Transposition Maximum Dewpoint	79.5 F			
Transposition Adjustment Factor	**1.11**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.50**			

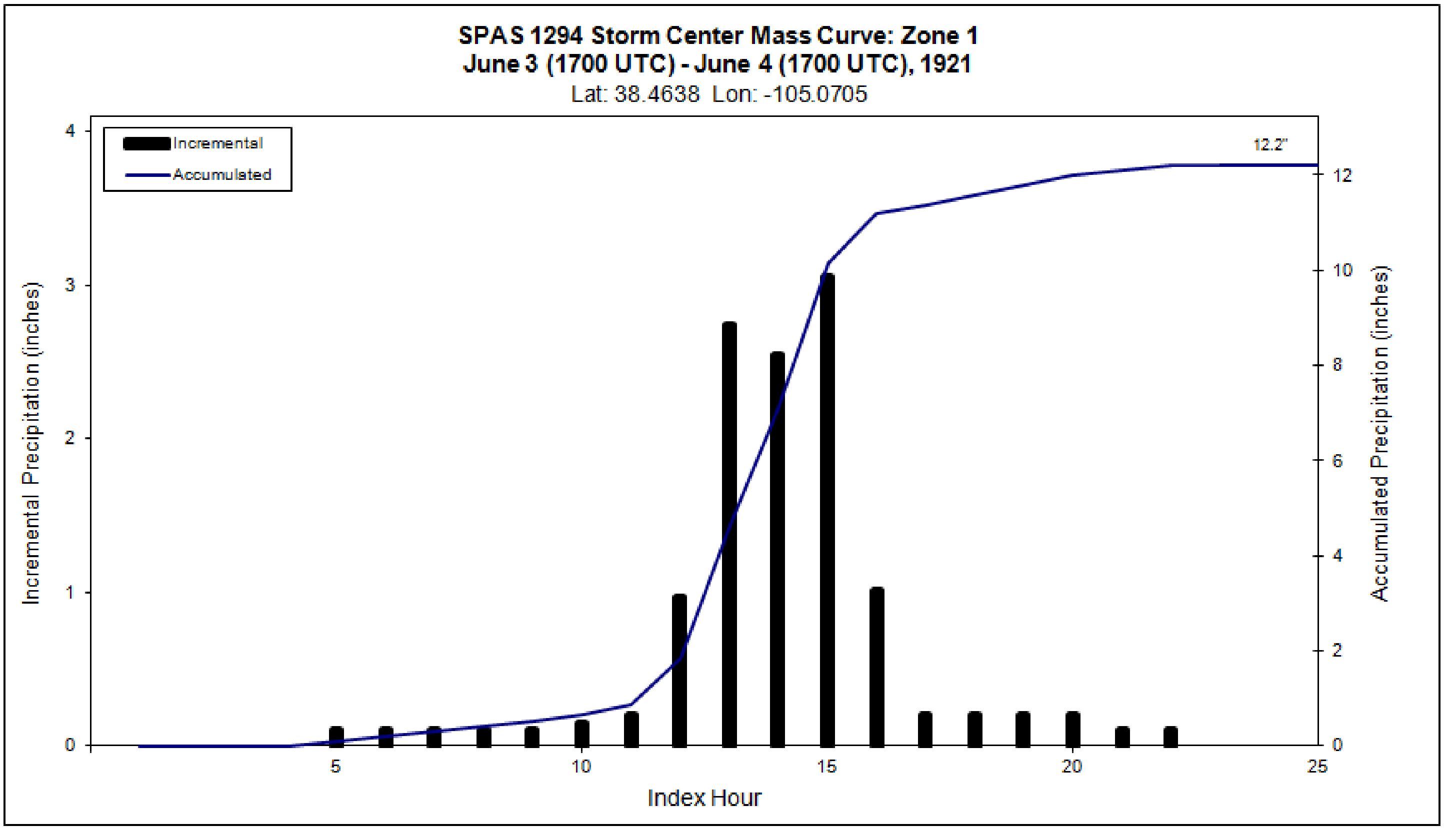
Appendix F: Table F.126: Storm spreadsheet for Penrose, CO June 2, 1921

SPAS 1294 - June 3 (1700 UTC) - June 4 (1700 UTC), 1921										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi^2)	1	2	3	4	5	6	12	18	24	Total
0.3	3.05	5.59	8.34	9.35	10.32	10.52	11.59	12.20	12.20	12.20
1	3.00	5.42	8.12	9.09	10.05	10.25	11.26	11.88	11.88	11.88
10	2.98	5.42	8.12	9.09	10.05	10.25	11.26	11.88	11.88	11.88
25	2.90	5.33	7.95	8.88	9.83	10.02	10.92	11.58	11.58	11.58
50	2.84	5.19	7.76	8.68	9.61	9.80	10.58	10.81	10.81	10.81
100	2.75	5.09	7.58	8.45	9.38	9.55	10.40	10.81	10.81	10.81
150	2.72	4.99	7.40	8.25	9.15	9.33	10.22	10.80	10.80	10.80
200	2.70	4.90	7.32	8.21	9.07	9.26	10.00	10.31	10.31	10.31
300	2.65	4.84	7.23	8.10	8.95	9.13	9.92	10.30	10.30	10.30
400	2.60	4.78	7.13	8.00	8.82	9.00	9.85	10.30	10.30	10.30
500	2.57	4.72	7.03	7.89	8.70	8.87	9.77	10.03	10.03	10.03
1,000	2.44	4.48	6.68	7.49	8.26	8.43	9.20	9.67	9.67	9.67
2,000	2.23	4.03	6.08	6.82	7.53	7.67	8.41	8.89	8.89	8.89
5,000	1.63	3.33	4.96	5.56	6.14	6.15	6.84	7.14	7.14	7.14
10,000	1.22	2.69	3.98	4.47	4.92	4.97	5.49	5.76	5.76	5.76
20,000	1.12	2.15	2.88	3.60	3.97	4.05	4.39	4.53	4.53	4.53
63,927	0.62	1.14	1.70	1.91	2.10	2.15	2.36	2.49	2.49	2.49

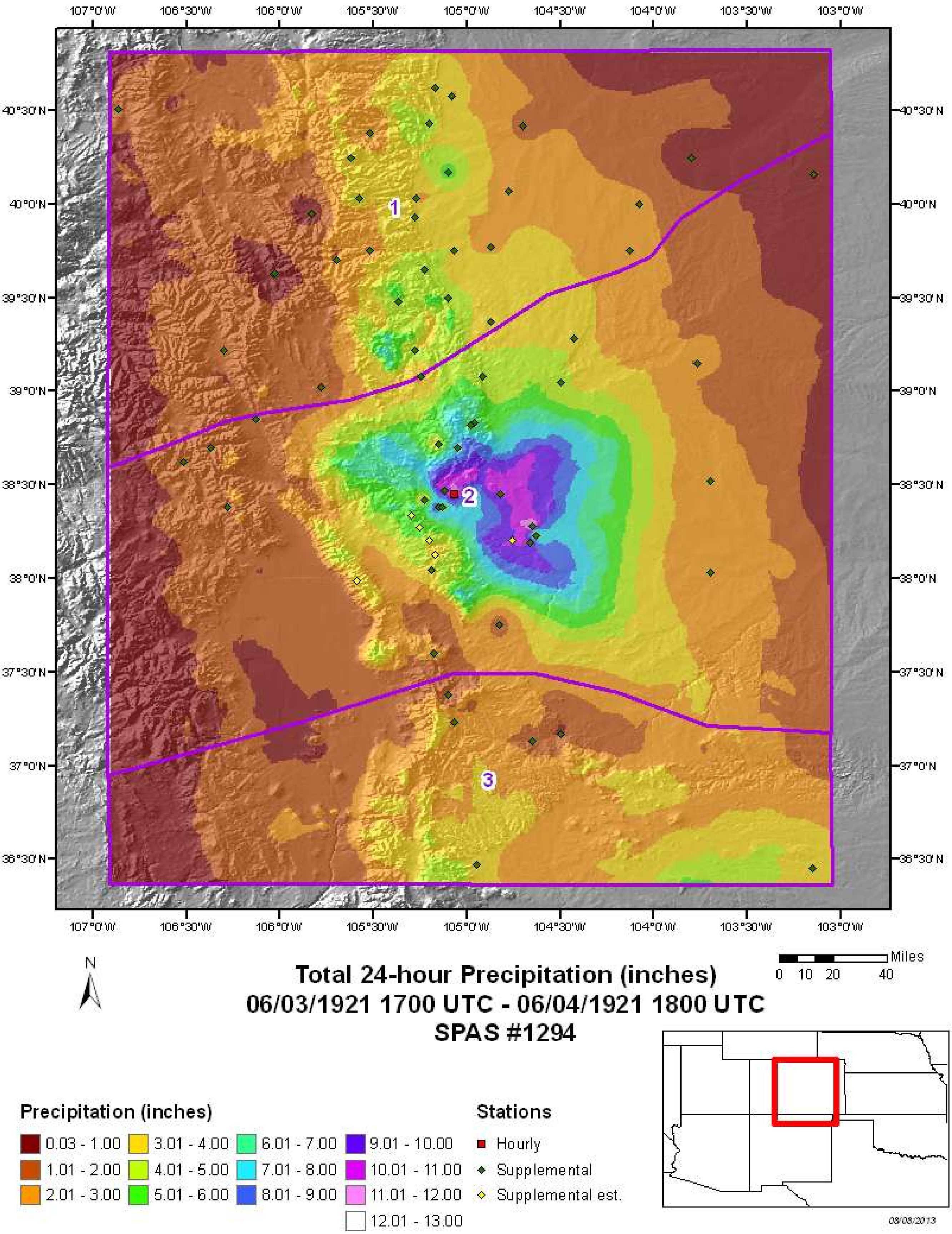
Appendix F: Table F.127: Depth-area-duration values for Penrose, CO June 2, 1921



Appendix F: Figure F.157: Depth-area-duration chart for Penrose, CO June 2, 1921



Appendix F: Figure F.158: Mass curve chart for Penrose, CO June 2, 1921



Appendix F: Figure F.159: Total storm isohyetal analysis for Penrose, CO June 2, 1921

Meek, NM, AWA 63

September 15, 1919

Storm Type: Frontal

Grid Points Used: 6, 13

Storm Name:	Meek, NM USACE GM 5-15B
Storm Date:	9/15-17/1919
AWA Analysis Date:	12/16/2013

Storm Adjustment for ANO Grid Point 6

Temporal Transposition Date	1-Sep	
	Lat	Long
Storm center location	33.68 N	105.18 W
Storm Rep dew point location	31.30 N	98.90 W
Transposition dewpoint location	38.16 N	87.45 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	ESE @ 400	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	5,224	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place storm elevation is	5,224	which subtracts	1.09	inches of precipitable water at	74.0 F	
The in-place storm elevation is	5,224	which subtracts	1.28	inches of precipitable water at	78.5 F	
The transposition basin elevation at	4,400	which subtracts	1.09	inches of precipitable water at	78.0 F	
The Grid Point/Inflow barrier height is	xx	which subtracts	1.09	inches of precipitable water at	78.0 F	

The in-place storm maximization factor is	1.27
The transposition/elevation to basin factor is	1.06
The barrier adjustment factor is	1.00
The total adjustment factor is	1.34

Notes: DAD values taken from GM 5-15B. Added 2°F to USACE storm rep to convert ot average maximum Td climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	3.8	4.5	6.2	7.4	8.5	9.1	9.5	9.5	-
100 sq miles	3.2	4.2	5.1	6.4	7.3	7.9	8.3	8.3	-
200 sq miles	3.0	4.1	4.7	6.0	6.9	7.5	7.9	7.9	-
500 sq miles	2.7	3.8	4.3	5.4	6.3	7.0	7.3	7.3	-
1000 sq miles	2.5	3.4	4.0	5.0	5.8	6.5	6.9	6.9	-
2000 sq miles	2.2	3.1	3.6	4.6	5.4	6.0	6.5	6.5	-
5000 sq miles	1.9	2.7	3.2	4.0	4.8	5.3	5.9	6.0	-
10000 sq miles	1.6	2.4	2.9	3.6	4.3	4.8	5.5	5.6	-
20000 sq miles	1.3	2.0	2.5	3.1	3.8	4.3	5.1	5.2	-

Adjusted Storm Depth-Area-Duration

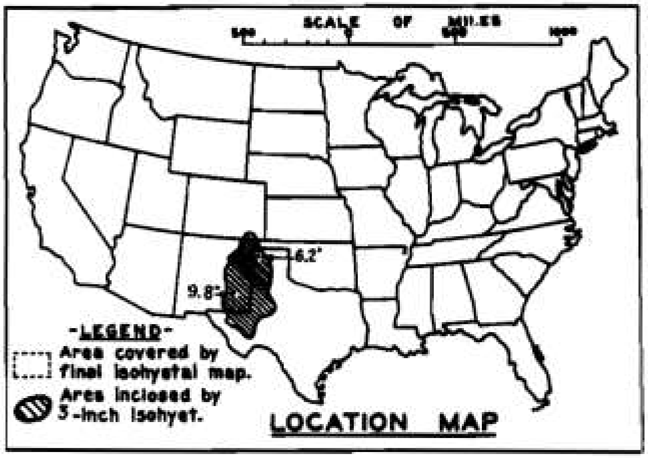
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	5.1	6.0	8.3	9.9	11.4	12.2	12.7	12.7	-
100 sq miles	4.3	5.6	6.8	8.6	9.8	10.6	11.1	11.1	-
200 sq miles	4.0	5.5	6.3	8.0	9.3	10.1	10.6	10.6	-
500 sq miles	3.6	5.1	5.8	7.2	8.5	9.4	9.8	9.8	-
1000 sq miles	3.4	4.6	5.4	6.7	7.8	8.7	9.3	9.3	-
2000 sq miles	3.0	4.2	4.8	6.2	7.2	8.0	8.7	8.7	-
5000 sq miles	2.5	3.6	4.3	5.4	6.4	7.1	7.9	8.0	-
10000 sq miles	2.1	3.2	3.9	4.8	5.8	6.4	7.4	7.5	-
20000 sq miles	1.7	2.7	3.4	4.2	5.1	5.8	6.8	7.0	-

Storm or Storm Center Name	Meek, NM USACE GM 5-15B			
Storm Date(s)	9/15-17/1919			
Storm Type	Synoptic			
Storm Location	33.68 N	105.18 W		
Storm Center Elevation	5,224			
Precipitation Total & Duration	9.50 Inches 54-hours			
Storm Representative Dewpoint	74.0 F	24	ABI, FTW, OKC, SAT, GBK	
Storm Representative Dewpoint Location	31.30 N	98.90 W		
Maximum Dewpoint	78.5 F			
Moisture Inflow Vector	ESE @ 400		Aug	Sept
In-place Maximization Factor	1.27		79	76.5
Temporal Transposition (Date)	1-Sep			
Transposition Dewpoint Location	38.16 N	87.45 W		
Transposition Maximum Dewpoint	78.0 F			
Transposition Adjustment Factor	1.06			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.34			

Appendix F: Table F.128: Storm spreadsheet for Meek, NM September 15, 1919

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of September 15-17, 1919
Assignment G M 5 - 15 B
Location New Mexico and Texas
Study Prepared by:
Southwestern Division
Galveston District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 5/24/43
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/27/44
Remarks: Centers at ;
Meek, N.Mex., & Romero, Tex.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheet, scale 1 : 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	12
Form 5001-B (24-hour " ")	55
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	1
Form 5002 (Mass rainfall curves)	39

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

Data and computation sheets:

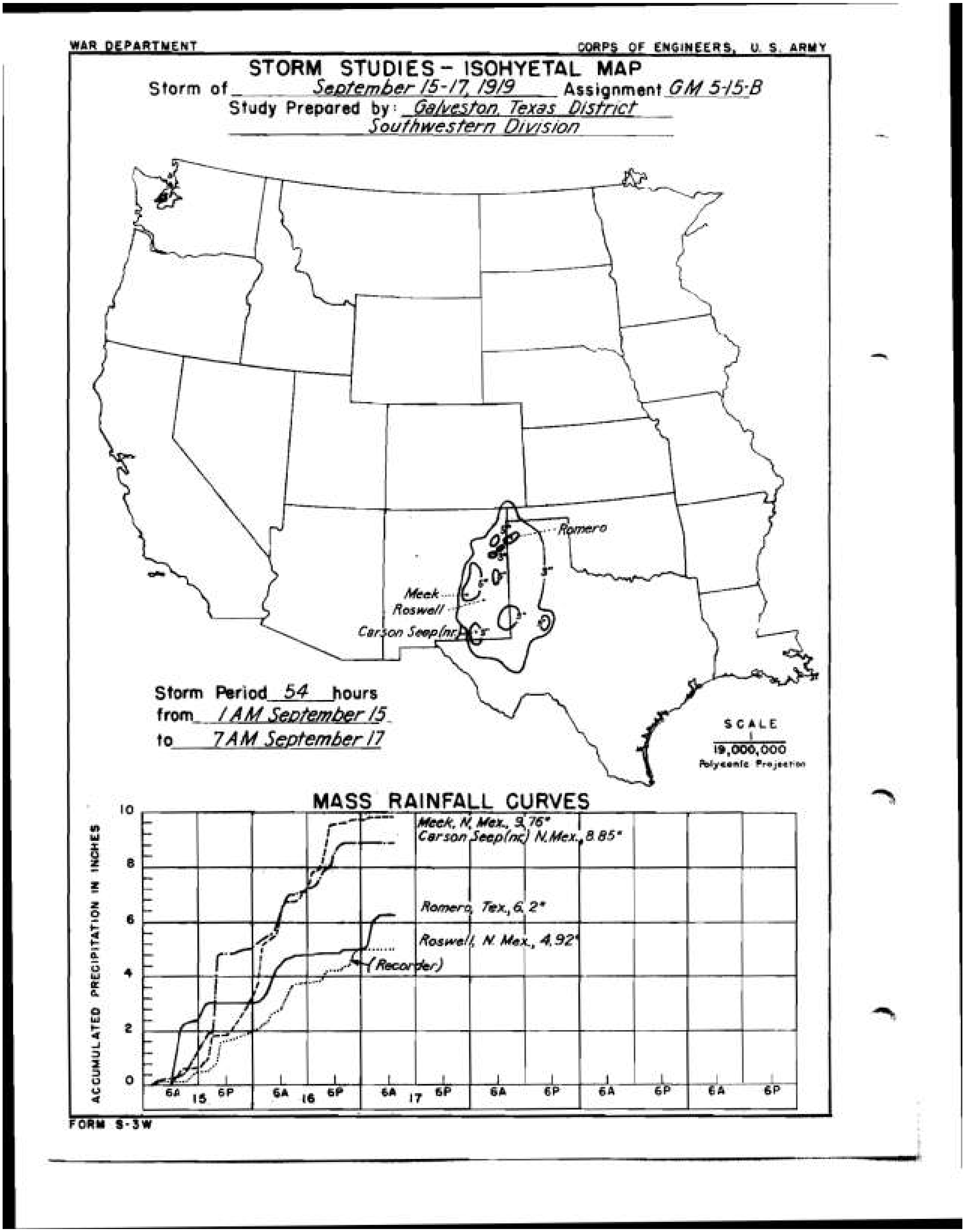
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	11
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	3

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	54			
Max. Station	4.0	4.6	6.5	7.7	8.8	9.4	9.8	9.8			
10	3.8	4.5	6.2	7.4	8.5	9.1	9.5	9.5			
100	3.2	4.2	5.1	6.4	7.3	7.9	8.3	8.3			
200	3.0	4.1	4.7	6.0	6.9	7.5	7.9	7.9			
500	2.7	3.8	4.3	5.4	6.3	7.0	7.3	7.3			
1,000	2.5	3.4	4.0	5.0	5.8	6.5	6.9	6.9			
2,000	2.2	3.1	3.6	4.6	5.4	6.0	6.5	6.5			
5,000	1.9	2.7	3.2	4.0	4.8	5.3	5.9	6.0			
10,000	1.6	2.4	2.9	3.6	4.3	4.8	5.5	5.6			
20,000	1.3	2.0	2.5	3.1	3.8	4.3	5.1	5.2			
40,000	1.0	1.7	2.2	2.7	3.4	3.8	4.7	4.8			
50,000	0.9	1.6	2.1	2.6	3.2	3.7	4.6	4.7			
75,000	0.8	1.4	1.9	2.3	3.0	3.4	4.3	4.4			

Form S-2

Appendix F: Table F.129: Depth-area-duration values for Meek, NM September 15, 1919



Appendix F: Figure F.160 and Figure F.161: Total storm isohyetal analysis and mass curve chart for Meek, NM September 15, 1919

Clayton, NM, AWA 64

April 29, 1914

Storm Type: Frontal

Grid Points Used: 5-6, 12-13

Storm Name:	Clayton, NM USACE SW 1-16	**Storm Adjustment for ANO Grid Point 6**
Storm Date:	4/29-5/2/1914	
AWA Analysis Date:	12/21/2013	

Temporal Transposition Date: 15-May

	Lat	Long
Storm center location	36.33 N	103.10 W
Storm Rep dew point location	28.80 N	99.55 W
Transposition dewpoint location	26.40 N	100.26 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	SSE @ 560	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	4,719	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	71.0 F	with total precipitable water above sea level of			2.36	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The in-place storm elevation is	4,719	which subtracts	0.90	inches of precipitable water at	71.0 F	
The in-place storm elevation is	4,719	which subtracts	1.09	inches of precipitable water at	76.5 F	
The transposition basin elevation at	4,400	which subtracts	1.04	inches of precipitable water at	76.5 F	
The Grid Point/Inflow barrier height is	4,400	which subtracts	1.04	inches of precipitable water at	76.5 F	

The in-place storm maximization factor is	1.35
The transposition/elevation to basin factor is	1.03
The barrier adjustment factor is	1.00
The total adjustment factor is	1.39

Notes: DAD values taken from SW 1-16. Added 2°F to USACE storm rep to convert ot average maximum Td climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	5.3	6.8	8.6	9.0	9.0	9.0	9.6	9.6	-
100 sq miles	4.8	6.7	8.2	8.8	8.9	8.9	9.4	9.4	-
200 sq miles	4.6	6.5	8.0	8.7	8.8	8.8	9.3	9.3	-
500 sq miles	4.2	6.2	7.8	8.3	8.5	8.5	9.0	9.0	-
1000 sq miles	3.9	5.8	7.4	7.9	8.2	8.2	8.7	8.7	-
2000 sq miles	3.5	5.0	6.7	7.2	7.6	7.6	8.1	8.1	-
5000 sq miles	2.0	3.8	5.4	6.2	6.6	6.8	7.3	7.3	-
10000 sq miles	2.0	3.0	4.5	5.2	5.8	6.0	6.5	6.5	-
20000 sq miles	1.4	2.3	3.5	4.2	4.9	5.1	5.6	5.6	-

Adjusted Storm Depth-Area-Duration

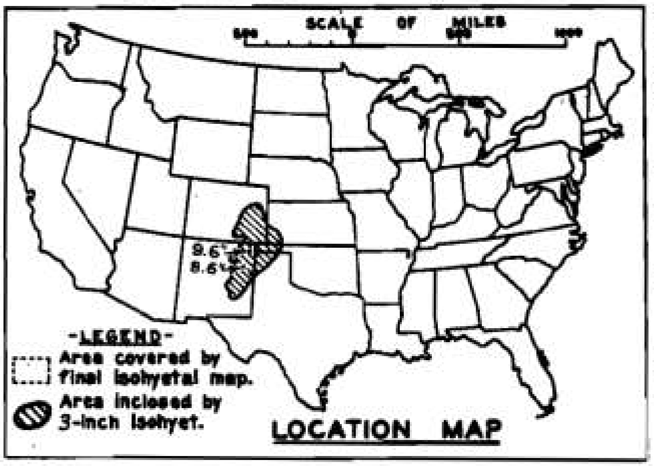
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	7.4	9.4	11.9	12.5	12.5	12.5	13.3	13.3	-
100 sq miles	6.7	9.3	11.4	12.2	12.3	12.3	13.0	13.0	-
200 sq miles	6.4	9.0	11.1	12.1	12.2	12.2	12.9	12.9	-
500 sq miles	5.8	8.6	10.8	11.5	11.8	11.8	12.5	12.5	-
1000 sq miles	5.4	8.0	10.3	11.0	11.4	11.4	12.1	12.1	-
2000 sq miles	4.9	6.9	9.3	10.0	10.5	10.5	11.2	11.2	-
5000 sq miles	2.8	5.3	7.5	8.6	9.2	9.4	10.1	10.1	-
10000 sq miles	2.8	4.2	6.2	7.2	8.0	8.3	9.0	9.0	-
20000 sq miles	1.9	3.2	4.9	5.8	6.8	7.1	7.8	7.8	-

Storm or Storm Center Name	**Clayton, NM USACE SW 1-16**			
Storm Date(s)	4/29-5/2/1914			
Storm Type	Synoptic			
Storm Location	36.33 N	103.10 W		
Storm Center Elevation	4,719			
Precipitation Total & Duration	9.60 Inches 66-hours			
Storm Representative Dewpoint	71.0 F	24	SAT, DRT, CRP	
Storm Representative Dewpoint Location	28.80 N	99.55 W		
Maximum Dewpoint	76.5 F			
Moisture Inflow Vector	SSE @ 560		Aug	Sept
In-place Maximization Factor	**1.35**		79	76.5
Temporal Transposition (Date)	15-May			
Transposition Dewpoint Location	26.40 N	100.26 W		
Transposition Maximum Dewpoint	76.5 F			
Transposition Adjustment Factor	**1.03**			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	4,400			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.39**			

Appendix F: Table F.130: Storm spreadsheet for Clayton, NM April 29, 1914

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of April 29,-May 2,1914
Assignment S W 1 - 16
Location N Mex., Colo., & Kan.
Study Prepared by:
Southwestern Division
Albuquerque District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 5/7/44
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/6/44
Remarks: Centers at; Clayton, Pleasant View, and Nara Visa, New Mexico

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet , scale 1 : 2,500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	7
Form 5001-B (24-hour " ")	57
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	-
Form 5002 (Mass rainfall curves)	30

PART II

Final isohyetal maps, in 1 sheet , scale 1 : 1,000,000

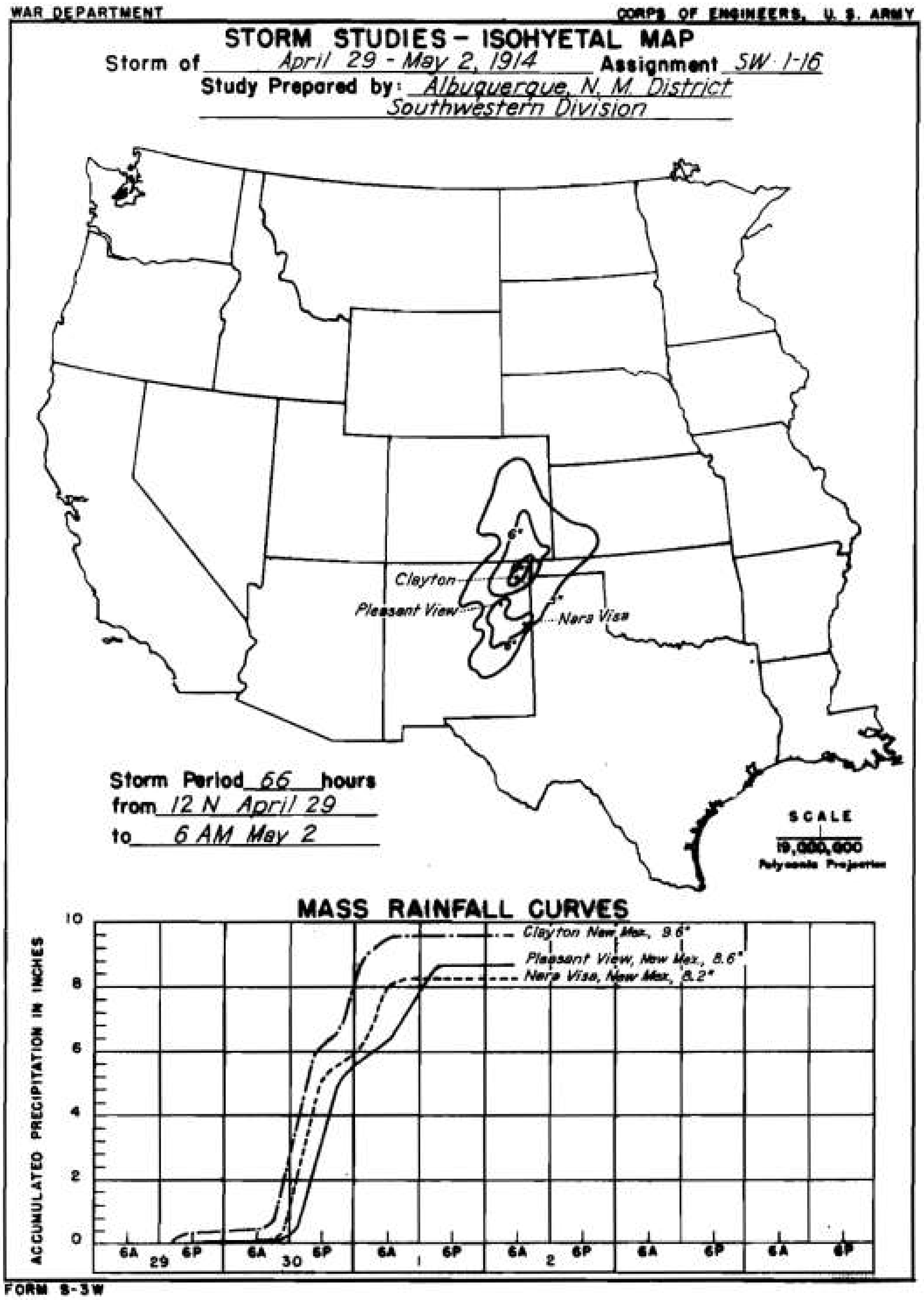
Data and computation sheets:

Form S-10 (Data from mass rainfall curves)	2
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	9
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	66		
10	5.3	6.8	8.6	9.0	9.0	9.0	9.6	9.6	9.6		
100	4.8	6.7	8.2	8.8	8.9	8.9	9.4	9.4	9.4		
200	4.6	6.5	8.0	8.7	8.8	8.8	9.3	9.3	9.3		
500	4.2	6.2	7.8	8.3	8.5	8.5	9.0	9.0	9.0		
1,000	3.9	5.8	7.4	7.9	8.2	8.2	8.7	8.7	8.7		
2,000	3.5	5.0	6.7	7.2	7.6	7.6	8.1	8.1	8.1		
5,000	2.8	3.8	5.4	6.2	6.6	6.8	7.3	7.3	7.3		
10,000	2.0	3.0	4.5	5.2	5.8	6.0	6.5	6.5	6.5		
20,000	1.4	2.3	3.5	4.2	4.9	5.1	5.6	5.6	5.6		
36,500	1.0	1.8	2.5	3.3	3.9	4.1	4.5	4.6	4.6		

Appendix F: Table F.131: Depth-area-duration values for Clayton, NM April 29, 1914



Appendix F: Figure F.162 and Figure F.163: Total storm isohyetal analysis and mass curve chart for Clayton, NM April 29, 1914

Cooper, MI, AWA 65

August 31, 1914

Storm Type: MCC

Grid Points Used: 8-10, 16-18

Storm Name:	USACE GL 2-16-Cooper, MI
Storm Date:	August 31, 1914
AWA Analysis Date:	12/16/2013

Storm Adjustment for ANO Grid Point 8

Temporal Transposition Date	16-Aug	
	Lat	Long
Storm Center Location	42.38 N	85.61 W
Storm Rep Dew Point Location	40.10 N	89.00 W
Transposition Dew Point Location	40.45 N	95.99 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SW @ 235	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	900	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	900	which subtracts	0.23	inches of precipitable water at	75.0 F	
The in-place storm elevation is	900	which subtracts	0.28	inches of precipitable water at	80.5 F	
The transposition storm elevation at	1,200	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place maximization factor is	1.30
The transposition factor is	1.02
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.32

Notes: DAD values taken from USACE GL 2-16. Storm representative dew point value was based on adding 7° to the USACE analysis using EPRI, Nebraska, and TRWD guidance.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	12.6	-	-	-	-	-	-	-	-
100 sq miles	11.3	-	-	-	-	-	-	-	-
200 sq miles	10.0	-	-	-	-	-	-	-	-
500 sq miles	7.6	-	-	-	-	-	-	-	-
1000 sq miles	5.7	-	-	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

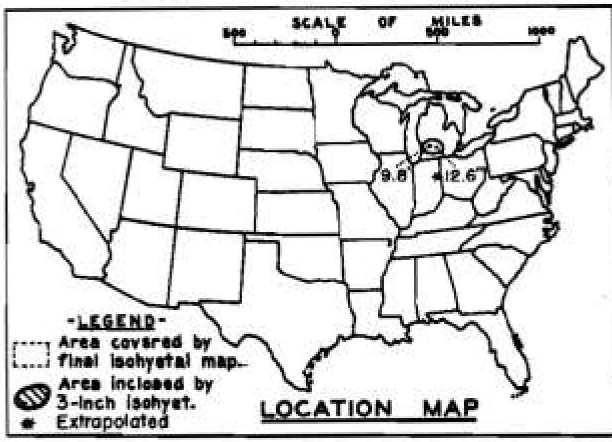
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	16.6	-	-	-	-	-	-	-	-
100 sq miles	14.9	-	-	-	-	-	-	-	-
200 sq miles	13.2	-	-	-	-	-	-	-	-
500 sq miles	10.0	-	-	-	-	-	-	-	-
1000 sq miles	7.5	-	-	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	USACE GL 2-16-Cooper, MI	
Storm Date(s)	31-Aug-1914	
Storm Type	MCS	
Storm Location	42.38 N	85.61 W
Storm Center Elevation	900	
Precipitation Total & Duration (10 sq mi)	12.60 Inches 6-hours USACE GL 2-16	
Storm Representative Dew Point	75.0 F	6
Storm Representative Dew Point Location	40.10 N	89.00 W
Maximum Dew Point	80.5 F	
Moisture Inflow Vector	SW @ 235	
In-place Maximization Factor	1.30	
Temporal Transposition (Date)	16-Aug	
Transposition Dew Point Location	40.45 N	95.99 W
Transposition Maximum Dew Point	81.0 F	
Transposition Adjustment Factor	1.02	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.32	

Appendix F: Table F.132: Storm spreadsheet for Cooper, MI August 31, 1914

WAR DEPARTMENT | CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of 31 Aug.-1 Sept. 1914
Assignment GL 2-16
Location Michigan
Study Prepared by:
Great Lakes Division
Milwaukee District Office and
Hydrometeorological Section of
U. S. Weather Bureau.
Part I Reviewed by H. M. Sec. of Weather Bureau, 10/26/39
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/26/46
Remarks: Centers near Cooper and Bloomingdale, Mich.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 2,500,000
Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	8
Form 5001-B (24-hour " ")	5
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	6
Form 5002 (Mass rainfall curves)	4

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000
Data and computation sheets:

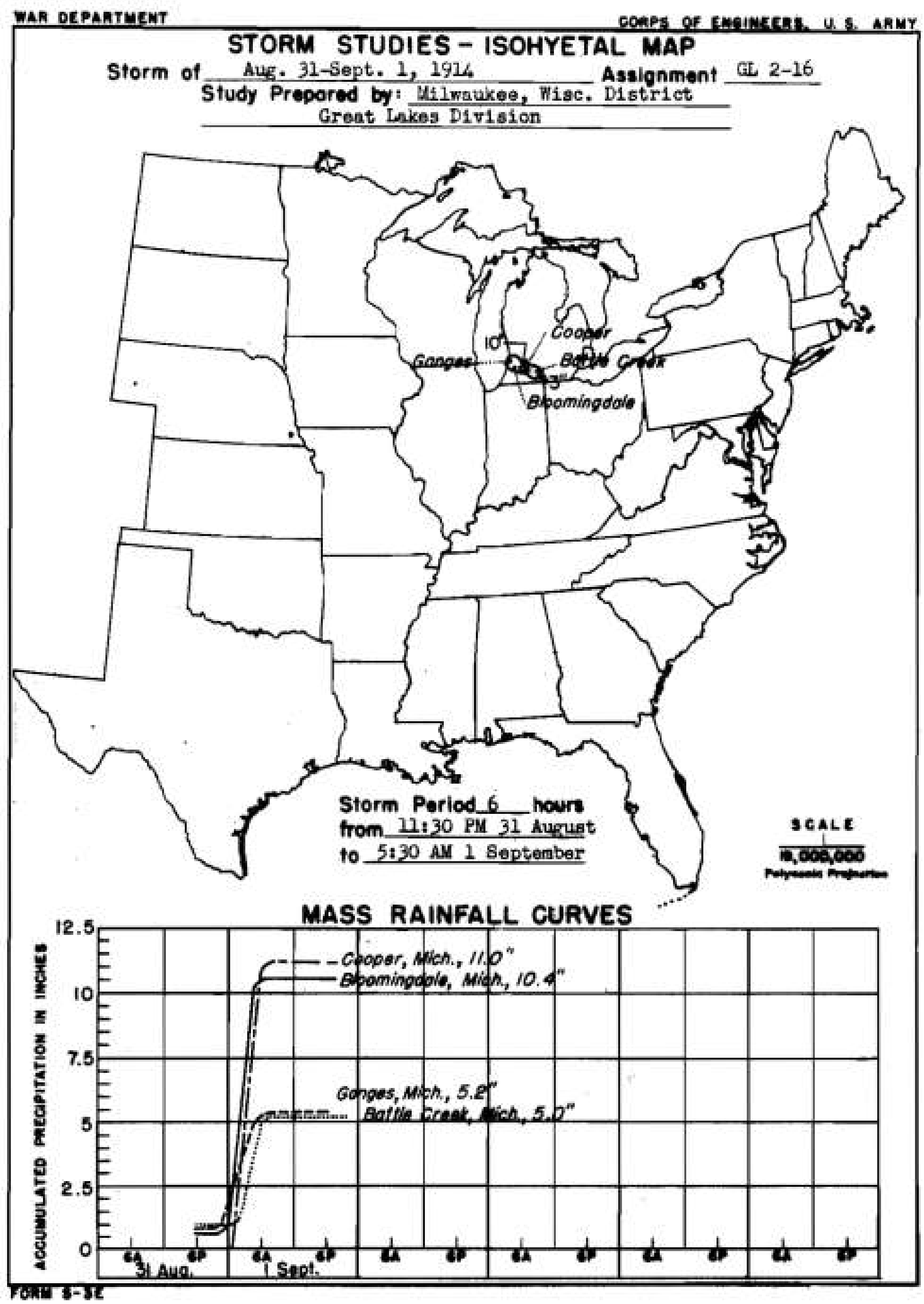
Form S-10 (Data from mass rainfall curves)	2
Form S-11 (Depth-area data from isohyetal map)	-
Form S-12 (Maximum depth-duration data)	-
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	-

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6										
10	12.6										
50	12.0										
100	11.3										
200	10.0										
500	7.6										
800	6.3										
1,000	5.7										
1,200	5.2										

Form S-2

Appendix F: Table F.133: Depth-area-duration values for Cooper, MI August 31, 1914



Appendix F: Figure F.164 and Figure F.165: Total storm isohyetal analysis and mass curve chart for Cooper, MI August 31, 1914

Wagon Wheel, CO, AWA 66
October 3, 1911
Storm Type: Remnant Tropical
Grid Points Used: 22

		Storm Adjustment for ANO Grid Point 22
Storm Name:	SPAS-1107-San Juan Mtns	
Storm Date:	10/4-6/1911	
AWA Analysis Date:	12/21/2013	

Temporal Transposition Date	20-Sep	
	Lat	Long
Storm center location	37.66 N	106.94 W
Storm Rep dew point location	34.50 N	111.60 W
Transposition dewpoint location	35.85 N	111.25 W
Grid Point location	39.00 N	106.50 W

Moisture Inflow Direction:	SW @ 350	miles
Grid Point Elevation	9,871	feet
Storm Center Elevation	12,500	feet
Strom Rep Analysis Duration	9,871	feet

The storm representative dew point is	68.0 F	with total precipitable water above sea level of			2.05	inches.
The in-place maximum dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The transpositioned maximum dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The in-place storm elevation is	12,500	which subtracts	1.60	inches of precipitable water at	68.0 F	
The in-place storm elevation is	12,500	which subtracts	2.03	inches of precipitable water at	74.0 F	
The transposition barrier elevation at	9,871	which subtracts	1.77	inches of precipitable water at	74.0 F	
The Grid point/inflow barrier height is	9,871	which subtracts	1.77	inches of precipitable water at	74.0 F	

The in-place maximization factor is	1.50
The transposition factor is	1.37
Orographic Transposition Factor	1.00
The total adjustment factor is	2.06

Notes: Formally known as Gladstone, CO

Observed Storm Depth-Area-Duration

	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	24 Hours	36 Hours	48 Hours	72 Hours
10 sq miles	0.3	1.0	2.4	2.6	2.7	2.8	4.8	6.7	6.9	7.1	7.2
100 sq miles	0.3	1.0	1.7	1.9	2.0	2.2	4.4	6.0	6.5	6.5	6.6
200 sq miles	0.3	1.0	1.6	1.7	1.8	2.2	4.2	5.9	6.3	6.3	6.3
500 sq miles	0.3	0.9	1.3	1.6	1.8	2.0	3.8	5.4	5.8	5.8	5.9
1000 sq miles	0.3	0.8	1.3	1.4	1.6	1.7	3.3	4.9	5.2	5.3	5.4
2000 sq miles	0.3	0.6	1.1	1.2	1.4	1.4	2.8	4.3	4.6	4.7	4.9
5000 sq miles	0.3	0.6	0.8	1.0	1.1	1.2	2.5	3.8	4.1	4.1	4.2
10000 sq miles	0.3	0.4	0.6	0.8	0.9	0.9	2.2	3.3	3.6	3.7	3.7
20000 sq miles	0.2	0.4	0.4	0.5	0.6	0.7	1.8	2.7	2.9	2.9	3.1
50000 sq miles	0.1	0.2	0.2	0.3	0.3	0.3	1.2	1.8	2.1	2.1	2.1

Adjusteded Storm Depth-Area-Duration

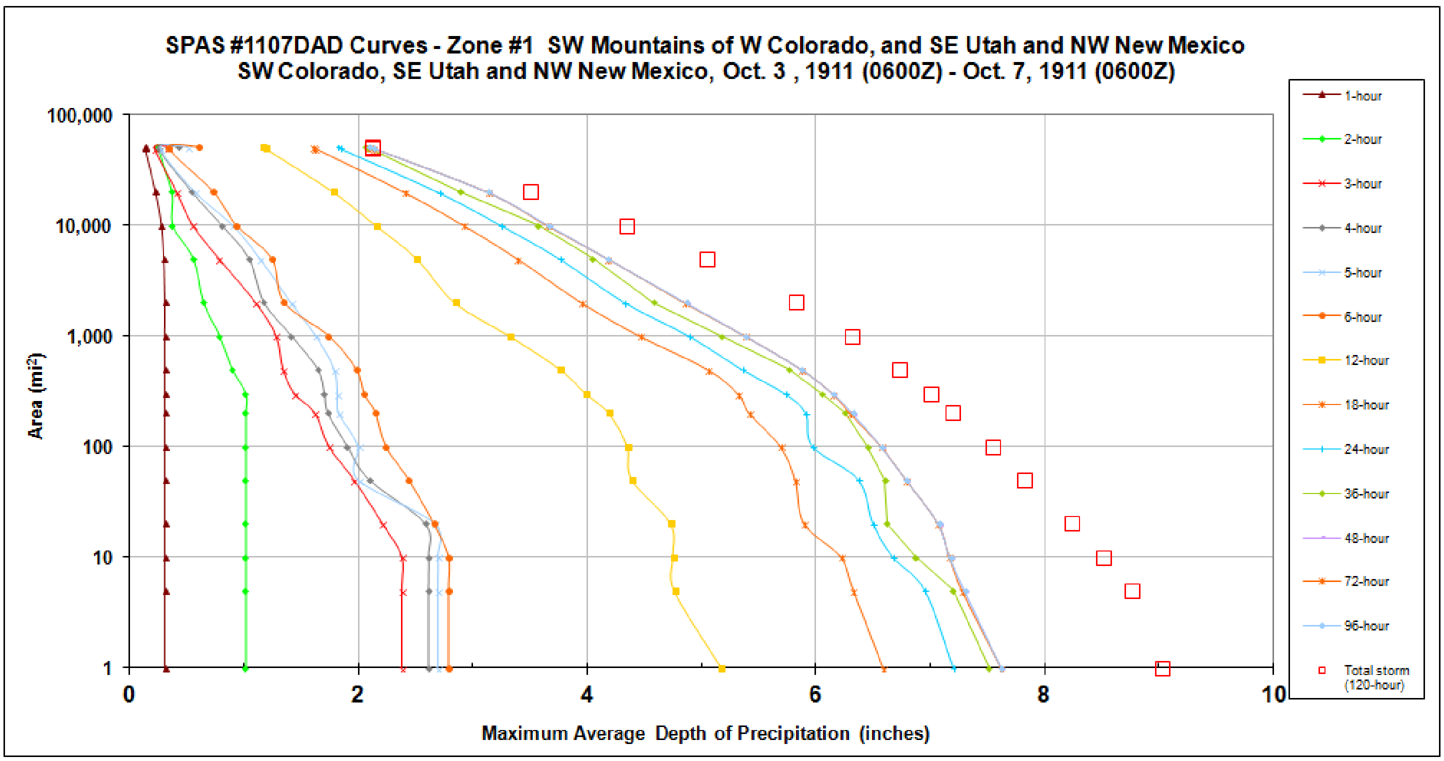
	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours	12 Hours	24 Hours	36 Hours	48 Hours	72 Hours
10 sq miles	0.6	2.1	4.9	5.4	5.6	5.7	9.8	13.7	14.1	14.5	14.7
100 sq miles	0.6	2.1	3.6	3.9	4.1	4.6	8.9	12.3	13.3	13.3	13.5
200 sq miles	0.6	2.1	3.3	3.6	3.8	4.4	8.6	12.2	12.9	12.9	13.0
500 sq miles	0.6	1.8	2.8	3.4	3.7	4.1	7.7	11.0	11.8	11.9	12.1
1000 sq miles	0.6	1.6	2.6	2.9	3.4	3.6	6.8	10.1	10.6	10.8	11.1
2000 sq miles	0.6	1.3	2.3	2.4	2.9	2.8	5.8	8.9	9.4	9.6	10.0
5000 sq miles	0.6	1.1	1.6	2.1	2.3	2.6	5.2	7.7	8.3	8.5	8.6
10000 sq miles	0.6	0.8	1.1	1.6	1.9	1.9	4.4	6.7	7.3	7.5	7.5
20000 sq miles	0.5	0.7	0.8	1.1	1.2	1.5	3.7	5.6	5.9	6.0	6.4
50000 sq miles	0.3	0.5	0.5	0.5	0.6	0.7	2.4	3.8	4.3	4.3	4.4

Storm or Storm Center Name	**SPAS-1107-San Juan Mtns**	
Storm Date(s)	10/4-6/1911	
Storm Type	Tropical	
Storm Location	37.66 N	106.94 W
Storm Center Elevation	12,500	orographic
Precipitation Total & Duration (10 sq mi)	7.88 inches 72 hours (SPAS 1107 DAD)	
Storm Representative Dewpoint	68.0 F	24
Storm Representative Dewpoint Location	34.50 N	111.60 W
In-place Maximum Dewpoint	74.0 F	
Moisture Inflow Vector	SW @ 350	
In-place Maximization Factor		
Temporal Transposition (Date)	20-Sep	
Transposition Dewpoint Location	35.85 N	111.25 W
Transposition Maximum Dewpoint	74.0 F	
Transposition Adjustment Factor		
Grid Point Elevation	9,871	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	9,871	
Elevation Adjustment Factor		
Total Adjustment Factor	2.06	

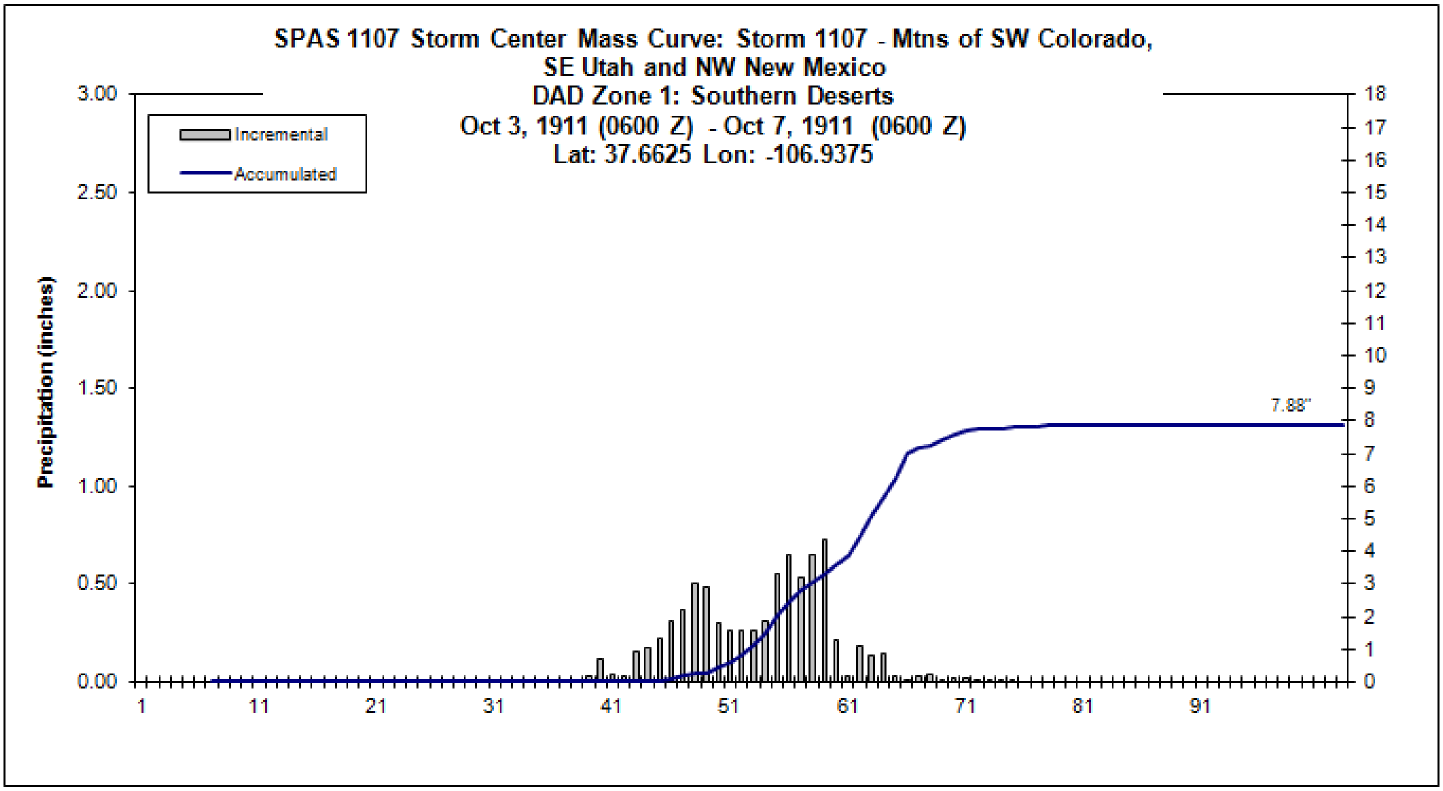
Appendix F: Table F.134: Storm spreadsheet for Wagon Wheel, CO October 3, 1911

Storm 1107 - SW Colorado, SE Utah and NW New Mexico, Oct 3. 1911 (0600Z) - Oct 7. 1911 (0600Z)																
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)																
	Duration (hours)															
Area (mi^2)	1	2	3	4	5	6	12	18	24	36	48	72	96			Total
0.27	0.72	1.37	2.66	2.93	3.03	3.10	5.49	6.92	7.50	7.84	7.88	7.88	7.88			9.31
1	0.30	1.01	2.38	2.61	2.70	2.79	5.17	6.59	7.20	7.51	7.62	7.62	7.62			9.03
5	0.30	1.01	2.38	2.61	2.70	2.79	4.76	6.33	6.95	7.20	7.27	7.28	7.30			8.76
10	0.30	1.01	2.38	2.61	2.70	2.79	4.75	6.22	6.67	6.87	7.05	7.17	7.17			8.51
20	0.30	1.01	2.21	2.58	2.67	2.66	4.73	5.90	6.50	6.62	6.98	7.07	7.07			8.23
50	0.30	1.01	1.96	2.09	2.00	2.44	4.39	5.82	6.37	6.60	6.76	6.79	6.79			7.82
100	0.30	1.01	1.74	1.90	2.00	2.24	4.35	5.69	5.97	6.45	6.45	6.57	6.57			7.55
200	0.30	1.01	1.62	1.73	1.83	2.15	4.19	5.42	5.91	6.26	6.28	6.30	6.32			7.19
300	0.30	1.01	1.44	1.70	1.82	2.05	3.99	5.32	5.73	6.05	6.07	6.15	6.15			7.00
500	0.30	0.89	1.34	1.64	1.79	1.98	3.76	5.05	5.35	5.76	5.78	5.87	5.87			6.73
1000	0.30	0.78	1.28	1.41	1.63	1.74	3.32	4.46	4.89	5.17	5.25	5.38	5.38			6.31
2000	0.30	0.64	1.10	1.17	1.41	1.35	2.84	3.95	4.33	4.58	4.65	4.85	4.86			5.82
5000	0.29	0.55	0.78	1.04	1.14	1.24	2.51	3.39	3.76	4.05	4.14	4.18	4.18			5.05
10000	0.27	0.37	0.55	0.80	0.90	0.93	2.15	2.92	3.25	3.57	3.65	3.65	3.66			4.34
20000	0.22	0.36	0.41	0.54	0.57	0.73	1.78	2.40	2.70	2.89	2.91	3.13	3.13			3.50
50000	0.13	0.24	0.22	0.25	0.27	0.34	1.18	1.62	1.84	2.08	2.11	2.13	2.13			2.12
51059	0.13	0.24	0.33	0.42	0.51	0.60	1.16	1.60	1.82	2.06	2.09	2.09	2.09			2.12

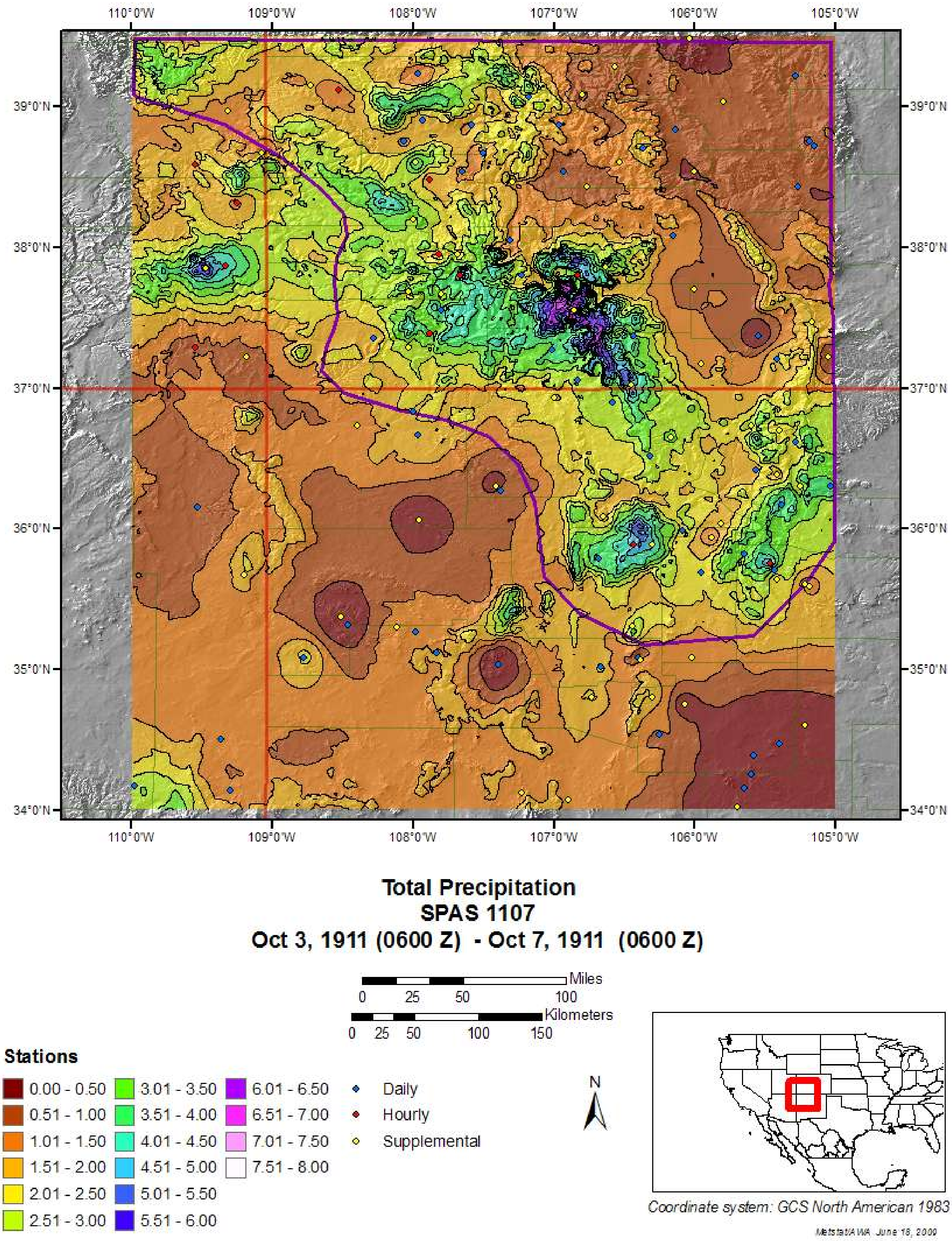
Appendix F: Table F.135: Depth-area-duration values for Wagon Wheel, CO October 3, 1911



Appendix F: Figure F.166: Depth-area-duration for Wagon Wheel, CO October 3, 1911



Appendix F: Figure F.167: Mass curve chart for Wagon Wheel, CO October 3, 1911



Appendix F: Figure F.168: Total storm isohyetal analysis for Wagon Wheel, CO October 3, 1911

Beaulieu, MN, AWA 67

July 18, 1909

Storm Type: MCC

Grid Points Used: 8-11, 16-18

Storm Name:	USACE- UMV 1-11A-Beaulieu, MN	Storm Adjustment for ANO Grid Point 8
Storm Date:	18-Jul-1909	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	47.30 N	95.90 W
Storm Rep Dew Point Location	43.32 N	98.08 W
Transposition Dew Point Location	38.75 N	94.62 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SSW @ 29	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,300	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place maximum dew point is	81.5 F	with total precipitable water above sea level of			3.84	inches.
The transpositioned maximum dew point is	82.5 F	with total precipitable water above sea level of			3.98	inches.
The in-place storm elevation is	1,300	which subtracts	0.36	inches of precipitable water at	78.0 F	
The in-place storm elevation is	1,300	which subtracts	0.40	inches of precipitable water at	81.5 F	
The transposition basin elevation at	1,200	which subtracts	0.32	inches of precipitable water at	82.5 F	
The Grid Point/Inflow barrier height is	1,000	which subtracts	0.32	inches of precipitable water at	82.5 F	

The in-place storm maximization factor is	1.17
The transposition/elevation to basin factor is	1.06
The barrier adjustment factor is	1.00
The total adjustment factor is	1.25

Notes: DAD values taken from USACE UMV 1-11. Added 7° to USACE storm rep analyzed Td based on guidance from EPRI, Nebraska, and TRWD.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.5	10.7	10.8	11.5	11.7	11.8	11.8	12.0	12.1
100 sq miles	10.3	10.5	10.7	11.3	11.5	11.7	11.7	12.0	12.0
200 sq miles	10.1	10.4	10.5	11.1	11.3	11.5	11.5	11.8	11.8
500 sq miles	9.7	10.1	10.2	10.6	11.0	11.2	11.2	11.5	11.5
1000 sq miles	9.2	9.6	9.7	10.0	10.4	10.5	10.6	10.8	10.9
2000 sq miles	7.9	8.5	8.6	8.7	9.3	9.4	9.5	9.8	9.9
5000 sq miles	4.8	5.9	6.0	6.1	7.1	7.3	7.5	7.9	8.0
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

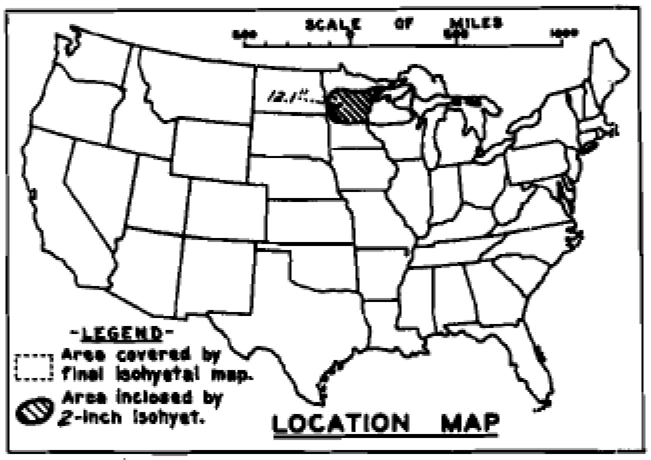
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	13.1	13.4	13.5	14.4	14.6	14.7	14.7	15.0	15.1
100 sq miles	12.9	13.1	13.4	14.1	14.4	14.6	14.6	15.0	15.0
200 sq miles	12.6	13.0	13.1	13.9	14.1	14.4	14.4	14.7	14.7
500 sq miles	12.1	12.6	12.7	13.2	13.7	14.0	14.0	14.4	14.4
1000 sq miles	11.5	12.0	12.1	12.5	13.0	13.1	13.2	13.5	13.6
2000 sq miles	9.9	10.6	10.7	10.9	11.6	11.7	11.9	12.2	12.4
5000 sq miles	6.0	7.4	7.5	7.6	8.9	9.1	9.4	9.9	10.0
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE- UMV 1-11A-Beaulieu, MN**	
Storm Date(s)	18-Jul-1909	
Storm Type	MCC	
Storm Location	47.30 N	95.90 W
Storm Center Elevation	1,300	
Precipitation Total & Duration	13.20 Inches 72-hours USACE UMV 1-11	
Storm Representative Dew Point	78.0 F	6
Storm Representative Dew Point Location	43.32 N	98.08 W
Maximum Dew Point	81.5 F	
Moisture Inflow Vector	SSW @ 295	
In-place Maximization Factor	**1.17**	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	38.75 N	94.62 W
Transposition Maximum Dew Point	82.5 F	
Transposition Adjustment Factor	**1.06**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.25**	

Appendix F: Table F.136: Storm spreadsheet for Beaulieu, MN July 18, 1909

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET (REV.)



Storm of 18-23 July 1909
Assignment UMV 1-11 (a)
Location Northern Minn. & Wis.
Study Prepared by:
Upper Mississippi Valley Division
St. Paul District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 6/7/39
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 5/24/41
Remarks: Rainfall data only for Beaulieu, Minn. center Dewpt. 71° - Ref. Pt. 300 SSW Grid A-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	4
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	8
Miscl. precip. records, meteorological data, etc.	1
Form 5002 (Mass rainfall curves)	24

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

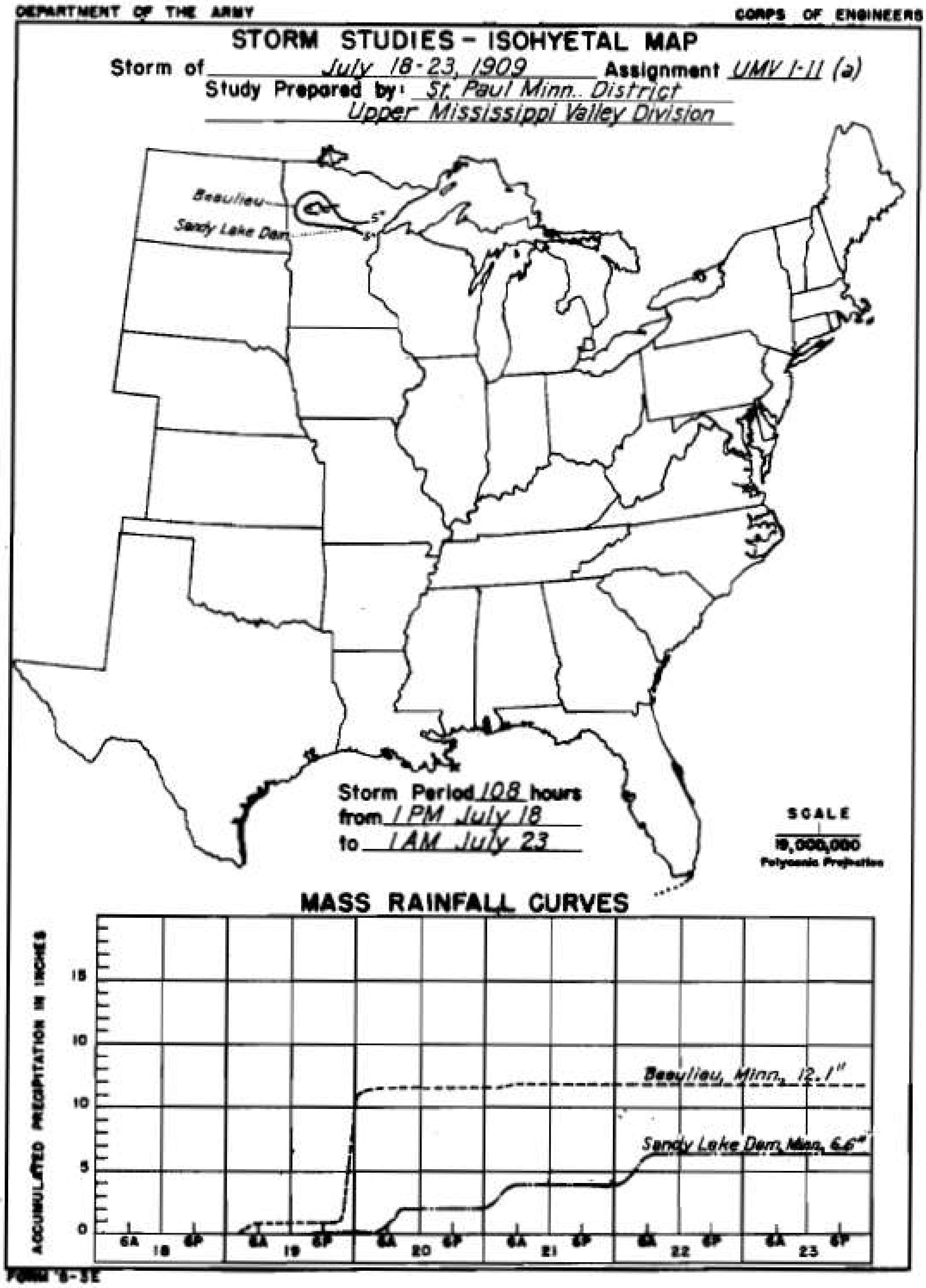
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	8
Maximum duration-depth-area curves	2
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	108
10	10.5	10.7	10.8	11.5	11.7	11.8	11.8	12.0	12.1	12.1	12.1
100	10.3	10.6	10.7	11.3	11.5	11.7	11.7	12.0	12.0	12.0	12.0
200	10.1	10.4	10.5	11.1	11.3	11.6	11.5	11.8	11.8	11.8	11.8
500	9.7	10.1	10.2	10.6	10.9	11.2	11.2	11.4	11.5	11.6	11.6
1,000	9.2	9.6	9.7	10.0	10.4	10.6	10.6	10.8	10.9	10.9	10.9
2,000	7.9	8.6	8.6	8.7	9.3	9.4	9.5	9.8	9.9	9.9	9.9
5,000	4.8	5.9	6.0	6.1	6.7	7.0	7.2	7.9	8.0	8.1	8.1

Form S-2

Appendix F: Table F.137: Depth-area-duration values for Beaulieu, MN July 18, 1909



Appendix F: Figure F.169 and Figure F.170: Total storm isohyetal analysis and mass curve chart for Beaulieu, MN July 18, 1909

Ironwood, MI, AWA 68

July 21, 1909

Storm Type: Frontal

Grid Points Used:

Storm Name:	USACE- UMV 1-11b-Ironwood, MI	Storm Adjustment for ANO Grid Point 8
Storm Date:	18-Jul-1909	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	46.45 N	90.18 W
Storm Rep Dew Point Location	42.75 N	92.25 W
Transposition Dew Point Location	39.02 N	94.50 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SSW @ 27	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,500	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	72.0 F	with total precipitable water above sea level of			2.47	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,500	which subtracts	0.34	inches of precipitable water at	72.0 F	
The in-place storm elevation is	1,500	which subtracts	0.44	inches of precipitable water at	80.5 F	
The transposition basin elevation at	1,200	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.50
The transposition/elevation to basin factor is	1.04
The barrier adjustment factor is	1.00
The total adjustment factor is	1.56

Notes: DAD values taken from USACE UMV 1-11b. Added 2° to USACE storm rep analyzed Td based on guidance from EPRI, Nebraska, and TRWD. In Place max factor held to 1.50 based on HMR guidance, calculated at 1.52.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	5.2	6.3	6.7	9.6	11.1	11.7	12.1	12.8	13.2
100 sq miles	5.1	6.2	6.6	9.4	10.8	11.4	11.8	12.5	12.9
200 sq miles	4.6	6.0	6.3	9.0	10.5	11.1	11.5	12.1	12.5
500 sq miles	3.9	5.5	5.8	7.9	9.8	10.1	10.7	11.2	11.5
1000 sq miles	3.2	5.0	5.3	6.9	9.0	9.3	9.7	10.3	10.5
2000 sq miles	2.8	4.4	4.6	6.0	7.9	8.2	8.7	9.2	9.5
5000 sq miles	2.3	3.6	3.8	5.0	6.5	6.8	7.2	7.8	8.0
10000 sq miles	2.1	3.2	3.4	4.2	5.4	5.6	6.0	6.5	6.7
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

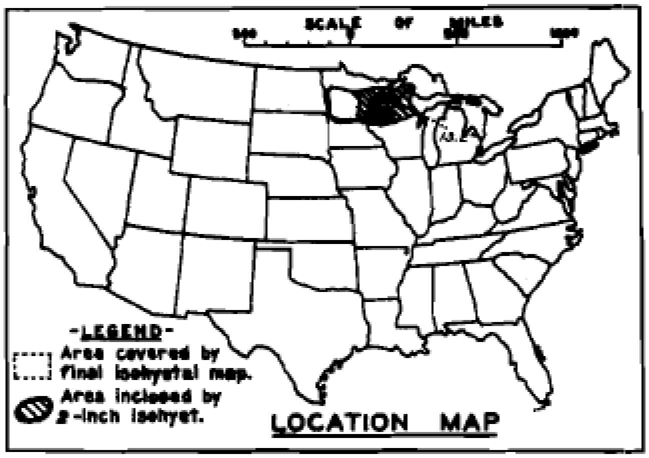
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	8.1	9.9	10.5	15.0	17.4	18.3	18.9	20.0	20.7
100 sq miles	8.0	9.7	10.3	14.7	16.9	17.8	18.5	19.6	20.2
200 sq miles	7.2	9.4	9.9	14.1	16.4	17.4	18.0	18.9	19.6
500 sq miles	6.1	8.6	9.1	12.4	15.3	15.8	16.7	17.5	18.0
1000 sq miles	5.0	7.8	8.3	10.8	14.1	14.6	15.2	16.1	16.4
2000 sq miles	4.4	6.9	7.2	9.4	12.4	12.8	13.6	14.4	14.9
5000 sq miles	3.6	5.6	5.9	7.8	10.2	10.6	11.3	12.2	12.5
10000 sq miles	3.3	5.0	5.3	6.6	8.5	8.8	9.4	10.2	10.5
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE- UMV 1-11b-Ironwood, MI**	
Storm Date(s)	18-Jul-1909	
Storm Type	Synoptic	
Storm Location	46.45 N	90.18 W
Storm Center Elevation	1,500	
Precipitation Total & Duration	13.20 Inches 72-hours USACE UMV 1-11b	
Storm Representative Dewpoint	72.0 F	24
Storm Representative Dewpoint Location	42.75 N	92.25 W
Maximum Dewpoint	80.5 F	
Moisture Inflow Vector	SSW @ 270	
In-place Maximization Factor	**1.50**	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	39.02 N	94.50 W
Transposition Maximum Dewpoint	80.5 F	
Transposition Adjustment Factor	**1.04**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.56**	

Appendix F: Table F.138: Storm spreadsheet for Ironwood, MI July 21, 1909

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET (REV.)



Storm of 18-23 July 1909
Assignment UMV 1-11 (b)
Location Northern Minn. & Wis.
Study Prepared by:
Upper Mississippi Valley Division
St. Paul District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 6/7/39
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 5/24/41
Remarks: Rainfall Data only for Ironwood, Mich. center
Dewpt. 70° - Ref. Pt. 275 SSW
Grid B-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	4
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	8
Miscl. precip. records, meteorological data, etc.	1
Form 5002 (Mass rainfall curves)	24

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

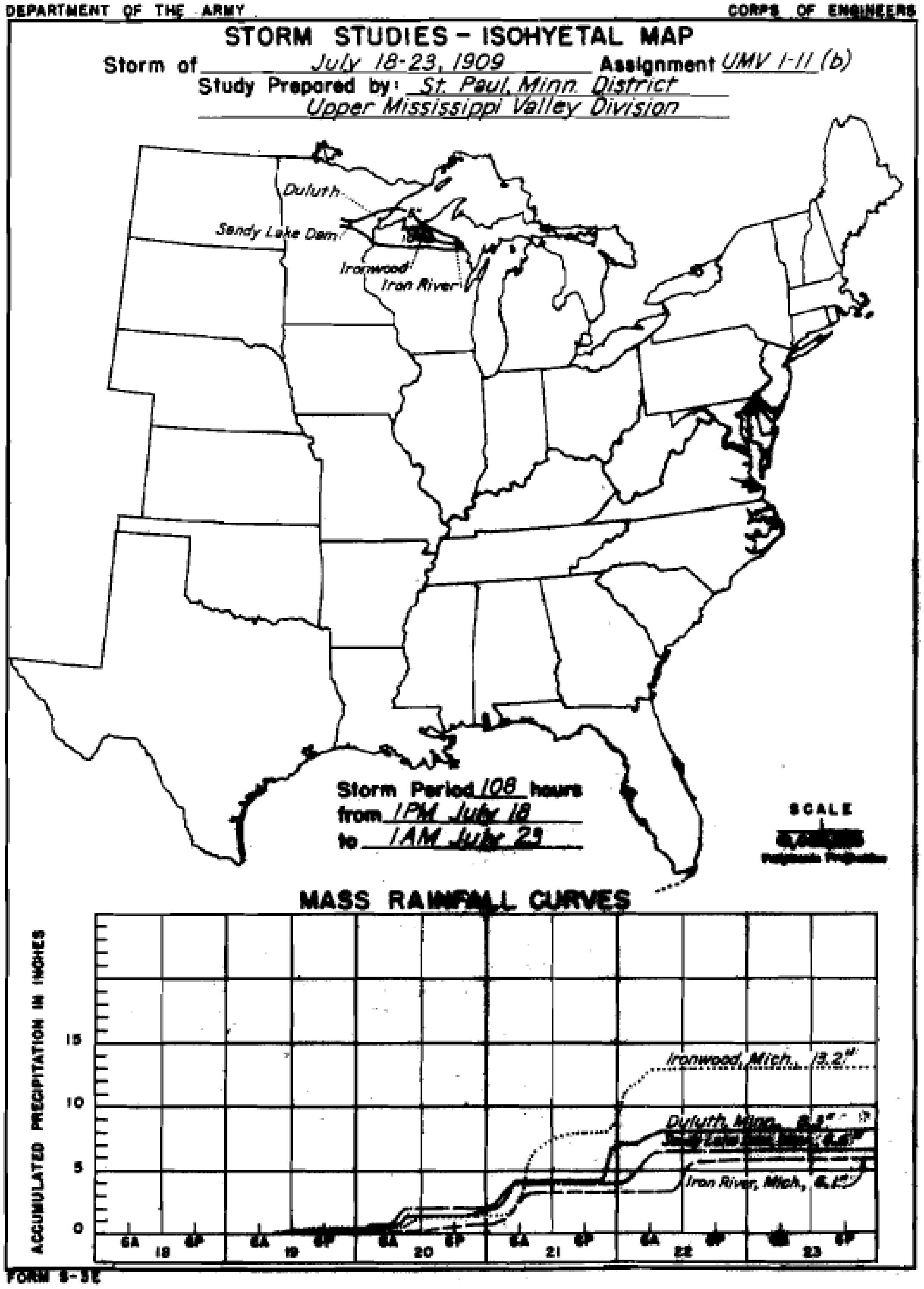
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	8
Maximum duration-depth-area curves	2
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	108
10	5.2	6.3	6.7	9.6	11.1	11.7	12.1	12.8	13.2	13.2	13.2
100	5.1	6.2	6.6	9.4	10.8	11.4	11.8	12.5	12.9	12.9	12.9
200	4.6	6.0	6.3	9.0	10.5	11.1	11.5	12.1	12.5	12.5	12.5
500	3.9	5.5	5.8	7.9	9.8	10.1	10.7	11.2	11.5	11.5	11.5
1,000	3.2	5.0	5.3	6.9	9.0	9.3	9.7	10.3	10.5	10.5	10.5
2,000	2.8	4.4	4.6	6.0	7.9	8.2	8.7	9.2	9.5	9.5	9.5
5,000	2.3	3.6	3.8	5.0	6.5	6.8	7.2	7.8	8.0	8.0	8.0
10,000	2.1	3.2	3.4	4.2	5.4	5.6	6.0	6.5	6.7	6.9	6.9

Form S-2

Appendix F: Table F.139: Depth-area-duration values for Ironwood, MI July 21, 1909



Appendix F: Figure F.171 and Figure F.172: Total storm isohyetal analysis and mass curve chart for Ironwood, MI July 21, 1909

Meeker, OK, AWA 69

October 19, 1908

Storm Type: Frontal

Storm Name:	SW 1-11-Meeker, OK	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	10/19-23/1908	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	5-Oct	
	Lat	Long
Storm Center Location	35.50 N	96.90 W
Storm Rep Dew Point Location	33.43 N	94.45 W
Transposition Dew Point Location	40.65 N	89.88 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SE @ 200	miles
Grid Point Elevation	350	feet
Storm Center Elevation	900	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	68.0 F	with total precipitable water above sea level of			2.05	inches.
The in-place maximum dew point is	75.5 F	with total precipitable water above sea level of			2.92	inches.
The transpositioned maximum dew point is	72.5 F	with total precipitable water above sea level of			2.54	inches.
The in-place storm elevation is	900	which subtracts	0.18	inches of precipitable water at	68.0 F	
The in-place storm elevation is	900	which subtracts	0.23	inches of precipitable water at	75.5 F	
The transposition basin elevation at	350	which subtracts	0.23	inches of precipitable water at	72.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.23	inches of precipitable water at	72.5 F	

The in-place storm maximization factor is	1.44
The transposition/elevation to basin factor is	0.86
The barrier adjustment factor is	1.00
The total adjustment factor is	1.23

Notes: DAD values taken from USACE SW 1-11. Added 2°F to the USACE storm rep Td to adjust the persisting Td to the average Td climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	9.4	10.0	10.0	11.4	11.8	12.0	14.5	14.9	15.2
100 sq miles	8.2	9.3	9.4	10.3	11.3	11.5	13.6	14.4	14.9
500 sq miles	7.1	8.4	8.5	9.2	10.5	10.7	13.2	13.8	14.2
1000 sq miles	6.3	7.5	7.7	8.6	9.9	10.2	12.7	13.3	13.7
2000 sq miles	5.5	6.6	6.8	7.8	9.0	9.4	11.9	12.5	12.9
5000 sq miles	4.4	5.4	5.7	6.6	7.6	8.2	10.5	11.3	11.7
10000 sq miles	3.5	4.5	4.8	5.6	6.4	7.1	9.2	10.0	10.6
20000 sq miles	2.7	3.6	3.9	4.6	5.3	5.9	7.7	8.6	9.0

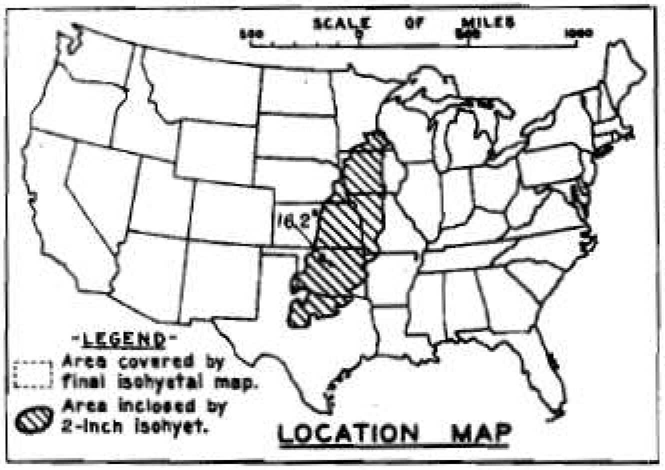
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	11.6	12.3	12.3	14.1	14.5	14.8	17.9	18.4	18.7
100 sq miles	10.1	11.5	11.6	12.7	13.9	14.2	16.8	17.7	18.4
500 sq miles	8.8	10.4	10.5	11.3	12.9	13.2	16.3	17.0	17.5
1000 sq miles	7.8	9.2	9.5	10.6	12.2	12.6	15.7	16.4	16.9
2000 sq miles	6.8	8.1	8.4	9.6	11.1	11.6	14.7	15.4	15.9
5000 sq miles	5.4	6.7	7.0	8.1	9.4	10.1	12.9	13.9	14.4
10000 sq miles	4.3	5.5	5.9	6.9	7.9	8.8	11.3	12.3	13.1
20000 sq miles	3.3	4.4	4.8	5.7	6.5	7.3	9.5	10.6	11.1

Storm or Storm Center Name	**SW 1-11-Meeker, OK**			
Storm Date(s)	10/19-23/1908			
Storm Type	General Storm			
Storm Location	35.50 N	96.90 W		
Storm Center Elevation	900			
Precipitation Total & Duration (10 sq mi)	16.23 Inches in 126 hours, 11.4 in 24 hours			
Storm Representative Td	68.0 F	24		
Storm Representative Td Location	33.43 N	94.45 W		
In-place Maximum Td	75.5 F			
Moisture Inflow Vector	SE @ 200			
In-place Maximization Factor	**1.44**			
Temporal Transposition (Date)	5-Oct			
Transposition Dewpoint Location	40.65 N	89.88 W	Sep	Oct
Transposition Maximum Td	72.5 F		74	72
Transposition Adjustment Factor	**0.86**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.23**			

Appendix F: Table F.140: Storm spreadsheet for Meeker, OK October 19, 1908

STORM STUDIES - PERTINENT DATA SHEET



Storm of October 19-24, 1908
Assignment S W 1 - 11
Location Okla., Tex.,-Ia.
Study Prepared by:

Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 11-12-40
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 7-15-45
Remarks: Center at:

Meeker, Okla.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:2,500,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	22
Form 5001-B (24-hour " ")	—
Form 5001-D (" " " ")	28
Miscl. precip. records, meteorological data, etc.	—
Form 5002 (Mass rainfall curves)	35

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

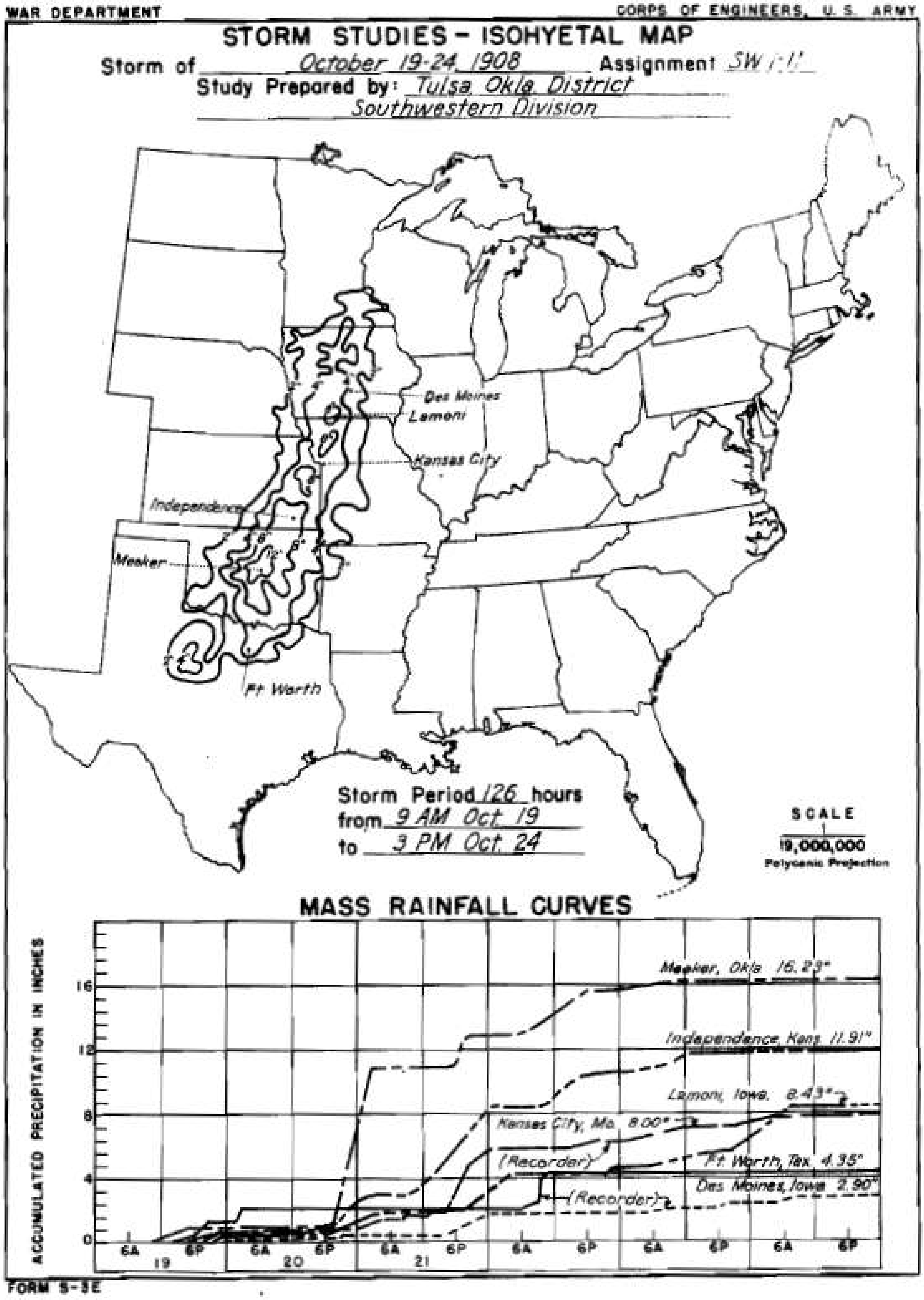
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	10
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	11
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	90	126
10	9.4	10.0	10.0	11.4	11.8	12.0	14.5	14.9	15.2	15.8	16.2
100	8.2	9.3	9.4	10.3	11.3	11.5	13.6	14.4	14.9	15.4	15.9
500	7.1	8.4	8.5	9.2	10.5	10.7	13.2	13.8	14.2	14.6	15.1
1,000	6.3	7.5	7.7	8.6	9.9	10.2	12.7	13.3	13.7	14.0	14.5
2,000	5.5	6.6	6.8	7.8	9.0	9.4	11.9	12.5	12.9	13.3	13.7
5,000	4.4	5.4	5.7	6.6	7.6	8.2	10.5	11.3	11.7	12.1	12.5
10,000	3.5	4.5	4.8	5.6	6.4	7.1	9.2	10.0	10.6	11.0	11.4
20,000	2.7	3.6	3.9	4.6	5.3	5.9	7.7	8.6	9.0	9.6	10.1
50,000	1.6	2.4	2.8	3.4	3.8	4.3	5.6	6.2	6.6	7.2	8.0
80,000	1.0	1.7	2.1	2.7	3.0	3.4	4.4	4.9	5.4	5.9	6.8

Form S-2
810658 O - 45 - 1

Appendix F: Table F.141: Depth-area-duration values for Meeker, OK October 19, 1908



Appendix F: Figure F.173 and Figure F.174: Total storm isohyetal analysis and mass curve chart for Meeker, OK October 19, 1908

Bonaparte, IA, AWA 70

June 10, 1905

Storm Type: MCC

Storm Name:	**USACE UMV 2-5-Bonaparte, IA**	**Storm Adjustment for ANO Grid Point 2**
Storm Date:	**June 9, 1905**	
AWA Analysis Date:	**12/16/2013**	

Temporal Transposition Date **30-Jun**

	Lat	Long
Storm Center Location	**40.77 N**	**91.75 W**
Storm Rep Dew Point Location	**38.52 N**	**91.81 W**
Transposition Dew Point Location	**40.48 N**	**92.64 W**
Grid Point Location	**34.50 N**	**95.50 W**

Moisture Inflow Direction	**S @ 155**	miles
Grid Point Elevation	**550**	feet
Storm Center Elevation	**1,500**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**77.0 F**	with total precipitable water above sea level of			**3.14**	inches.
The in-place maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The transpositioned maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The in-place storm elevation is	**1,500**	which subtracts	**0.39**	inches of precipitable water at	**77.0 F**	
The in-place storm elevation is	**1,500**	which subtracts	**0.43**	inches of precipitable water at	**80.0 F**	
The transposition storm elevation at	**550**	which subtracts	**0.30**	inches of precipitable water at	**80.0 F**	
The Grid Point/inflow barrier height is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**80.0 F**	

The in-place maximization factor is	**1.15**
The transposition factor is	**1.04**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.20**

Notes: DAD values taken from USACE UMV 2-5. Added 7° to the USACE analyzed storm rep dew point based on guidance from EPRI, Nebraska, TRWD.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.0**	**10.2**	**12.1**	-	-	-	-	-	-	-
10 sq miles	**2.0**	**10.0**	**12.0**	-	-	-	-	-	-	-
100 sq miles	**1.9**	**9.2**	**11.5**	-	-	-	-	-	-	-
200 sq miles	**1.8**	**8.9**	**11.3**	-	-	-	-	-	-	-
500 sq miles	**1.8**	**8.5**	**10.7**	-	-	-	-	-	-	-
1000 sq miles	**1.7**	**8.0**	**10.0**	-	-	-	-	-	-	-
2000 sq miles	**1.6**	**7.2**	**9.1**	-	-	-	-	-	-	-
5000 sq miles	**1.3**	**5.8**	**7.3**	-	-	-	-	-	-	-
10000 sq miles	**1.0**	**4.4**	**5.6**	-	-	-	-	-	-	-
20000 sq miles	**0.7**	**3.0**	**3.9**	-	-	-	-	-	-	-

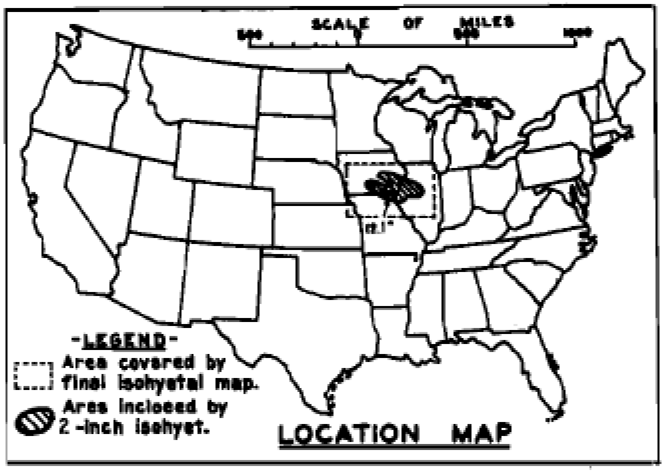
Adjusted Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.4**	**12.2**	**14.5**	-	-	-	-	-	-	-
10 sq miles	**2.4**	**12.0**	**14.4**	-	-	-	-	-	-	-
100 sq miles	**2.3**	**11.0**	**13.8**	-	-	-	-	-	-	-
200 sq miles	**2.2**	**10.7**	**13.6**	-	-	-	-	-	-	-
500 sq miles	**2.2**	**10.2**	**12.8**	-	-	-	-	-	-	-
1000 sq miles	**2.0**	**9.6**	**12.0**	-	-	-	-	-	-	-
2000 sq miles	**1.9**	**8.6**	**10.9**	-	-	-	-	-	-	-
5000 sq miles	**1.6**	**7.0**	**8.8**	-	-	-	-	-	-	-
10000 sq miles	**1.2**	**5.3**	**6.7**	-	-	-	-	-	-	-
20000 sq miles	**0.8**	**3.6**	**4.7**	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE UMV 2-5-Bonaparte, IA**			
Storm Date(s)	9-Jun-1905			
Storm Type	MCC			
Storm Location	40.77 N	91.75 W		
Storm Center Elevation	1,500			
Precipitation Total & Duration	12.10 Inches 12-hours USACE UMV 2-5			
Storm Representative Dew Point	77.0 F	12		
Storm Representative Dew Point Location	38.52 N	91.81 W		
Maximum Dew Point	80.0 F			
Moisture Inflow Vector	S @ 155			
In-place Maximization Factor	**1.15**			
Temporal Transposition (Date)	30-Jun			
Transposition Dew Point Location	40.48 N	92.64 W	Jun	July
Transposition Maximum Dew Point	80.0 F		79	81
Transposition Adjustment Factor	**1.04**			
Grid Point Elevation	550			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.20**			

Appendix F: Table F.142: Storm spreadsheet for Bonaparte, IA June 10, 1905

STORM STUDIES – PERTINENT DATA SHEET



Storm of June 9 – 10, 1905
Assignment U M V 2 – 5
Location S.E. Ia. and W.Cent.Ill
Study Prepared by:
Upper Mississippi Valley Division

Rock Island District Office
Part I Reviewed by H. M. Sec. of Weather Bureau, 6/20/40
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 6/22/44
Remarks: Centers at:
Bonapart (Near), Ia., and Le Harpe, Ill.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 2,500,000
Precipitation data and mass curves: (Number of Sheets)
Form 5001-C (Hourly precip. data) ---------- 8
Form 5001-B (24-hour " ") ---------- -
Form 5001-D (" " " ") ---------- 6
Miscl. precip. records, meteorological data, etc. ---------- 4
Form 5002 (Mass rainfall curves) ---------- 19

PART II

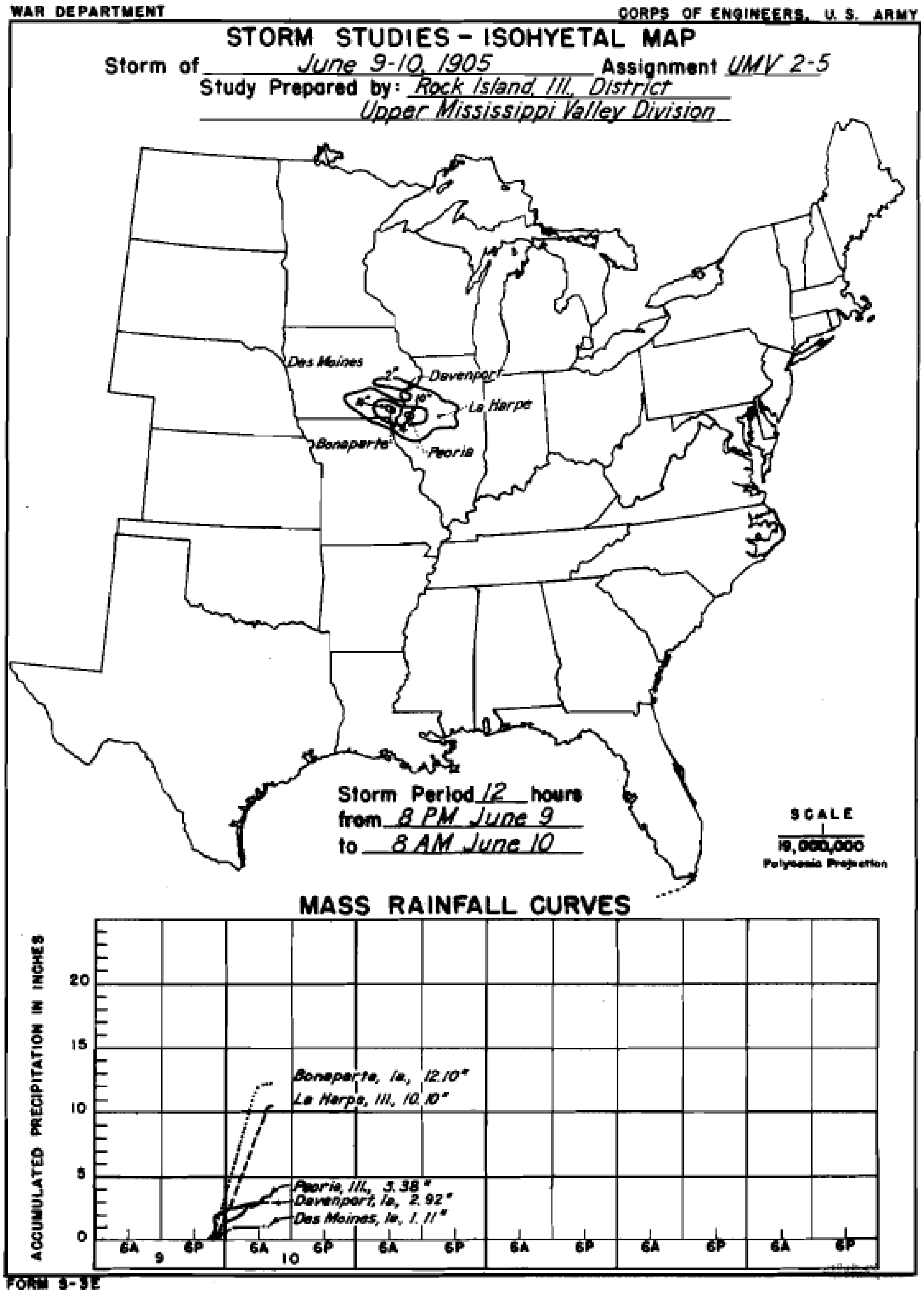
Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000
Data and computation sheets:
Form S-10 (Data from mass rainfall curves) ---------- 2
Form S-11 (Depth-area data from isohyetal map) ---------- 1
Form S-12 (Maximum depth-duration data) ---------- 6
Maximum duration-depth-area curves ---------- 1
Data relating to periods of maximum rainfall ---------- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	1	2	3	4	5	6	7	8	10	12
Max. Station	2.0	4.0	6.0	8.0	9.9	10.2	10.8	11.4	11.9	12.1
10	2.0	4.0	5.9	7.9	9.7	10.0	10.5	11.2	11.8	12.0
100	1.9	3.7	5.6	7.2	8.7	9.2	9.8	10.5	11.3	11.5
200	1.8	3.6	5.5	7.0	8.4	8.9	9.5	10.2	11.1	11.3
500	1.8	3.5	5.2	6.6	7.8	8.5	9.1	9.7	10.5	10.7
1,000	1.7	3.4	4.9	6.2	7.4	8.0	8.6	9.0	9.8	10.0
2,000	1.6	3.1	4.5	5.6	6.7	7.2	7.8	8.1	8.8	9.1
5,000	1.3	2.5	3.5	4.5	5.2	5.8	6.2	6.5	7.0	7.3
10,000	1.0	1.9	2.7	3.4	3.9	4.4	4.8	5.0	5.4	5.6
20,000	0.7	1.3	1.7	2.1	2.5	3.0	3.1	3.3	3.7	3.9

Form S-2

Appendix F: Table F.143: Depth-area-duration values for Bonaparte, IA June 10, 1905



Appendix F: Figure F.175 and Figure F.176: Total storm isohyetal analysis and mass curve chart for Bonaparte, IA June 10, 1905

Medford, WI, AWA 71

June 4, 1905

Storm Type: Frontal/MCC

Grid Points Used: 8-11, 16-18

Storm Name:	GL 2-12, Medford, WI
Storm Date:	6/3-8/1905
AWA Analysis Date:	12/16/2013

Storm Adjustment for ANO Grid Point 8

Temporal Transposition Date	15-Jun	
	Lat	Long
Storm Center Location	45.14 N	90.34 W
Storm Rep Dew Point Location	43.06 N	93.14 W
Transposition Dew Point Location	40.65 N	95.28 W
Grid point Location	37.50 N	93.00 W

Moisture Inflow Direction:	SW @ 200	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,500	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	70.0 F	with total precipitable water above sea level of			2.25	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	78.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place storm elevation is	1,500	which subtracts	0.31	inches of precipitable water at	70.0 F	
The in-place storm elevation is	1,500	which subtracts	0.39	inches of precipitable water at	76.5 F	
The transposition basin elevation at	1,200	which subtracts	0.28	inches of precipitable water at	78.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.28	inches of precipitable water at	78.0 F	

The in-place storm maximization factor is	1.38
The transposition/elevation to basin factor is	1.07
The barrier adjustment factor is	1.00
The total adjustment factor is	1.47

Notes: DAD values taken from USACE GL 2-12. Added 2°F to USACE storm rep Td based on 12hr persisting to average Td adjustment.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	7.2	8.4	8.5	8.9	9.1	9.9	10.5	11.2	11.2
100 sq miles	6.8	8.1	8.3	8.5	8.7	9.6	10.1	10.7	10.7
200 sq miles	6.6	7.8	8.0	8.2	8.5	9.2	9.9	10.5	10.5
500 sq miles	6.0	7.0	7.1	7.6	8.1	8.6	9.3	9.9	9.9
1000 sq miles	5.4	6.2	6.4	7.0	7.6	8.0	8.7	9.3	9.3
5000 sq miles	3.8	4.5	4.8	5.5	6.1	6.5	7.0	7.6	7.7
10000 sq miles	3.1	3.8	4.0	4.8	5.4	5.8	6.2	6.9	7.0
20000 sq miles	2.4	3.0	3.3	4.1	4.8	5.1	5.3	6.1	6.2

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.6	12.4	12.5	13.1	13.4	14.6	15.5	16.5	16.5
100 sq miles	10.0	11.9	12.2	12.5	12.8	14.2	14.9	15.8	15.8
200 sq miles	9.7	11.5	11.8	12.1	12.5	13.6	14.6	15.5	15.5
500 sq miles	8.8	10.3	10.5	11.2	11.9	12.7	13.7	14.6	14.6
1000 sq miles	8.0	9.1	9.4	10.3	11.2	11.8	12.8	13.7	13.7
5000 sq miles	5.6	6.6	7.1	8.1	9.0	9.6	10.3	11.2	11.4
10000 sq miles	4.6	5.6	5.9	7.1	8.0	8.6	9.1	10.2	10.3
20000 sq miles	3.5	4.4	4.9	6.0	7.1	7.5	7.8	9.0	9.1

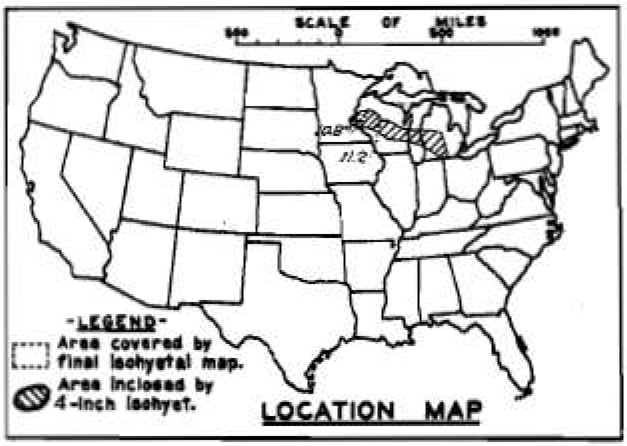
Storm or Storm Center Name	GL 2-12, Medford, WI	
Storm Date(s)	6/3-8/1905	
Storm Type	Synoptic	
Storm Location	45.14 N	90.34 W
Storm Center Elevation	1,500	
Precipitation Total & Duration	11.20 Inches 72-hours USACE GL 2-12	
Storm Representative Dewpoint	70.0 F	24
Storm Representative Dewpoint Location	43.06 N	93.14 W
Maximum Dewpoint	76.5 F	
Moisture Inflow Vector	SW @ 200 Miles	
In-place Maximization Factor	1.38	
Temporal Transposition (Date)	15-Jun	
Transposition Dewpoint Location	40.65 N	95.28 W
Transposition Maximum Dewpoint	78.0 F	
Transposition Adjustment Factor	1.07	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.47	

Appendix F: Table F.144: Storm spreadsheet for Medford, WI June 4, 1905

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of 3-8 June 1905
Assignment G L 2 - 12
Location Minn., Wis., Mich.,Ohio
Study Prepared by:
Great Lakes Division
Milwaukee District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 6-17-40
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 12-6-45
Remarks: Centers at Medford and Barron, Wis.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:2,500,000

Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) ---------- 16
- Form 5001-B (24-hour " ") ---------- —
- Form 5001-D (" " " ") ---------- 10
- Miscl. precip. records, meteorological data, etc. ---------- 20
- Form 5002 (Mass rainfall curves) ---------- 29

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

Data and computation sheets:

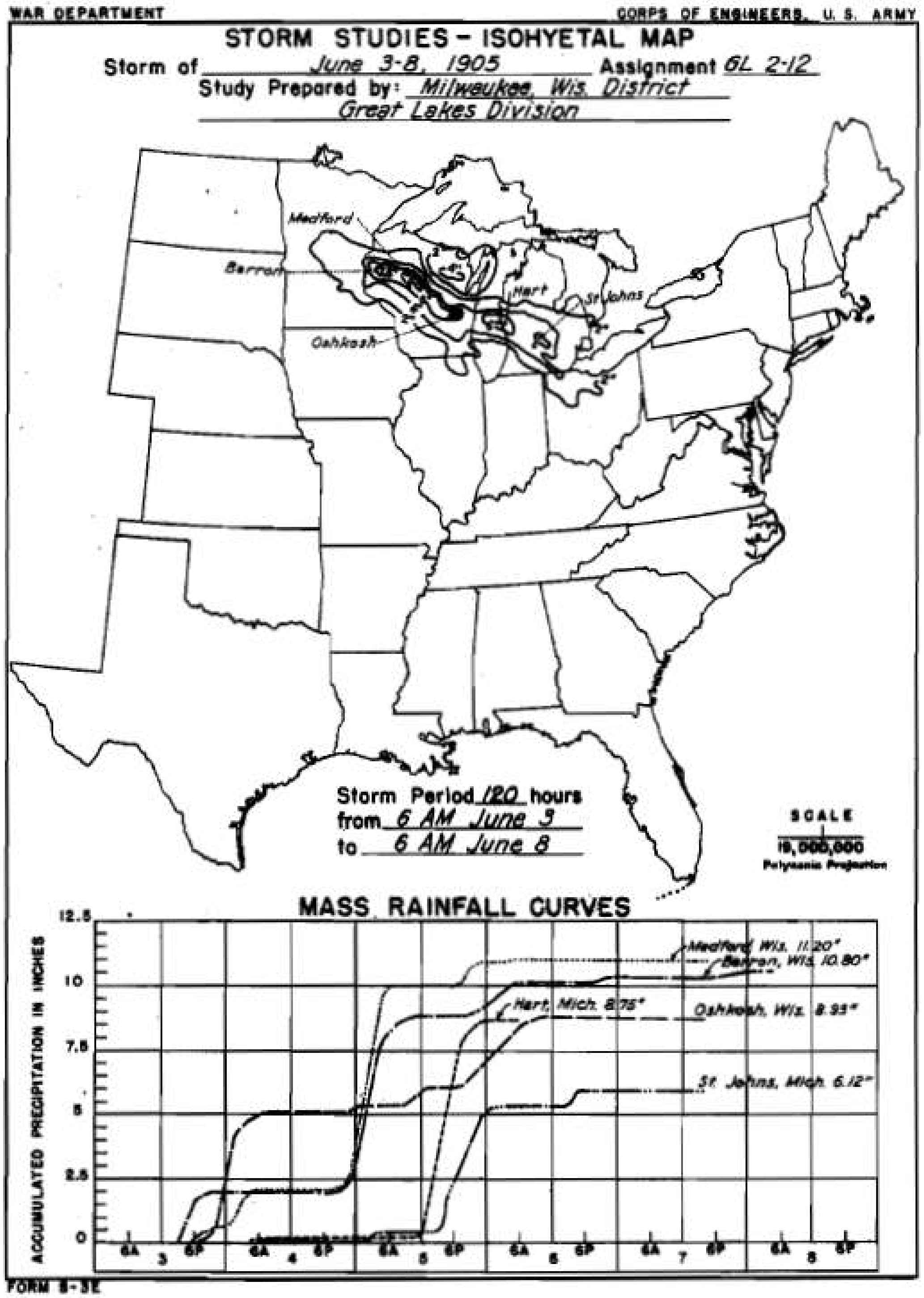
- Form S-10 (Data from mass rainfall curves) ---------- 4
- Form S-11 (Depth-area data from isohyetal map) ---------- 2
- Form S-12 (Maximum depth-duration data) ---------- 8
- Maximum duration-depth-area curves ---------- 1
- Data relating to periods of maximum rainfall ---------- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	120
10	7.2	8.4	8.5	8.9	9.1	9.9	10.5	11.2	11.2	11.2	11.2
100	6.8	8.1	8.3	8.5	8.7	9.6	10.1	10.7	10.7	10.7	10.7
200	6.6	7.8	8.0	8.2	8.5	9.2	9.9	10.5	10.5	10.5	10.5
500	6.0	7.0	7.1	7.6	8.1	8.6	9.3	9.9	9.9	9.9	9.9
1,000	5.4	6.2	6.4	7.0	7.6	8.0	8.7	9.3	9.3	9.3	9.3
2,000	4.7	5.5	5.7	6.4	7.0	7.4	8.0	8.6	8.6	8.7	8.7
5,000	3.8	4.5	4.8	5.5	6.1	6.5	7.0	7.6	7.7	7.8	7.8
10,000	3.1	3.8	4.0	4.8	5.4	5.8	6.2	6.9	7.0	7.1	7.1
20,000	2.4	3.0	3.3	4.1	4.8	5.1	5.3	6.1	6.2	6.3	6.3
50,000	1.5	2.1	2.4	2.9	3.5	3.6	4.0	4.5	4.7	4.8	4.8
67,000	1.2	1.8	2.1	2.4	3.0	3.1	3.3	3.8	4.0	4.2	4.2

Form S-2

Appendix F: Table F.145: Depth-area-duration values for Medford, WI June 4, 1905



Appendix F: Figure F.177 and Figure F.178: Total storm isohyetal analysis and mass curve chart for Medford, WI June 4, 1905

Rociada, NM, AWA 72

September 26, 1904

Storm Type: Frontal

Grid Points Used: 7, 13-14

Storm Name:	Rociada, NM USACE SW 1-6	Storm Adjustment for ANO Grid Point 6
Storm Date:	9/26-30/1904	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date: 10-Sep

	Lat	Long
Storm center location	35.87 N	105.33 W
Storm Rep dew point location	34.10 N	100.50 W
Transposition dewpoint location	38.16 N	87.45 W
Grid Point location	34.50 N	104.00 W

Moisture Inflow Direction:	ESE @ 300	miles
Grid Point Elevation	4,400	feet
Storm Center Elevation	7,743	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	74.0 F	with total precipitable water above sea level of			2.73	inches.
The in-place maximum dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The transpositioned maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place storm elevation is	7,743	which subtracts	1.46	inches of precipitable water at	74.0 F	
The in-place storm elevation is	7,743	which subtracts	1.63	inches of precipitable water at	77.0 F	
The transposition basin elevation at	4,400	which subtracts	1.09	inches of precipitable water at	78.0 F	
The Grid Point/Inflow barrier height is	xx	which subtracts	1.09	inches of precipitable water at	78.0 F	

The in-place storm maximization factor is	1.19
The transposition/elevation to basin factor is	1.46
The barrier adjustment factor is	1.00
The total adjustment factor is	1.73

Notes: DAD values taken from SW 1-6. Added 2°F to USACE storm rep to convert ot average maximum Td climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	3.8	4.2	5.2	6.6	7.3	7.3	7.3	7.3	7.3
100 sq miles	3.1	3.8	4.7	6.3	7.0	7.0	7.0	7.0	7.0
200 sq miles	2.9	3.7	4.6	6.2	6.8	6.8	6.9	6.9	6.9
500 sq miles	2.6	3.5	4.3	5.8	6.4	6.5	6.5	6.6	6.7
1000 sq miles	2.4	3.3	4.1	5.4	6.1	6.2	6.4	6.4	6.5
2000 sq miles	2.2	3.1	3.9	5.0	5.7	5.9	6.1	6.2	6.3
5000 sq miles	1.8	2.8	3.5	4.4	5.2	5.5	5.7	5.8	6.0
10000 sq miles	1.5	2.4	3.1	3.8	4.6	5.0	5.2	5.4	5.6
20000 sq miles	1.3	2.0	2.7	3.3	3.9	4.3	4.5	4.8	5.0

Adjusted Storm Depth-Area-Duration

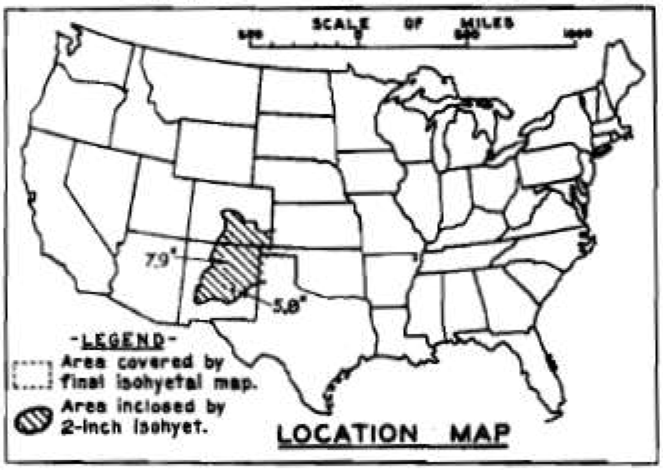
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	-	-	-	-	-	-	-	-	-
10 sq miles	6.6	7.3	9.0	11.4	12.6	12.6	12.6	12.6	12.6
100 sq miles	5.4	6.6	8.1	10.9	12.1	12.1	12.1	12.1	12.1
200 sq miles	5.0	6.4	8.0	10.7	11.8	11.8	12.0	12.0	12.0
500 sq miles	4.5	6.1	7.4	10.0	11.1	11.3	11.3	11.4	11.6
1000 sq miles	4.2	5.7	7.1	9.4	10.6	10.7	11.1	11.1	11.3
2000 sq miles	3.8	5.4	6.8	8.7	9.9	10.2	10.6	10.7	10.9
5000 sq miles	3.1	4.9	6.1	7.6	9.0	9.5	9.9	10.0	10.4
10000 sq miles	2.6	4.2	5.4	6.6	8.0	8.7	9.0	9.4	9.7
20000 sq miles	2.3	3.5	4.7	5.7	6.8	7.4	7.8	8.3	8.7

Storm or Storm Center Name	Rociada, NM USACE SW 1-6			
Storm Date(s)	9/26-30/1904			
Storm Type	Synoptic			
Storm Location	35.87 N	105.33 W		
Storm Center Elevation	7,743			
Precipitation Total & Duration	7.90 Inches 30-hours			
Storm Representative Dewpoint	74.0 F	24	ABI, AMA	
Storm Representative Dewpoint Location	34.10 N	100.50 W		
Maximum Dewpoint	77.0 F			
Moisture Inflow Vector	ESE @ 300		Aug	Sept
In-place Maximization Factor	1.19		79	76.5
Temporal Transposition (Date)	10-Sep			
Transposition Dewpoint Location	38.16 N	87.45 W		
Transposition Maximum Dewpoint	78.0 F			
Transposition Adjustment Factor	1.46			
Grid Point Elevation	4,400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.73			

Appendix F: Table F.146: Storm spreadsheet for Rociada, NM September 26, 1904

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of September 26-30, 1904
Assignment S W 1 - 6
Location N.Mex. and Colorado
Study Prepared by:
Southwestern Division
Albuquerque District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 5/22/44
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/6/44
Remarks: Centers at;
Rociada, New Mexico and
Fort Stanton, New Mexico

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet , scale 1 : 2,500,000
Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	7
Form 5001-B (24-hour " ")	22
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	-
Form 5002 (Mass rainfall curves)	23

PART II

Final isohyetal maps, in 1 sheet , scale 1 : 2,500,000
Data and computation sheets:

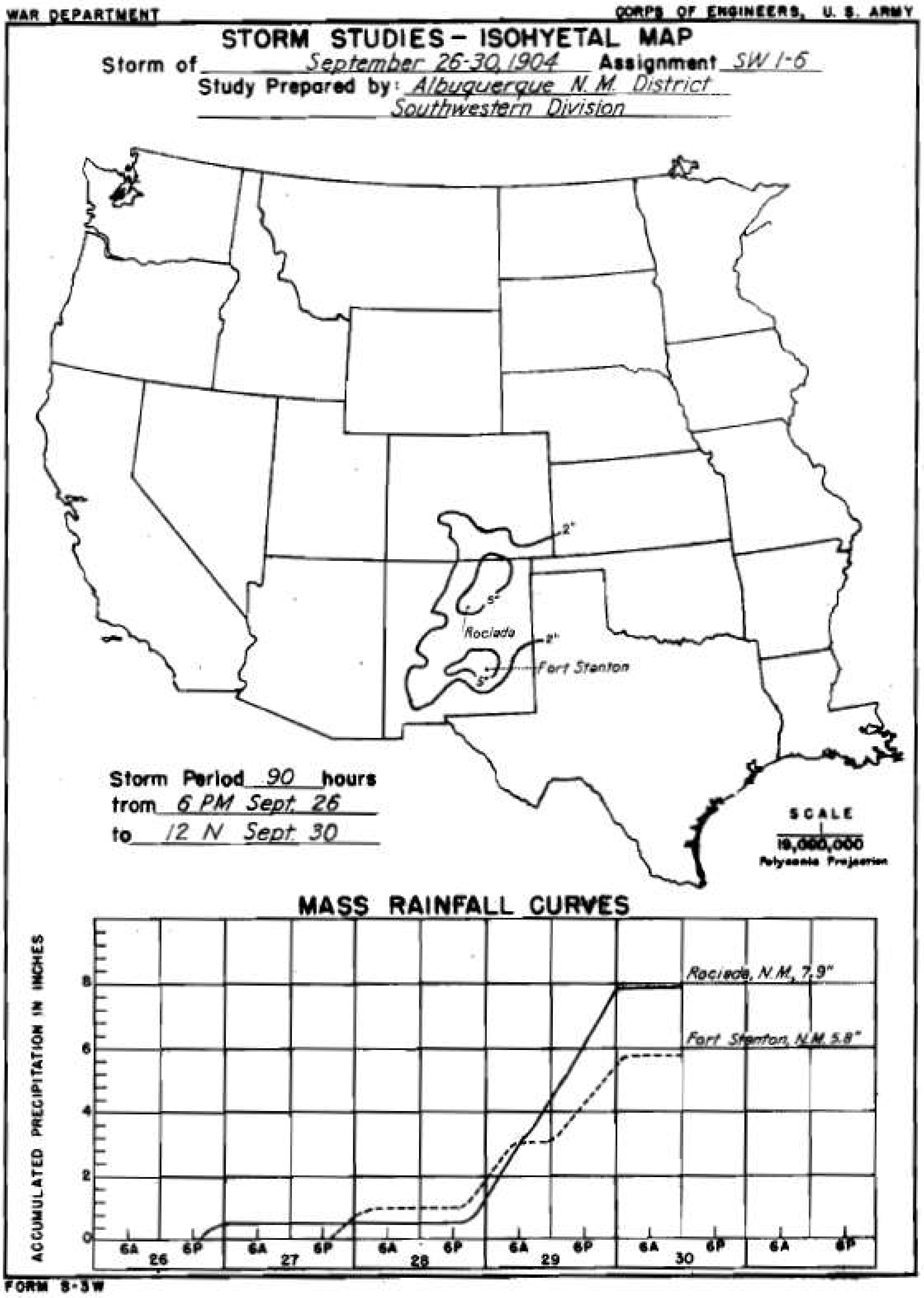
Form S-10 (Data from mass rainfall curves)	1
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	5
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	90
10	3.8	4.2	5.2	6.6	7.3	7.3	7.3	7.3	7.3	7.9
100	3.1	3.8	4.7	6.3	7.0	7.0	7.0	7.0	7.0	7.6
200	2.9	3.7	4.6	6.2	6.8	6.8	6.9	6.9	6.9	7.5
500	2.6	3.5	4.3	5.8	6.4	6.5	6.5	6.6	6.7	7.3
1,000	2.4	3.3	4.1	5.4	6.1	6.2	6.4	6.4	6.5	7.2
2,000	2.2	3.1	3.9	5.0	5.7	5.9	6.1	6.2	6.3	7.0
5,000	1.8	2.8	3.5	4.4	5.2	5.5	5.7	5.8	6.0	6.8
10,000	1.5	2.4	3.1	3.8	4.6	5.0	5.2	5.4	5.6	6.2
20,000	1.3	2.0	2.7	3.3	3.9	4.3	4.5	4.8	5.0	5.4
50,000	0.8	1.4	1.9	2.4	2.8	3.2	3.4	3.7	3.9	4.2
70,000	0.6	1.1	1.6	2.1	2.4	2.7	2.9	3.2	3.4	3.7

Form S-2

Appendix F: Table F.147: Depth-area-duration values for Rociada, NM September 26, 1904



Appendix F: Figure F.179 and Figure F.180: Total storm isohyetal analysis and mass curve chart for Rociada, NM September 26, 1904

Woodburn, IA, AWA 73

August 24, 1903

Storm Type: Frontal/MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	MR 1-10-Woodburn, IA	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	24-Aug-1903	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	5-Aug	
	Lat	Long
Storm Center Location	41.01 N	93.60 W
Storm Rep Dew Point Location	38.52 N	91.81 W
Transposition Dew Point Location	40.25 N	90.75 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSE @ 195	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,150	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,150	which subtracts	0.30	inches of precipitable water at	75.0 F	
The in-place storm elevation is	1,150	which subtracts	0.34	inches of precipitable water at	80.5 F	
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.31
The transposition/elevation to basin factor is	1.01
The barrier adjustment factor is	1.00
The total adjustment factor is	1.32

Notes: DAD values taken from USACE MR 1-10. 2° added to the storm rep based on EPRI and Nebraska analyses to adjust 12-hr persisting Td to 24-hr average Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	6.9	11.5	11.9	14.7	14.7	14.7	15.4	15.5	15.5
100 sq miles	6.6	10.3	11.4	12.8	13.8	13.8	13.9	14.4	14.6
200 sq miles	6.3	9.9	11.0	12.2	13.2	13.2	13.2	13.8	13.9
500 sq miles	5.7	9.3	10.3	11.2	12.2	12.2	12.6	12.8	12.8
1000 sq miles	5.2	8.7	9.5	10.3	11.1	11.2	11.2	11.5	11.7
2000 sq miles	4.6	7.8	8.6	9.2	10.0	10.1	10.2	10.4	10.6
5000 sq miles	3.7	6.4	7.3	7.7	8.4	8.7	8.8	8.8	9.0
10000 sq miles	3.0	5.2	6.3	6.5	7.1	7.3	7.5	7.5	7.7
20000 sq miles	2.3	4.0	5.0	5.2	5.6	5.9	6.1	6.1	6.3

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	9.1	15.2	15.7	19.4	19.4	19.4	20.4	20.5	20.5
100 sq miles	8.7	13.6	15.1	16.9	18.2	18.2	18.4	19.0	19.3
200 sq miles	8.3	13.1	14.5	16.1	17.4	17.4	17.4	18.2	18.4
500 sq miles	7.5	12.3	13.6	14.8	16.1	16.1	16.7	16.9	16.9
1000 sq miles	6.9	11.5	12.6	13.6	14.7	14.8	14.8	15.2	15.5
2000 sq miles	6.1	10.3	11.4	12.2	13.2	13.3	13.5	13.7	14.0
5000 sq miles	4.9	8.5	9.6	10.2	11.1	11.5	11.6	11.6	11.9
10000 sq miles	4.0	6.9	8.3	8.6	9.4	9.6	9.9	9.9	10.2
20000 sq miles	3.0	5.3	6.6	6.9	7.4	7.8	8.1	8.1	8.3

Storm or Storm Center Name	**MR 1-10-Woodburn, IA**			
Storm Date(s)	24-Aug-1903			
Storm Type	MCC			
Storm Location	41.01 N	93.60 W		
Storm Center Elevation	1,150			
Precipitation Total & Duration	14.70 Inches 24-hours USACE MR 1-10			
Storm Representative Dewpoint	75.0 F	24		
Storm Representative Dewpoint Location	38.52 N	91.81 W		
Maximum Dewpoint	80.5 F			
Moisture Inflow Vector	SSE @ 195			
In-place Maximization Factor	**1.31**			
Temporal Transposition (Date)	5-Aug			
Transposition Dewpoint Location	40.25 N	90.75 W	J	A
Transposition Maximum Td	80.5 F		80.5	80.5
Transposition Adjustment Factor	**1.01**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.32**			

Appendix F: Table F.148: Storm spreadsheet for Woodburn, IA August 24, 1903

WAR DEPARTMENT | CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET

Storm of August 24 - 28, 1903
Assignment MR 1 - 10
Location Iowa
Study Prepared by:
Missouri River Division
Kansas City District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 6/6/39
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 11/4/44
Remarks: Centers at Woodburn, Ia., and Council Bluffs, Ia.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 2,500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	5
Form 5001-B (24-hour " ")	21
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	-
Form 5002 (Mass rainfall curves)	11

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

Data and computation sheets:

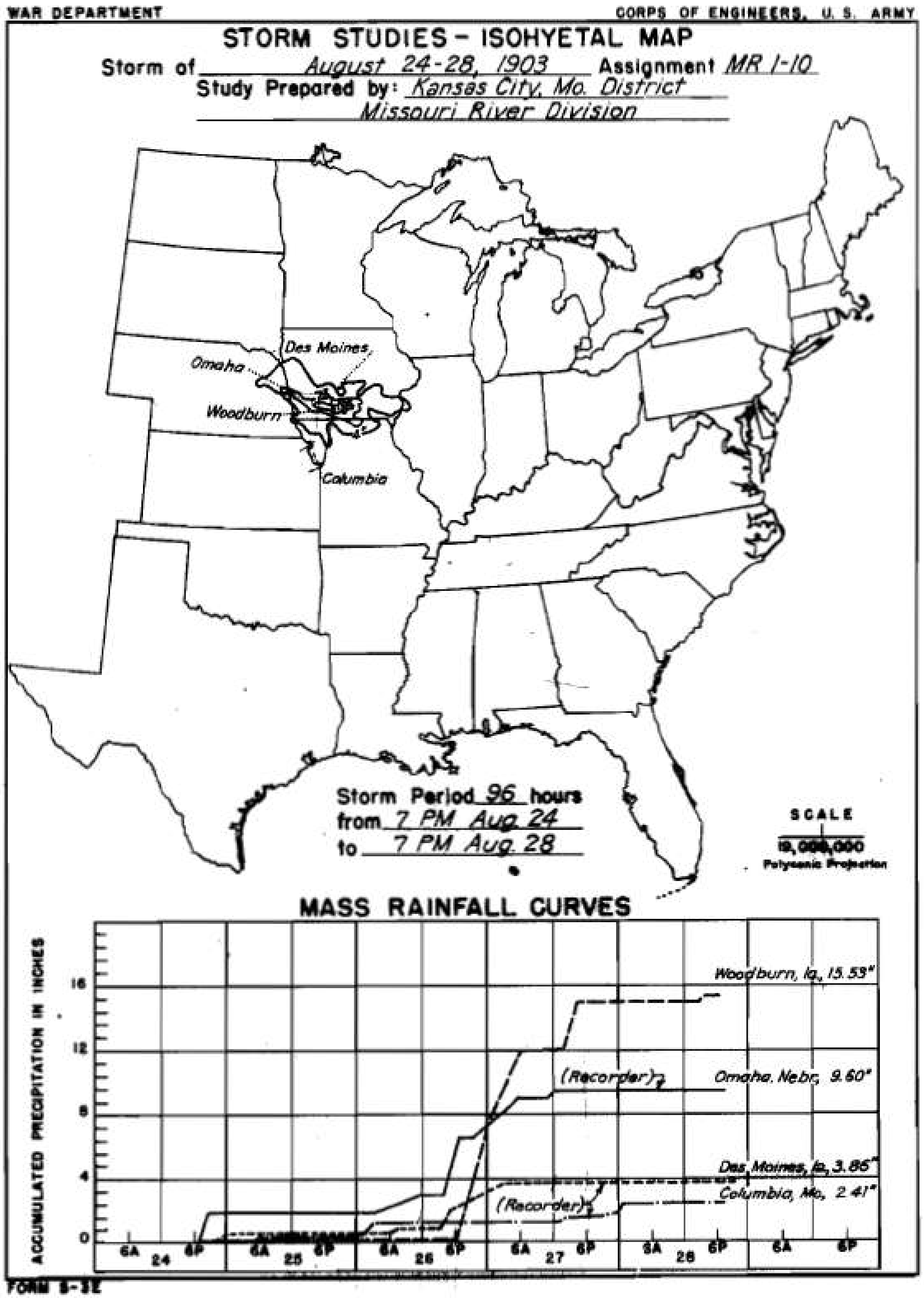
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	6
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	96
10	6.9	~~11.5~~	11.9	14.7	14.7	14.7	15.4	15.5	15.5	15.5
100	6.6	10.3	11.4	12.8	13.8	13.8	13.9	14.4	14.6	14.6
200	6.3	9.9	11.0	12.2	13.2	13.2	13.2	13.8	13.9	13.9
500	5.7	9.3	10.3	11.2	12.2	12.2	12.2	12.6	12.8	12.8
1,000	5.2	8.7	9.5	10.3	11.1	11.2	11.2	11.5	11.7	11.7
2,000	4.6	7.8	8.6	9.2	10.0	10.1	10.2	10.4	10.6	10.7
5,000	3.7	6.4	7.3	7.7	8.4	8.7	8.8	8.8	9.0	9.2
10,000	3.0	5.2	6.3	6.5	7.1	7.3	7.5	7.5	7.7	7.9
20,000	2.3	4.0	5.0	5.2	5.6	5.9	6.1	6.1	6.3	6.5
50,000	1.3	2.4	3.1	3.2	3.5	4.0	4.2	4.3	4.4	4.7
59,000	1.1	2.1	2.8	2.9	3.2	3.6	3.9	4.0	4.1	4.4

Form S-2

Appendix F: Table F.149: Depth-area-duration values for Woodburn, IA August 24, 1903



Appendix F: Figure F.181 and Figure F.182: Total storm isohyetal analysis and mass curve chart for Woodburn, IA August 24, 1903

Lambert, MN, AWA 75, UMV 1-2
July 18, 1897
Storm Type: Frontal/MCC

Storm Name:	UMV 1-2, Lambert, MN		
Storm Date:	7/18-22/1897		
AWA Analysis Date:	12/16/2013		

Storm Adjustment for ANO Grid Point 8

Temporal Transposition Date	15-Jul	
	Lat	**Long**
Storm Center Location	47.80 N	96.00 W
Storm Rep Dew Point Location	43.70 N	93.60 W
Transposition Dew Point Location	38.94 N	90.47 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SSE @ 300	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,150	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	71.0 F	with total precipitable water above sea level of			2.36	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	1,150	which subtracts	0.25	inches of precipitable water at	71.0 F	
The in-place storm elevation is	1,150	which subtracts	0.35	inches of precipitable water at	80.5 F	
The transposition basin elevation at	1,200	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place storm maximization factor is	1.58
The transposition/elevation to basin factor is	1.04
The barrier adjustment factor is	1.00
The total adjustment factor is	1.64

Notes: DAD values taken from USACE UMV 1-2. In-place maximization factor of 1.55, although a factor of 1.50 was adopted as the upper limit for this study through guidance from HMR.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	3.2	5.2	6.2	6.5	6.5	6.5	6.9	8.0	8.0
100 sq miles	3.1	4.8	6.0	6.3	6.3	6.3	6.8	7.9	7.9
200 sq miles	3.0	4.6	5.9	6.2	6.2	6.2	6.7	7.8	7.8
500 sq miles	2.9	4.4	5.7	6.0	6.0	6.0	6.5	7.6	7.6
1000 sq miles	2.7	4.2	5.5	5.8	5.8	5.8	6.3	7.3	7.3
5000 sq miles	2.3	3.4	4.3	4.5	4.7	4.7	5.2	6.1	6.2
10000 sq miles	1.9	3.0	3.8	4.0	4.2	4.2	4.5	5.4	5.5
20000 sq miles	1.7	2.8	3.5	3.7	3.8	3.8	4.2	4.8	5.0

Adjusted Storm Depth-Area-Duration

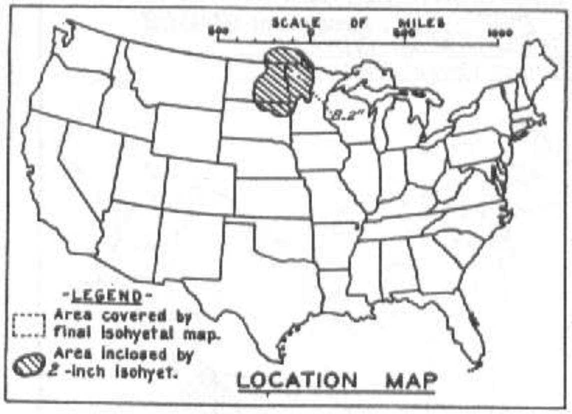
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	5.2	8.5	10.2	10.7	10.7	10.7	11.3	13.1	13.1
100 sq miles	5.1	7.9	9.8	10.3	10.3	10.3	11.2	13.0	13.0
200 sq miles	4.9	7.5	9.7	10.2	10.2	10.2	11.0	12.8	12.8
500 sq miles	4.8	7.2	9.3	9.8	9.8	9.8	10.7	12.5	12.5
1000 sq miles	4.4	6.9	9.0	9.5	9.5	9.5	10.3	12.0	12.0
5000 sq miles	3.8	5.6	7.1	7.4	7.7	7.7	8.5	10.0	10.2
10000 sq miles	3.1	4.9	6.2	6.6	6.9	6.9	7.4	8.9	9.0
20000 sq miles	2.8	4.6	5.7	6.1	6.2	6.2	6.9	7.9	8.2

Storm or Storm Center Name	**UMV 1-2, Lambert, MN**	
Storm Date(s)	7/18-22/1897	
Storm Type	Synoptic/Thunderstorms	
Storm Location	47.80 N	96.00 W
Storm Center Elevation	1,150	
Precipitation Total & Duration	8.00 Inches 72-hours USACE UMV 1-2	
Storm Representative Dewpoint	71.0 F	24
Storm Representative Dewpoint Location	43.70 N	93.60 W
Maximum Dewpoint	80.5 F	
Moisture Inflow Vector	S @ 285	
In-place Maximization Factor	**1.58**	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	38.94 N	90.47 W
Transposition Maximum Dewpoint	81.0 F	
Transposition Adjustment Factor	**1.04**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.58**	

Appendix F: Table F.150: Storm spreadsheet for Lambert, MN July 18, 1897

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET (REV.)



Storm of 18 - 22 July 1897
Assignment UMV 1-2
Location Minn. and N. D.
Study Prepared by:
Upper Mississippi Valley Division
St. Paul District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 12-7-40
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 7-19-45
Remarks: Center at:
Lambert, Minn.
Dewpt. 65° - Ref. Pt. 300 S
Grid A-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000
Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	4
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	5
Miscl. precip. records, meteorological data, etc.	6
Form 5002 (Mass rainfall curves)	13

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000
Data and computation sheets:

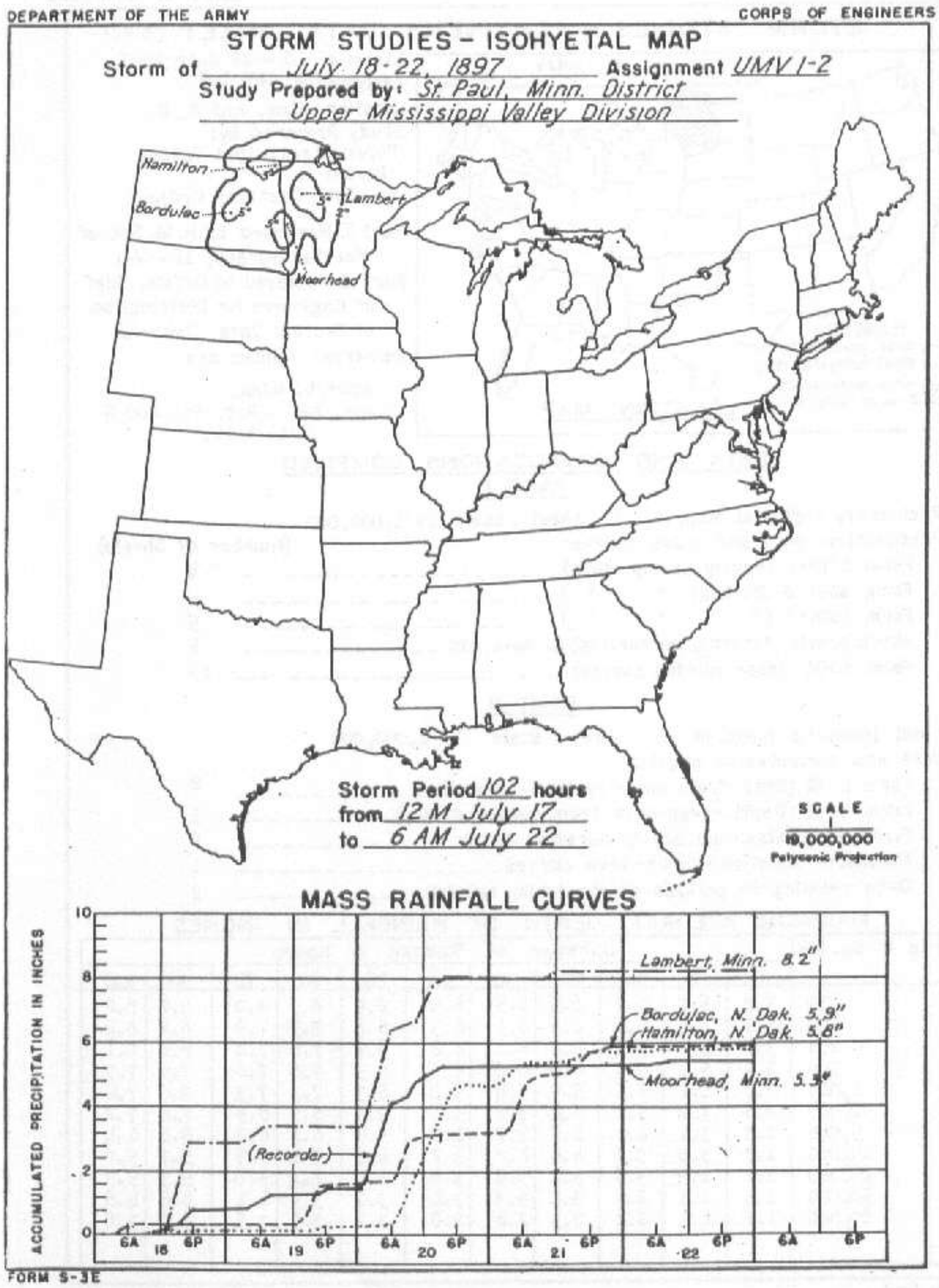
Form S-10 (Data from mass rainfall curves)	2
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	9
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	102
10	3.2	5.2	6.2	6.5	6.5	6.5	6.9	8.0	8.0	8.2	8.2
100	3.1	4.8	6.0	6.3	6.3	6.3	6.8	7.9	7.9	8.2	8.2
200	3.0	4.6	5.9	6.2	6.2	6.2	6.7	7.8	7.8	8.1	8.1
500	2.9	4.4	5.7	6.0	6.0	6.0	6.5	7.6	7.6	7.9	7.9
1,000	2.7	4.2	5.5	5.8	5.8	5.8	6.3	7.3	7.3	7.6	7.6
2,000	2.6	3.9	5.1	5.4	5.5	5.5	5.9	6.9	6.9	7.2	7.2
5,000	2.3	3.4	4.3	4.5	4.7	4.7	5.2	6.1	6.2	6.4	6.4
10,000	1.9	3.0	3.8	4.0	4.2	4.2	4.5	5.4	5.5	5.7	5.7
20,000	1.7	2.8	3.5	3.7	3.8	3.8	4.2	4.8	5.0	5.3	5.3
50,000	1.3	2.3	2.9	3.1	3.3	3.4	3.7	3.9	4.1	4.6	4.6
80,000	1.1	1.7	2.2	2.3	2.8	2.8	3.1	3.3	3.5	3.8	3.8

Form S-2

Appendix F: Table F.151: Depth-area-duration values for Lambert, MN July 18, 1897



Appendix F: Figure F.183 and Figure F.184: Total storm isohyetal analysis and mass curve chart for Lambert, MN July 18, 1897

Greeley, NE, AWA 76

June 4, 1896

Storm Type: MCC

Grid Points Used: 3-4, 8-11, 16-18

Storm Name:	USACE MR 4-3-Greeley, NE		
Storm Date:	6/4/1896	**Storm Adjustment for ANO Grid Point 3**	
AWA Analysis Date:	12/16/2013		

Temporal Transposition Date	**19-Jun**	
	Lat	**Long**
Storm Center Location	**41.55 N**	**98.53 W**
Storm Rep Dew Point Location	**40.05 N**	**96.55 W**
Transposition Dew Point Location	**41.23 N**	**90.57 W**
Grid Point Location	**34.50 N**	**98.00 W**

Moisture Inflow Direction	**SE @ 145**	miles
Grid Point Elevation	**1,150**	feet
Storm Center Elevation	**2,000**	feet
Storm Rep Analysis Duration	**6**	hours

The storm representative dew point is	**76.0 F**	with total precipitable water above sea level of			**2.99**	inches.
The in-place maximum dew point is	**79.5 F**	with total precipitable water above sea level of			**3.52**	inches.
The transpositioned maximum dew point is	**79.0 F**	with total precipitable water above sea level of			**3.44**	inches.
The in-place storm elevation is	**2,000**	which subtracts	**0.50**	inches of precipitable water at	**76.0 F**	
The in-place storm elevation is	**2,000**	which subtracts	**0.55**	inches of precipitable water at	**79.5 F**	
The transposition basin elevation at	**1,150**	which subtracts	**0.28**	inches of precipitable water at	**79.0 F**	
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.28**	inches of precipitable water at	**79.0 F**	

The in-place storm maximization factor is	**1.19**
The transposition/elevation to basin factor is	**1.06**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.27**

Notes: DAD values taken from USACE MR 4-3. 6hr average, 7° added to USACE storm rep Td based on EPRI , Nebraska, and TRWD guidance.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	12.0	12.0	12.2	12.3	12.3	12.3	12.3	12.3	12.3
100 sq miles	11.6	11.6	11.6	11.8	11.8	11.8	11.8	11.8	11.8
200 sq miles	11.2	11.2	11.2	11.5	11.5	11.5	11.5	11.5	11.5
500 sq miles	10.2	10.2	10.2	10.6	10.6	10.6	10.6	10.6	10.6
1000 sq miles	8.7	8.9	9.0	9.2	9.4	9.4	9.4	9.4	9.4
2000 sq miles	6.6	6.9	7.0	7.2	7.5	7.5	7.5	7.5	7.5
5000 sq miles	4.0	4.3	4.9	5.1	5.2	5.3	5.3	5.3	5.3
10000 sq miles	2.4	2.8	3.7	4.0	4.1	4.2	4.2	4.4	4.5
20000 sq miles	1.3	1.8	2.6	3.0	3.1	3.2	3.2	3.7	3.8

Adjusted Storm Depth-Area-Duration

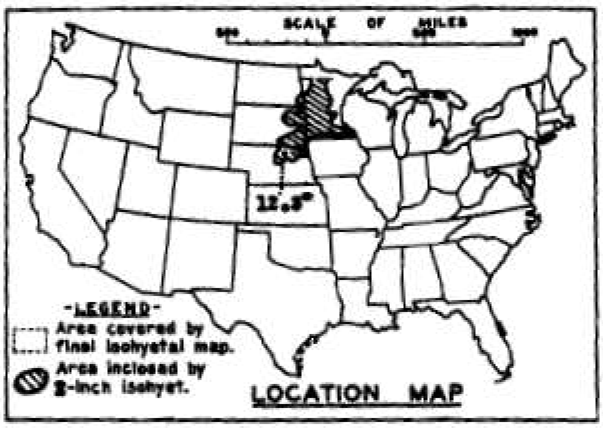
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	15.2	15.2	15.5	15.6	15.6	15.6	15.6	15.6	15.6
100 sq miles	14.7	14.7	14.7	15.0	15.0	15.0	15.0	15.0	15.0
200 sq miles	14.2	14.2	14.2	14.6	14.6	14.6	14.6	14.6	14.6
500 sq miles	12.9	12.9	12.9	13.5	13.5	13.5	13.5	13.5	13.5
1000 sq miles	11.0	11.3	11.4	11.7	11.9	11.9	11.9	11.9	11.9
2000 sq miles	8.4	8.8	8.9	9.1	9.5	9.5	9.5	9.5	9.5
5000 sq miles	5.1	5.5	6.2	6.5	6.6	6.7	6.7	6.7	6.7
10000 sq miles	3.0	3.6	4.7	5.1	5.2	5.3	5.3	5.6	5.7
20000 sq miles	1.6	2.3	3.3	3.8	3.9	4.1	4.1	4.7	4.8

Storm or Storm Center Name	**USACE MR 4-3-Greeley, NE**			
Storm Date(s)	6/4/1896			
Storm Type	MCC			
Storm Location	41.55 N	98.53 W		
Storm Center Elevation	2,000			
Precipitation Total & Duration	12.30 Inches 24-hours USACE MR 4-3			
Storm Representative Dew Point	76.0 F	6		
Storm Representative Dew Point Location	40.05 N	96.55 W		
Maximum Dew Point	79.5 F			
Moisture Inflow Vector	SE @ 145			
In-place Maximization Factor	**1.19**			
Temporal Transposition (Date)	19-Jun			
Transposition Dew Point Location	41.23 N	90.57 W	June	July
Transposition Maximum Dew Point	79.0 F		78.5	81
Transposition Adjustment Factor	**1.06**			
Grid Point Elevation	1,150			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.27**			

Appendix F: Table F.152: Storm spreadsheet for Greeley, NE June 4, 1896

DEPARTMENT OF THE ARMY | CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 4-7 June 1896
Assignment MR 4-3
Location Nebr., S.D. Minn.
Study Prepared by:
Missouri River Division
Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/11/48
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 2/9/51
Remarks: Center at Greeley, Nebr.
Dewpt. 69°-Ref. Pt. 145 SE
Grid D-16

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 2,500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	8
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	10
Miscl. precip. records, meteorological data, etc.	9
Form 5002 (Mass rainfall curves)	24

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

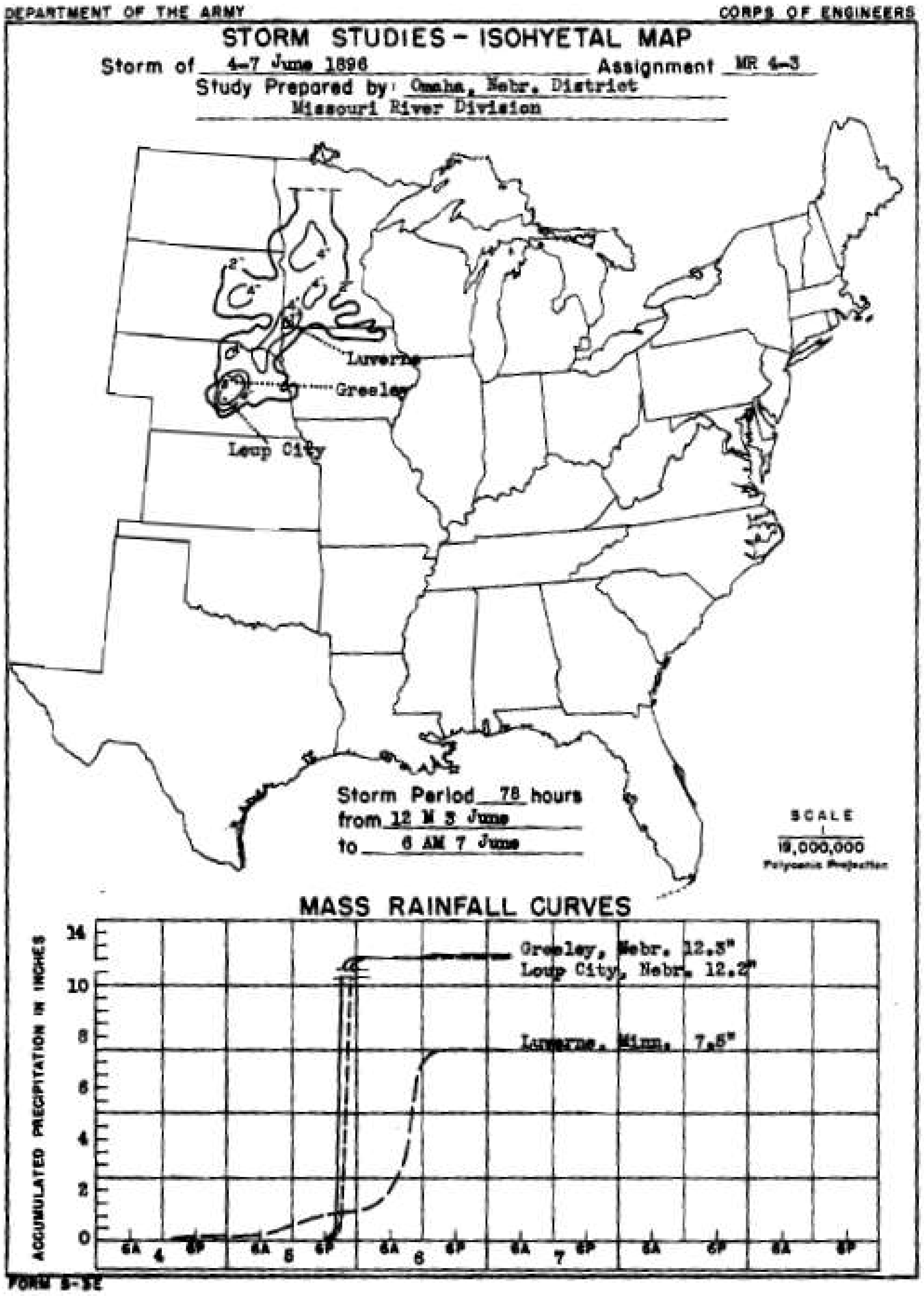
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	13
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	7

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	78	
10	12.0	12.0	12.2	12.3	12.3	12.3	12.3	12.3	12.3	12.3	
100	11.6	11.6	11.6	11.8	11.8	11.8	11.8	11.8	11.8	11.8	
200	11.2	11.2	11.2	11.5	11.5	11.5	11.5	11.5	11.5	11.5	
500	10.2	10.2	10.2	10.6	10.6	10.6	10.6	10.6	10.6	10.6	
1,000	8.7	8.9	9.0	9.2	9.4	9.4	9.4	9.4	9.4	9.4	
2,000	6.6	6.9	7.0	7.2	7.5	7.5	7.5	7.5	7.5	7.5	
5,000	4.0	4.3	4.9	5.1	5.2	5.3	5.3	5.3	5.3	5.3	
10,000	2.4	2.8	3.7	4.0	4.1	4.2	4.2	4.4	4.5	4.5	
20,000	1.3	1.8	2.6	3.0	3.1	3.2	3.2	3.7	3.8	3.8	
50,000	0.6	1.1	1.7	2.1	2.3	2.4	2.5	3.1	3.3	3.3	
84,000	0.5	1.0	1.4	1.8	2.2	2.3	2.4	3.0	3.2	3.2	

Form S-2

Appendix F: Table F.153: Depth-area-duration values for Greeley, NE June 4, 1896



Appendix F: Figure F.185 and Figure F.186: Total storm isohyetal analysis and mass curve chart for Greeley, NE June 4, 1896

Larrabee, IA, AWA 77

September 10, 1891

Storm Type: MCC

Grid Points Used: 1-4, 8-11, 16-18

Storm Name:	USACE MR 4-2-Larrabee, IA	**Storm Adjustment for For ANO Grid Point 1**
Storm Date:	6/23/1891	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date	**10-Jul**	
	Lat	**Long**
Storm Center Location	**42.86 N**	**95.55 W**
Storm Rep Dew Point Location	**39.96 N**	**95.55 W**
Transposition Dew Point Location	**39.83 N**	**92.58 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**S @ 200**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**1,400**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**79.0 F**	with total precipitable water above sea level of		**3.44**	inches.
The in-place maximum dew point is	**81.0 F**	with total precipitable water above sea level of		**3.75**	inches.
The transpositioned maximum dew point is	**81.0 F**	with total precipitable water above sea level of		**3.75**	inches.
The in-place storm elevation is	**1,400**	which subtracts	**0.39**	inches of precipitable water at	**79.0 F**
The in-place storm elevation is	**1,400**	which subtracts	**0.43**	inches of precipitable water at	**81.0 F**
The transposition basin elevation at	**350**	which subtracts	**0.30**	inches of precipitable water at	**81.0 F**
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**81.0 F**

The in-place storm maximization factor is	**1.09**
The transposition/elevation to basin factor is	**1.04**
The barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.13**

Notes: DAD values taken from USACE MR 4-2. Storm representative dew point value was based on adding 7° to the USACE analyzed storm rep Td based on guidance from EPRI, Nebraska, and TRWD.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	10.4	11.7	11.7	12.9	12.9	12.9	12.9	12.9	12.9
10 sq miles	9.0	11.1	11.6	12.8	12.8	12.8	12.8	12.8	12.8
100 sq miles	7.5	10.0	11.1	12.2	12.2	12.2	12.2	12.2	12.2
200 sq miles	7.0	9.5	10.5	11.5	11.6	11.6	11.6	11.6	11.6
500 sq miles	6.1	8.6	9.6	10.3	10.5	10.5	10.5	10.5	10.5
1000 sq miles	5.3	7.7	8.7	9.3	9.5	9.5	9.5	9.5	9.5
2000 sq miles	4.5	6.6	7.7	8.2	8.3	8.3	8.3	8.3	8.3
5000 sq miles	3.4	5.0	5.8	6.5	6.6	6.6	6.6	6.6	6.6
10000 sq miles	2.5	3.7	4.4	5.2	5.3	5.3	5.3	5.3	5.3
20000 sq miles	1.6	2.5	2.9	3.6	3.9	4.2	4.2	4.4	4.6

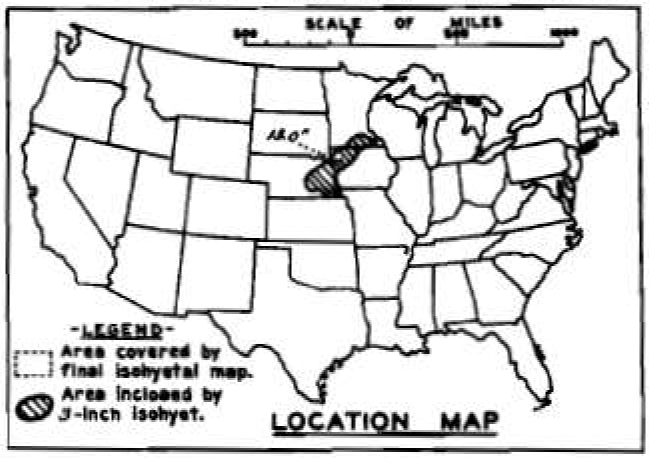
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	11.8	13.2	13.2	14.6	14.6	14.6	14.6	14.6	14.6
10 sq miles	10.2	12.6	13.1	14.5	14.5	14.5	14.5	14.5	14.5
100 sq miles	8.5	11.3	12.6	13.8	13.8	13.8	13.8	13.8	13.8
200 sq miles	7.9	10.8	11.9	13.0	13.1	13.1	13.1	13.1	13.1
500 sq miles	6.9	9.7	10.9	11.7	11.9	11.9	11.9	11.9	11.9
1000 sq miles	6.0	8.7	9.8	10.5	10.8	10.8	10.8	10.8	10.8
2000 sq miles	5.1	7.5	8.7	9.3	9.4	9.4	9.4	9.4	9.4
5000 sq miles	3.8	5.7	6.6	7.4	7.5	7.5	7.5	7.5	7.5
10000 sq miles	2.8	4.2	5.0	5.9	6.0	6.0	6.0	6.0	6.0
20000 sq miles	1.8	2.8	3.3	4.1	4.4	4.8	4.8	5.0	5.2

Storm or Storm Center Name	**USACE MR 4-2-Larrabee, IA**			
Storm Date(s)	6/23/1891			
Storm Type	MCC-Thunderstorm Complex			
Storm Location	42.86 N	95.55 W		
Storm Center Elevation	1,400			
Precipitation Total & Duration	12.90 Inches 24-hours			
Storm Representative Dewpoint	79.0 F	12		
Storm Representative Dewpoint Location	39.96 N	95.55 W	June	July
Maximum Dewpoint	81.0 F		80	81.5
Moisture Inflow Vector	S @ 200			
In-place Maximization Factor	**1.09**			
Temporal Transposition (Date)	10-Jul			
Transposition Dewpoint Location	39.83 N	92.58 W	June	July
Transposition Maximum Dewpoint	81.0 F		79	81
Transposition Adjustment Factor	**1.04**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.13**			

Appendix F: Table F.154: Storm spreadsheet for Larrabee, IA September 10, 1891

STORM STUDIES – PERTINENT DATA SHEET



LOCATION MAP

Storm of 23-27 June 1891
Assignment MR 4-2
Location Iowa-Nebr-Minn,
Study Prepared by:
Missouri River Division
Omaha, District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 10/29/47
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/14/48
Remarks: Center at Larrabee, Ia.
Dewpt. 72° - Ref. Pt. 200 S
Grid D-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 2,500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	6
Form 5001-B (24-hour " ")	0
Form 5001-D (" " ")	3
Miscl. precip. records, meteorological data, etc.	12
Form 5002 (Mass rainfall curves)	9

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

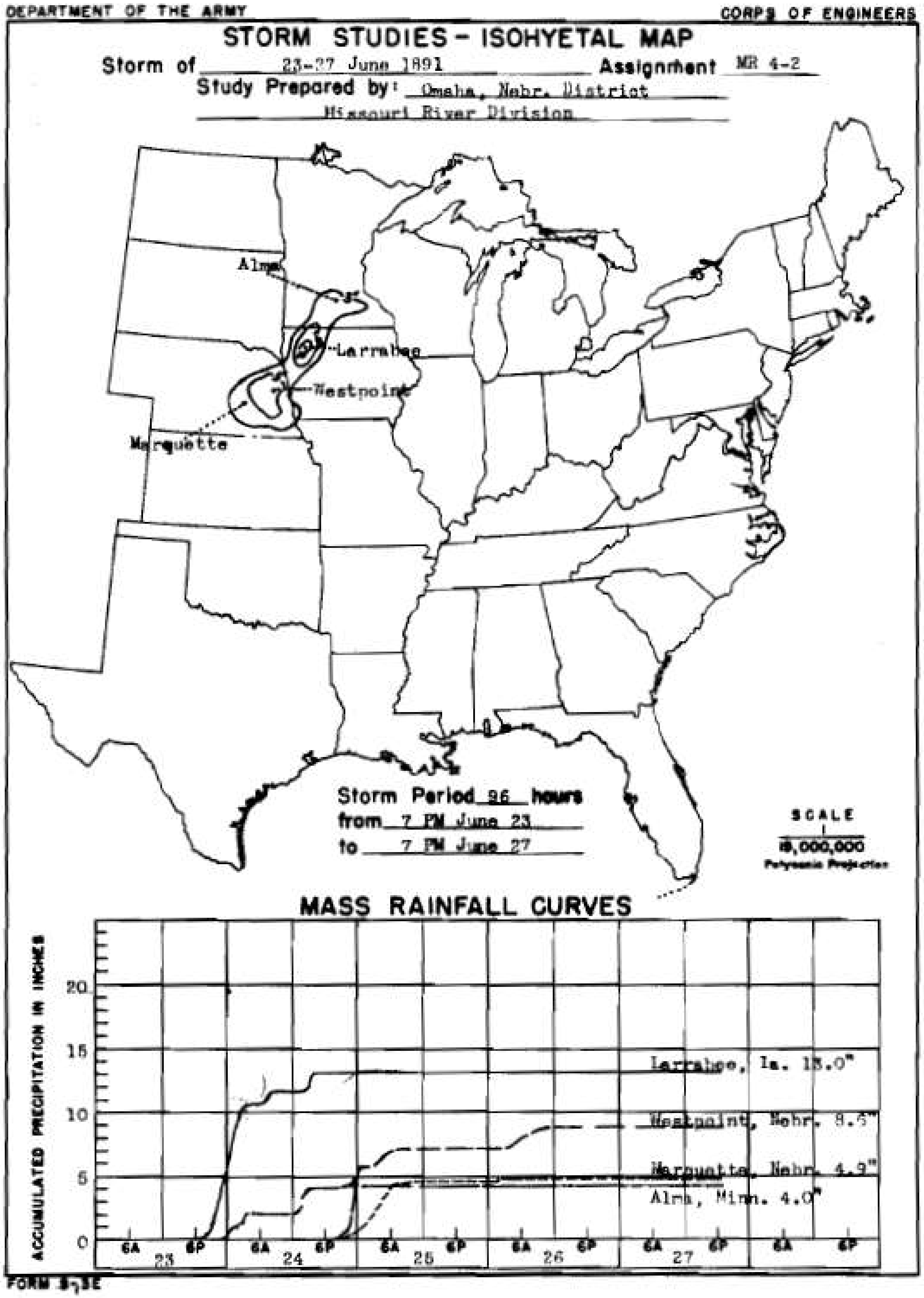
Form S-10 (Data from mass rainfall curves)	1
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	7
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	3

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	96
Max. Station	10.4	11.7	11.7	12.9	12.9	12.9	12.9	13.0	13.0	13.0
10	9.0	11.1	11.6	12.8	12.8	12.8	12.8	12.8	12.8	12.8
100	7.5	10.0	11.1	12.2	12.2	12.2	12.2	12.2	12.2	12.2
200	7.0	9.5	10.5	11.5	11.6	11.6	11.6	11.6	11.6	11.6
500	6.1	8.6	9.6	10.3	10.5	10.5	10.5	10.5	10.5	10.5
1,000	5.3	7.7	8.7	9.3	9.5	9.5	9.5	9.5	9.5	9.5
2,000	4.5	6.6	7.7	8.2	8.3	8.3	8.3	8.3	8.3	8.3
5,000	3.4	5.0	5.8	6.5	6.6	6.6	6.6	6.6	6.6	6.6
10,000	2.5	3.7	4.4	5.2	5.3	5.3	5.3	5.3	5.3	5.3
20,000	1.6	2.5	2.9	3.6	3.9	4.2	4.2	4.4	4.6	4.7
30,000	1.1	1.7	2.0	2.4	3.1	3.7	3.8	4.2	4.5	4.6

Form S-2

Appendix F: Table F.155: Depth-area-duration values for Larrabee, IA September 10, 1891



Appendix F: Figure F.187 and Figure F.188: Total storm isohyetal analysis and mass curve chart for Larrabee, IA September 10, 1891

Appendix G

LIP Short Storm List Storm Data

Appendix G:
Local Intense Precipitation Short Storm Analyses

Storm Name	State	AWA Storm Number	Lat	Lon	Year	Month	Day	Max Rainfall	Precipitation Source	ANO Total Adjustment Factor	ANO 1-hour 1mi^2 PMP
WARNER PARK	TN	2	36.0611	-86.9056	2010	4	30	19.71	SPAS 1208	1.18	5.40
LARTO LAKE	LA	4	31.220	-92.130	2008	9	1	23.31	SPAS 1182	1.15	7.07
FALL RIVER	KS	5	37.6300	-96.0500	2007	6	30	25.50	SPAS 1228	1.23	5.76
ALBANY	TX	18	32.7260	-99.3500	1978	8	3	32.50	SPAS 1179	1.26	15.36
ENID	OK	21	36.3805	-97.8683	1973	10	10	19.45	SPAS 1034	1.20	8.88
WOOSTER	OH	24	40.9146	-81.9729	1969	7	4	14.95	SPAS 1209	1.30	6.01
GLADEWATER	TX	25	32.5365	-94.9427	1966	4	27	25.33	SPAS 1181	1.24	3.62
EDGERTON	MO	26	40.4125	-95.5125	1965	7	18	20.76	SPAS 1183	1.27	4.67
COLLEGE HILL	OH	30	40.0854	-81.6479	1963	6	3	19.39	SPAS 1226	1.84	4.67
CAMP POLK	LA	81	31.067	-93.200	1953	4	23	21.10	LMV 5-3	0.97	4.97
HARRISONBURG DAM	LA	79	31.767	-91.817	1953	5	11	25.40	LMV 5-4	1.02	6.01
KELSO	MO	37	37.1906	-89.5495	1952	8	11	13.00	UMV 3-30	1.27	10.57
HOLT	MO	40	39.4528	-94.3422	1947	6	18	17.60	MR 8-20	1.18	14.16
COLLINSVILLE	IL	42	38.6717	-89.9800	1946	8	12	18.70	MR 7-2B	1.19	4.57
MOUNDS	OK	44	35.8770	-96.0610	1943	5	16	17.00	SW 2-21	1.39	14.14
SILVER LAKE	TX	45	32.6700	-95.5960	1943	6	5	16.50	SW 3-3	1.15	10.45
HALLETT	OK	52	36.2000	-96.6000	1940	9	2	24.00	SW 2-18	1.17	13.78
ENGLE	TX	83	29.681	-97.009	1940	6	29	22.70	GM 5-11	1.22	8.59
BEBE	TX	84	29.332	-97.682	1936	6	30	21.00	GM 5-6	1.11	9.95
NEOSHO FALLS	KS	61	38.0820	-95.7010	1926	9	12	14.00	SW 2-1	1.34	11.49
THRALL	TX	77	30.591	-97.297	1921	9	9	39.70	GM 4-12	1.14	16.34
BONAPARTE	IA	70	40.7667	-91.7500	1905	6	10	12.10	UMV 2-5	1.29	8.26

Appendix G: Table G.1: List of storms used in the Local Intense Precipitation PMP development

Warner Park, TN, AWA 2

April 30, 2010

Storm Type: Frontal/MCC

Storm Name:	SPAS 1208 - Tennessee	Storm Adjustment for ANO Grid Point 1
Storm Date:	5/1-3/2010	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-May	
	Lat	Long
Storm Center Location	36.06 N	86.91 W
Storm Rep Dew Point Location	31.50 N	90.00 W
Transposition Dew Point Location	38.16 N	95.94 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 360	miles
Grid Point Elevation	350	feet
Storm Center Elevation	600	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of		2.85	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of		3.07	inches.
The transpositioned maximum dew point is	75.0 F	with total precipitable water above sea level of		2.85	inches.
The in-place storm elevation is	600	which subtracts	0.15	inches of precipitable water at	75.0 F
The in-place storm elevation is	600	which subtracts	0.16	inches of precipitable water at	76.5 F
The transposition storm elevation at	350	which subtracts	0.25	inches of precipitable water at	75.0 F
The Grid point/inflow barrier height is	1,000	which subtracts	0.25	inches of precipitable water at	75.0 F

The in-place maximization factor is	1.08
The transposition/elevation factor is	0.90
The barrier adjustment factor is	1.00
The total adjustment factor is	0.96

Notes: Storm representative Td value was based on 12-hr surface dewpoint values between on May 1 along with Hysplit backward trajectory. Values were selected in region where temperature did not vary more than a degree over a large area. Used an average of KJAN, KMCB, KHBG, and KASD.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	4.4	15.0	17.3	18.0	18.1	19.0	19.2	19.4	-
100 sq miles	3.7	13.2	15.9	16.5	16.6	18.3	18.5	18.7	-
200 sq miles	3.4	12.2	15.0	15.6	15.8	17.8	18.1	18.3	-
500 sq miles	2.8	10.6	13.5	14.3	14.6	16.8	17.4	17.7	-
1000 sq miles	2.3	9.0	12.6	13.3	13.5	16.4	16.9	17.1	-
2000 sq miles	1.8	7.4	11.1	12.0	12.6	15.7	16.1	16.4	-
5000 sq miles	1.4	5.2	9.2	10.3	10.9	14.1	14.8	15.0	-
10000 sq miles	1.0	3.8	7.4	8.4	8.6	12.2	13.0	13.1	-
20000 sq miles	0.7	2.9	5.4	6.3	7.2	10.2	11.0	11.2	-

Adjusted Storm Depth-Area-Duration

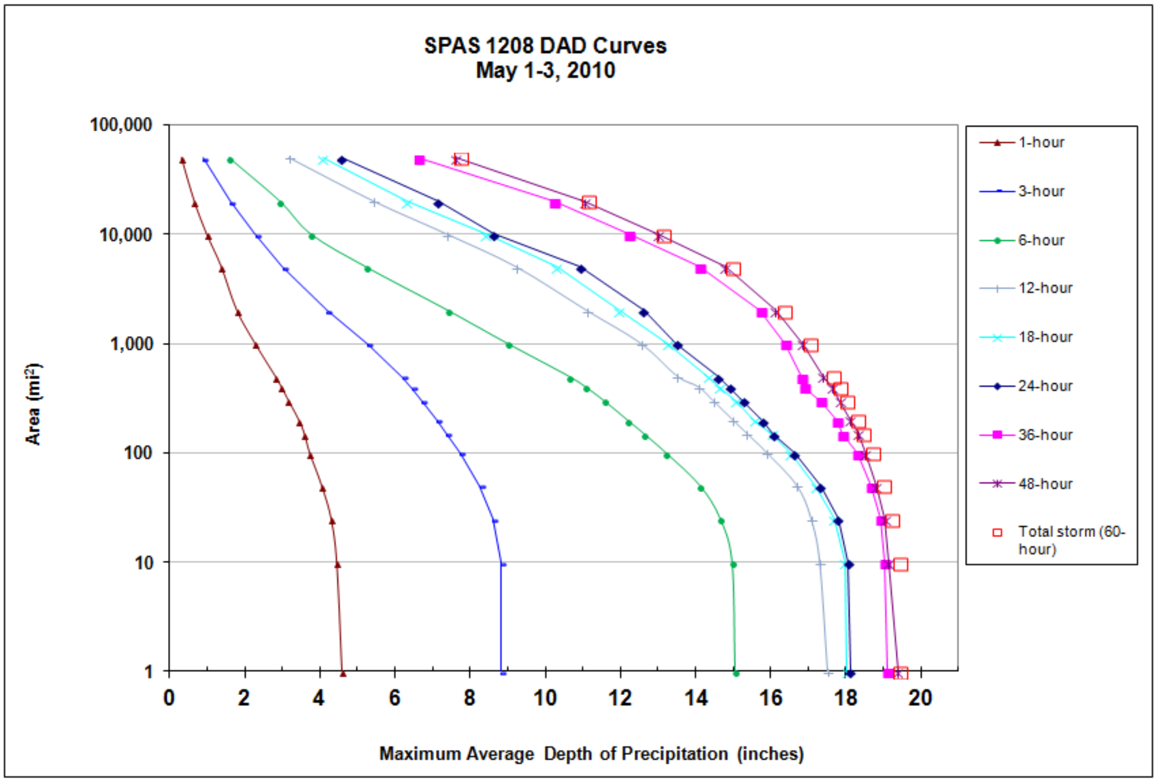
	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	4.3	14.4	16.7	17.3	17.4	18.3	18.4	18.7	-
100 sq miles	3.6	12.7	15.3	15.9	16.0	17.6	17.8	18.0	-
200 sq miles	3.3	11.7	14.4	15.0	15.2	17.1	17.4	17.6	-
500 sq miles	2.7	10.2	13.0	13.8	14.1	16.2	16.8	17.0	-
1000 sq miles	2.2	8.7	12.1	12.8	13.0	15.8	16.2	16.4	-
2000 sq miles	1.7	7.1	10.7	11.5	12.2	15.1	15.5	15.8	-
5000 sq miles	1.3	5.0	8.9	9.9	10.5	13.6	14.2	14.4	-
10000 sq miles	1.0	3.6	7.1	8.1	8.3	11.8	12.5	12.6	-
20000 sq miles	0.6	2.8	5.2	6.1	6.9	9.9	10.6	10.7	-

Storm or Storm Center Name	**SPAS 1208 - Tennessee**	
Storm Date(s)	5/1-3/2010	
Storm Type	Synoptic	
Storm Location	36.06 N	86.91 W
Storm Center Elevation	600	
Precipitation Total & Duration (10 sq mi)	19.71 inches in 60 hours	
Storm Representative Td	75.0 F	12
Storm Representative Td Location	31.50 N	90.00 W
In-place Maximum Td	76.5 F	
Moisture Inflow Vector	SSW @ 360	
In-place Maximization Factor	**1.08**	
Temporal Transposition (Date)	15-May	
Transposition Td Location	38.16 N	95.94 W
Transposition Maximum Td	75.0 F	
Transposition Adjustment Factor	**0.90**	
Grid point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**0.96**	

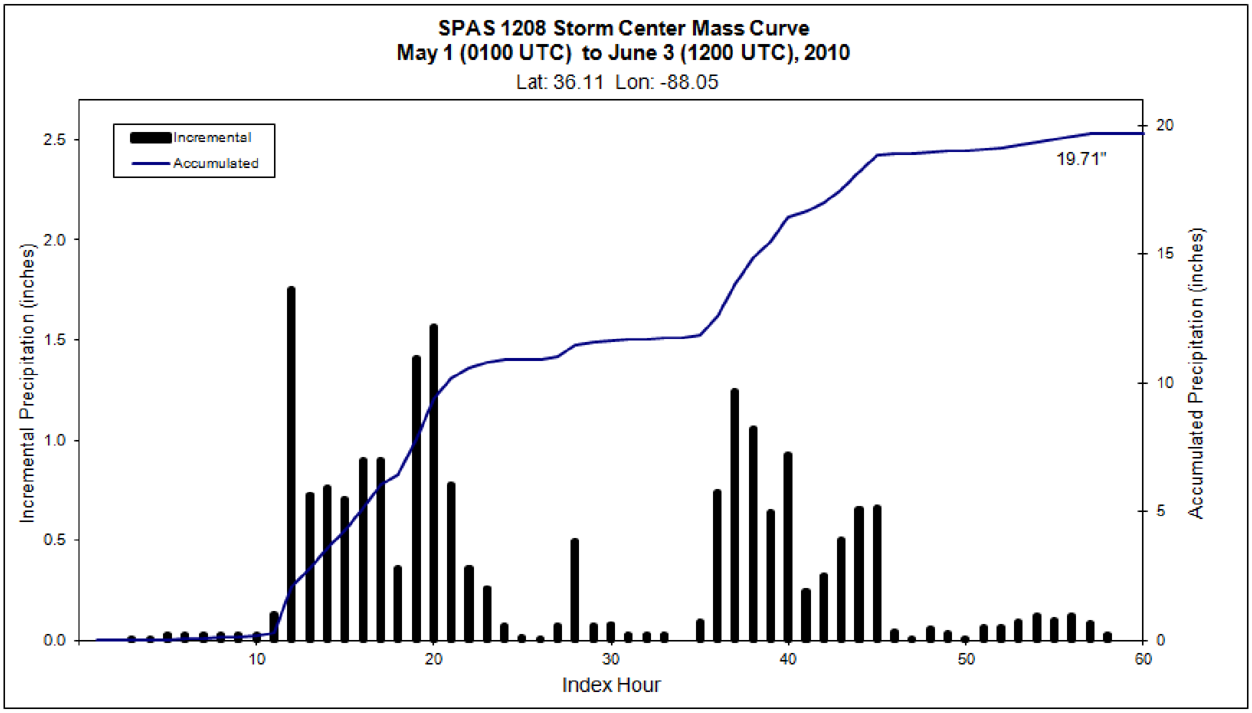
Appendix G: Table G.2: Storm spreadsheet for Warner Park, TN May 30, 2010

Storm 1208 - May 1 (0100 UTC) - May 3 (1200 UTC), 2010										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi^2)	1	3	6	12	18	24	36	48	60	Total
0.4	4.63	8.92	15.31	17.77	18.33	18.39	19.36	19.66	19.71	19.71
1	4.58	8.82	15.06	17.52	18.03	18.12	19.11	19.38	19.45	19.45
10	4.44	8.81	14.98	17.31	17.97	18.06	19.04	19.15	19.43	19.43
25	4.29	8.61	14.66	17.08	17.69	17.8	18.91	19.05	19.24	19.24
50	4.04	8.25	14.12	16.7	17.2	17.33	18.67	18.82	19.01	19.01
100	3.72	7.72	13.21	15.9	16.52	16.63	18.31	18.51	18.71	18.71
150	3.58	7.37	12.62	15.37	16.04	16.07	17.91	18.35	18.48	18.48
200	3.43	7.12	12.18	14.99	15.57	15.78	17.75	18.11	18.32	18.32
300	3.16	6.72	11.56	14.47	15.07	15.28	17.33	17.85	18.05	18.05
400	2.97	6.44	11.07	14.08	14.65	14.91	16.9	17.65	17.85	17.85
500	2.81	6.19	10.63	13.52	14.34	14.61	16.84	17.4	17.67	17.67
1,000	2.27	5.26	8.99	12.55	13.27	13.5	16.39	16.86	17.05	17.05
2,000	1.79	4.19	7.41	11.11	11.96	12.62	15.72	16.14	16.37	16.37
5,000	1.38	3	5.23	9.24	10.3	10.93	14.12	14.79	15	15.00
10,000	0.99	2.28	3.76	7.39	8.42	8.64	12.21	13	13.13	13.13
20,000	0.66	1.6	2.93	5.44	6.33	7.16	10.24	11.04	11.15	11.15
50,000	0.32	0.88	1.58	3.19	4.08	4.59	6.63	7.63	7.75	7.75

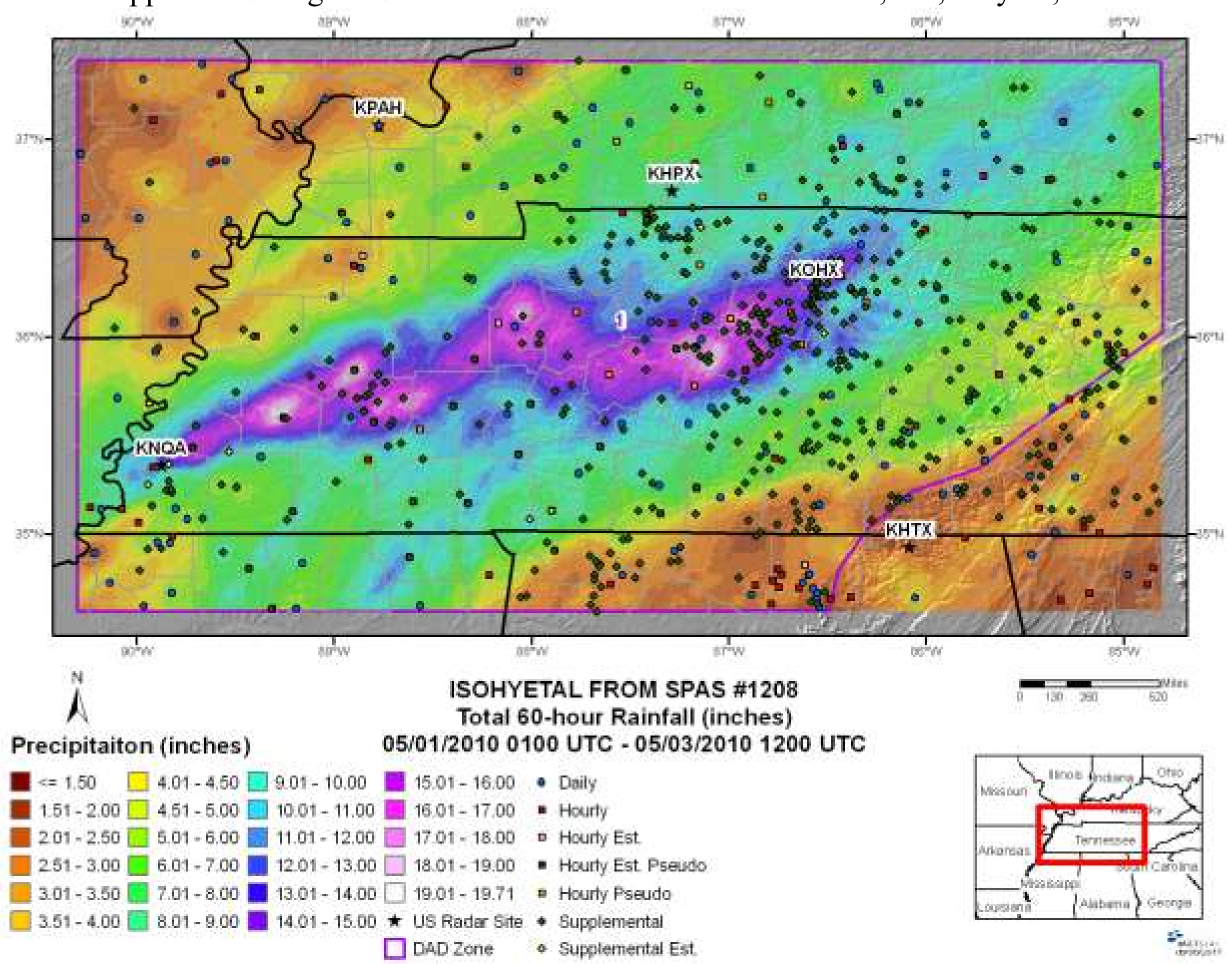
Appendix G: Table G.3: Depth-area-duration values for Warner Park, TN, May 30, 2010



Appendix G: Figure G.1: Depth-area-duration chart for Warner Park, TN, May 30, 2010



Appendix G: Figure G.2: Mass curve chart for Warner Park, TN, May 30, 2010



Appendix G: Figure G.3: Total storm isohyetal analysis for Warner Park, TN, May 30, 2010

Larto Lake, LA, AWA 4

September 1, 2008

Storm Type: Tropical

Storm Name:	**SPAS 1182-Larto Lake, LA**		
Storm Date:	**9/1-5/2008**		
AWA Analysis Date:	**12/13/2013**		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	**15-Aug**	
	Lat	**Long**
Storm center location	**31.22 N**	**92.13 W**
Storm Rep Td location	**30.00 N**	**94.00 W**
Transposition Td location	**34.10 N**	**95.19 W**
Grid Point location	**35.31 N**	**93.23 W**

Moisture Inflow Direction:	**SW @ 150**	miles
Grid Point Elevation	**400**	feet
Storm Center Elevation	**50**	feet
Storm Rep Analysis Duration	**24**	hours

The storm representative Td is	**76.0 F**	with total precipitable water above sea level of			**2.99**	inches.
The in-place maximum Td is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The transpositioned maximum Td is	**79.5 F**	with total precipitable water above sea level of			**3.52**	inches.
The in-place storm elevation is	**50**	which subtracts	**0.03**	inches of precipitable water at	**76.0 F**	
The in-place storm elevation is	**50**	which subtracts	**0.03**	inches of precipitable water at	**80.0 F**	
The transposition storm elevation at	**400**	which subtracts	**0.12**	inches of precipitable water at	**79.5 F**	
The Grid point/inflow barrier height is	**400**	which subtracts	**0.12**	inches of precipitable water at	**79.5 F**	

The in-place maximization factor is	**1.21**
The transposition factor is	**0.95**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.15**

Notes:

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**10.9**	**12.8**	**14.8**	**16.1**	-	**18.6**	**22.0**	-	**22.4**
100 sq miles	**7.9**	**11.9**	**13.7**	**14.9**	-	**17.5**	**20.2**	-	**21.1**
200 sq miles	**7.4**	**11.5**	**13.5**	**14.3**	-	**17.0**	**20.2**	-	**20.7**
500 sq miles	**6.7**	**10.2**	**12.3**	**13.2**	-	**16.2**	**19.5**	-	**19.8**
1000 sq miles	**6.0**	**9.2**	**11.1**	**12.0**	-	**15.5**	**18.1**	-	**18.9**
2000 sq miles	**5.3**	**8.1**	**9.5**	**10.3**	-	**14.4**	**16.5**	-	**17.7**
5000 sq miles	**3.9**	**6.7**	**8.0**	**9.1**	-	**12.3**	**14.7**	-	**14.9**
10000 sq miles	**3.2**	**5.6**	**6.9**	**8.1**	-	**10.4**	**12.4**	-	**12.6**
20000 sq miles	**2.5**	**4.5**	**5.6**	**6.9**	-	**8.5**	**10.3**	-	**11.1**

Adjusted Storm Depth-Area-Duration

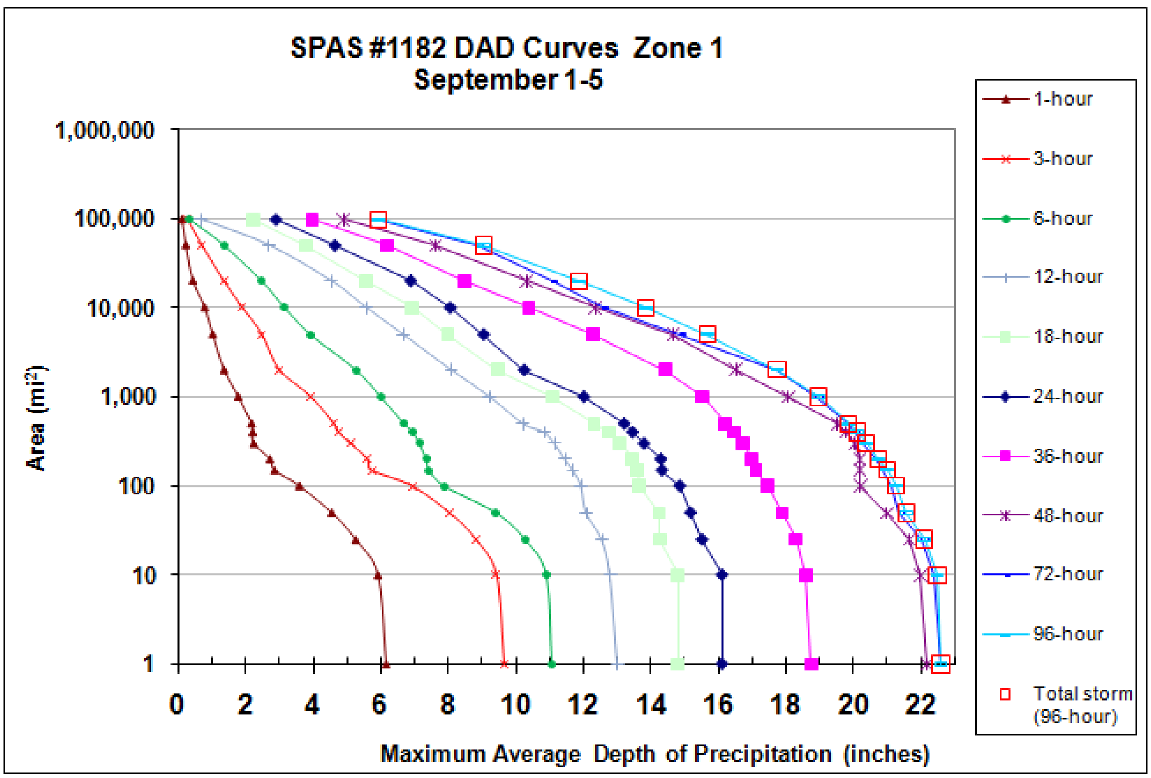
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**12.5**	**14.7**	**17.0**	**18.5**	-	**21.4**	**25.2**	-	**25.7**
100 sq miles	**9.1**	**13.7**	**15.7**	**17.1**	-	**20.1**	**23.2**	-	**24.2**
200 sq miles	**8.4**	**13.2**	**15.4**	**16.4**	-	**19.5**	**23.2**	-	**23.7**
500 sq miles	**7.7**	**11.7**	**14.2**	**15.2**	-	**18.6**	**22.4**	-	**22.8**
1000 sq miles	**6.9**	**10.6**	**12.7**	**13.8**	-	**17.9**	**20.8**	-	**21.7**
2000 sq miles	**6.1**	**9.3**	**10.9**	**11.8**	-	**16.6**	**19.0**	-	**20.4**
5000 sq miles	**4.5**	**7.7**	**9.2**	**10.4**	-	**14.1**	**16.9**	-	**17.1**
10000 sq miles	**3.6**	**6.4**	**8.0**	**9.3**	-	**11.9**	**14.2**	-	**14.4**
20000 sq miles	**2.8**	**5.2**	**6.4**	**7.9**	-	**9.7**	**11.8**	-	**12.7**

Storm or Storm Center Name	**SPAS 1182-Larto Lake, LA**		
Storm Date(s)	9/1-5/2008		
Storm Type	Tropical Storm	**Gustav**	
Storm Location	31.22 N	92.13 W	
Storm Center Elevation	50		
Precipitation Total & Duration (10 sq mi)	23.31 inches in 72hrs		
Storm Representative Td	76.0 F		
Storm Representative Td Location	30.00 N	94.00 W	A
In-place Maximum Td	80.0 F		79
Moisture Inflow Vector	SW @ 150		
In-place Maximization Factor			
Temporal Transposition (Date)	15-Aug		
Transposition Dewpoint Location	34.10 N	95.19 W	A
Transposition Maximum Td	79.5 F		78.5
Transposition Adjustment Factor			
Grid Point Elevation	400		
Highest Elevation in Basin	14,344		
Inflow Barrier Height	N/A		
Elevation Adjustment Factor			
Total Adjustment Factor	**1.15**		

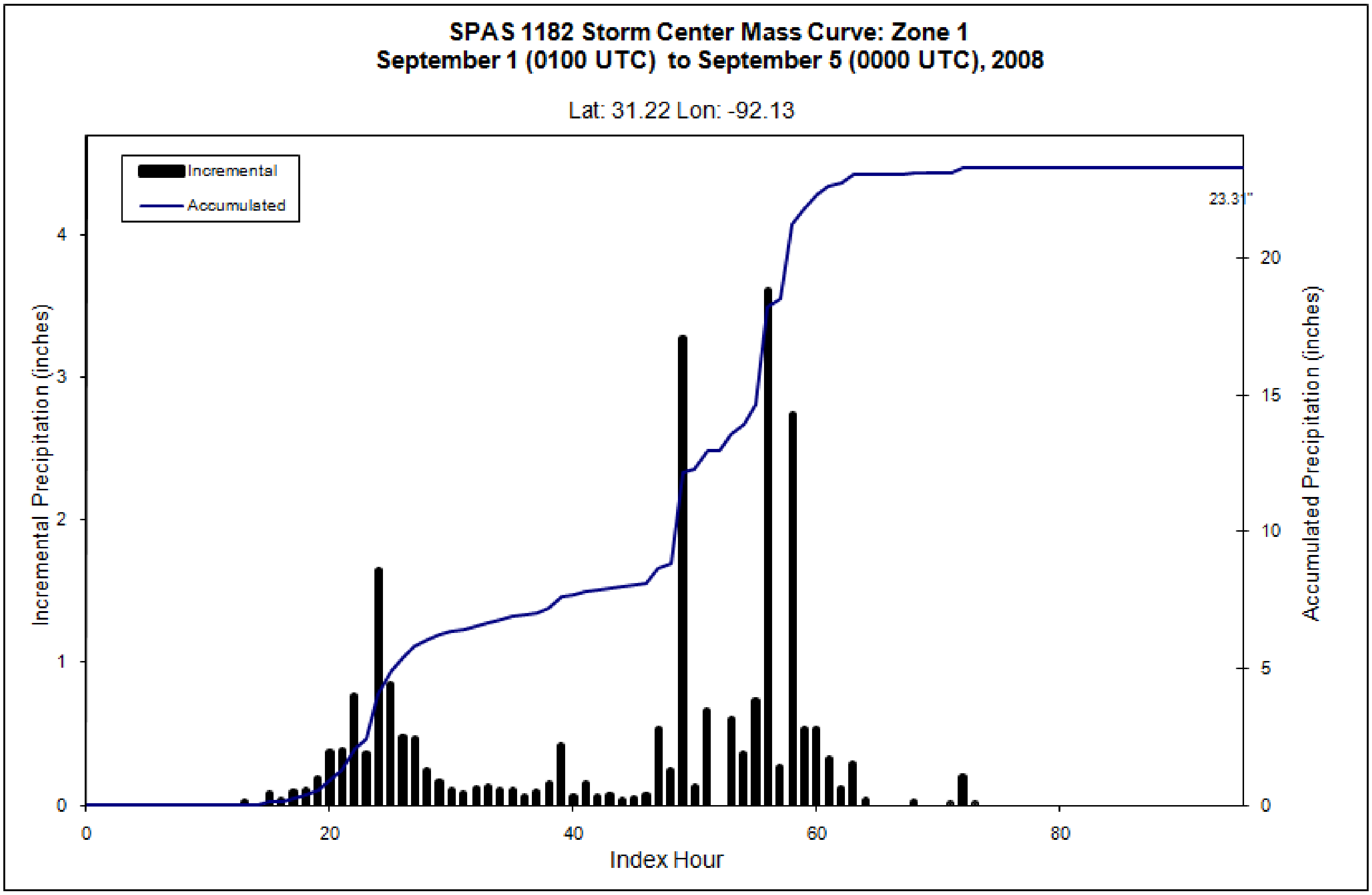
Appendix G: Table G.4: Storm spreadsheet for Larto Lake, LA, September 1, 2008

Storm 1182 - September 1 (0100 UTC) to September 5 (0000 UTC), 2008 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	Total
0.40	6.35	9.89	11.34	13.44	15.26	16.55	19.37	22.93	23.31	23.31	23.31
1	6.15	9.65	11.08	13.02	14.80	16.10	18.75	22.17	22.60	22.60	22.60
10	5.90	9.42	10.91	12.80	14.80	16.10	18.59	21.98	22.37	22.48	22.48
25	5.25	8.82	10.29	12.56	14.26	15.51	18.29	21.66	22.03	22.10	22.10
50	4.54	8.03	9.42	12.09	14.24	15.17	17.89	21.00	21.34	21.56	21.56
100	3.58	6.92	7.88	11.94	13.66	14.85	17.47	20.21	21.11	21.28	21.28
150	2.85	5.72	7.44	11.70	13.60	14.32	17.11	20.20	20.89	21.01	21.01
200	2.71	5.61	7.35	11.46	13.45	14.29	16.99	20.19	20.67	20.73	20.73
300	2.23	5.10	7.15	11.15	13.09	13.79	16.72	20.03	20.25	20.39	20.39
400	2.20	4.74	6.96	10.84	12.75	13.45	16.45	19.77	20.04	20.13	20.13
500	2.17	4.61	6.70	10.22	12.32	13.20	16.21	19.51	19.83	19.87	19.87
1,000	1.78	3.93	6.00	9.23	11.08	12.01	15.54	18.07	18.90	18.98	18.98
2,000	1.36	3.00	5.27	8.09	9.47	10.25	14.42	16.52	17.74	17.75	17.75
5,000	1.02	2.48	3.92	6.66	7.99	9.05	12.30	14.67	14.86	15.67	15.67
10,000	0.79	1.91	3.16	5.57	6.93	8.06	10.39	12.35	12.57	13.85	13.85
20,000	0.44	1.35	2.47	4.52	5.55	6.89	8.47	10.31	11.06	11.87	11.87
50,000	0.23	0.71	1.36	2.68	3.78	4.64	6.20	7.63	8.86	9.05	9.05
97,260	0.12	0.28	0.34	0.67	2.22	2.90	3.98	4.89	5.86	5.94	5.94

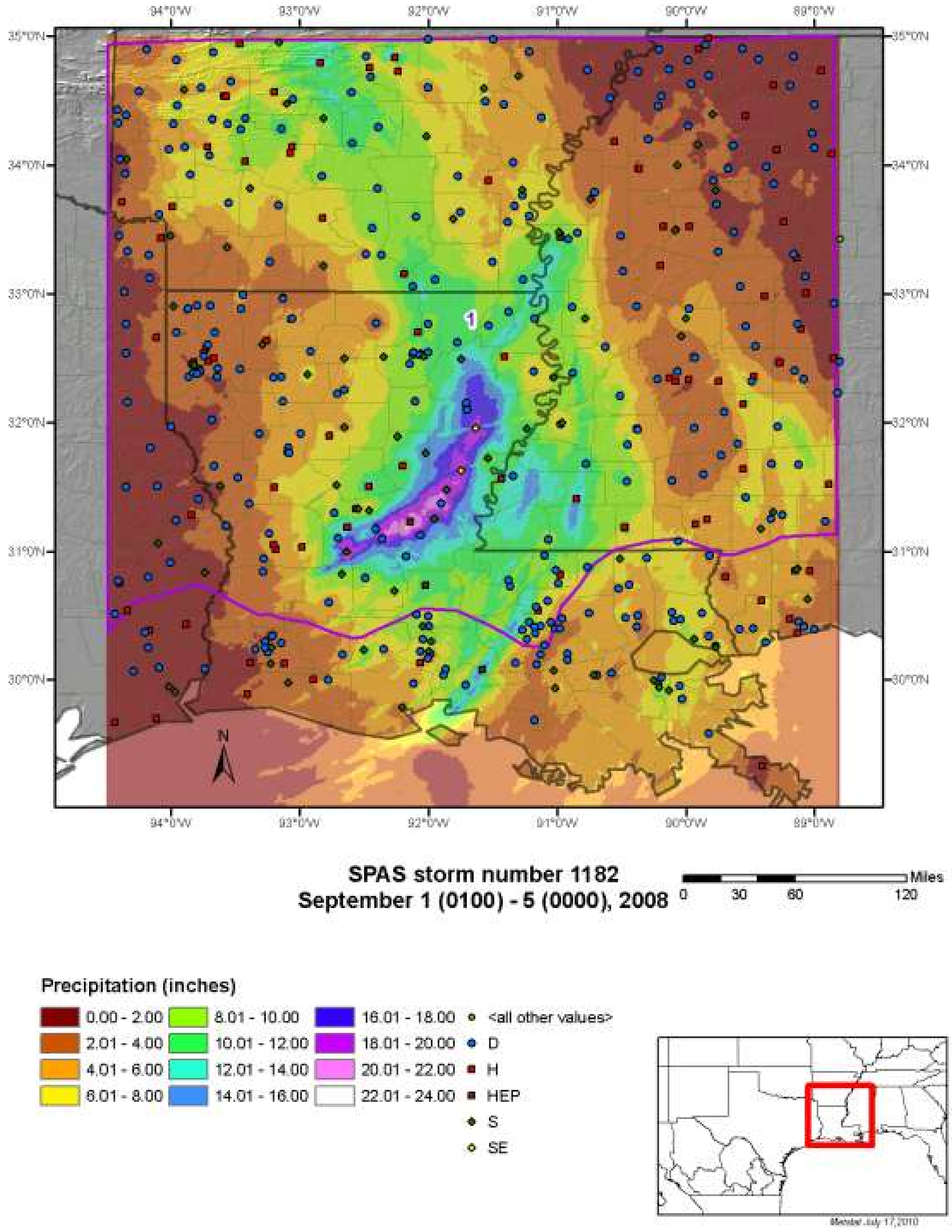
Appendix G: Table G.5: Depth-area-duration values for Larto Lake, LA, September 1, 2008



Appendix G: Figure G.4: Depth-area-duration chart for Larto Lake, LA, September 1, 2008



Appendix G: Figure G.5: Mass curve chart for Larto Lake, LA, September 1, 2008



Appendix G: Figure G.6: Total storm isohyetal analysis for Larto Lake, LA, September 1, 2008

Fall River, KS, AWA 5

June 30, 2007

Storm Type: Frontal/MCC

Storm Name:	SPAS 1228 Fall River, KS	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	6/28/2007 - 7/2/2007	
AWA Analysis Date:	12/13/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	37.63 N	96.05 W
Storm Rep Dew Point Location	31.00 N	95.50 W
Transposition Dew Point Location	36.10 N	92.00 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 460	miles
Grid Point Elevation	350	feet
Storm Center Elevation	900	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.5 F	with total precipitable water above sea level of		3.07	inches.
The in-place maximum dew point is	80.0 F	with total precipitable water above sea level of		3.60	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of		3.68	inches.
The in-place storm elevation is	900	which subtracts	0.21	inches of precipitable water at	76.5 F
The in-place storm elevation is	900	which subtracts	0.27	inches of precipitable water at	80.0 F
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F
The grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F

The in-place storm maximization factor is	1.17
The transposition/elevation to basin factor is	1.02
The barrier adjustment factor is	1.00
The total adjustment factor is	1.18

Notes: DAD values taken from SPAS 1228. Storm representative dew point value was based on maximum 24-hr Td values between June 27-28, 2007 at KDKR and KUTS.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.6	6.4	8.9	11.0	14.4	14.5	17.2	22.1	24.8
10 sq miles	4.2	6.3	8.8	10.7	13.8	13.9	17.1	21.9	24.8
100 sq miles	3.1	5.1	7.6	10.2	12.7	13.0	15.7	18.1	21.7
200 sq miles	2.8	4.7	7.0	9.6	11.8	11.9	14.8	17.1	20.7
500 sq miles	2.2	3.5	5.9	8.4	10.4	10.7	13.2	15.5	19.2
1000 sq miles	1.6	3.3	4.8	7.2	9.0	10.0	12.1	14.2	18.1
2000 sq miles	1.1	2.4	3.9	6.0	7.8	9.0	10.8	12.6	16.0
5000 sq miles	0.7	1.8	2.9	4.7	6.3	6.4	9.0	10.4	13.7
10000 sq miles	0.4	1.4	2.2	3.7	5.1	6.0	7.5	8.7	11.1
20000 sq miles	0.3	0.6	1.5	2.7	3.8	4.6	5.7	7.0	9.2

Adjusted Storm Depth-Area-Duration

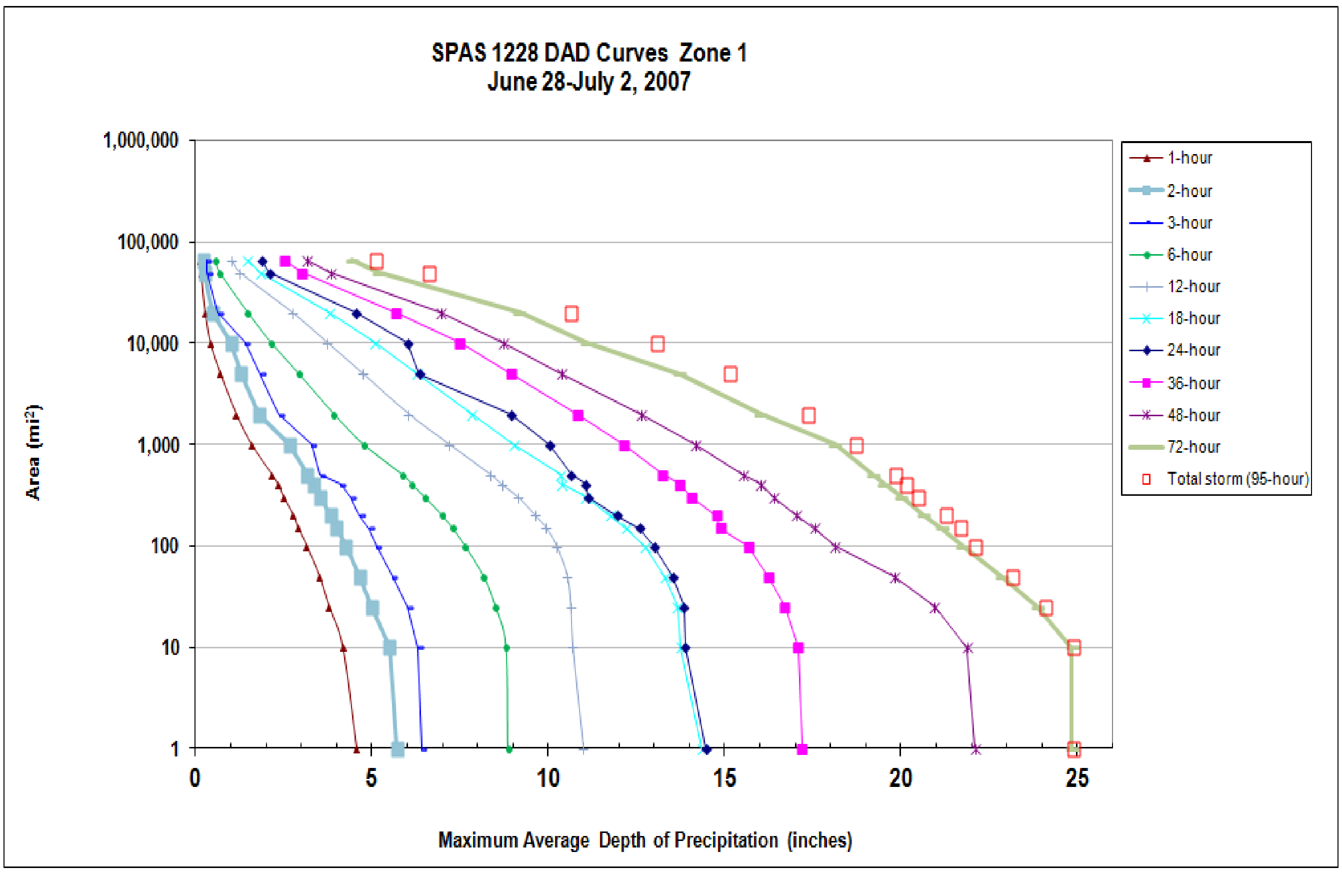
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	5.4	7.6	10.5	13.0	17.0	17.1	20.4	26.2	29.4
10 sq miles	4.9	7.5	10.4	12.7	16.3	16.4	20.2	25.9	29.4
100 sq miles	3.7	6.1	9.0	12.1	15.1	15.4	18.6	21.5	25.7
200 sq miles	3.3	5.5	8.3	11.4	13.9	14.1	17.5	20.2	24.4
500 sq miles	2.6	4.2	6.9	9.9	12.3	12.6	15.7	18.4	22.7
1000 sq miles	1.9	3.9	5.6	8.5	10.7	11.9	14.4	16.8	21.5
2000 sq miles	1.3	2.8	4.6	7.1	9.3	10.6	12.8	14.9	19.0
5000 sq miles	0.8	2.2	3.5	5.6	7.4	7.5	10.6	12.3	16.3
10000 sq miles	0.5	1.7	2.5	4.4	6.0	7.1	8.9	10.3	13.1
20000 sq miles	0.3	0.7	1.8	3.2	4.5	5.4	6.7	8.2	10.9

Storm or Storm Center Name	**SPAS 1228 Fall River, KS**	
Storm Date(s)	6/28/2007 - 7/2/2007	
Storm Type	Synoptic	
Storm Location	37.63 N	96.05 W
Storm Center Elevation	900	
Precipitation Total & Duration	25.50 Inches 95-hours	
Storm Representative Dew Point	76.5 F	24
Storm Representative Dew Point Location	31.00 N	95.50 W
Maximum Dew Point	80.0 F	
Moisture Inflow Vector	S @ 460	Miles
In-place Maximization Factor	**1.17**	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	36.10 N	92.00 W
Transposition Maximum Dew Point	80.5 F	
Transposition Adjustment Factor	**1.02**	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.18**	

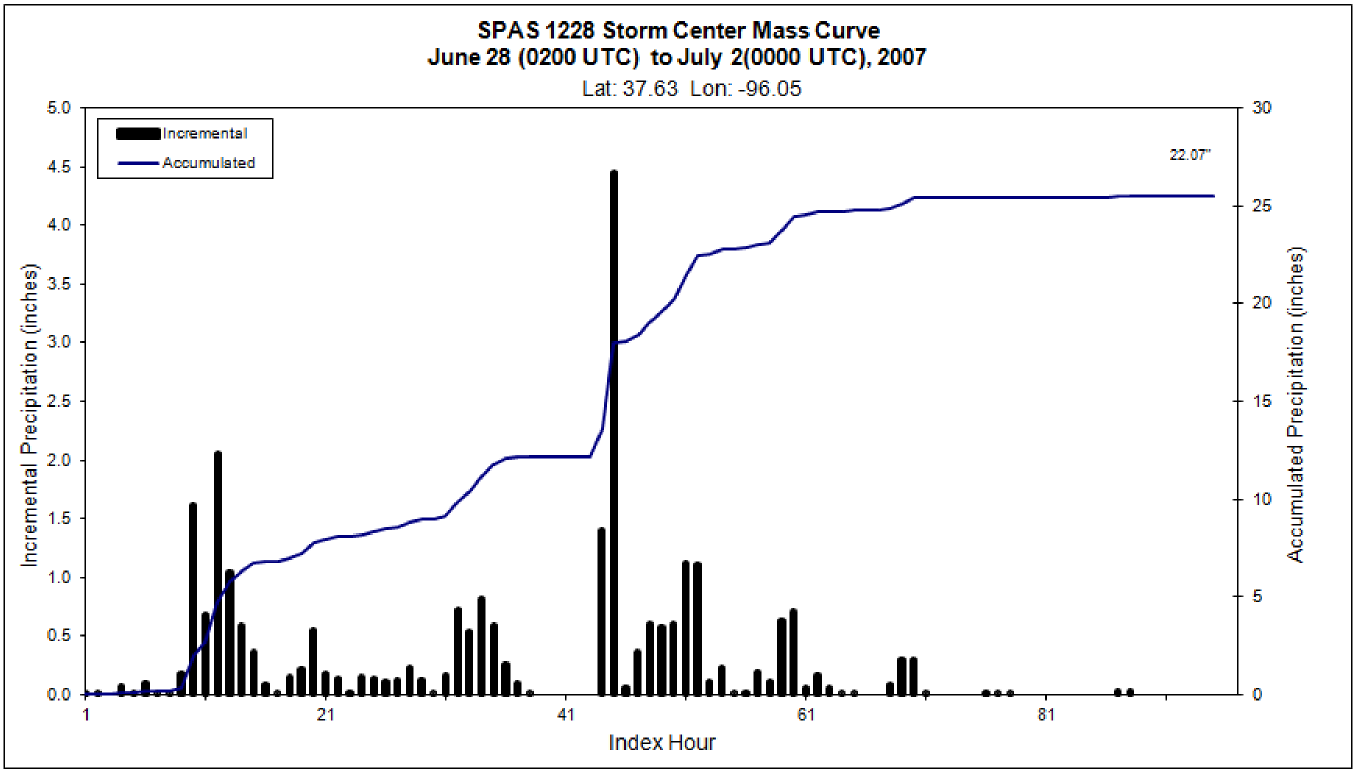
Appendix G: Table G.6: Storm spreadsheet for Fall River, KS, June 30, 2007

Storm 1228 - June 28 (0200 UTC) - July 2 (0000 UTC), 2007											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	2	3	6	12	18	24	36	48	72	Total
0.4	4.68	5.84	6.6	9.12	11.37	14.72	14.91	17.72	22.66	25.43	25.50
1	4.56	5.7	6.41	8.86	10.99	14.35	14.46	17.2	22.09	24.84	24.90
10	4.16	5.5	6.31	8.81	10.69	13.76	13.89	17.08	21.88	24.84	24.90
25	3.78	4.99	6.02	8.51	10.63	13.66	13.85	16.71	20.96	23.86	24.10
50	3.5	4.66	5.58	8.17	10.53	13.31	13.53	16.24	19.81	22.86	23.18
100	3.14	4.26	5.12	7.64	10.22	12.73	13.01	15.68	18.13	21.74	22.11
150	2.9	4	4.91	7.28	9.93	12.22	12.58	14.89	17.55	21.16	21.69
200	2.76	3.83	4.65	6.99	9.61	11.77	11.94	14.76	17.05	20.65	21.28
300	2.49	3.54	4.4	6.5	9.14	11.07	11.13	14.05	16.39	20.02	20.49
400	2.33	3.35	4.11	6.15	8.67	10.39	11.07	13.73	16.03	19.53	20.17
500	2.16	3.18	3.52	5.87	8.36	10.36	10.65	13.24	15.53	19.21	19.84
1,000	1.57	2.66	3.29	4.76	7.18	9.02	10.04	12.13	14.17	18.13	18.71
2,000	1.14	1.79	2.37	3.92	6.03	7.83	8.95	10.82	12.62	16.03	17.37
5,000	0.69	1.29	1.83	2.92	4.73	6.29	6.35	8.96	10.39	13.73	15.17
10,000	0.41	1	1.4	2.15	3.74	5.09	6.01	7.5	8.72	11.08	13.09
20,000	0.26	0.48	0.63	1.48	2.73	3.79	4.55	5.68	6.95	9.18	10.66
50,000	0.14	0.25	0.34	0.68	1.24	1.84	2.11	3.02	3.82	5.21	6.63
65,761	0.12	0.23	0.31	0.55	1.03	1.48	1.87	2.51	3.15	4.44	5.10

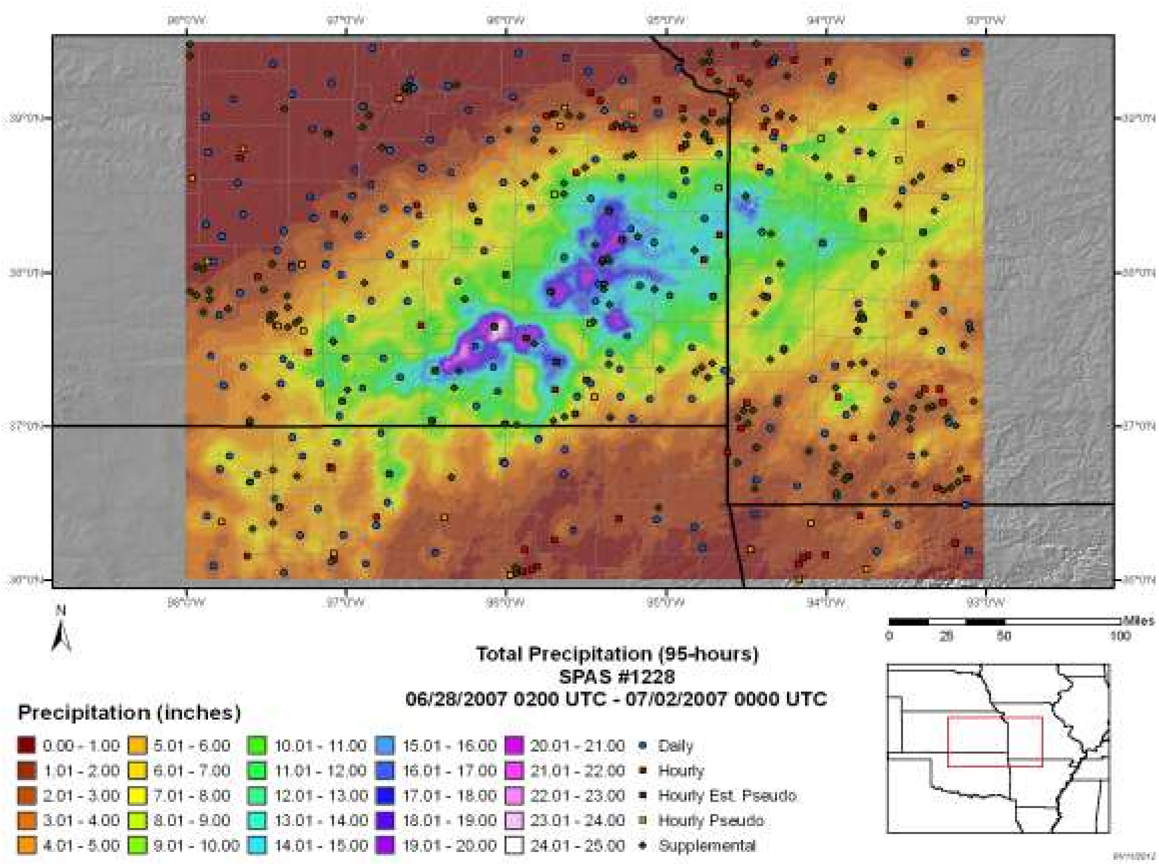
Appendix G: Table G.7: Depth-area-duration values for Fall River, KS June 30, 2007



Appendix G: Figure G.7: Depth-area-duration chart for Fall River, KS June 30, 2007



Appendix G: Figure G.8: Mass curve chart for Fall River, KS June 30, 2007



Appendix G: Figure G.9: Total storm isohyetal analysis for Fall River, KS June 30, 2007

Albany, TX AWA 18

August 3, 1978

Storm Type: Tropical

Storm Name:	**SPAS 1179 Amelia- Albany, TX**		
Storm Date:	**8/1-5/1978**	**Storm Adjustment for ANO Grid Point 2**	
AWA Analysis Date:	**12/13/2013**		

Temporal Transposition Date	**15-Jul**	
	Lat	**Long**
Storm center location	**32.74 N**	**99.33 W**
Storm Rep SST location	**29.30 N**	**97.50 W**
Transposition Dew Point Location	**31.08 N**	**93.65 W**
Grid Point location	**34.50 N**	**95.50 W**

Moisture Inflow Direction:	**SSE @ 260**	miles
Grid Point Elevation	**550**	feet
Storm Center Elevation	**1,500**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative SST is	**78.0 F**	with total precipitable water above sea level of			**3.29**	inches.
The in-place maximum SST is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The transpositioned maximum SST is	**81.0 F**	with total precipitable water above sea level of			**3.76**	inches.
The in-place storm elevation is	**1,500**	which subtracts	**0.41**	inches of precipitable water at	**78.0 F**	
The in-place storm elevation is	**1,500**	which subtracts	**0.43**	inches of precipitable water at	**80.0 F**	
The transposition storm elevation at	**550**	which subtracts	**0.175**	inches of precipitable water at	**81.0 F**	
The grid point/inflow barrier height is	**550**	which subtracts	**0.175**	inches of precipitable water at	**81.0 F**	

The in-place maximization factor is	**1.10**
The transposition factor is	**1.13**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.24**

Notes: Storm Rep Td taken from ave of KSJT, KJCT, KATT, KSAT

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**20.8**	**26.4**	-	**29.7**	-	**31.4**	**31.5**	-	**31.6**
100 sq miles	**15.3**	**23.8**	-	**27.6**	-	**29.2**	**29.4**	-	**29.5**
200 sq miles	**10.3**	**20.9**	-	**24.4**	-	**26.6**	**26.8**	-	**27.0**
500 sq miles	**8.4**	**16.0**	-	**19.0**	-	**20.9**	**23.1**	-	**23.4**
1000 sq miles	**6.6**	**12.6**	-	**15.8**	-	**18.4**	**20.8**	-	**21.0**
2000 sq miles	**4.7**	**7.5**	-	**12.2**	-	**15.7**	**17.4**	-	**17.7**
5000 sq miles	**2.7**	**4.2**	-	**7.8**	-	**8.5**	**12.0**	-	**13.2**
10000 sq miles	**1.9**	**3.2**	-	**5.1**	-	**7.5**	**8.8**	-	**9.6**
20000 sq miles	**1.3**	**2.3**	-	**3.4**	-	**3.7**	**4.3**	-	**6.7**

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**25.8**	**32.9**	-	**37.0**	-	**39.0**	**39.2**	-	**39.3**
100 sq miles	**19.1**	**29.6**	-	**34.3**	-	**36.4**	**36.6**	-	**36.7**
200 sq miles	**12.9**	**26.1**	-	**30.4**	-	**33.1**	**33.3**	-	**33.6**
500 sq miles	**10.5**	**19.9**	-	**23.6**	-	**26.0**	**28.8**	-	**29.1**
1000 sq miles	**8.2**	**15.7**	-	**19.7**	-	**22.9**	**25.9**	-	**26.2**
2000 sq miles	**5.8**	**9.4**	-	**15.2**	-	**19.5**	**21.6**	-	**22.0**
5000 sq miles	**3.3**	**5.2**	-	**9.7**	-	**10.6**	**15.0**	-	**16.4**
10000 sq miles	**2.4**	**4.0**	-	**6.3**	-	**9.3**	**11.0**	-	**12.0**
20000 sq miles	**1.6**	**2.9**	-	**4.2**	-	**4.6**	**5.3**	-	**8.3**

Storm or Storm Center Name	**SPAS 1179 Amelia- Albany, TX**		
Storm Date(s)	8/1-5/1978		
Storm Type	Remnant Tropical-Frontal		
Storm Location	32.74 N	99.33 W	
Storm Center Elevation	1500		
Precipitation Total & Duration (10 sq mi)	32.5 inches in 48 hours, 29.5 " 24 hours, 12.47" in 1hr, 21.94" in 6hrs		
Storm Representative SST	78.0 F	12	
Storm Representative SST Location	29.30 N	97.50 W	J
In-place Maximum SST	80.0 F		80
Moisture Inflow Vector	SSE @ 260		
In-place Maximization Factor			
Temporal Transposition (Date)	15-Jul		
Transposition Dewpoint Location	31.08 N	93.65 W	J
Transposition Maximum SST	81.0 F		81
Transposition Adjustment Factor			
Grid Point Elevation	550		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	**1.24**		

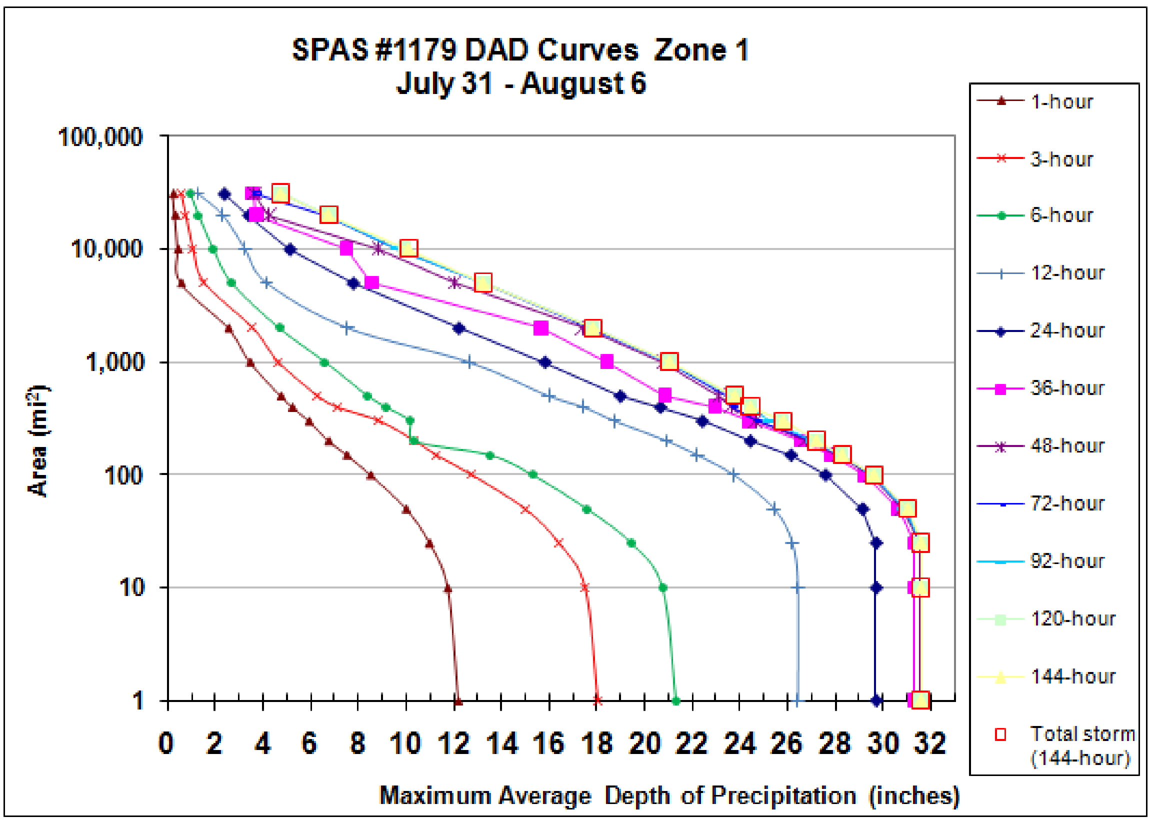
Appendix G: Table G.8: Storm spreadsheet for Albany, TX, August 3, 1978

Storm 1179 - July 31, 1978 (0600 UTC) - August 6, 1978 (0500 UTC)

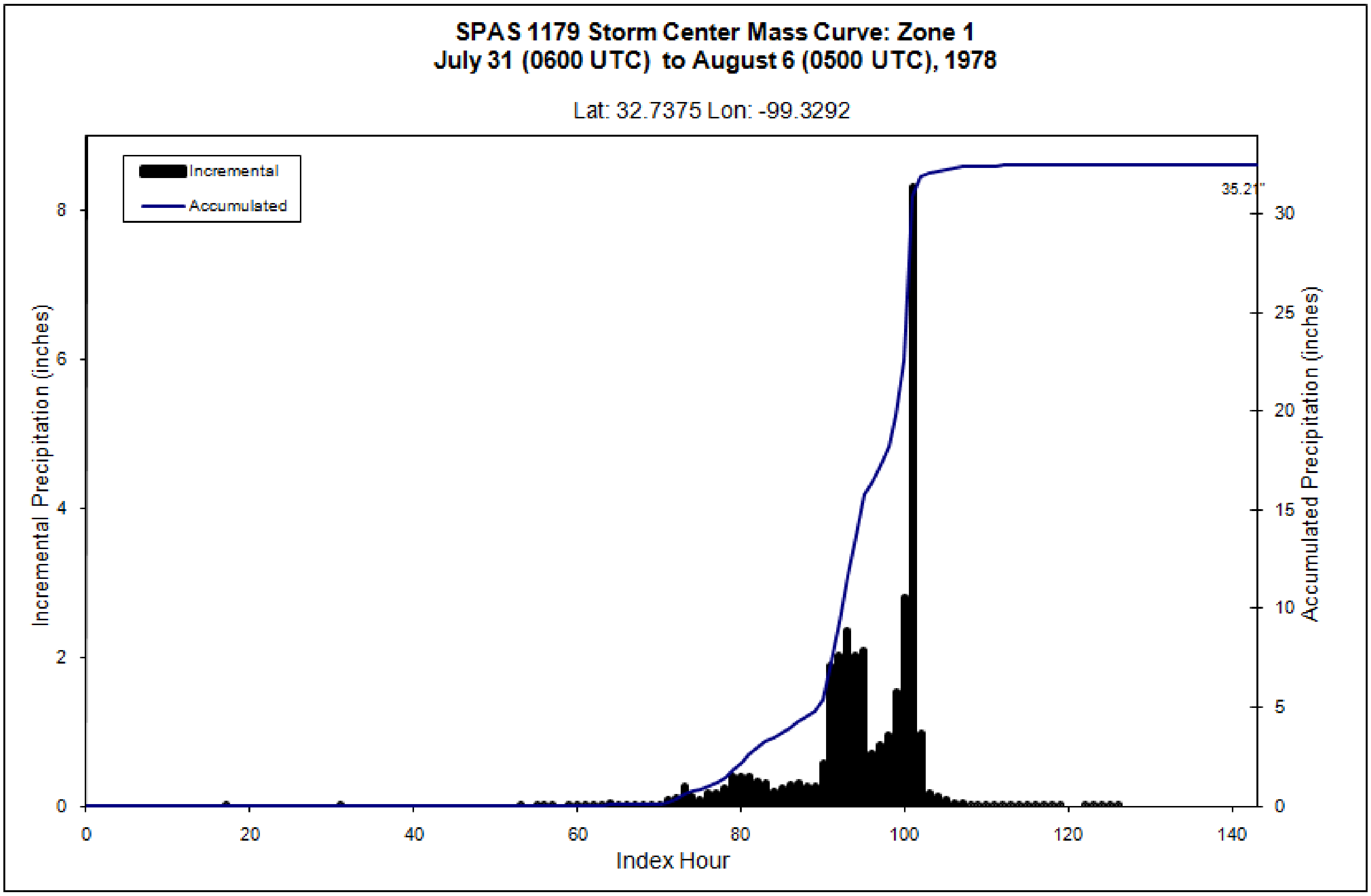
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

	Duration (hours)											
Area (mi^2)	1	3	6	12	24	36	48	72	96	120	144	Total
0.30	12.47	18.53	21.94	27.16	30.54	32.22	32.41	32.50	32.51	32.51	32.51	32.51
1	12.19	18.01	21.33	26.43	29.71	31.35	31.52	31.60	31.60	31.60	31.60	31.60
10	11.74	17.48	20.76	26.43	29.71	31.35	31.52	31.60	31.60	31.60	31.60	31.60
25	10.98	16.38	19.45	26.20	29.71	31.35	31.52	31.60	31.60	31.60	31.60	31.60
50	10.00	14.97	17.59	25.44	29.14	30.67	30.83	30.91	30.91	31.06	31.06	31.06
100	8.51	12.74	15.32	23.75	27.58	29.22	29.44	29.51	29.51	29.62	29.62	29.62
150	7.51	11.25	13.52	22.20	26.13	27.86	28.13	28.26	28.27	28.27	28.29	28.29
200	6.75	10.34	10.34	20.94	24.43	26.58	26.77	27.03	27.03	27.21	27.22	27.22
300	5.92	8.87	10.15	18.76	22.41	24.40	24.66	24.69	25.23	25.77	25.83	25.83
400	5.22	7.08	9.16	17.42	20.65	22.97	23.63	23.67	24.45	24.45	24.45	24.45
500	4.74	6.28	8.40	15.98	18.97	20.85	23.11	23.41	23.78	23.78	23.79	23.79
1,000	3.45	4.62	6.61	12.63	15.81	18.43	20.77	21.03	21.04	21.05	21.06	21.06
2,000	2.54	3.55	4.67	7.54	12.19	15.66	17.39	17.66	17.78	17.82	17.84	17.84
5,000	0.55	1.52	2.68	4.15	7.76	8.54	12.04	13.19	13.21	13.22	13.23	13.23
10,000	0.42	1.04	1.91	3.24	5.10	7.50	8.83	9.63	9.65	9.94	10.11	10.11
20,000	0.30	0.74	1.29	2.31	3.38	3.71	4.25	6.67	6.74	6.75	6.75	6.75
31,010	0.22	0.54	0.95	1.27	2.35	3.57	3.63	3.63	4.74	4.75	4.75	4.75

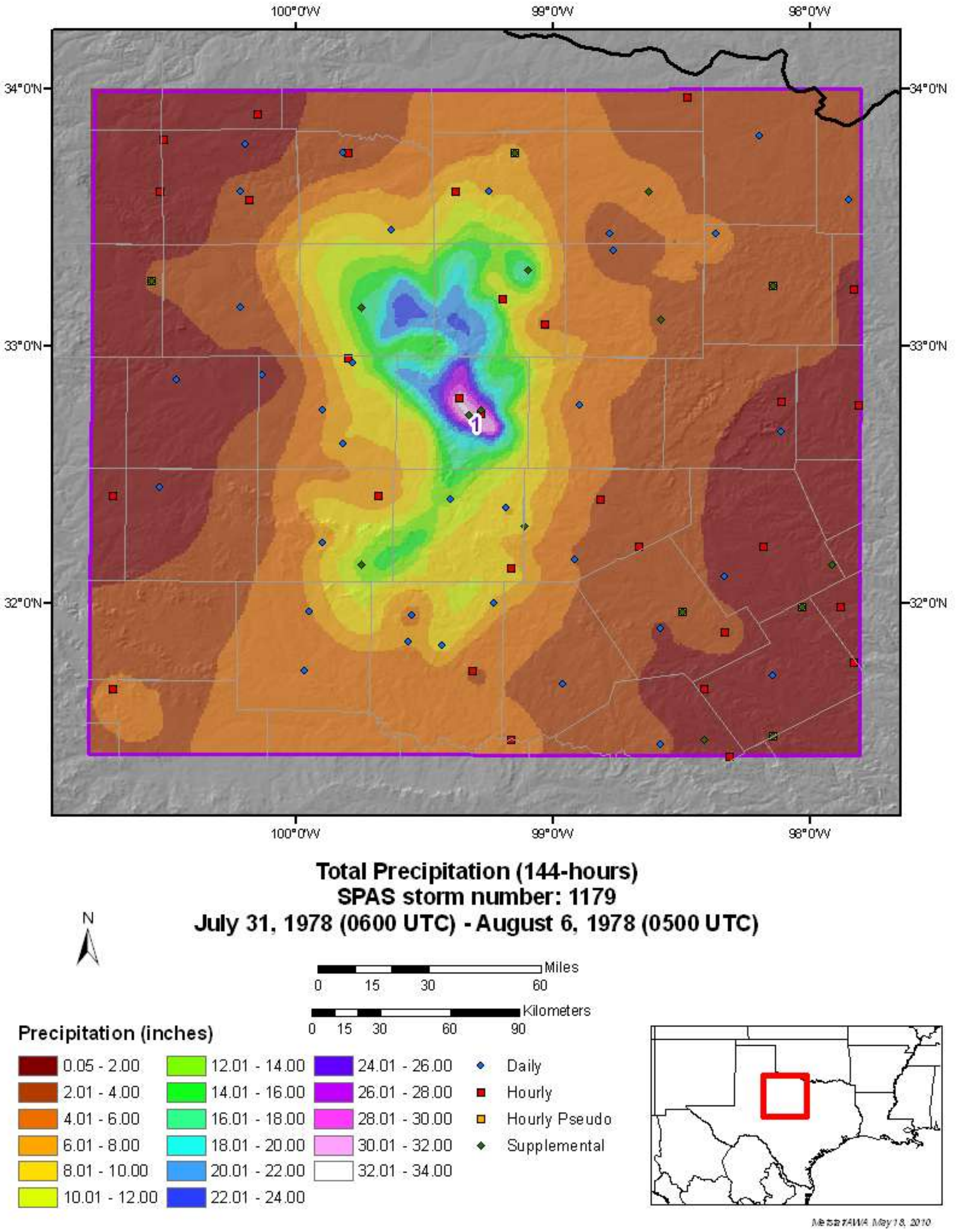
Appendix G: Table G.9: Depth-area-duration values for Albany, TX, August 3, 1978



Appendix G: Figure G.10: Depth-area-duration chart for Albany, TX, August 3, 1978



Appendix G: Figure G.11: Mass curve chart for Albany, TX, August 3, 1978



Appendix G: Figure G.12: Total storm isohyetal analysis for Albany, TX, August 3, 1978

Enid, OK, AWA 21
October 10, 1973
Storm Type: MCC

Storm Name:	SPAS -1034-Enid, OK	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	10-Oct-1973	
AWA Analysis Date:	12/14/2013	

Temporal Transposition Date	25-Sep	
	Lat	Long
Storm center location	36.38 N	97.87 W
Storm Rep dew point location	33.35 N	96.55 W
Transposition dewpoint location	30.30 N	96.92 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	SSE @ 225	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,250	feet
Storm Rep Analysis Duration	12	hrs

The storm representative dew point is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	77.5 F	with total precipitable water above sea level of			3.22	inches.
The in-place storm elevation is	1,250	which subtracts	0.31	inches of precipitable water at	75.0 F	
The in-place storm elevation is	1,250	which subtracts	0.325	inches of precipitable water at	76.5 F	
The transposition basin elevation at	0	which subtracts	0.285	inches of precipitable water at	77.5 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.285	inches of precipitable water at	77.5 F	

The in-place storm maximization factor is	1.08
The transposition/elevation to basin factor is	1.07
The barrier adjustment factor is	1.00
The total adjustment factor is	1.16

Notes: DAD values taken from SPAS 1034. 12hr average taken from KDFW and WACO from 2100CDT 10-9-73 to 0900CDT10-10-73

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	11.2	17.1	19.0	19.0	-	19.0	19.2	-	19.4
10 sq miles	10.7	16.3	18.1	18.1	-	18.1	18.3	-	18.5
100 sq miles	9.7	14.6	16.2	16.2	-	16.2	16.4	-	16.6
200 sq miles	9.1	13.7	15.2	15.2	-	15.2	15.3	-	15.5
500 sq miles	7.9	11.3	12.7	12.7	-	12.7	12.9	-	12.9
1000 sq miles	6.7	9.5	10.5	10.5	-	10.5	10.6	-	10.6
5000 sq miles	3.9	5.2	5.6	5.6	-	5.6	5.7	-	5.7
10000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0
20000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	13.0	19.7	21.9	22.0	-	22.0	22.2	-	22.4
10 sq miles	12.4	18.9	20.9	20.9	-	20.9	21.1	-	21.4
100 sq miles	11.2	16.9	18.7	18.7	-	18.7	18.9	-	19.2
200 sq miles	10.5	15.8	17.6	17.6	-	17.6	17.7	-	17.9
500 sq miles	9.1	13.1	14.7	14.7	-	14.7	14.9	-	14.9
1000 sq miles	7.8	10.9	12.2	12.2	-	12.2	12.2	-	12.3
5000 sq miles	4.5	6.0	6.5	6.5	-	6.5	6.6	-	6.6
10000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0
20000 sq miles	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0

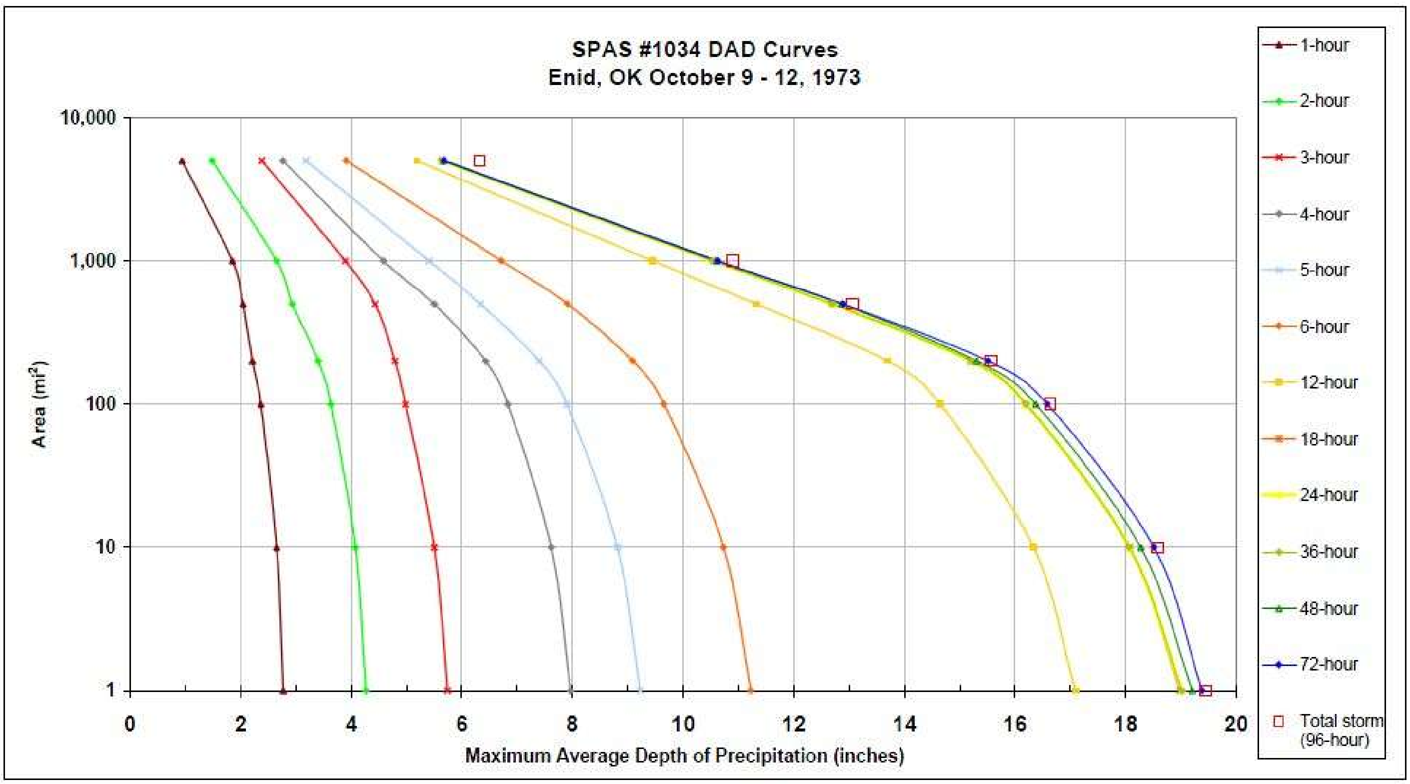
Storm or Storm Center Name	**SPAS -1034-Enid, OK**			
Storm Date(s)	10/10/73			
Storm Type	MCC			
Storm Location	36.38 N	97.87 W		
Storm Center Elevation	1,250			
Precipitation Total & Duration	20.00 Inches 15-hours NCDC Storm Data report			
Storm Representative Dewpoint	75.0 F	12		
Storm Representative Dewpoint Location	33.35 N	96.55 W		
Maximum Dewpoint	76.5 F			
Moisture Inflow Vector	SSE @ 225			
In-place Maximization Factor	1.08			
Temporal Transposition (Date)	25-Sep		S	O
Transposition Dewpoint Location	30.30 N	96.92 W	78	77
Transposition Maximum Dewpoint	77.5 F			
Transposition Adjustment Factor				
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height				
Elevation Adjustment Factor				
Total Adjustment Factor	**1.16**			

Appendix G: Table G.10: Storm spreadsheet for Enid, OK, October 10, 1973

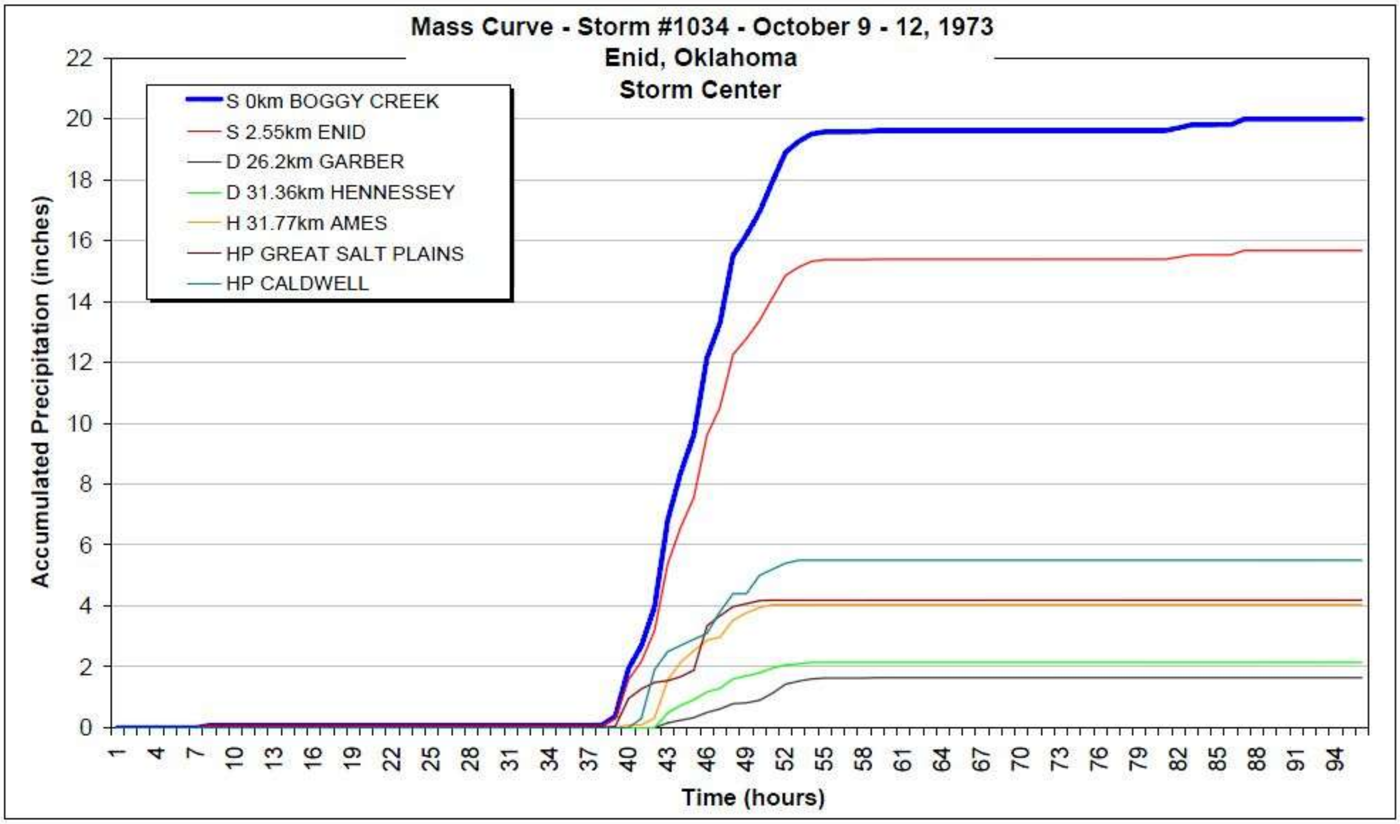
Storm 1034 - Enid OK, October 9 - 12, 1973

MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

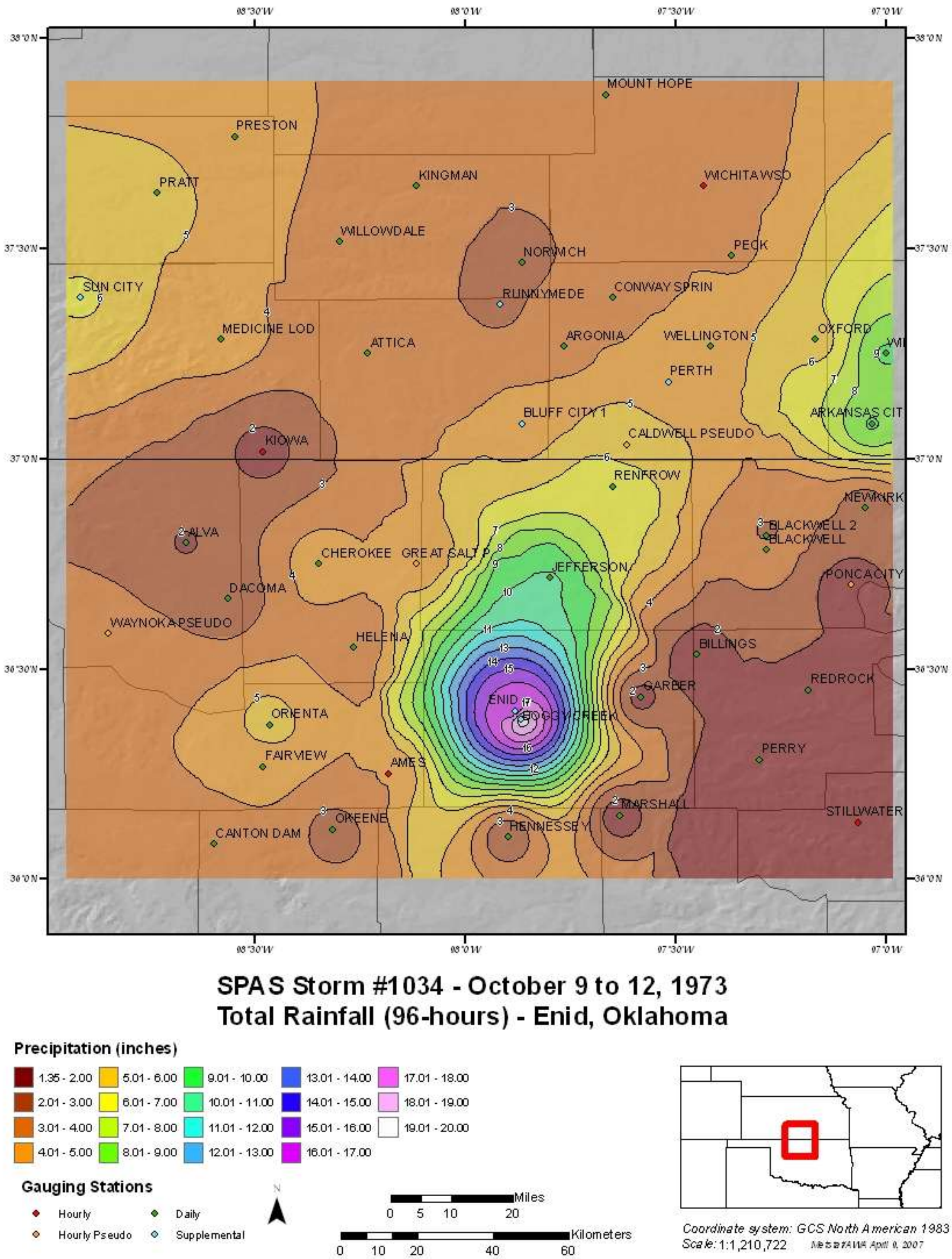
Area (mi²)	Duration (hours)													
	1	2	3	4	5	6	12	18	24	36	48	72	96	total
1	2.77	4.26	5.74	7.96	9.22	11.22	17.09	18.98	19.02	19.02	19.20	19.38	19.45	19.45
10	2.65	4.07	5.50	7.61	8.81	10.73	16.33	18.07	18.07	18.07	18.27	18.51	18.58	18.58
100	2.36	3.63	4.98	6.83	7.90	9.65	14.64	16.19	16.20	16.20	16.37	16.58	16.64	16.64
200	2.21	3.40	4.79	6.43	7.40	9.09	13.69	15.19	15.21	15.21	15.30	15.51	15.57	15.57
500	2.04	2.93	4.43	5.50	6.33	7.91	11.32	12.69	12.69	12.69	12.86	12.89	13.06	13.06
1,000	1.85	2.65	3.89	4.58	5.40	6.71	9.45	10.53	10.53	10.53	10.60	10.63	10.89	10.89
5,000	0.94	1.48	2.38	2.76	3.18	3.91	5.18	5.63	5.63	5.63	5.67	5.68	6.32	6.32



Appendix G: Table G.11: and Appendix G: Figure G.13: Depth-area-duration values Depth-area-duration chart for Enid, OK, October 10, 1973



Appendix G: Figure G.14: Mass curve chart for Enid, OK, October 10, 1973



Appendix G: Figure G.15: Total storm isohyetal analysis for Enid, OK, October 10, 1973

Wooster, OH, AWA 24

July 4, 1969

Storm Type: Frontal/MCC

Storm Name:	Wooster, OH SPAS 1209	**Storm Adjustment for ANO Grid Point 8**
Storm Date:	7/4-7/1969	
AWA Analysis Date:	12/14/2013	

Temporal Transposition Date 15-Jul

	Lat	Long
Storm Center Location	40.91 N	81.97 W
Storm Rep Dew Point Location	39.43 N	83.80 W
Transposition Dew Point Location	41.25 N	94.46 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SW @ 140	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,150	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	1,150	which subtracts	0.30	inches of precipitable water at	76.0 F	
The in-place storm elevation is	1,150	which subtracts	0.32	inches of precipitable water at	78.0 F	
The transposition basin elevation at	1,200	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.10
The transposition/elevation to basin factor is	1.14
The barrier adjustment factor is	1.00
The total adjustment factor is	1.25

Notes: DAD values taken from SPAS 1209. Storm representative dew point value was based on maximum 24-hr Td values between July 4-5, 1969 at KILN, KFFO, and KCVG.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.6	6.2	8.8	12.7	14.3	14.4	14.5	14.6	14.7
10 sq miles	4.2	6.0	8.7	12.3	13.7	13.7	13.8	14.0	14.0
100 sq miles	2.9	5.7	8.0	10.7	12.0	12.1	12.1	12.6	12.8
200 sq miles	2.5	5.5	7.7	10.4	11.6	11.6	11.7	12.2	12.4
500 sq miles	2.1	4.8	7.3	9.9	11.0	11.0	11.2	11.6	11.8
1000 sq miles	1.7	4.2	6.9	9.3	10.3	10.5	10.7	11.0	11.3
2000 sq miles	1.5	3.7	6.2	8.5	9.4	9.7	9.8	10.2	10.4
5000 sq miles	1.0	2.6	4.5	6.3	7.0	7.1	7.4	7.6	7.9
10000 sq miles	0.5	1.6	2.7	4.4	4.7	4.8	5.4	5.5	5.8
20000 sq miles	0.3	1.0	1.8	2.6	3.4	3.5	3.7	3.8	4.0

Adjusted Storm Depth-Area-Duration

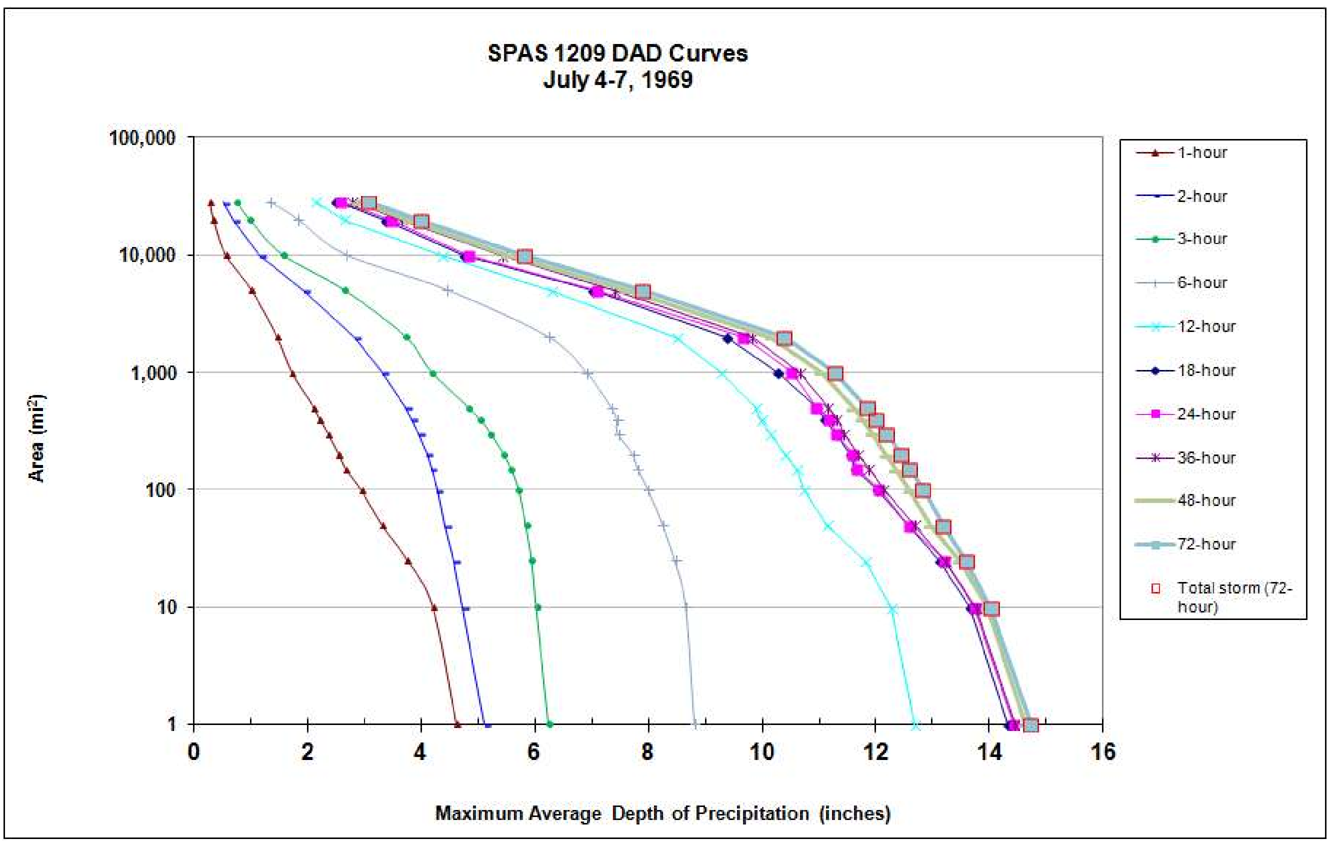
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	5.8	7.8	11.0	15.9	18.0	18.1	18.1	18.3	18.5
10 sq miles	5.3	7.6	10.9	15.4	17.1	17.2	17.3	17.5	17.6
100 sq miles	3.7	7.2	10.0	13.4	15.1	15.1	15.2	15.8	16.1
200 sq miles	3.2	6.8	9.7	13.0	14.5	14.5	14.7	15.3	15.6
500 sq miles	2.6	6.1	9.2	12.4	13.7	13.7	14.0	14.6	14.8
1000 sq miles	2.1	5.2	8.7	11.6	12.9	13.2	13.4	13.8	14.1
2000 sq miles	1.8	4.7	7.8	10.6	11.8	12.1	12.3	12.7	13.0
5000 sq miles	1.3	3.3	5.6	7.9	8.8	8.9	9.3	9.6	9.9
10000 sq miles	0.7	1.9	3.3	5.5	5.9	6.1	6.8	6.9	7.3
20000 sq miles	0.4	1.2	2.3	3.3	4.2	4.4	4.6	4.7	5.0

Storm or Storm Center Name	**Wooster, OH SPAS 1209**	
Storm Date(s)	7/4-7/1969	
Storm Type	Synoptic	
Storm Location	40.91 N	81.97 W
Storm Center Elevation	1,150	
Precipitation Total & Duration	14.73 Inches	72-hours
Storm Representative Dewpoint	76.0 F	24
Storm Representative Dewpoint Location	39.43 N	83.80 W
Maximum Dewpoint	78.0 F	
Moisture Inflow Vector	SW @ 140	Miles
In-place Maximization Factor	**1.10**	
Temporal Transposition (Date)	15-Jul	
Transposition Dewpoint Location	41.25 N	94.46 W
Transposition Maximum Dewpoint	80.5 F	
Transposition Adjustment Factor	**1.14**	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	**1.00**	
Total Adjustment Factor	**1.25**	

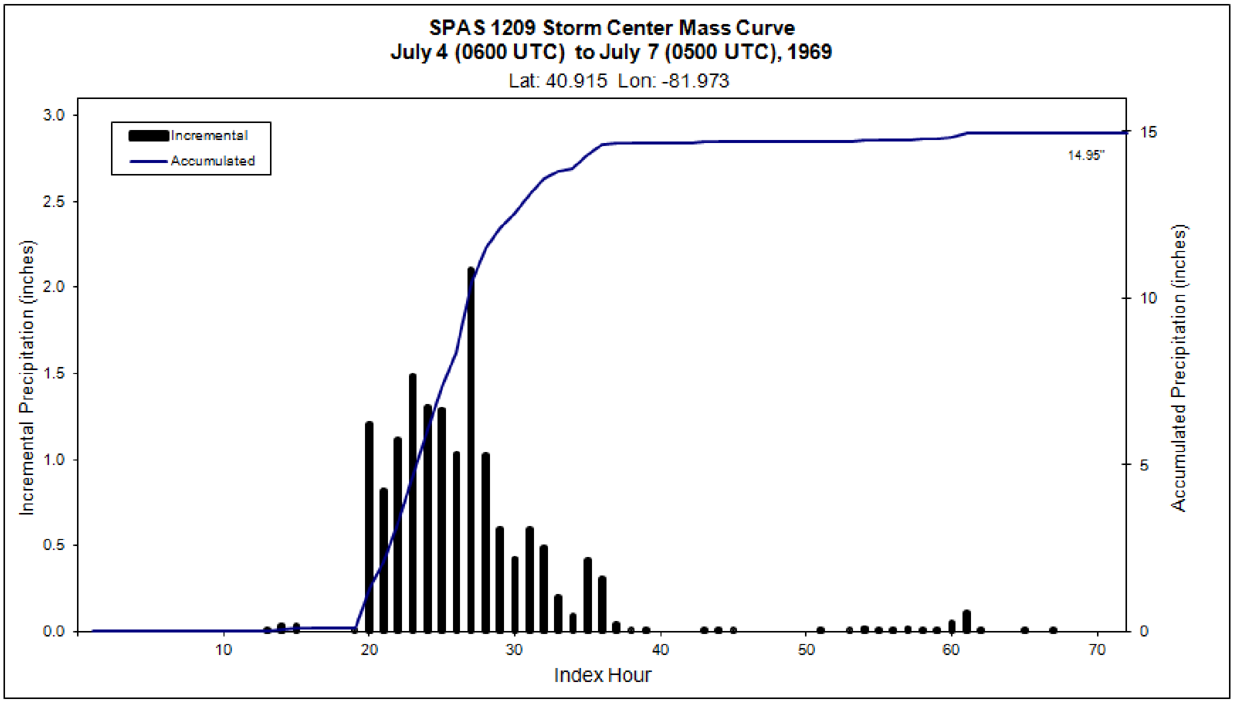
Appendix G: Table G.12: Storm spreadsheet for Wooster, OH July 4, 1969

Storm 1209 - July 4 (0600 UTC) - July 7 (0500 UTC),1969											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
	Duration (hours)										
Area (mi^2)	1	2	3	6	12	18	24	36	48	72	Total
0.3	4.82	5.33	6.41	8.95	13.02	14.58	14.67	14.69	14.94	14.95	14.95
1	4.62	5.11	6.24	8.81	12.67	14.32	14.44	14.45	14.63	14.73	14.73
10	4.2	4.72	6.02	8.66	12.26	13.66	13.74	13.77	13.97	14.02	14.02
25	3.75	4.56	5.94	8.46	11.81	13.13	13.21	13.23	13.47	13.58	13.58
50	3.3	4.42	5.84	8.25	11.14	12.57	12.59	12.69	12.97	13.19	13.19
100	2.93	4.27	5.71	7.99	10.72	12.02	12.06	12.14	12.59	12.83	12.83
150	2.66	4.17	5.58	7.81	10.59	11.63	11.66	11.88	12.35	12.6	12.60
200	2.54	4.09	5.45	7.72	10.4	11.56	11.6	11.69	12.18	12.44	12.44
300	2.35	3.96	5.22	7.46	10.14	11.3	11.3	11.44	11.94	12.19	12.19
400	2.2	3.83	5.02	7.44	9.97	11.1	11.18	11.31	11.75	12	12.00
500	2.1	3.72	4.83	7.34	9.88	10.95	10.96	11.16	11.61	11.84	11.84
1,000	1.71	3.31	4.18	6.9	9.27	10.28	10.52	10.66	11.04	11.27	11.27
2,000	1.45	2.82	3.72	6.23	8.48	9.38	9.67	9.83	10.15	10.39	10.39
5,000	1	1.93	2.64	4.45	6.27	7.02	7.09	7.4	7.62	7.9	7.90
10,000	0.54	1.14	1.55	2.66	4.35	4.74	4.83	5.42	5.52	5.81	5.81
20,000	0.33	0.69	0.97	1.82	2.64	3.37	3.47	3.65	3.78	3.98	3.98
28,279	0.27	0.51	0.74	1.33	2.13	2.5	2.59	2.79	2.89	3.06	3.06

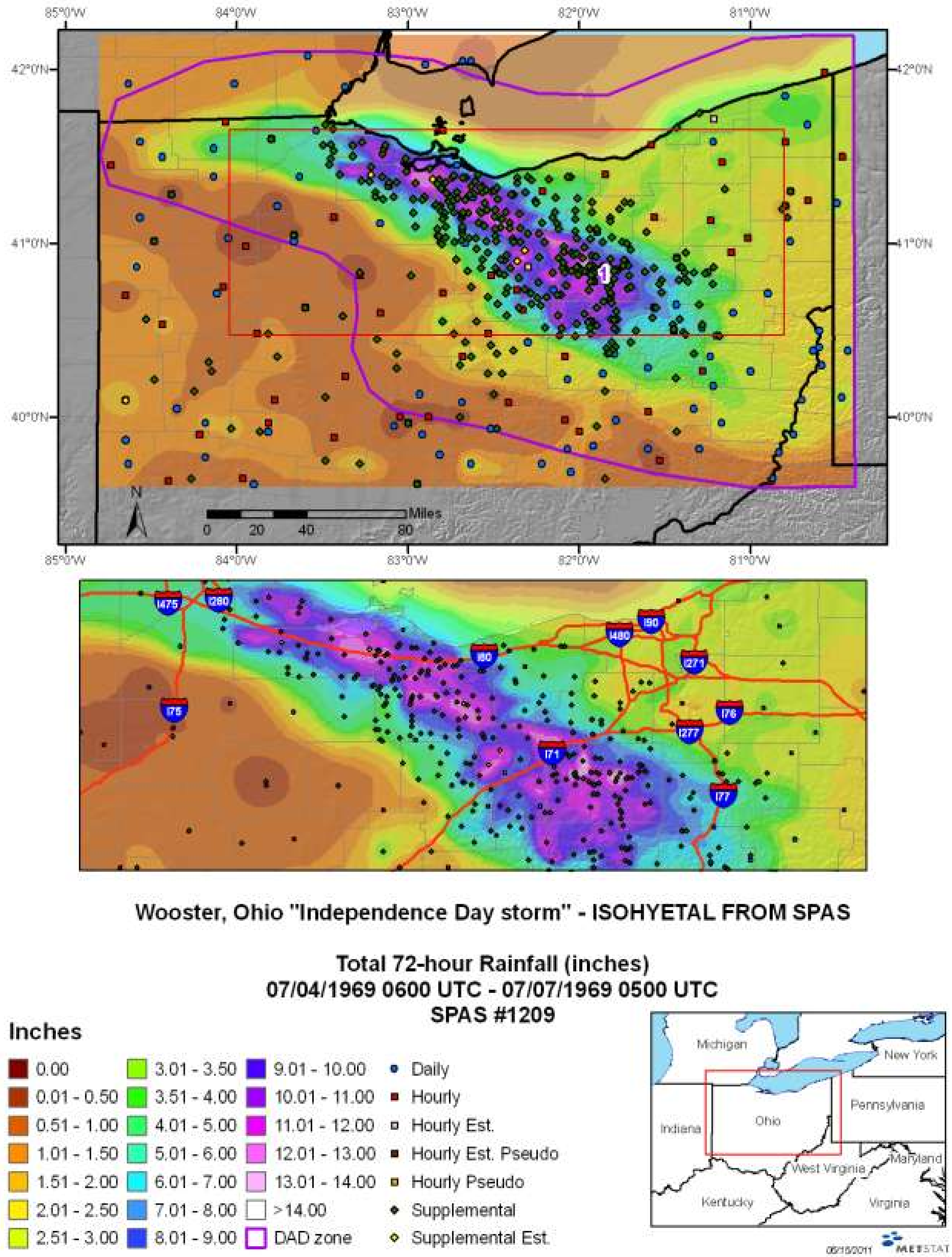
Appendix G: Table G.13: Depth-area-duration values for Wooster, OH July 4, 1969



Appendix G: Figure G.16: Depth-area-duration chart for Wooster, OH July 4, 1969



Appendix G: Figure G.17: Mass curve chart for Wooster, OH July 4, 1969



Appendix G: Figure G.18: Total storm isohyetal analysis for Wooster, OH July 4, 1969

Gladewater, TX, AWA 25

April 27, 1966

Storm Type: Frontal

Storm Name:	**SPAS 1181-Gladewater, TX**	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	**4/22-5-1/1966**	
AWA Analysis Date:	**12/14/2013**	

Temporal Transposition Date **15-May**

	Lat	Long
Storm center location	**32.80 N**	**94.71 W**
Storm Rep SST location	**31.00 N**	**94.00 W**
Transposition SST location	**31.52 N**	**97.49 W**
Grid Point location	**35.31 N**	**93.23 W**

Moisture Inflow Direction:	**SSE @ 130**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**250**	feet
Storm Rep Analysis Duration	**24**	hours

The storm representative SST is	**71.5 F**	with total precipitable water above sea level of			**2.42**	inches.
The in-place maximum SST is	**77.0 F**	with total precipitable water above sea level of			**3.14**	inches.
The transpositioned maximum SST is	**77.0 F**	with total precipitable water above sea level of			**3.14**	inches.
The in-place storm elevation is	**250**	which subtracts	**0.06**	inches of precipitable water at	**71.5 F**	
The in-place storm elevation is	**250**	which subtracts	**0.07**	inches of precipitable water at	**77.0 F**	
The transposition storm elevation at	**350**	which subtracts	**0.28**	inches of precipitable water at	**77.0 F**	
The Grid point/inflow barrier height is	**1,050**	which subtracts	**0.28**	inches of precipitable water at	**77.0 F**	

The in-place maximization factor is	**1.30**
The transposition factor is	**0.93**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.21**

Notes:

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	8.8	10.6	10.8	14.1	-	17.5	18.1	-	20.5
100 sq miles	7.9	9.5	9.6	12.5	-	14.9	15.2	-	18.2
200 sq miles	7.4	9.0	9.1	11.6	-	13.1	14.3	-	17.0
500 sq miles	6.6	8.1	8.2	10.3	-	12.6	13.0	-	16.7
1000 sq miles	6.0	7.0	7.1	9.3	-	11.8	12.2	-	15.9
2000 sq miles	4.9	6.0	6.1	8.1	-	10.2	11.0	-	14.6
5000 sq miles	3.4	4.8	5.1	6.4	-	8.6	8.6	-	11.6
10000 sq miles	2.7	4.0	4.1	5.0	-	7.3	7.4	-	10.6
20000 sq miles	2.1	3.4	3.9	4.3	-	5.6	6.0	-	9.0

Adjusted Storm Depth-Area-Duration

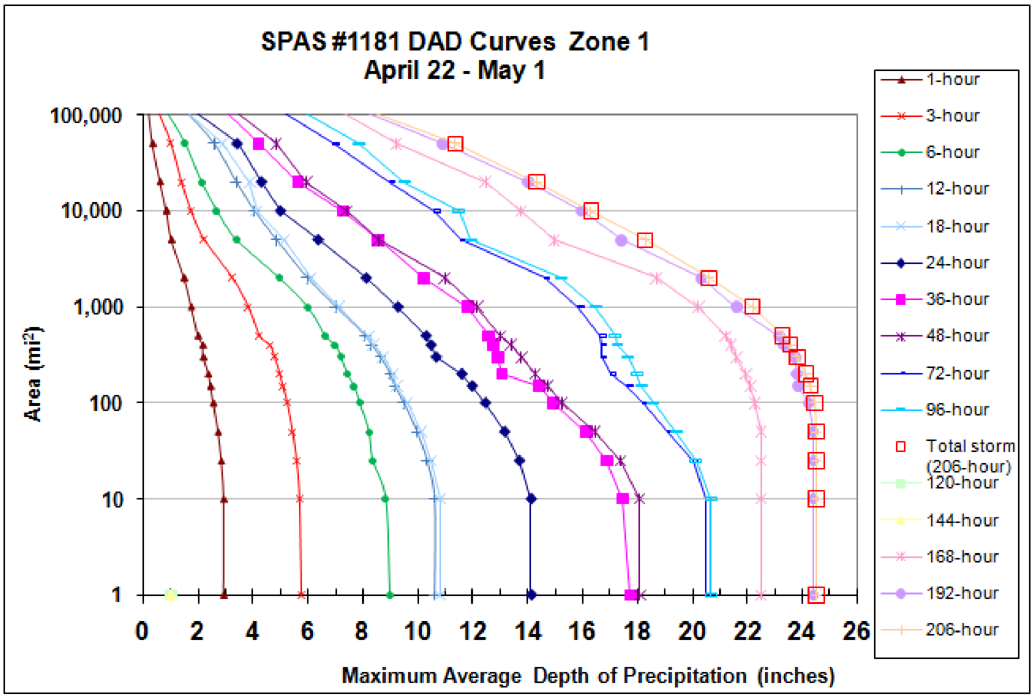
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	10.7	12.8	13.1	17.1	-	21.1	21.9	-	24.8
100 sq miles	9.5	11.5	11.6	15.1	-	18.1	18.5	-	22.1
200 sq miles	9.0	10.9	11.0	14.1	-	15.8	17.3	-	20.6
500 sq miles	8.0	9.8	9.9	12.5	-	15.3	15.8	-	20.2
1000 sq miles	7.2	8.5	8.7	11.2	-	14.3	14.7	-	19.2
2000 sq miles	6.0	7.2	7.4	9.9	-	12.4	13.3	-	17.7
5000 sq miles	4.1	5.9	6.2	7.7	-	10.4	10.4	-	14.0
10000 sq miles	3.2	4.9	5.0	6.1	-	8.8	9.0	-	12.9
20000 sq miles	2.6	4.1	4.7	5.2	-	6.8	7.2	-	10.9

Storm or Storm Center Name	**SPAS 1181-Gladewater, TX**		
Storm Date(s)	4/22-5-1/1966		
Storm Type	General Storm		
Storm Location	32.80 N	94.71 W	
Storm Center Elevation	250		
Precipitation Total & Duration (10 sq mi)	25.35 inches in 206 hours, 18.57" in 72hrs		
Storm Representative SST	71.5 F		
Storm Representative SST Location	31.00 N	94.00 W	M
In-place Maximum SST	77.0 F		77
Moisture Inflow Vector	SSE @ 130		
In-place Maximization Factor			
Temporal Transposition (Date)	15-May		
Transposition Dewpoint Location	31.52 N	97.49 W	M
Transposition Maximum SST	77.0 F		77
Transposition Adjustment Factor			
Grid Point Elevation	350		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	**1.21**		

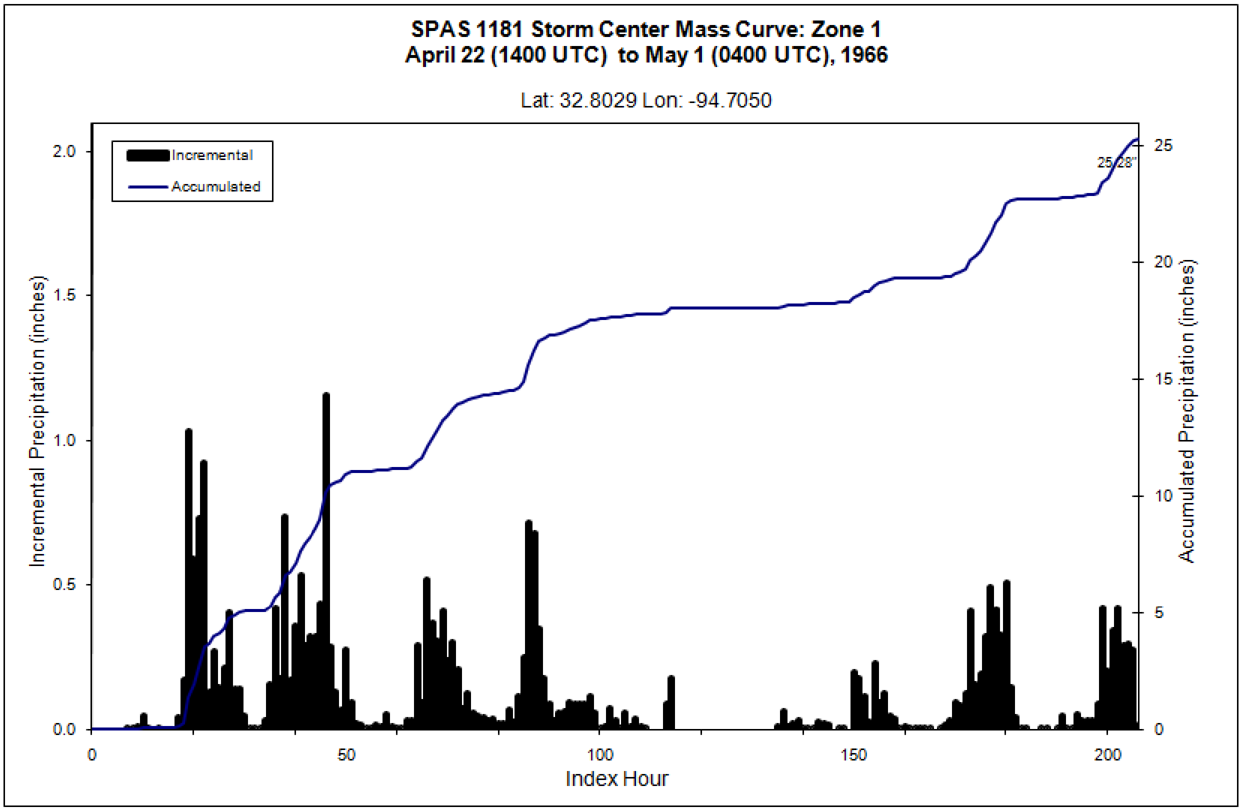
Appendix G: Table G.14: Storm spreadsheet for Gladewater, TX, April 27, 1966

Storm 1181 - April 22, 1966 (1400 UTC) - May 1, 1966 (0400 UTC) MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
	Duration (hours)														
Area (mi^2)	1	3	6	12	18	24	36	48	72	96	120	144	168	192	206	Total
0.30	2.98	5.88	9.17	10.89	11.12	14.53	18.21	18.57	21.04	21.17	21.17	21.59	23.27	25.21	25.28	25.28
1	2.92	5.75	8.97	10.59	10.80	14.13	17.74	18.09	20.49	20.68	20.69	21.10	22.51	24.41	24.52	24.52
10	2.92	5.68	8.82	10.59	10.80	14.12	17.45	18.07	20.49	20.68	20.69	21.10	22.51	24.41	24.52	24.52
25	2.83	5.57	8.35	10.32	10.47	13.69	16.88	17.38	20.01	20.13	20.13	20.61	22.51	24.41	24.52	24.52
50	2.71	5.43	8.21	9.96	10.13	13.16	16.14	16.47	19.11	19.42	19.46	19.53	22.51	24.41	24.52	24.52
100	2.54	5.23	7.87	9.48	9.61	12.46	14.93	15.23	18.20	18.57	18.57	19.35	22.28	24.22	24.46	24.46
150	2.44	5.08	7.67	9.15	9.24	11.98	14.43	14.74	17.64	18.15	18.15	19.02	22.12	23.84	24.30	24.30
200	2.36	4.96	7.42	8.98	9.09	11.60	13.07	14.28	17.02	17.98	18.02	18.89	21.95	23.80	24.14	24.14
300	2.18	4.77	7.19	8.63	8.74	10.67	12.91	13.78	16.67	17.65	17.88	18.63	21.61	23.72	23.82	23.82
400	2.16	4.61	6.99	8.31	8.38	10.48	12.75	13.39	16.67	17.27	17.30	18.31	21.41	23.32	23.55	23.55
500	1.99	4.23	6.62	8.08	8.19	10.31	12.59	13.01	16.66	17.19	17.26	17.90	21.21	23.15	23.29	23.29
1,000	1.74	3.82	5.97	7.01	7.14	9.28	11.83	12.17	15.85	16.49	16.70	17.35	20.22	21.60	22.20	22.20
2,000	1.48	3.24	4.94	5.97	6.10	8.13	10.22	10.97	14.62	15.22	15.34	16.02	18.68	20.32	20.60	20.60
5,000	1.02	2.21	3.38	4.84	5.13	6.38	8.56	8.56	11.57	11.93	13.28	13.60	14.97	17.43	18.28	18.28
10,000	0.84	1.73	2.68	4.04	4.14	5.01	7.27	7.41	10.61	11.50	11.87	12.20	13.75	15.98	16.30	16.30
20,000	0.61	1.38	2.11	3.38	3.88	4.32	5.64	5.95	8.98	9.52	9.53	9.92	12.48	14.03	14.34	14.34
50,000	0.34	1.00	1.52	2.57	2.88	3.44	4.20	4.84	6.94	7.86	7.97	8.44	9.21	10.90	11.37	11.37
110,790	0.20	0.52	0.81	1.50	1.50	1.77	2.92	3.28	4.96	5.68	5.80	6.18	7.06	7.87	8.14	8.14

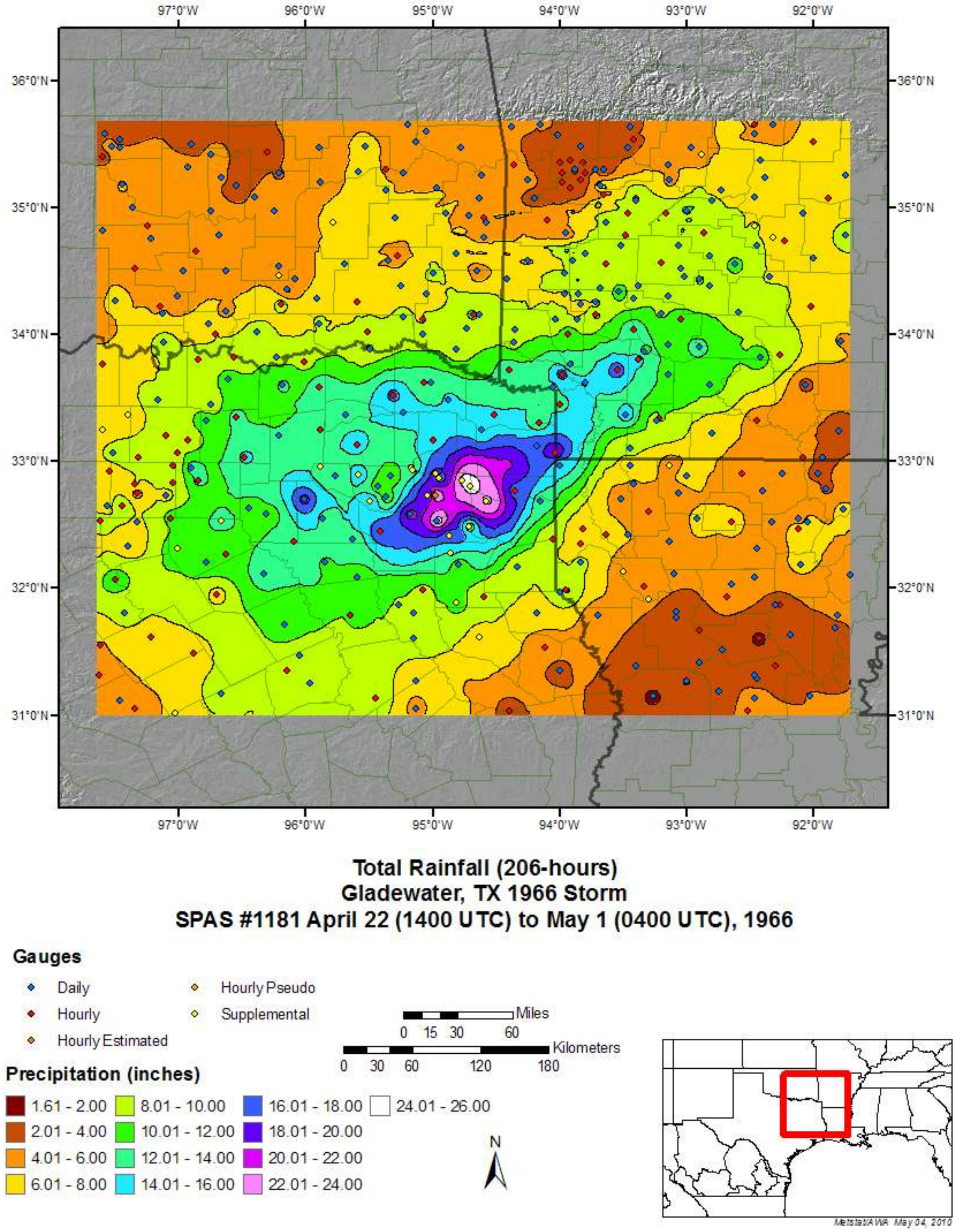
Appendix G: Table G.15: Depth-area-duration values for Gladewater, TX, April 27, 1966



Appendix G: Figure G.19: Depth-area-duration chart for Gladewater, TX, April 27, 1966



Appendix G: Figure G.20: Mass curve chart for Gladewater, TX, April 27, 1966



Appendix G: Figure G.21: Total storm isohyetal analysis for Gladewater, TX, April 27, 1966

Edgerton, MO, AWA 26

July 18, 1965

Storm Type: Frontal/MCC

Storm Name:	SPAS 1183-Edgerton, MO	Storm Adjustment for ANO Grid Point 1
Storm Date:	7/18-20/1965	
AWA Analysis Date:	12/14/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm Center Location	40.41 N	95.51 W
Storm Rep Dew Point Location	39.22 N	96.58 W
Transposition Dew Point Location	41.54 N	93.69 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SW @ 100	miles
Grid Point Elevation	350	feet
Storm Center Elevation	950	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	950	which subtracts	0.25	inches of precipitable water at	76.0 F	
The in-place storm elevation is	950	which subtracts	0.29	inches of precipitable water at	80.5 F	
The transposition storm elevation at	350	which subtracts	0.30	inches of precipitable water at	80.5 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	80.5 F	

The in-place maximization factor is	1.24
The transposition factor is	1.00
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.23

Notes:

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	3.7	11.8	16.7	17.3	18.0	-	19.3	19.4	20.1	-
10 sq miles	3.5	11.1	15.4	16.5	17.6	-	19.0	19.1	19.7	-
100 sq miles	2.4	7.5	11.0	11.5	13.4	-	15.3	16.4	17.2	-
200 sq miles	1.8	6.2	9.2	9.9	12.7	-	14.2	15.4	16.2	-
500 sq miles	1.4	4.4	6.1	8.2	10.9	-	13.4	13.9	15.2	-
1000 sq miles	1.2	3.7	5.8	7.6	9.5	-	12.1	13.0	13.8	-
2000 sq miles	1.0	3.5	4.9	6.8	8.7	-	10.8	11.8	12.7	-
5000 sq miles	0.6	2.7	3.8	5.6	6.9	-	8.5	9.7	10.4	-
10000 sq miles	0.4	2.1	3.2	4.0	5.2	-	7.0	7.7	8.2	-
20000 sq miles	0.3	1.4	2.2	2.8	3.6	-	4.9	5.4	5.8	-

Adjusted Storm Depth-Area-Duration

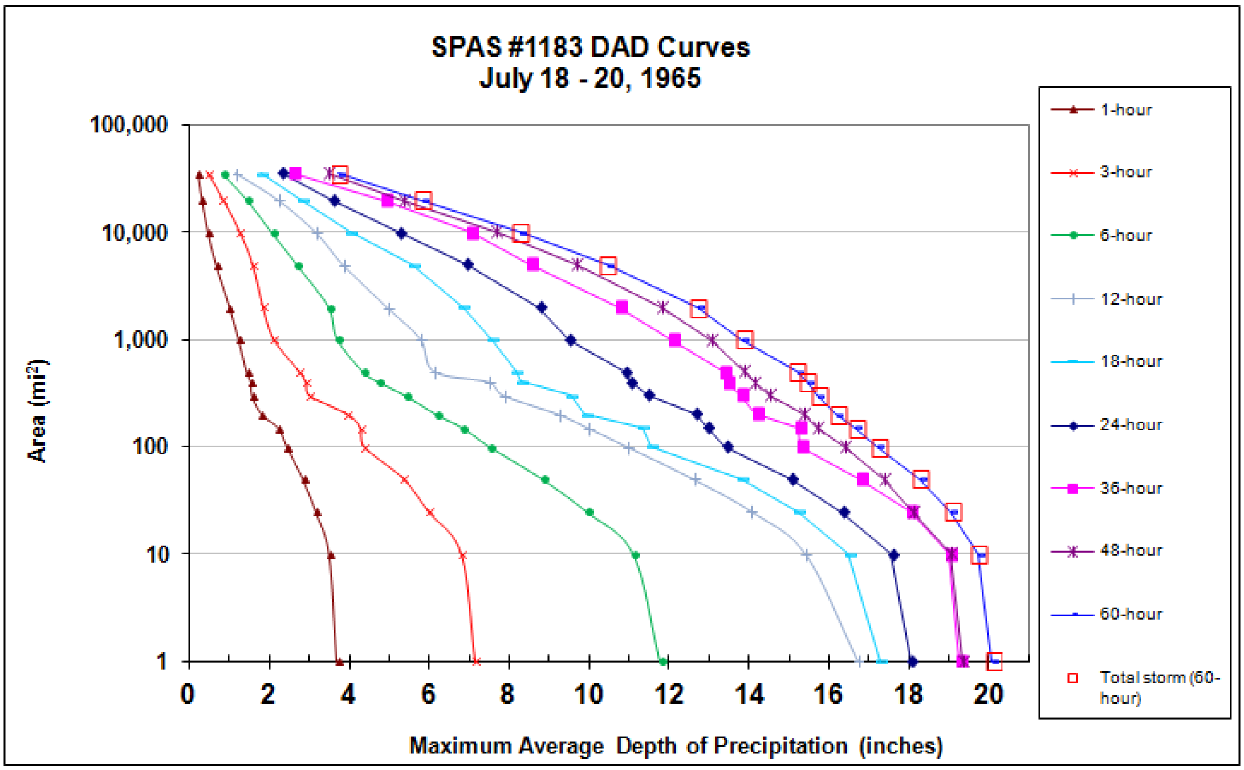
	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	4.5	14.5	20.6	21.3	22.2	-	23.7	23.8	24.7	-
10 sq miles	4.3	13.7	19.0	20.3	21.6	-	23.4	23.4	24.2	-
100 sq miles	3.0	9.2	13.5	14.2	16.5	-	18.8	20.2	21.2	-
200 sq miles	2.2	7.6	11.4	12.2	15.6	-	17.4	18.9	19.9	-
500 sq miles	1.7	5.4	7.5	10.0	13.4	-	16.4	17.1	18.7	-
1000 sq miles	1.5	4.6	7.1	9.3	11.7	-	14.9	16.0	17.0	-
2000 sq miles	1.2	4.3	6.1	8.4	10.8	-	13.2	14.5	15.6	-
5000 sq miles	0.8	3.3	4.7	6.9	8.5	-	10.5	11.9	12.8	-
10000 sq miles	0.5	2.5	3.9	4.9	6.4	-	8.6	9.4	10.1	-
20000 sq miles	0.4	1.8	2.7	3.5	4.4	-	6.0	6.6	7.1	-

Storm or Storm Center Name	SPAS 1183-Edgerton, MO	
Storm Date(s)	7/18-20/1965	
Storm Type	General Storm/MCC	
Storm Location	40.41 N	95.51 W
Storm Center Elevation	950	
Precipitation Total & Duration (10 sq mi)	20.76 inches in 60hrs, 18.59" in 24hrs	
Storm Representative Dew Point	76.0 F	24
Storm Representative Dew Point Location	39.22 N	96.58 W
Maximum Dew Point	80.5 F	
Moisture Inflow Vector	SW @ 100	
In-place Maximization Factor	1.24	
Temporal Transposition (Date)	15-Jul	
Transposition Dew Point Location	41.54 N	93.69 W
Transposition Maximum Dew Point	80.5 F	
Transposition Adjustment Factor	1.00	
Grid Point Elevation	350	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.23	

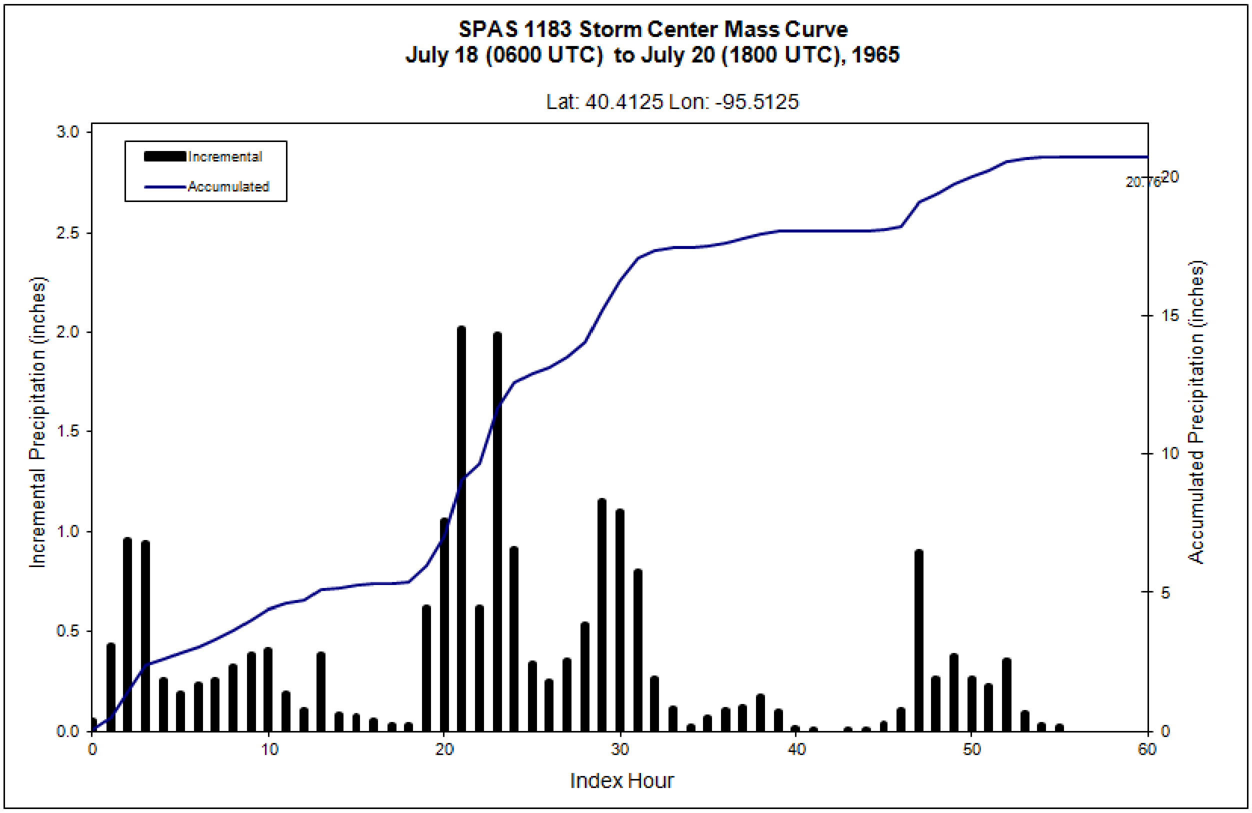
Appendix G: Table G.16: Storm spreadsheet for Edgerton, MO July 18, 1965

Storm 1183 - July 18, 1965 (0600 UTC) to July 20 (1800 UTC), 1965 MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
	Duration (hours)									
Area (mi²)	1	3	6	12	18	24	36	48	60	Total
0.30	3.77	7.34	12.06	17.13	17.80	18.59	19.82	19.86	20.76	20.76
1	3.68	7.13	11.77	16.72	17.29	18.04	19.27	19.35	20.08	20.08
10	3.49	6.79	11.11	15.41	16.49	17.56	19.00	19.06	19.71	19.71
25	3.15	5.96	9.93	14.05	15.23	16.32	18.04	18.12	19.06	19.06
50	2.83	5.35	8.83	12.60	13.81	15.05	16.79	17.37	18.27	18.27
100	2.43	4.36	7.52	10.95	11.54	13.41	15.27	16.39	17.22	17.22
150	2.21	4.26	6.84	9.96	11.34	12.96	15.23	15.69	16.66	16.66
200	1.79	3.94	6.18	9.23	9.90	12.66	14.18	15.38	16.18	16.18
300	1.55	2.99	5.41	7.86	9.53	11.45	13.80	14.49	15.71	15.71
400	1.52	2.90	4.74	7.48	8.30	11.04	13.43	14.13	15.44	15.44
500	1.41	2.73	4.35	6.13	8.17	10.88	13.37	13.88	15.17	15.17
1,000	1.21	2.09	3.71	5.79	7.57	9.48	12.08	13.04	13.83	13.83
2,000	0.98	1.82	3.49	4.94	6.83	8.74	10.76	11.80	12.70	12.70
5,000	0.64	1.56	2.69	3.84	5.57	6.92	8.50	9.66	10.42	10.42
10,000	0.44	1.24	2.06	3.16	4.00	5.23	7.03	7.67	8.24	8.24
20,000	0.29	0.82	1.44	2.21	2.81	3.59	4.86	5.36	5.81	5.81
35,221	0.19	0.45	0.83	1.17	1.78	2.29	2.57	3.46	3.72	3.72

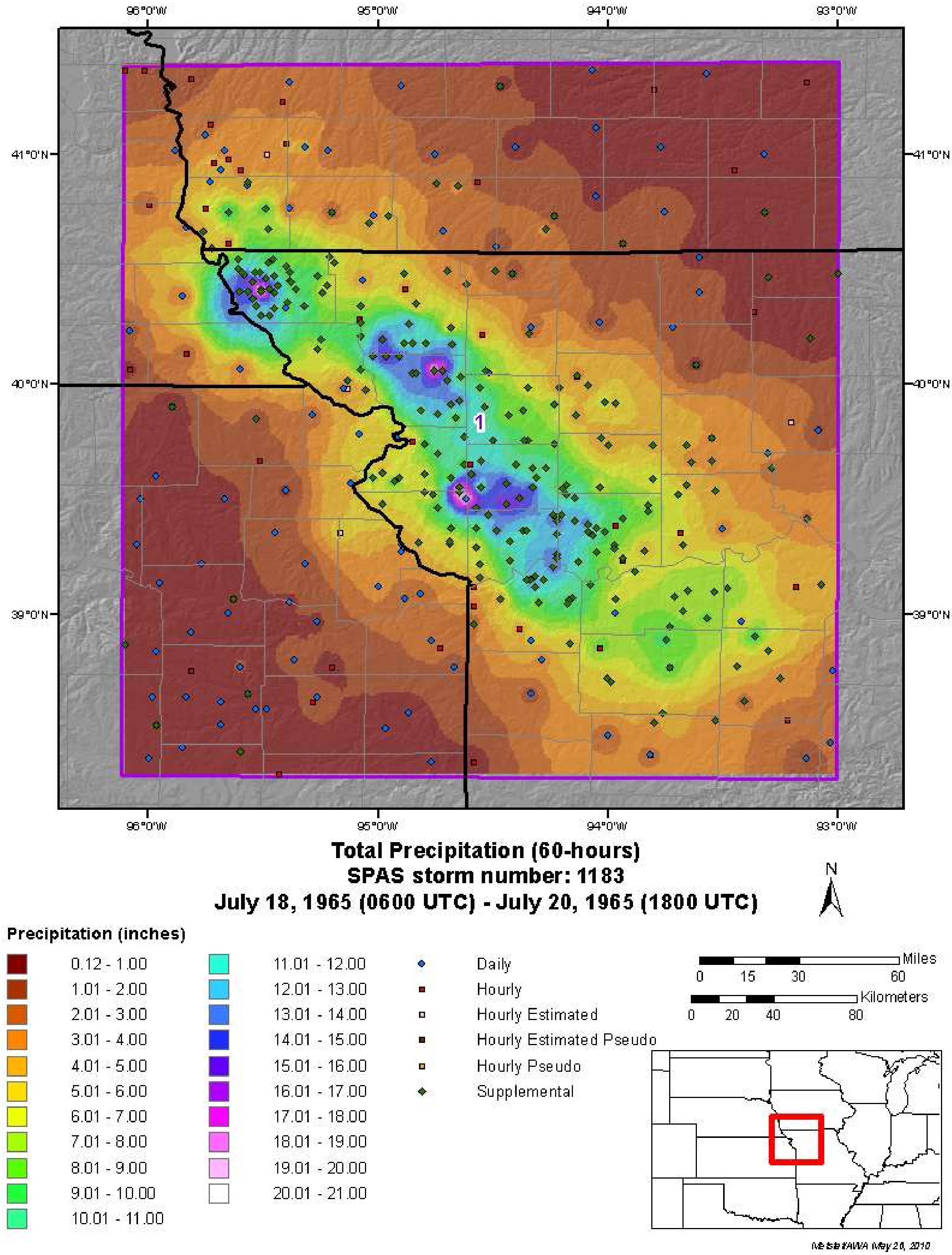
Appendix G: Table G.17: Depth-area-duration values for Edgerton, MO July 18, 1965



Appendix G: Figure G.22: Depth-area-duration chart for Edgerton, MO July 18, 1965



Appendix G: Figure G.23: Mass curve chart for Edgerton, MO July 18, 1965



Appendix G: Figure G.24: Total storm isohyetal analysis for Edgerton, MO July 18, 1965

College Hill, OH, AWA 30

June 3, 1963

Storm Type: MCC

Storm Name:	College Hill, OH SPAS 1226	Storm Adjustment for ANO Grid Point 8
Storm Date:	6/3-5/1963	
AWA Analysis Date:	12/14/2013	

Temporal Transposition Date	15-Jun	
	Lat	Long
Storm Center Location	40.09 N	81.65 W
Storm Rep Dew Point Location	39.20 N	83.00 W
Transposition Dew Point Location	42.84 N	93.99 W
Grid Point Location	37.50 N	93.00 W

Moisture Inflow Direction	SW @ 95	miles
Grid Point Elevation	1,200	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	68.5 F	with total precipitable water above sea level of			2.10	inches.
The in-place maximum dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place storm elevation is	1,000	which subtracts	0.21	inches of precipitable water at	68.5 F	
The in-place storm elevation is	1,000	which subtracts	0.27	inches of precipitable water at	76.5 F	
The transposition basin elevation at	1,200	which subtracts	0.28	inches of precipitable water at	78.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.28	inches of precipitable water at	78.0 F	

The in-place storm maximization factor is	1.48
The transposition/elevation to basin factor is	1.08
The barrier adjustment factor is	1.00
The total adjustment factor is	1.60

Notes: Storm representative dew point value was based on maximum 12hr Td values between June 4-5, 1963 at KLCK, KILN, and KHTS.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	2.5	5.6	10.5	15.1	17.1	17.6	17.7	17.7	-
10 sq miles	2.1	4.6	8.1	12.4	13.3	13.9	14.0	14.1	-
100 sq miles	1.4	2.9	5.5	7.8	8.6	8.7	9.7	9.9	-
200 sq miles	1.0	2.3	4.5	5.8	6.5	6.6	8.1	8.3	-
500 sq miles	0.6	1.6	2.2	3.7	4.4	5.3	5.7	6.6	-
1000 sq miles	0.5	1.3	2.2	3.3	3.4	3.4	5.1	5.2	-
2000 sq miles	0.4	0.5	1.0	2.3	3.2	3.3	4.3	4.5	-
5000 sq miles	0.2	0.4	0.7	1.1	1.3	1.7	2.9	3.0	-
10000 sq miles	0.1	0.2	0.5	0.8	1.1	1.3	1.6	1.7	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

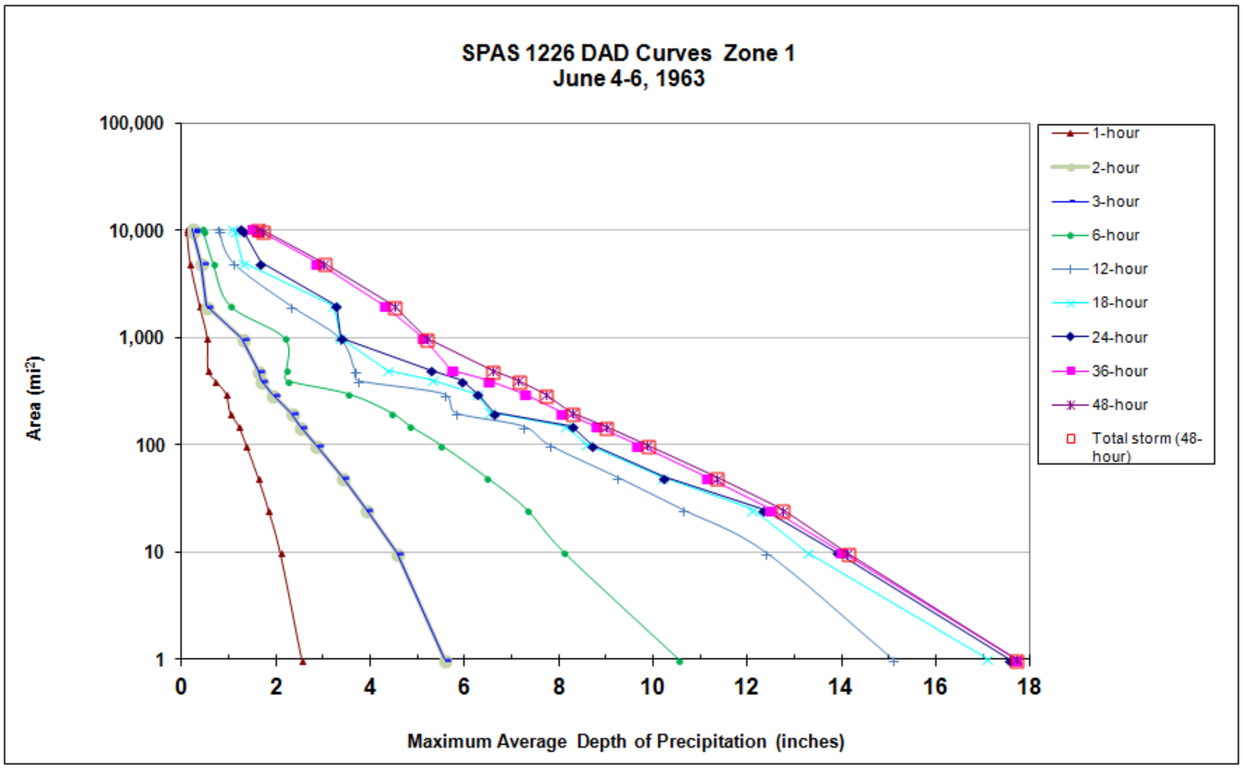
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
1 sq miles	4.1	8.9	16.8	24.1	27.3	28.0	28.3	28.3	-
10 sq miles	3.3	7.3	12.9	19.8	21.2	22.2	22.4	22.5	-
100 sq miles	2.2	4.6	8.8	12.4	13.7	13.9	15.4	15.7	-
200 sq miles	1.6	3.7	7.1	9.3	10.4	10.6	12.9	13.2	-
500 sq miles	0.9	2.6	3.6	5.8	7.0	8.4	9.1	10.5	-
1000 sq miles	0.8	2.0	3.5	5.3	5.4	5.4	8.2	8.3	-
2000 sq miles	0.6	0.8	1.6	3.7	5.1	5.2	6.9	7.2	-
5000 sq miles	0.3	0.7	1.1	1.7	2.1	2.7	4.6	4.8	-
10000 sq miles	0.2	0.4	0.7	1.2	1.8	2.1	2.6	2.7	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	College Hill, OH SPAS 1226	
Storm Date(s)	6/3-5/1963	
Storm Type	MCC	
Storm Location	40.09 N	81.65 W
Storm Center Elevation	1,000	
Precipitation Total & Duration	19.39 Inches 48-hours	
Storm Representative Dew Point	68.5 F	12
Storm Representative Dew Point Location	39.20 N	83.00 W
Maximum Dew Point	76.5 F	
Moisture Inflow Vector	SW @ 95	
In-place Maximization Factor	1.48	
Temporal Transposition (Date)	15-Jun	
Transposition Dew Point Location	42.84 N	93.99 W
Transposition Maximum Dew Point	78.0 F	
Transposition Adjustment Factor	1.08	
Grid Point Elevation	1,200	
Highest Elevation in Basin	14,344	
Inflow Barrier Height	1,000	
Elevation Adjustment Factor	1.00	
Total Adjustment Factor	1.60	

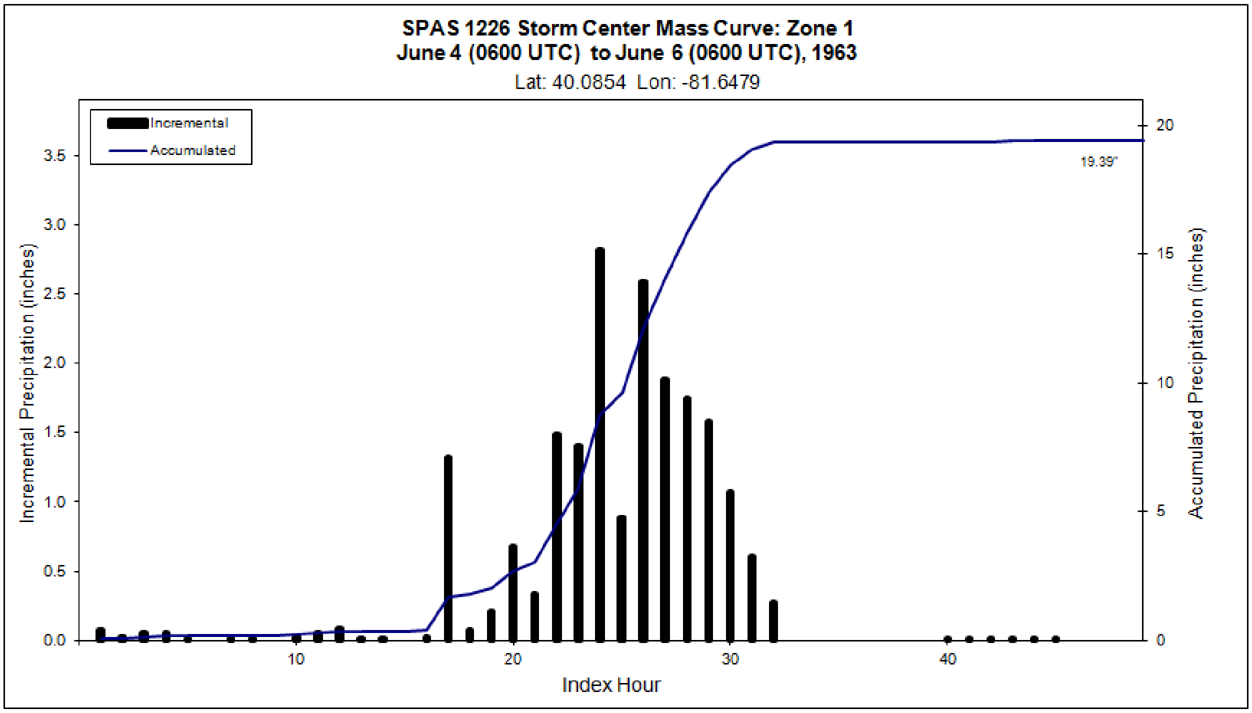
Appendix G: Table G.18: Storm spreadsheet for College Hill, OH, June 3, 1963

Storm 1226 - June 4 (0600 UTC) - June 6 (0600 UTC), 1963									
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)									
	Duration (hours)								
Area (mi^2)	1	3	6	12	18	24	36	48	Total
0.1	2.81	6.28	11.5	17.08	18.99	19.16	19.37	19.39	19.39
1	2.54	5.56	10.53	15.07	17.09	17.56	17.7	17.7	17.70
10	2.08	4.56	8.1	12.37	13.28	13.9	14	14.11	14.11
25	1.83	3.9	7.32	10.61	12.1	12.33	12.49	12.72	12.72
50	1.61	3.4	6.46	9.23	10.18	10.23	11.13	11.34	11.34
100	1.36	2.85	5.5	7.79	8.59	8.69	9.66	9.86	9.86
150	1.2	2.5	4.85	7.23	8.14	8.28	8.79	8.98	8.98
200	1.02	2.32	4.45	5.8	6.54	6.62	8.06	8.26	8.26
300	0.93	1.93	3.54	5.55	6.26	6.28	7.28	7.7	7.70
400	0.7	1.67	2.24	3.73	5.31	5.93	6.5	7.13	7.13
500	0.55	1.61	2.23	3.66	4.37	5.28	5.73	6.57	6.57
1,000	0.53	1.28	2.18	3.34	3.37	3.39	5.12	5.19	5.19
2,000	0.37	0.52	1.03	2.3	3.22	3.28	4.3	4.5	4.50
5,000	0.17	0.41	0.67	1.09	1.31	1.67	2.86	3	3.00
10,000	0.1	0.24	0.46	0.78	1.12	1.3	1.61	1.7	1.70
10,512	0.1	0.24	0.44	0.75	1.08	1.26	1.5	1.6	1.60

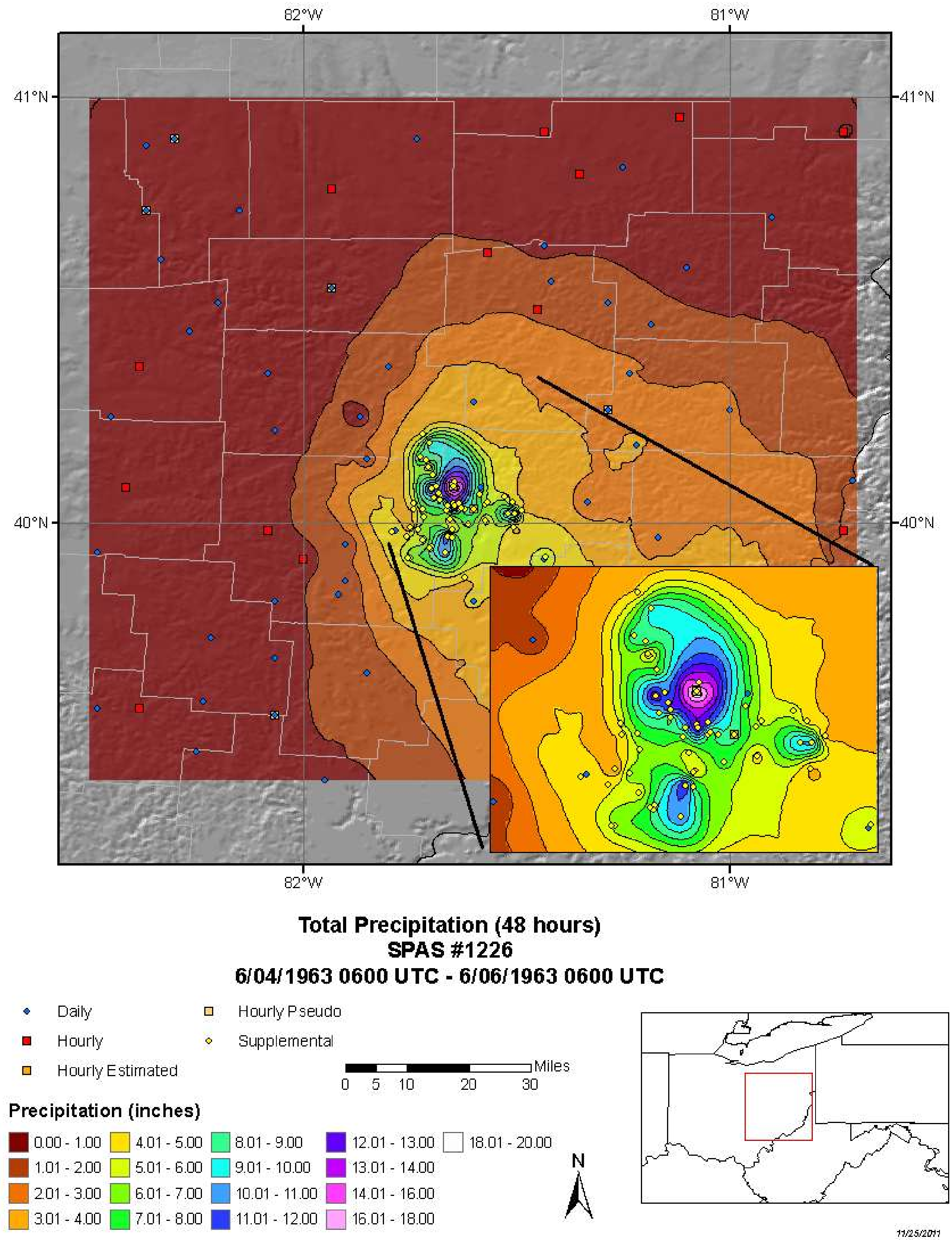
Appendix G: Table G.19: Depth-area-duration values for College Hill, OH June 3, 1963



Appendix G: Figure G.25: Depth-area-duration chart for College Hill, OH, June 3, 1963



Appendix G: Figure G.26: Mass curve chart for College Hill, OH, June 3, 1963



Appendix G: Figure C.27: Total storm isohyetal analysis for College Hill, OH June 1963

Camp Polk, LA, AWA 81

April 23, 1953

Storm Type: Frontal

Storm Name:	USACE LMV 5-3 Camp Polk, LA		
Storm Date:	4/24-5-4/1953	**Storm Adjustment for ANO Grid Point 1**	
AWA Analysis Date:	12/17/2013		

Temporal Transposition Date	15-May					
	Lat	Long	Moisture Inflow Direction:	ESE @ 50	miles
Storm center location	31.05 N	93.20 W	Grid Point Elevation	400	feet
Storm Rep SST location	30.77 N	92.42 W	Storm Center Elevation	350	feet
Transposition Dew Point Location	35.03 N	92.41 W	Storm Rep Analysis Duration	12	hours
Grid Point location	35.31 N	93.23 W			

The storm representative SST is	75.0 F	with total precipitable water above sea level of			2.85	inches.
The in-place maximum SST is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The transpositioned maximum SST is	74.5 F	with total precipitable water above sea level of			2.79	inches.
The in-place storm elevation is	350	which subtracts	0.08	inches of precipitable water at	75.0 F	
The in-place storm elevation is	350	which subtracts	0.08	inches of precipitable water at	76.5 F	
The transposition storm elevation at	400	which subtracts	0.10	inches of precipitable water at	74.5 F	
The grid point/inflow barrier height is	400	which subtracts	0.10	inches of precipitable water at	74.5 F	

The in-place maximization factor is	1.08
The transposition factor is	0.90
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	0.97

Notes: DAD values from SUACE LMV 5-3. Added 2°F to the USACE Storm Rep Td to account for average climatology from 12-hr persisting climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	8.0	13.2	15.0	15.5	15.7	16.2	16.2	16.2	20.0
100 sq miles	7.6	11.7	13.5	13.8	14.0	14.2	14.2	14.5	19.1
200 sq miles	7.3	11.2	12.9	13.3	13.4	13.5	13.5	13.9	18.6
500 sq miles	6.8	10.5	12.1	12.5	12.5	12.6	12.6	13.1	17.6
1000 sq miles	6.3	9.8	11.4	11.8	11.8	11.8	11.8	12.5	16.8
2000 sq miles	5.7	9.0	10.5	11.0	11.0	11.0	11.0	11.7	15.8
5000 sq miles	4.7	7.6	9.1	9.7	9.7	9.7	9.7	10.6	14.3
10000 sq miles	3.9	6.4	7.8	8.7	8.7	8.4	8.7	9.5	13.0
20000 sq miles	3.0	5.0	6.4	7.4	7.4	7.4	7.4	8.2	11.4
50000 sq miles	1.8	3.1	4.1	4.8	5.4	5.4	5.4	6.1	8.8

Adjusted Storm Depth-Area-Duration

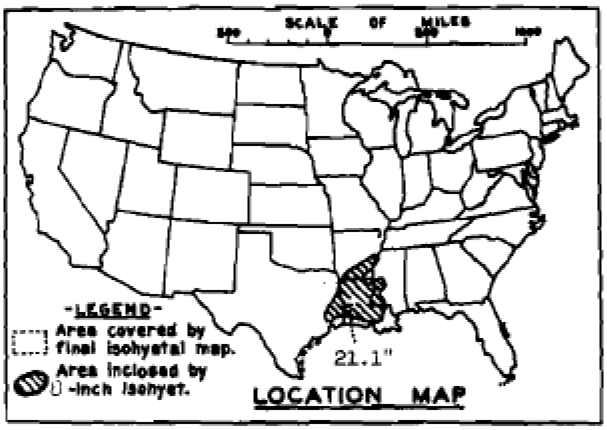
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	7.8	12.8	14.6	15.1	15.2	15.7	15.7	15.7	19.4
100 sq miles	7.4	11.4	13.1	13.4	13.6	13.8	13.8	14.1	18.5
200 sq miles	7.1	10.9	12.5	12.9	13.0	13.1	13.1	13.5	18.1
500 sq miles	6.6	10.2	11.8	12.1	12.1	12.2	12.2	12.7	17.1
1000 sq miles	6.1	9.5	11.1	11.5	11.5	11.5	11.5	12.1	16.3
2000 sq miles	5.5	8.7	10.2	10.7	10.7	10.7	10.7	11.4	15.3
5000 sq miles	4.6	7.4	8.8	9.4	9.4	9.4	9.4	10.3	13.9
10000 sq miles	3.8	6.2	7.6	8.4	8.4	8.2	8.4	9.2	12.6
20000 sq miles	2.9	4.9	6.2	7.2	7.2	7.2	7.2	8.0	11.1
50000 sq miles	1.7	3.0	4.0	4.7	5.2	5.2	5.2	5.9	8.5

Storm or Storm Center Name	**USACE LMV 5-3 Camp Polk, LA**		
Storm Date(s)	4/24-5-4/1953		
Storm Type	Frontal		
Storm Location	31.05 N	93.20 W	
Storm Center Elevation	350		
Precipitation Total & Duration (10 sq mi)	21.10 inches in 264 hours		
Storm Representative SST	75.0 F	24	
Storm Representative SST Location	30.77 N	92.42 W	M
In-place Maximum SST	76.5 F		**80**
Moisture Inflow Vector	ESE @ 50		
In-place Maximization Factor			
Temporal Transposition (Date)	15-May		
Transposition Dewpoint Location	35.03 N	92.41 W	**M**
Transposition Maximum SST	74.5 F		**81**
Transposition Adjustment Factor			
Grid Point Elevation	400		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	**0.97**		

Appendix G: Table G.20: Storm spreadsheet for Camp Polk, LA April 23, 1953

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 23 April - 4 May 1953
Assignment LMV 5-3
Location La., Miss., Ark., Tex.
Study Prepared by:
Lower Mississippi Valley Division, New Orleans District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 4-10-58
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 6-13-61
Remarks:
Center at Camp Polk, La.
Dewpt 73° - Ref Pt 50 ESE
Grid H-13

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 4 sheet, scale 1:2,500,000
Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) ---------------------- 59
- Form 5001-B (24-hour " ") ---------------------- 49
- Form 5001-D (" " " ") ---------------------- -
- Miscl. precip. records, meteorological data, etc. ---------------- -
- Form 5002 (Mass rainfall curves) ---------------------- 87

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000
Data and computation sheets:

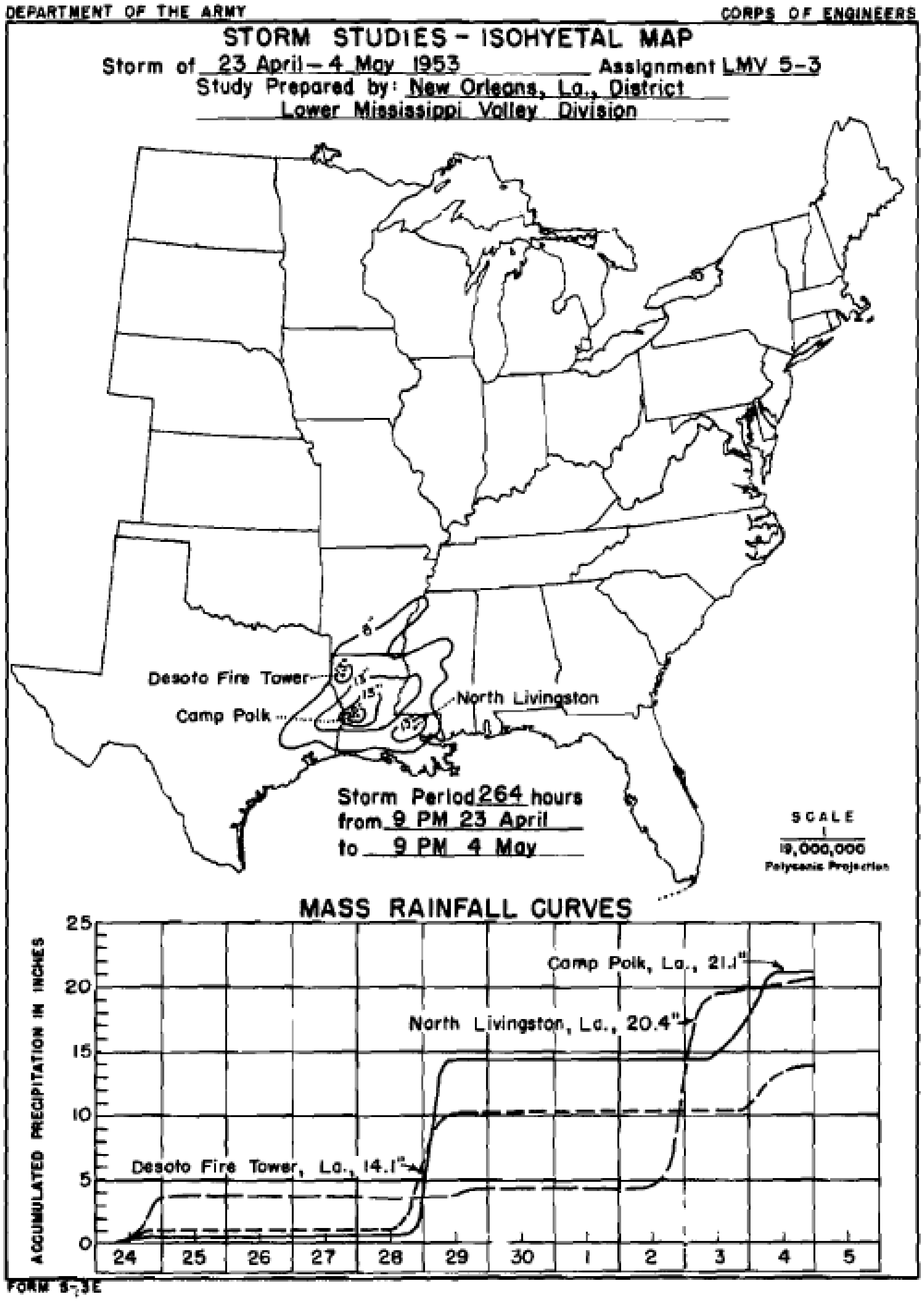
- Form S-10 (Data from mass rainfall curves) -------------- 21
- Form S-11 (Depth-area data from isohyetal map) ----------- 3
- Form S-12 (Maximum depth-duration data) ---------------- 36
- Maximum duration-depth-area curves ------------------ 1
- Data relating to periods of maximum rainfall ------------- 6

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	36	48	72	96	120	144	264
10	8.0	13.2	15.0	15.5	15.7	15.7	16.2	16.2	16.2	20.0	21.1
100	7.6	11.7	13.5	13.8	14.0	14.0	14.2	14.2	14.5	19.1	20.1
200	7.3	11.2	12.9	13.3	13.4	13.4	13.5	13.5	13.9	18.6	19.6
500	6.8	10.5	12.1	12.5	12.5	12.5	12.6	12.6	13.1	17.6	18.9
1000	6.3	9.8	11.4	11.8	11.8	11.8	11.8	11.8	12.5	16.8	18.1
2000	5.7	9.0	10.5	11.0	11.0	11.0	11.0	11.0	11.7	15.8	17.2
5000	4.7	7.6	9.1	9.7	9.7	9.7	9.7	9.7	10.6	14.3	15.8
10000	3.9	6.4	7.8	8.7	8.7	8.7	8.7	8.7	9.5	13.0	14.5
20000	3.0	5.0	6.4	7.4	7.4	7.4	7.4	7.4	8.2	11.4	13.3
50000	1.8	3.1	4.1	4.8	5.1	5.4	5.4	5.4	6.1	8.8	11.3
70000	1.3	2.4	3.2	3.6	4.1	4.4	4.4	4.4	5.3	7.7	10.5

Form S-2

Appendix G: Table G.21: Depth-area-duration values for Camp Polk, LA April 23, 1953



Appendix G: Figure G.28 and Figure G.29: Total storm isohyetal analysis and mass curve chart for Camp Polk, LA April 23, 1953

Harrisonburg Dam, LA, AWA 79

May 11, 1953

Storm Type: MCC

Storm Name:	USACE LMV 5-4 Harrisonburg Dam		
Storm Date:	5/11-19/1953		
AWA Analysis Date:	12/17/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	1-Jun	
	Lat	Long
Storm center location	31.77 N	91.82 W
Storm Rep dew point location	30.60 N	92.53 W
Transposition dewpoint location	34.15 N	93.97 W
Basin location	35.31 N	93.23 W

Moisture Inflow Direction:	SSW @ 90	miles
Grid Point Elevation	400	feet
Storm Center Elevation	100	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	76.0 F	with total precipitable water above sea level of		2.99	inches.
The in-place maximum dew point is	79.0 F	with total precipitable water above sea level of		3.44	inches.
The transpositioned maximum dew point is	77.0 F	with total precipitable water above sea level of		3.14	inches.
The in-place storm elevation is	100	which subtracts	0.03	inches of precipitable water at	76.0 F
The in-place storm elevation is	100	which subtracts	0.03	inches of precipitable water at	79.0 F
The transposition basin elevation at	400	which subtracts	0.11	inches of precipitable water at	77.0 F
The inflow barrier/basin elevation height is	4,400	which subtracts	0.11	inches of precipitable water at	77.0 F

The in-place storm maximization factor is	1.15
The transposition/elevation to basin factor is	0.89
The barrier adjustment factor is	1.00
The total adjustment factor is	1.02

Notes: DAD values from SUACE LMV 5-3. Added 2°F to the USACE Storm Rep Td to account for average climatology from 12-hr persisting climatology.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	9.2	11.7	17.5	18.0	19.6	20.4	21.3	23.7	25.4
100 sq miles	8.3	10.9	16.5	17.4	18.7	19.5	20.3	22.6	24.2
200 sq miles	7.9	10.5	15.9	16.0	18.2	19.0	19.9	22.1	23.6
500 sq miles	7.2	9.6	14.6	15.5	17.0	18.0	18.9	21.2	22.6
1000 sq miles	6.5	8.7	13.0	14.0	15.8	16.9	17.9	20.0	21.8
2000 sq miles	5.7	7.6	11.3	12.3	14.5	15.8	16.8	18.7	20.9
5000 sq miles	4.5	6.1	8.9	9.9	12.7	14.0	15.2	16.7	19.3
10000 sq miles	3.5	4.9	6.9	8.0	11.1	12.6	13.7	15.0	17.7
20000 sq miles	2.4	3.6	5.0	6.1	9.2	10.7	12.0	12.9	15.5
50000 sq miles	1.4	2.3	3.0	4.3	6.8	8.1	9.3	10.0	12.1

Adjusted Storm Depth-Area-Duration

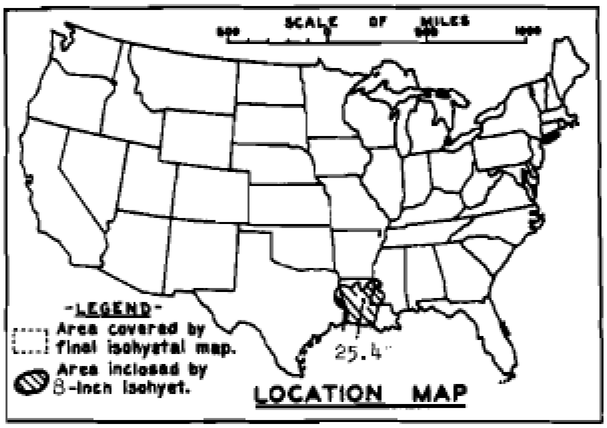
	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	9.4	12.0	17.9	18.4	20.1	20.9	21.8	24.3	26.0
100 sq miles	8.5	11.2	16.9	17.8	19.1	20.0	20.8	23.1	24.8
200 sq miles	8.1	10.7	16.3	16.4	18.6	19.4	20.4	22.6	24.2
500 sq miles	7.4	9.8	14.9	15.9	17.4	18.4	19.3	21.7	23.1
1000 sq miles	6.7	8.9	13.3	14.3	16.2	17.3	18.3	20.5	22.3
2000 sq miles	5.8	7.8	11.6	12.6	14.8	16.2	17.2	19.1	21.4
5000 sq miles	4.6	6.2	9.1	10.1	13.0	14.3	15.6	17.1	19.8
10000 sq miles	3.6	5.0	7.1	8.2	11.4	12.9	14.0	15.4	18.1
20000 sq miles	2.5	3.7	5.1	6.2	9.4	11.0	12.3	13.2	15.9
50000 sq miles	1.4	2.4	3.1	4.4	7.0	8.3	9.5	10.2	12.4

Storm or Storm Center Name	**USACE LMV 5-4 Harrisonburg Dam, LA**			
Storm Date(s)	5/11-19/1953			
Storm Type	Frontal			
Storm Location	31.77 N	91.82 W		
Storm Center Elevation	100			
Precipitation Total & Duration (10 sq mi)	25.40 inches in 180 hours			
Storm Representative SST	76.0 F	24		
Storm Representative SST Location	30.60 N	92.53 W	M	J
In-place Maximum SST	79.0 F		80	
Moisture Inflow Vector	SSW @ 90			
In-place Maximization Factor	1.15			
Temporal Transposition (Date)	1-Jun			
Transposition Dewpoint Location	34.15 N	93.97 W	M	J
Transposition Maximum SST	77.0 F		81	
Transposition Adjustment Factor				
Grid Point Elevation	400			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	xx			
Elevation Adjustment Factor	1.00			
Total Adjustment Factor	1.02			

Appendix G: Table G.22: Storm spreadsheet for Harrisonburg Dam, LA May 11, 1953

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 11-19 May 1953
Assignment LMV 5-4
Location La., Miss., Tex.
Study Prepared by:
Lower Mississippi Valley Division, New Orleans District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 6-15-56
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 6-13-61
Remarks: Center at Harrisonburg Dam, Louisiana
Dewpt 74° Ref Pt 50 S of Alexandria, Louisiana
Grid I-13

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 4 sheets, scale 1:2,500,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	48
Form 5001-B (24-hour " ")	41
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	-
Form 5002 (Mass rainfall curves)	46

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000

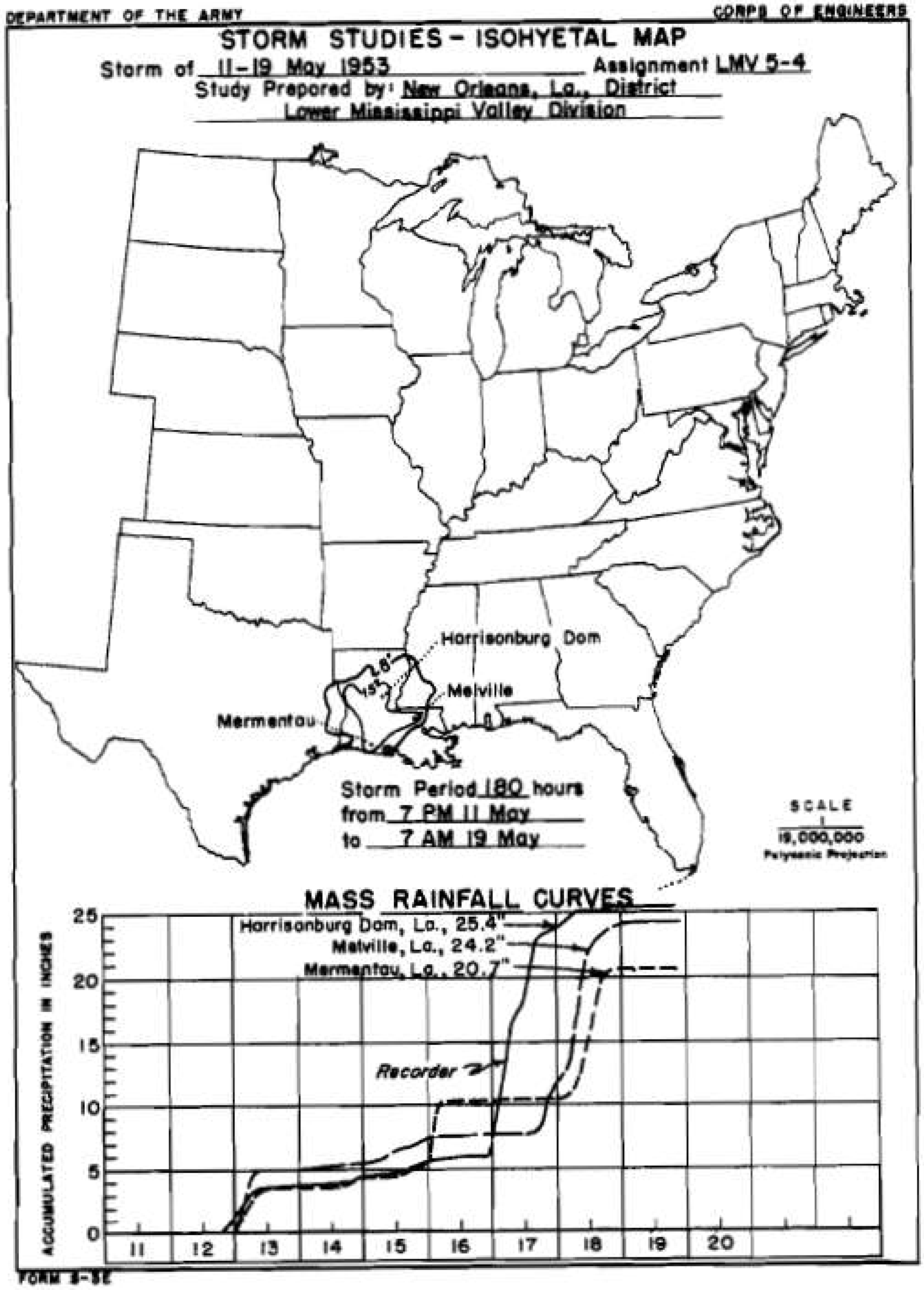
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	10
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	18
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	4

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	36	48	72	96	120	144	180
10	9.2	11.7	17.5	18.0	19.2	19.6	20.4	21.3	23.7	25.4	25.4
100	8.3	10.9	16.5	17.4	18.3	18.7	19.5	20.3	22.6	24.2	24.2
200	7.9	10.5	15.9	16.8	17.7	18.2	19.0	19.9	22.1	23.6	23.7
500	7.2	9.6	14.6	15.5	16.6	17.0	18.0	18.9	21.2	22.6	22.8
1,000	6.5	8.7	13.0	14.0	15.4	15.8	16.9	17.9	20.0	21.8	22.0
2,000	5.7	7.6	11.3	12.3	13.9	14.5	15.8	16.8	18.7	20.9	21.1
5,000	4.5	6.1	8.9	9.9	11.6	12.7	14.0	15.2	16.7	19.3	19.6
10,000	3.5	4.9	6.9	8.0	9.7	11.1	12.6	13.7	15.0	17.7	18.0
20,000	2.4	3.6	5.0	6.1	7.7	9.2	10.7	12.0	12.9	15.5	16.0
40,000	1.4	2.3	3.0	4.3	5.6	6.8	8.1	9.3	10.0	12.1	12.7

Form S-2

Appendix G: Table G.23: Depth-area-duration values for Harrisonburg Dam, LA May 11, 1953



Appendix G: Figure G.30 and Figure G.31: Total storm isohyetal analysis and mass curve chart for Harrisonburg Dam, LA May 11, 1953

Kelso, MO, AWA 37

August 11, 1952

Storm Type: MCC

Storm Name:	USACE UMV 3-30-Kelso, MO
Storm Date:	11-Aug-1952
AWA Analysis Date:	12/15/2013

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	25-Jul	
	Lat	Long
Storm Center Location	37.19 N	89.55 W
Storm Rep Dew Point Location	35.17 N	89.50 W
Transposition Dew Point Location	40.71 N	92.53 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	S @ 140	miles
Grid Point Elevation	350	feet
Storm Center Elevation	500	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	76.5 F	with total precipitable water above sea level of			3.07	inches.
The in-place maximum dew point is	81.0 F	with total precipitable water above sea level of			3.75	inches.
The transpositioned maximum dew point is	81.5 F	with total precipitable water above sea level of			3.83	inches.
The in-place storm elevation is	500	which subtracts	0.14	inches of precipitable water at	76.5 F	
The in-place storm elevation is	500	which subtracts	0.15	inches of precipitable water at	81.0 F	
The transposition basin elevation at	350	which subtracts	0.31	inches of precipitable water at	81.5 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.31	inches of precipitable water at	81.5 F	

The in-place storm maximization factor is	1.23
The transposition/elevation to basin factor is	0.98
The barrier adjustment factor is	1.00
The total adjustment factor is	1.20

Notes: DAD values taken from USACE UMV 3-30. Storm representative Td value was based on maximum 6-hr Td values between August 11, 1952 at KMEM, KNQA, KMKL, and KDYR.

Observed Storm Depth-Area-Duration

	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
10 sq miles	5.5	11.5	13.0	-	-	-	-	-	-
100 sq miles	4.2	10.4	11.9	-	-	-	-	-	-
200 sq miles	0.0	0.0	0.0	-	-	-	-	-	-
500 sq miles	2.9	7.4	8.7	-	-	-	-	-	-
1000 sq miles	2.3	5.7	6.9	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

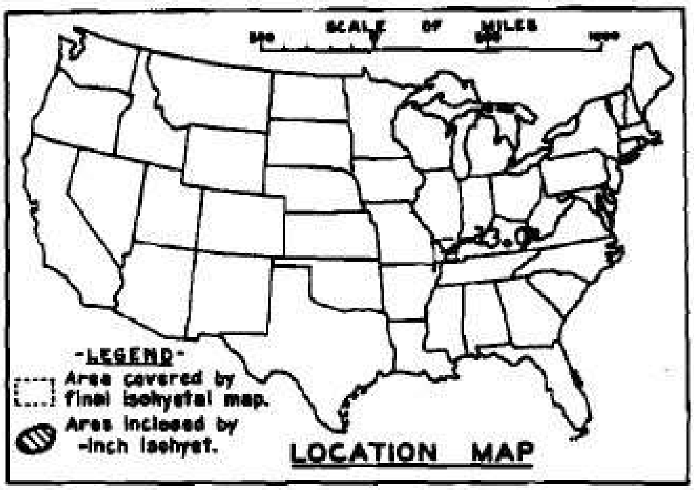
	1 Hours	3 Hours	6 Hours	12 Hours	18 Hours	24 Hours	36 Hours	48 Hours	72 Hours
10 sq miles	6.6	13.8	15.6	-	-	-	-	-	-
100 sq miles	5.1	12.5	14.3	-	-	-	-	-	-
200 sq miles	0.0	0.0	0.0	-	-	-	-	-	-
500 sq miles	3.5	8.9	10.5	-	-	-	-	-	-
1000 sq miles	2.8	6.9	8.3	-	-	-	-	-	-
5000 sq miles	-	-	-	-	-	-	-	-	-
10000 sq miles	-	-	-	-	-	-	-	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE UMV 3-30-Kelso, MO**			
Storm Date(s)	11-Aug-1952			
Storm Type	MCC			
Storm Location	37.19 N	89.55 W		
Storm Center Elevation	500			
Precipitation Total & Duration	13.00 Inches 6-hours USACE UMV 3-30			
Storm Representative Td	76.5 F	6		
Storm Representative Td Location	35.17 N	89.50 W		
Maximum Td	81.0 F			
Moisture Inflow Vector	S @ 140	Miles		
In-place Maximization Factor	**1.23**			
Temporal Transposition (Date)	25-Jul			
Transposition Td Location	40.71 N	92.53 W	July	August
Transposition Maximum Td	81.5 F		82	81
Transposition Adjustment Factor	**0.98**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.20**			

Appendix G: Table G.24: Storm spreadsheet for Kelso, MO August 11, 1952

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 11-12 August 1952
Assignment UMV 3-30
Location SE Mo. and SW Ill.
Study Prepared by:
Lower Mississippi Valley Division
St. Louis District

Part I Reviewed by H. M. Sec. of Weather Bureau, 9/29/60
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 5/10/63
Remarks: Center at Kelso, Missouri. Dewpoint 75°F, 135 SSW.
Grid F-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1:500,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	13
Form 5001-B (24-hour " ")	0
Form 5001-D (" " " ")	2
Miscl. precip. records, meteorological data, etc.	9
Form 5002 (Mass rainfall curves)	5

PART II

Final isohyetal maps, in 1 sheet, scale 1:500,000

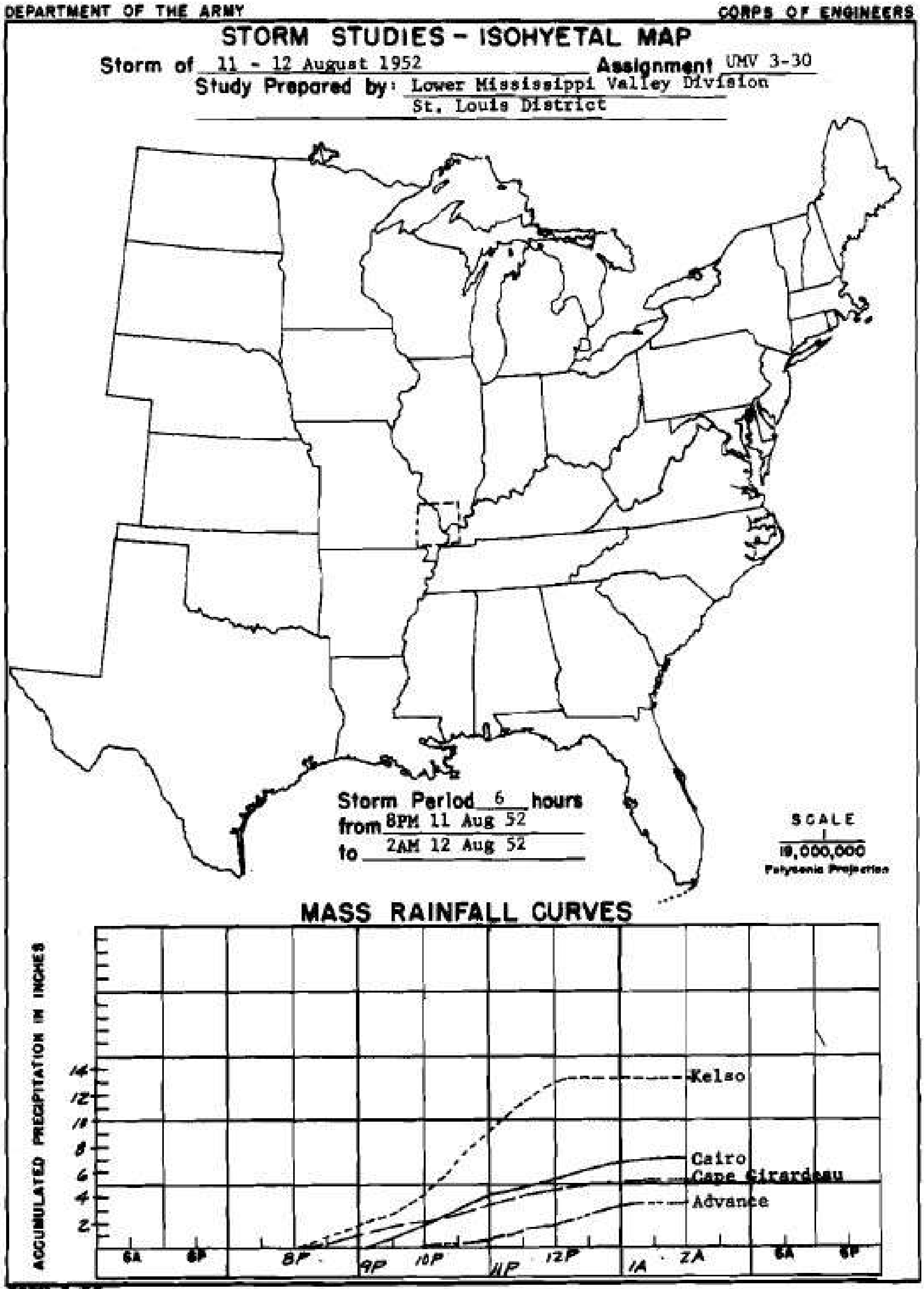
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	1
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	5
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	1	2	3	4	5	6					
10	5.5	9.1	11.5	12.9	13.0	13.0					
100	4.2	8.0	10.4	11.7	11.9	11.9					
500	2.9	5.5	7.4	8.0	8.6	8.7					
1,000	2.3	4.1	5.7	6.2	6.8	6.9					
1,730	1.7	3.1	4.3	4.9	5.4	5.5					

Form S-2

Appendix G: Table G.25: Depth-area-duration chart for Kelso, MO August 11, 1952



Appendix G: Figure G.32 and Figure G.33: Total storm isohyetal and Mass curve chart for Kelso, MO August 11, 1952

Holt, MO, AWA 40

June 18, 1947

Storm Type: MCC

Storm Name:	USACE MR 8-20-Holt, MO		
Storm Date:	6/18-22/1947		
AWA Analysis Date:	12/15/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	5-Jul	
	Lat	Long
Storm Center Location	39.45 N	94.34 W
Storm Rep Dew Point Location	36.18 N	95.25 W
Transposition Dew Point Location	39.46 N	93.53 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 230	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place maximum dew point is	81.5 F	with total precipitable water above sea level of			3.84	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of			3.76	inches.
The in-place storm elevation is	1,000	which subtracts	0.28	inches of precipitable water at	79.0 F	
The in-place storm elevation is	1,000	which subtracts	0.30	inches of precipitable water at	81.5 F	
The transposition basin elevation at	350	which subtracts	0.30	inches of precipitable water at	81.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.30	inches of precipitable water at	81.0 F	

The in-place storm maximization factor is	1.12
The transposition/elevation to basin factor is	0.98
The barrier adjustment factor is	1.00
The total adjustment factor is	1.09

Notes: DAD values taken from USACE MR 8-20, 1sqmi amount taken from Holt, MO world record rainfall within the overall storm. Storm representative Td value was based on maximum 6-hr Td values between June 22-23, 1947 at KHRO and KTUL.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	12.0	12.0	12.0	12.0	-	12.0	14.4	-	16.6
10 sq miles	11.5	11.5	11.5	11.5	-	11.5	12.6	-	15.8
100 sq miles	7.9	7.9	7.9	7.9	-	7.9	9.3	-	12.9
200 sq miles	7.1	7.1	7.1	7.1	-	7.1	8.4	-	11.9
500 sq miles	6.3	6.3	6.3	6.3	-	6.3	7.4	-	10.6
1000 sq miles	5.6	5.6	5.6	5.6	-	5.6	6.6	-	9.6
5000 sq miles	3.5	3.7	3.7	3.7	-	3.7	4.6	-	6.7
10000 sq miles	2.6	2.9	3.0	3.0	-	3.0	3.7	-	5.4
20000 sq miles	1.8	2.1	2.2	2.2	-	2.2	3.1	-	4.4

Adjusted Storm Depth-Area-Duration

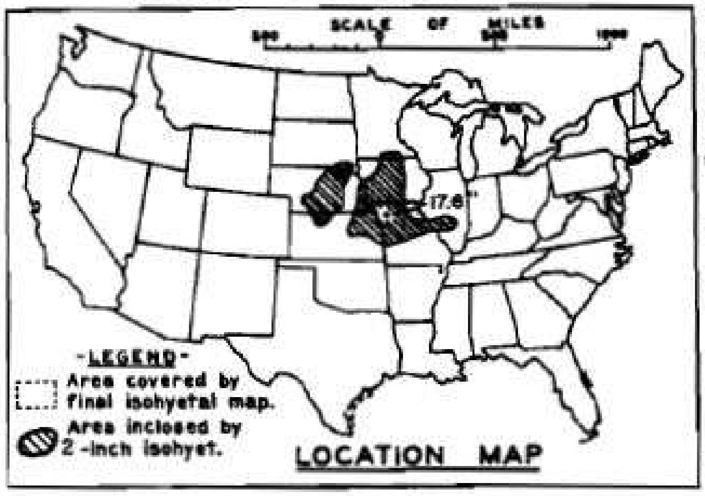
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	13.1	13.1	13.1	13.1	-	13.1	15.8	-	18.2
10 sq miles	12.6	12.6	12.6	12.6	-	12.6	13.8	-	17.3
100 sq miles	8.7	8.7	8.7	8.7	-	8.7	10.2	-	14.1
200 sq miles	7.8	7.8	7.8	7.8	-	7.8	9.2	-	13.0
500 sq miles	6.9	6.9	6.9	6.9	-	6.9	8.1	-	11.6
1000 sq miles	6.1	6.1	6.1	6.1	-	6.1	7.2	-	10.5
5000 sq miles	3.8	4.1	4.1	4.1	-	4.1	5.0	-	7.3
10000 sq miles	2.8	3.2	3.3	3.3	-	3.3	4.1	-	5.9
20000 sq miles	2.0	2.3	2.4	2.4	-	2.4	3.4	-	4.8

Storm or Storm Center Name	**USACE MR 8-20-Holt, MO**			
Storm Date(s)	6/18-22/1947			
Storm Type	MCC			
Storm Location	39.45 N	94.34 W		
Storm Center Elevation	1,000			
Precipitation Total & Duration	17.6 Inches 6-hours USACE MR 8-20			
Storm Representative Dew Point	79.0 F	6		
Storm Representative Dew Point Location	36.18 N	95.25 W		
Maximum Dew Point	81.5 F			
Moisture Inflow Vector	SSW @ 230	Miles		
In-place Maximization Factor	**1.12**			
Temporal Transposition (Date)	5-Jul			
Transposition Dew Point Location	39.46 N	93.53 W	June	July
Transposition Maximum Dew Point	81.0 F		79	82
Transposition Adjustment Factor	**0.98**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.09**			

Appendix G: Table G.26: Storm spreadsheet for Holt, MO June 18, 1947

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 18-23 June 1947
Assignment MR 8-20
Location Ill, Ia, Kans, Minn. Mo, Nebr, & S.Dak.
Study Prepared by:
Missouri River Division
Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 12/17/52
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 9/10/54
Remarks:

Center near Holt, Mo.
Dewpoint 75°, Ref. Pt. 140 S

DATA AND COMPUTATIONS COMPILED Grid E-14

PART I

Preliminary isohyetal map, in sheet , scale
Precipitation data and mass curves: (Number of Sheets)
Form 5001-C (Hourly precip. data)-- NOTE: This study was computed
Form 5001-B (24-hour " ")--------by the Regional Method
Form 5001-D (" " ")--------which does not employ the
Miscl. precip. records, meteorological data, etc. Part I and Part II phases
Form 5002 (Mass rainfall curves)------------ in their entirety.------------

PART II

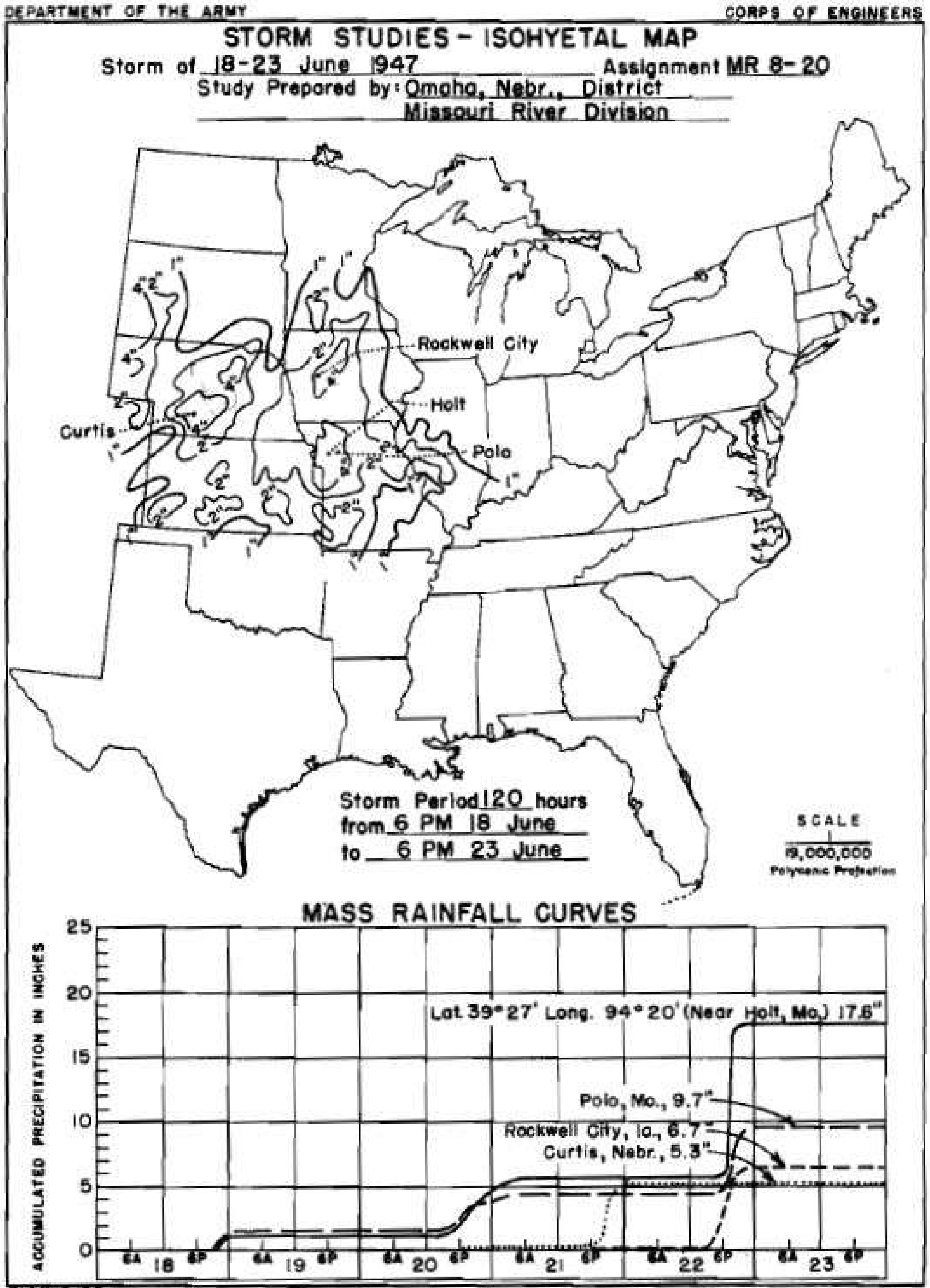
Final isohyetal maps, in 1 sheet , scale 1:100,000
Data and computation sheets:
Form S-10 (Data from mass rainfall curves)-------------- 9
Form S-11 (Depth-area data from isohyetal map)----------- 4
Form S-12 (Maximum depth-duration data)---------------- 7
Maximum duration-depth-area curves------------------ 1
Data relating to periods of maximum rainfall-------------

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	36	48	72	96	120		
Max.Station	~~12.0~~	~~12.0~~	~~12.0~~	~~12.0~~	~~12.0~~	~~14.4~~	~~16.6~~	~~16.6~~	~~17.6~~		
10	11.6	11.5	11.6	11.6	11.6	12.6	15.8	15.8	14.9		
100	7.9	7.9	7.9	7.9	7.9	9.3	12.9	12.9	14.1		
200	7.1	7.1	7.1	7.1	7.1	8.4	11.9	11.9	13.0		
500	6.3	6.3	6.3	6.3	6.3	7.4	10.6	10.6	11.6		
1000	5.6	5.6	5.6	5.5	5.6	6.6	9.6	9.6	10.5		
2000	4.9	4.9	4.9	4.9	4.9	5.7	8.4	8.4	9.3		
5000	3.5	3.7	3.7	3.7	3.7	4.6	6.7	6.7	7.3		
10000	2.6	2.9	3.0	3.0	3.0	3.7	5.4	5.4	5.9		
20000	1.9	2.1	2.2	2.2	2.2	3.1	4.4	4.6	4.9		
50000	1.2	1.4	1.5	1.6	1.9	2.5	3.2	3.5	3.6		
100000	0.8	1.0	1.2	1.4	1.6	2.1	2.7	2.9	3.0		
200000	0.5	0.7	0.9	1.1	1.4	1.7	2.1	2.2	2.3		
306000	0.3	0.5	0.6	0.7	0.9	1.2	1.5	1.6	1.8		

Form S-2

Appendix G: Table G.27: Depth-area-duration chart for Holt, MO June 18, 1947



Appendix G: Figure G.34 and Figure G.35: Total storm isohyetal and Mass curve chart for Holt, MO June 1947

Collinsville, IL, AWA 42

August 12, 1946

Storm Type: Frontal

Storm Name:	USACE MR 7-2B-Collinsville, IL	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	8/12-15/1946	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date 1-Aug

	Lat	Long
Storm Center Location	38.67 N	89.98 W
Storm Rep Dew Point Location	32.55 N	93.00 W
Transposition Dew Point Location	36.61 N	95.75 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 455	miles
Grid Point Elevation	350	feet
Storm Center Elevation	500	feet
Storm Rep Analysis Duration	24	hours

The storm representative Td is	76.0 F	with total precipitable water above sea level of			2.99	inches.
The in-place maximum Td is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The transpositioned maximum Td is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The in-place storm elevation is	500	which subtracts	0.13	inches of precipitable water at	76.0 F	
The in-place storm elevation is	500	which subtracts	0.16	inches of precipitable water at	80.5 F	
The transposition storm elevation at	350	which subtracts	0.29	inches of precipitable water at	80.0 F	
The Grid Point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	80.0 F	

The in-place maximization factor is	1.23
The transposition factor is	0.94
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.16

Notes: DAD values taken from HMR 51 DAD Table Storm Index N. 80-USACE MR 7-2B. Storm representative dew point value was based on maximum 24-hr Td values between August 10-11, 1946 at KBAD and KMLU.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	6.4	10.2	12.6	12.7	14.1	18.0	18.1	18.6	18.7
10 sq miles	6.0	9.8	12.1	12.1	13.7	17.5	17.6	18.3	18.3
100 sq miles	5.6	8.8	10.9	11.1	13.2	16.6	16.7	17.5	17.6
200 sq miles	5.4	8.3	10.5	10.6	13.0	16.2	16.3	17.2	17.3
500 sq miles	5.2	7.7	9.7	9.9	12.8	15.5	15.6	16.7	16.9
1000 sq miles	4.9	7.0	8.9	9.0	12.6	14.7	14.8	15.9	16.0
2000 sq miles	4.3	6.1	7.6	7.8	11.2	13.3	13.4	14.3	14.3
5000 sq miles	3.3	4.8	5.9	6.0	8.6	10.4	10.6	11.3	11.4
10000 sq miles	2.4	3.7	4.5	4.6	6.6	8.0	8.2	8.7	8.8
20000 sq miles	1.5	2.5	3.1	3.2	4.6	5.6	5.8	6.0	6.1

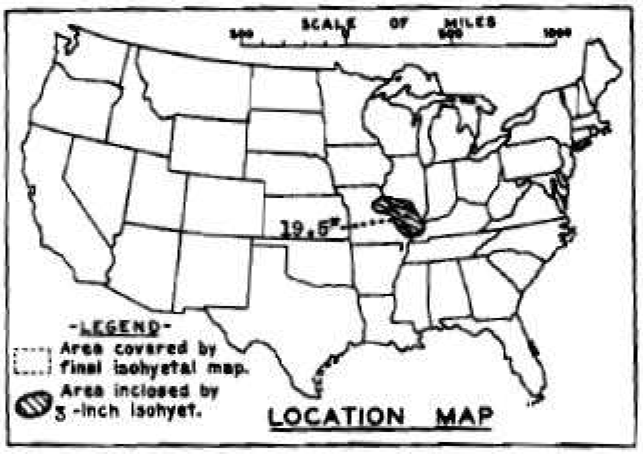
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	7.4	11.8	14.6	14.7	16.3	20.8	20.9	21.5	21.6
10 sq miles	6.9	11.3	14.0	14.0	15.9	20.3	20.4	21.2	21.2
100 sq miles	6.5	10.2	12.6	12.8	15.3	19.2	19.3	20.3	20.4
200 sq miles	6.2	9.6	12.2	12.3	15.0	18.7	18.9	19.9	20.0
500 sq miles	6.0	8.9	11.2	11.5	14.8	17.9	18.1	19.3	19.6
1000 sq miles	5.7	8.1	10.3	10.4	14.6	17.0	17.1	18.4	18.5
2000 sq miles	5.0	7.1	8.8	9.0	13.0	15.4	15.5	16.6	16.6
5000 sq miles	3.8	5.6	6.8	6.9	10.0	12.0	12.3	13.1	13.2
10000 sq miles	2.8	4.3	5.2	5.3	7.6	9.3	9.5	10.1	10.2
20000 sq miles	1.7	2.9	3.6	3.7	5.3	6.5	6.7	6.9	7.1

Storm or Storm Center Name	**USACE MR 7-2B-Collinsville, IL**			
Storm Date(s)	8/12-15/1946			
Storm Type	General Storm			
Storm Location	38.67 N	89.98 W		
Storm Center Elevation	500			
Precipitation Total & Duration (10 sq mi)	18.7 Inches in 72-hours			
Storm Representative Dew Point	76.0 F	24		
Storm Representative Dew Point Location	32.55 N	93.00 W	Jul	Aug
Maximum Dew Point	80.5 F		80.5	80
Moisture Inflow Vector	SSW @ 455			
In-place Maximization Factor	**1.23**			
Temporal Transposition (Date)	1-Aug			
Transposition Dew Point Location	36.61 N	95.75 W	Jul	Aug
Transposition Maximum Dew Point	80.0 F		80	80
Transposition Adjustment Factor	**0.94**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.16**			

Appendix G: Table G.28: Storm spreadsheet for Collinsville, IL August 12, 1946

STORM STUDIES – PERTINENT DATA SHEET



Storm of 12-16 August 1946
Assignment MR 7-2B
Location Mo., Ill., Ind. & Ky.
Study Prepared by: Upper Mississippi Valley Division St. Louis District

Part I Reviewed by H. M. Sec. of Weather Bureau, 3/8/49
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/20/50
Remarks: Center near Collinsville, Ill. Dewpt. 74° Ref. Pt. 225 S Grid F-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	58
Form 5001-B (24-hour " ")	—
Form 5001-D (" " " ")	16
Miscl. precip. records, meteorological data, etc.	15
Form 5002 (Mass rainfall curves)	44

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

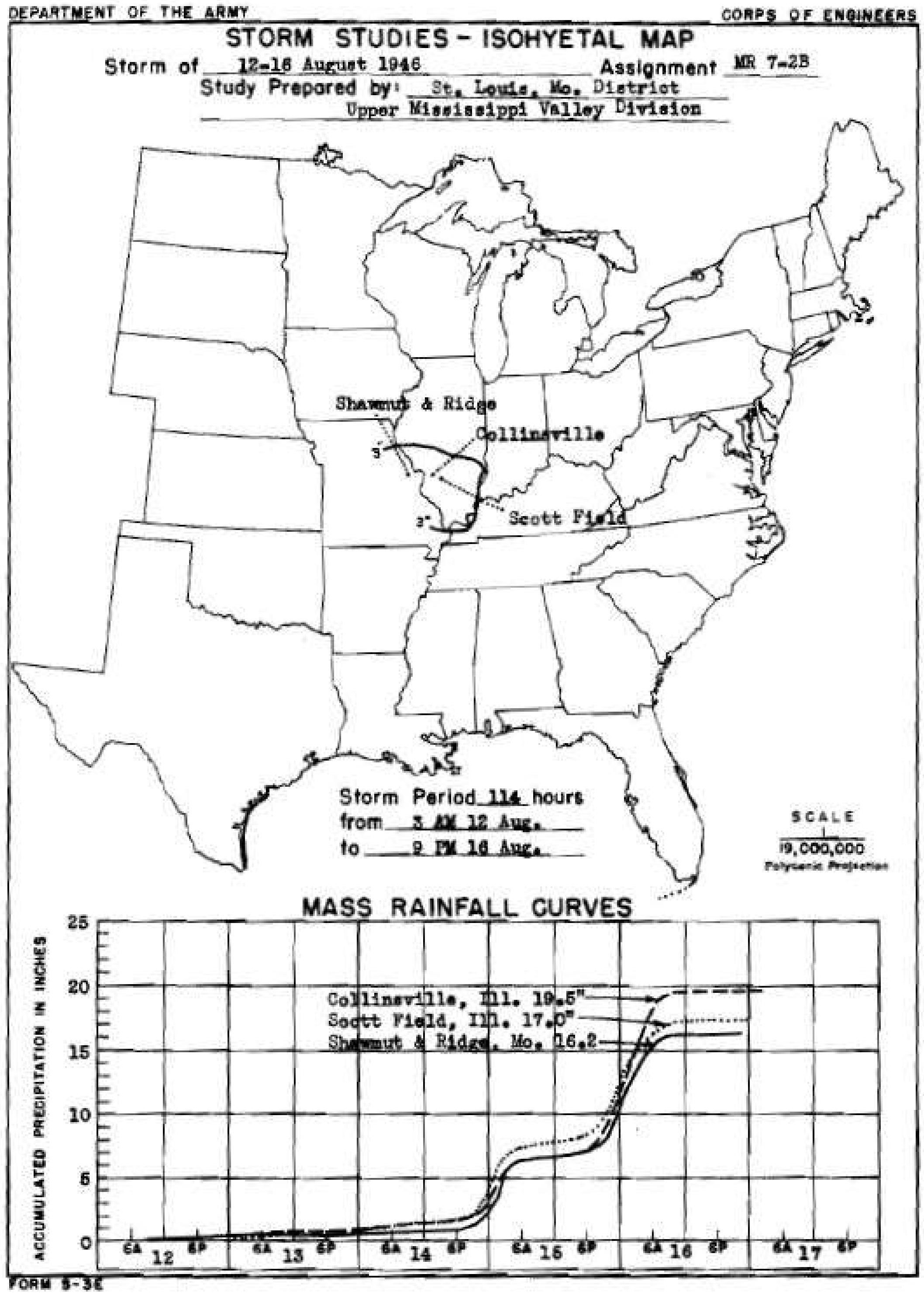
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	5
Form S-11 (Depth-area data from isohyetal map)	3
Form S-12 (Maximum depth-duration data)	7
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	114
Max. Sta.	6.4	10.2	12.6	12.7	14.1	18.0	18.1	18.6	18.7	19.4	19.5
10	6.0	9.8	12.1	12.1	13.7	17.5	17.6	18.3	18.3	18.9	19.0
100	5.6	8.8	10.9	11.1	13.2	16.6	16.7	17.5	17.6	18.0	18.1
200	5.4	8.3	10.5	10.6	13.0	16.2	16.3	17.2	17.3	17.7	17.8
500	5.2	7.7	9.7	9.9	12.8	15.5	15.6	16.7	16.9	17.1	17.2
1,000	4.9	7.0	8.9	9.0	12.6	14.7	14.8	15.9	16.0	16.3	16.4
2,000	4.3	6.1	7.6	7.8	11.2	13.3	13.4	14.3	14.3	14.6	14.7
5,000	3.3	4.8	5.9	6.0	8.6	10.4	10.6	11.3	11.4	11.6	11.8
10,000	2.4	3.7	4.5	4.6	6.6	8.0	8.2	8.7	8.8	9.0	9.1
20,000	1.5	2.5	3.1	3.2	4.5	5.6	5.8	6.0	6.1	6.3	6.5
20,400	1.5	2.5	3.1	3.2	4.5	5.5	5.7	6.0	6.1	6.3	6.4

Form S-2

Appendix G: Table G.29: Depth-area-duration values for Collinsville, IL August 12, 1946



Appendix G: Figure G.36 and Figure G.37: Isohyetal map and mass curve chart for Collinsville, IL August 12, 1946

Mounds, OK, AWA 44

May 16, 1943

Storm Type: MCC

Storm Name:	SW 2-21-Mounds, OK		
Storm Date:	5/15-20/1943		
AWA Analysis Date:	12/15/2013		

Storm Adjustment for ANO Grid Point 1

Temporal Transposition Date	1-Jun	
	Lat	Long
Storm Center Location	35.88 N	96.06 W
Storm Rep Dew Point Location	33.84 N	96.98 W
Transposition Dew Point Location	40.69 N	93.58 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSW @ 150	miles
Grid Point Elevation	350	feet
Storm Center Elevation	750	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	73.0 F	with total precipitable water above sea level of			2.60	inches.
The in-place maximum dew point is	78.5 F	with total precipitable water above sea level of			3.37	inches.
The transpositioned maximum dew point is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place storm elevation is	750	which subtracts	0.18	inches of precipitable water at	73.0 F	
The in-place storm elevation is	750	which subtracts	0.22	inches of precipitable water at	78.5 F	
The transposition storm elevation at	350	which subtracts	0.27	inches of precipitable water at	77.0 F	
The Grid point/inflow barrier height is	1,000	which subtracts	0.27	inches of precipitable water at	77.0 F	

The in-place maximization factor is	1.30
The transposition factor is	0.91
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.19

Notes: Storm rep Td re-analyzed using hourly surface observations. KADM, KFWH, and KGVT used to derive the 6 hour average storm rep Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	15.9	16.7	16.7	16.7	-	16.7	16.7	16.7	16.7
100 sq miles	14.2	14.8	14.9	14.9	-	14.9	14.9	15.0	15.4
200 sq miles	13.0	13.5	13.9	13.9	-	13.9	13.9	13.9	14.4
500 sq miles	9.2	10.6	11.1	11.1	-	11.5	12.0	13.7	14.4
1000 sq miles	6.2	7.9	8.4	8.5	-	10.0	10.8	13.2	13.8
2000 sq miles	4.0	5.3	6.3	6.6	-	9.2	10.0	12.6	13.2
5000 sq miles	3.0	3.6	4.9	5.4	-	8.3	8.9	11.5	12.1
10000 sq miles	2.6	3.1	4.2	4.8	-	7.3	8.0	10.2	10.7
20000 sq miles	2.1	2.6	3.5	4.2	-	6.2	6.9	8.6	9.1

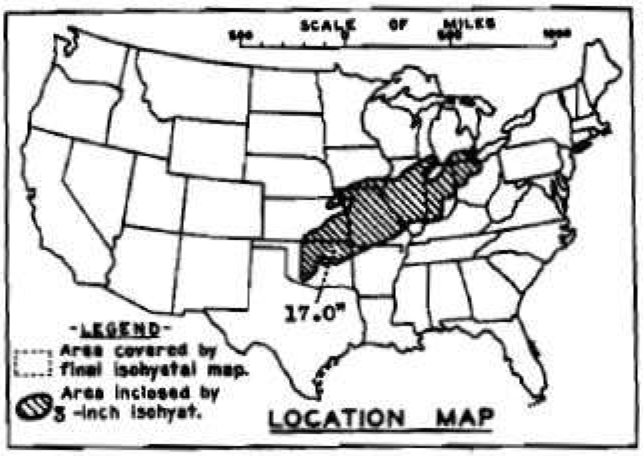
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	18.9	19.8	19.8	19.8	-	19.8	19.8	19.8	19.8
100 sq miles	16.8	17.6	17.7	17.7	-	17.7	17.7	17.8	18.3
200 sq miles	15.4	16.0	16.5	16.5	-	16.5	16.5	16.5	17.1
500 sq miles	10.9	12.6	13.2	13.2	-	13.6	14.2	16.2	17.1
1000 sq miles	7.4	9.4	10.0	10.1	-	11.9	12.8	15.7	16.4
2000 sq miles	4.7	6.3	7.5	7.8	-	10.9	11.9	14.9	15.7
5000 sq miles	3.6	4.3	5.8	6.4	-	9.8	10.6	13.6	14.4
10000 sq miles	3.1	3.7	5.0	5.7	-	8.7	9.5	12.1	12.7
20000 sq miles	2.5	3.1	4.2	5.0	-	7.4	8.2	10.2	10.8

Storm or Storm Center Name	**SW 2-21-Mounds, OK**			
Storm Date(s)	5/15-20/1943			
Storm Type	MCC			
Storm Location	35.88 N	96.06 W		
Storm Center Elevation	750			
Precipitation Total & Duration (10 sq mi)	17.0 inches in 12 hours			
Storm Representative Td	73.0 F	6		
Storm Representative Td Location	33.84 N	96.98 W	May	June
In-place Maximum Td	78.5 F		77	79
Moisture Inflow Vector	SSW @ 150			
In-place Maximization Factor	**1.30**			
Temporal Transposition (Date)	1-Jun			
Transposition Dewpoint Location	40.69 N	93.58 W	May	June
Transposition Maximum Td	77.0 F		74.5	79
Transposition Adjustment Factor	**0.91**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.19**			

Appendix G: Table G.30: Storm spreadsheet for Mounds, OK May 16, 1943

STORM STUDIES - PERTINENT DATA SHEET



Storm of 12-20 May 1943
Assignment SW 2-21
Location Oklahoma to Great Lakes
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 10/9/46
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 8/15/49
Remarks: Center near Mounds, Okla.
Dewpt. 71° - Ref. Pt. 60 ESE
Grid G-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) 531
- Form 5001-B (24-hour " ") .... --
- Form 5001-D (" " " ") 147
- Miscl. precip. records, meteorological data, etc. 10
- Form 5002 (Mass rainfall curves) 251

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

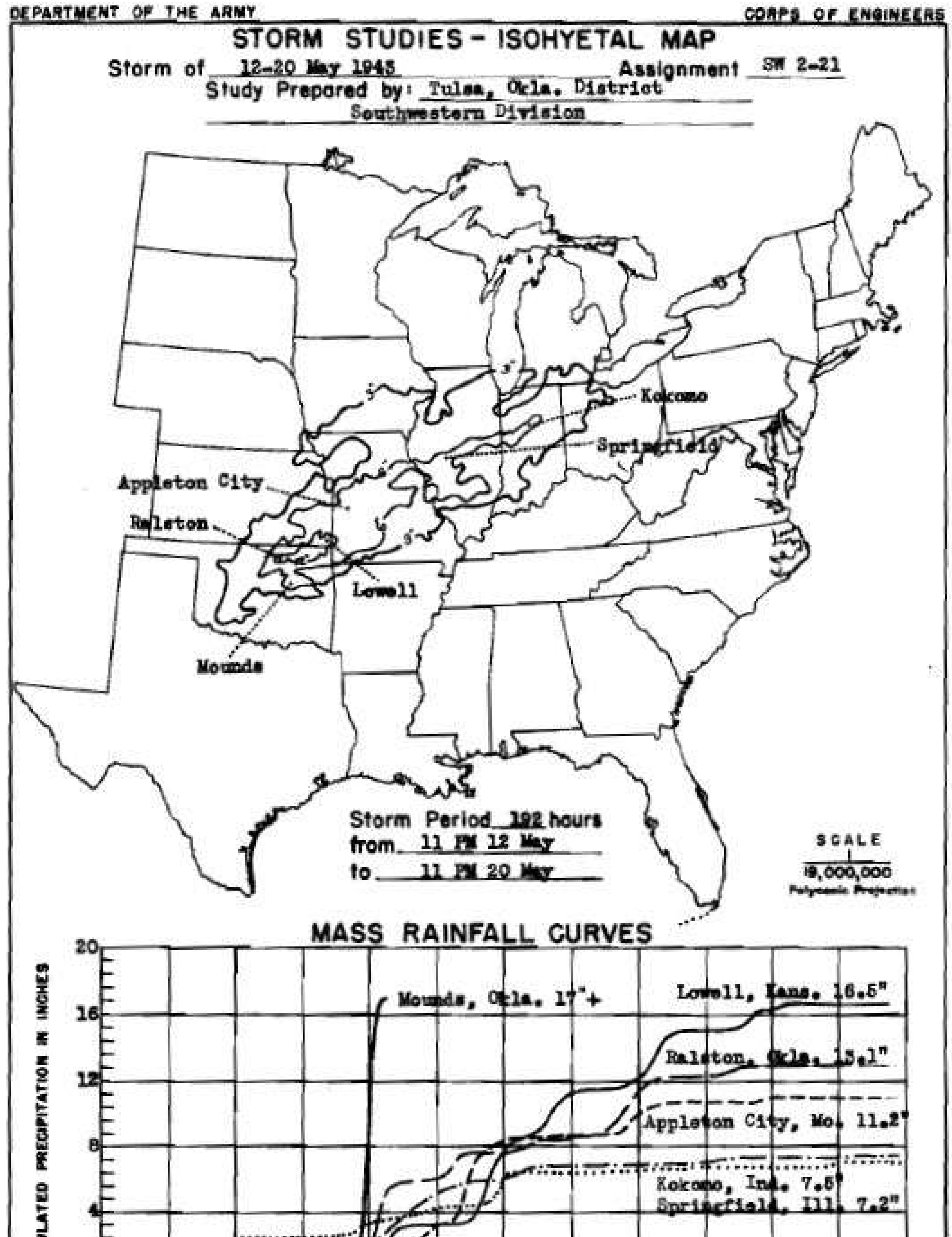
- Form S-10 (Data from mass rainfall curves) 44
- Form S-11 (Depth-area data from isohyetal map) 8
- Form S-12 (Maximum depth-duration data) 12
- Maximum duration-depth-area curves 1
- Data relating to periods of maximum rainfall 1

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										144/
	6	12	18	24	36	48	60	72	96	120	192
Max. Station	16.2	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
10	15.9	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.8	16.9	16.9
100	14.2	14.8	14.9	14.9	14.9	14.9	15.0	15.4	15.6	15.9	15.9
200	13.0	13.5	13.9	13.9	13.9	13.9	13.9	14.4	15.0	15.5	15.5
500	9.2	10.6	11.1	11.1	11.5	12.0	13.7	14.4	14.6	14.9	14.9
1,000	6.2	7.9	8.4	8.5	10.0	10.8	13.2	13.8	14.1	14.9	14.9
2,000	4.0	5.3	6.3	6.6	9.2	10.0	12.6	13.2	13.5	13.7	13.7
5,000	3.0	3.6	4.9	5.4	8.3	8.9	11.5	12.1	12.4	12.5	12.6
10,000	2.6	3.1	4.2	4.8	7.3	8.0	10.2	10.7	11.0	11.3	11.4
20,000	2.1	2.6	3.5	4.2	6.2	6.9	8.6	9.1	9.4	9.8	10.1
50,000	1.6	2.0	2.6	3.4	4.6	5.3	6.6	7.0	7.4	7.8	8.2
100,000	1.1	1.5	2.0	2.6	3.5	4.1	5.0	5.4	5.8	6.4	6.8
200,000	0.7	1.0	1.3	1.7	2.3	2.7	3.5	3.8	4.3	4.9	5.2

Form S-2

Appendix G: Table G.31: Depth-area-duration chart for Mounds, OK May 16, 1943



Appendix G: Figure G.38 and Figure G.39: Isohyetal map and mass curve chart for Mounds, OK May 16, 1943

Silver Lake, TX AWA 45

June 5, 1943

Storm Type: MCC

Storm Name:	USACE SW 3-3-Silver Lake, TX	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	6/5-6/1943	
AWA Analysis Date:	12/15/2013	

Temporal Transposition Date	15-Jun	
	Lat	Long
Storm center location	32.67 N	95.60 W
Storm Rep SST location	30.05 N	97.00 W
Transposition SST location	30.65 N	99.60 W
Grid Point location	35.31 N	93.23 W

Moisture Inflow Direction:	SSW @ 200	miles
Grid Point Elevation	350	feet
Storm Center Elevation	400	feet
Storm Rep Analysis Duration	6	hours

The storm representative SST is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum SST is	80.0 F	with total precipitable water above sea level of			3.60	inches.
The transpositioned maximum SST is	79.0 F	with total precipitable water above sea level of			3.44	inches.
The in-place storm elevation is	400	which subtracts	0.10	inches of precipitable water at	77.0 F	
The in-place storm elevation is	400	which subtracts	0.12	inches of precipitable water at	80.0 F	
The transposition storm elevation at	350	which subtracts	0.295	inches of precipitable water at	79.0 F	
The Grid point/inflow barrier height is	1,050	which subtracts	0.295	inches of precipitable water at	79.0 F	

The in-place maximization factor is	1.14
The transposition factor is	0.90
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.03

Notes: Storm rep Td re-analyzed using hourly surface observations at KBSM, KEFD, and KSRO for the 6 hour duration.

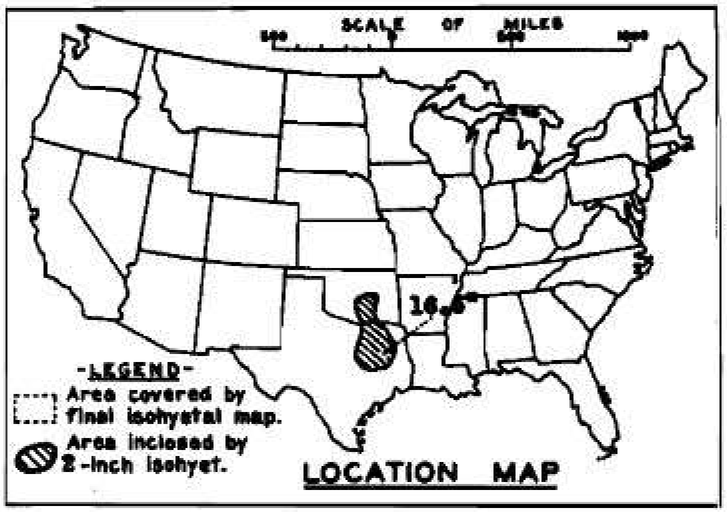
Observed Storm Depth-Area-Duration	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	14.2	16.5	16.5	16.5	16.5	16.5	16.5	-	-
100 sq miles	11.1	14.8	15.0	15.1	15.1	15.1	15.1	-	-
200 sq miles	9.7	14.1	14.3	14.6	14.6	14.6	14.6	-	-
500 sq miles	8.0	12.9	13.4	13.7	13.7	13.7	13.7	-	-
1000 sq miles	6.8	11.6	12.5	12.8	12.8	12.8	12.8	-	-
2000 sq miles	5.6	9.9	10.9	11.0	11.0	11.0	11.0	-	-
5000 sq miles	4.1	7.0	7.8	8.0	8.1	8.1	8.1	-	-
10000 sq miles	2.9	4.3	5.4	5.7	5.8	5.8	5.9	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	14.7	17.1	17.1	17.1	17.1	17.1	17.1	-	-
100 sq miles	11.5	15.3	15.5	15.6	15.6	15.6	15.6	-	-
200 sq miles	10.0	14.6	14.8	15.1	15.1	15.1	15.1	-	-
500 sq miles	8.3	13.3	13.9	14.2	14.2	14.2	14.2	-	-
1000 sq miles	7.0	12.0	12.9	13.2	13.2	13.2	13.2	-	-
2000 sq miles	5.8	10.2	11.3	11.4	11.4	11.4	11.4	-	-
5000 sq miles	4.2	7.2	8.1	8.3	8.4	8.4	8.4	-	-
10000 sq miles	3.0	4.4	5.6	5.9	6.0	6.0	6.1	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	USACE SW 3-3-Silver Lake, TX		
Storm Date(s)	6/5-6/1943		
Storm Type	MCC		
Storm Location	32.67 N	95.60 W	
Storm Center Elevation	400		
Precipitation Total & Duration (10 sq mi)	16.5 inches in 12 hours		
Storm Representative SST	77.0 F		
Storm Representative SST Location	30.05 N	97.00 W	J
In-place Maximum SST	80.0 F		80
Moisture Inflow Vector	SSW @ 200		
In-place Maximization Factor			
Temporal Transposition (Date)	15-Jun		
Transposition Dewpoint Location	30.65 N	99.60 W	J
Transposition Maximum SST	79.0 F		79
Transposition Adjustment Factor			
Grid Point Elevation	350		
Highest Elevation in Basin	14,344		
Inflow Barrier Height			
Elevation Adjustment Factor			
Total Adjustment Factor	1.03		

Appendix G: Table G.32: Storm spreadsheet for Silver Lake, TX June 5, 1943

STORM STUDIES – PERTINENT DATA SHEET



Storm of 5-7 June 1943
Assignment SW 3-3
Location Texas & Oklahoma
Study Prepared by: Southwestern Division Fort Worth, Texas

Part I Reviewed by H. M. Sec. of Weather Bureau, 7/7/49
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 10/17/51
Remarks: Center at Silver Lake, Texas Dewpt. 75°- Ref. Pt. 230 S Grid I-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	15
Form 5001-B (24-hour " ")	0
Form 5001-D (" " " ")	8
Miscl. precip. records, meteorological data, etc.	9
Form 5002 (Mass rainfall curves)	23

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

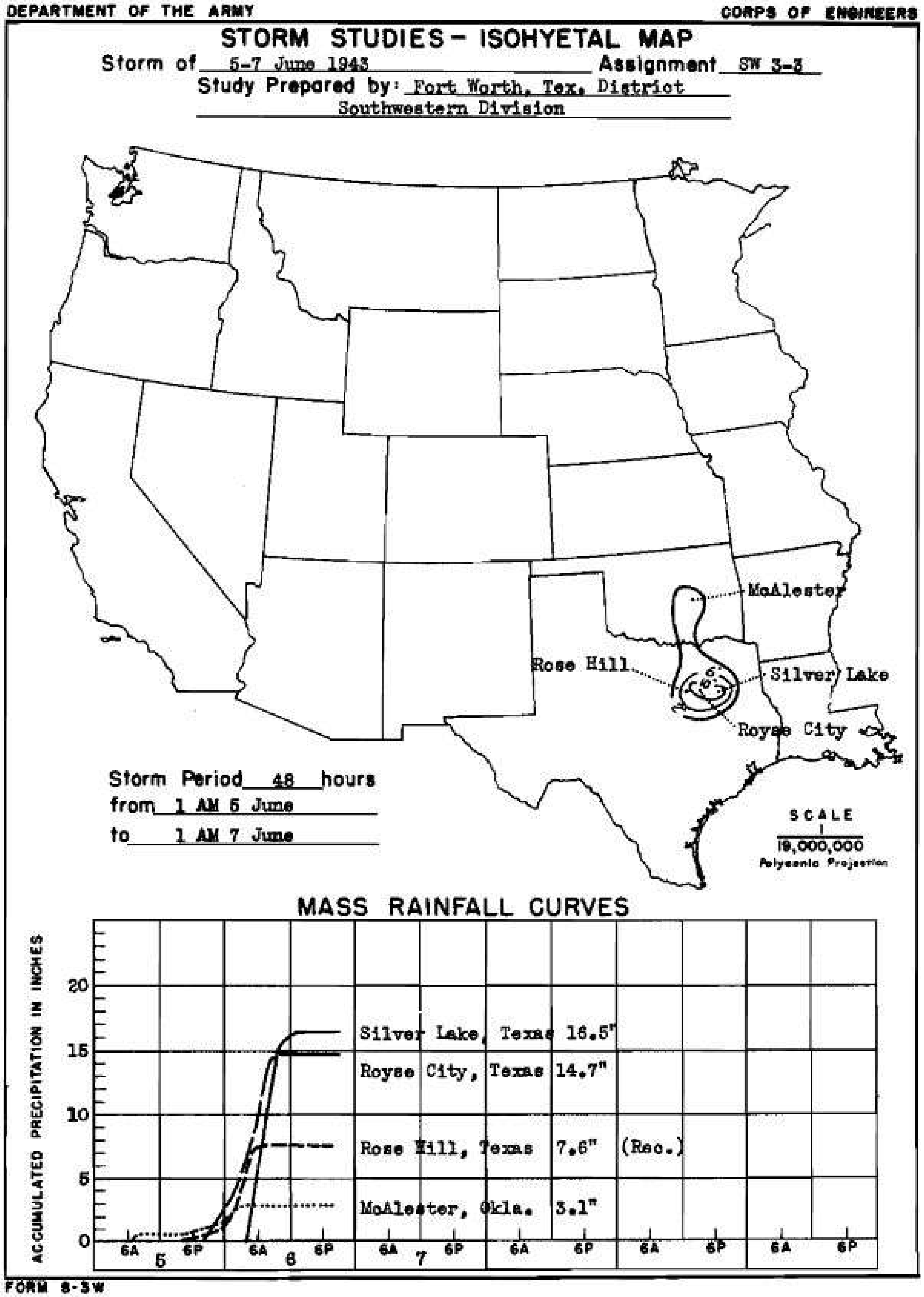
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	3
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	2
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48			
10	14.2	16.5	16.5	16.5	16.5	16.5	16.5			
100	11.1	14.8	15.0	15.1	15.1	15.1	15.1			
200	9.7	14.1	14.3	14.6	14.6	14.6	14.6			
500	8.0	12.9	13.4	13.7	13.7	13.7	13.7			
1000	6.8	11.6	12.5	12.8	12.8	12.8	12.8			
2000	5.6	9.9	10.9	11.0	11.0	11.0	11.0			
5000	4.1	7.0	7.8	8.0	8.1	8.1	8.1			
10,000	2.9	4.3	5.4	5.7	5.8	5.8	5.9			
16,000	2.0	3.2	3.7	4.0	4.1	4.1	4.2			

Form S-2

Appendix G: Table G.33: Depth-area-duration chart for Silver Lake, TX June 5, 1943



Appendix G: Figure G.40 and Figure G.41: Total storm isohyetal and mass curve chart for Silver Lake, TX June 5, 1943

Hallett, OK AWA 52

September 2, 1940

Storm Type: MCC

Storm Name:	**USACE SW 2-18-Hallett, OK**	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	**9/2-4/1940**	
AWA Analysis Date:	**12/15/2013**	

Temporal Transposition Date	**17-Aug**	
	Lat	**Long**
Storm Center Location	**36.23 N**	**96.57 W**
Storm Rep Dew Point Location	**32.90 N**	**93.15 W**
Transposition Dew Point Location	**39.39 N**	**89.86 W**
Grid Point Location	**35.31 N**	**93.23 W**

Moisture Inflow Direction	**SE @ 300**	miles
Grid Point Elevation	**350**	feet
Storm Center Elevation	**900**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**77.5 F**	with total precipitable water above sea level of			**3.22**	inches.
The in-place maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.52**	inches.
The transpositioned maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.52**	inches.
The in-place storm elevation is	**900**	which subtracts	**0.25**	inches of precipitable water at	**77.5 F**	
The in-place storm elevation is	**900**	which subtracts	**0.27**	inches of precipitable water at	**80.0 F**	
The transposition storm elevation at	**350**	which subtracts	**0.29**	inches of precipitable water at	**80.0 F**	
The Grid point/inflow barrier height is	**1,000**	which subtracts	**0.29**	inches of precipitable water at	**80.0 F**	

The in-place maximization factor is	**1.09**
The transposition factor is	**0.99**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.09**

Notes: Reanalyzed the storm rep Td using hourly surface obs in the region. Used KBAD, Shreveprot, LA to derive the 6 hour average storm rep Td.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**18.4**	**23.4**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	-	-
100 sq miles	**14.7**	**19.2**	**19.4**	**19.6**	**19.7**	**19.8**	**19.8**	-	-
200 sq miles	**12.5**	**17.6**	**17.8**	**18.0**	**18.1**	**18.2**	**18.3**	-	-
500 sq miles	**9.7**	**15.4**	**15.6**	**15.7**	**15.8**	**16.1**	**16.2**	-	-
1000 sq miles	**7.9**	**13.3**	**13.4**	**13.6**	**13.7**	**14.0**	**14.1**	-	-
2000 sq miles	**6.2**	**10.3**	**10.5**	**10.7**	**10.9**	**11.1**	**11.3**	-	-
5000 sq miles	**4.3**	**7.3**	**7.4**	**7.5**	**7.7**	**7.8**	**7.9**	-	-
10000 sq miles	**3.0**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**	**5.8**	-	-
20000 sq miles	**2.0**	**3.9**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	-	-

Adjusted Storm Depth-Area-Duration

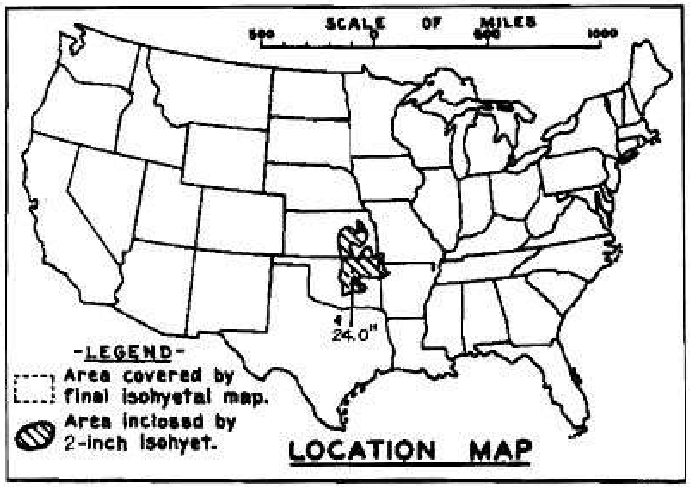
	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	**20.0**	**25.4**	**25.6**	**25.6**	**25.6**	**25.6**	**25.6**	-	-
100 sq miles	**16.0**	**20.8**	**21.1**	**21.3**	**21.4**	**21.5**	**21.5**	-	-
200 sq miles	**13.6**	**19.1**	**19.3**	**19.5**	**19.7**	**19.8**	**19.9**	-	-
500 sq miles	**10.5**	**16.7**	**16.9**	**17.0**	**17.2**	**17.5**	**17.6**	-	-
1000 sq miles	**8.6**	**14.4**	**14.5**	**14.8**	**14.9**	**15.2**	**15.3**	-	-
2000 sq miles	**6.7**	**11.2**	**11.4**	**11.6**	**11.8**	**12.1**	**12.3**	-	-
5000 sq miles	**4.7**	**7.9**	**8.0**	**8.1**	**8.4**	**8.5**	**8.6**	-	-
10000 sq miles	**3.3**	**5.8**	**5.9**	**6.0**	**6.1**	**6.2**	**6.3**	-	-
20000 sq miles	**2.2**	**4.2**	**4.5**	**4.6**	**4.7**	**4.8**	**4.9**	-	-

Storm or Storm Center Name	**USACE SW 2-18-Hallett, OK**			
Storm Date(s)	9/2-4/1940			
Storm Type	MCC			
Storm Location	36.23 N	96.57 W		
Storm Center Elevation	900			
Precipitation Total & Duration (10 sq mi)	24.00 inches in 12 hours			
Storm Representative Dew Point	77.5 F	12		
Storm Representative Dew Point Location	32.90 N	93.15 W	A	
Maximum Dew Point	80.0 F		79.5	
Moisture Inflow Vector	SE @ 300			
In-place Maximization Factor	**1.09**			
Temporal Transposition (Date)	17-Aug			
Transposition Dew Point Location	39.39 N	89.86 W	A	S
Transposition Maximum Dew Point	80.0 F		80.5	76
Transposition Adjustment Factor	**0.99**			
Grid Point Elevation	350			
Highest Elevation in Basin	**14,344**			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.09**			

Appendix G: Table G.34: Storm spreadsheet for Hallett, OK September 2, 1940

WAR DEPARTMENT — CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of September 2 - 6, 1940
Assignment S W 2 - 18
Location Okla. Kans. Mo. & Ark.
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/18/41
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 3/25/43
Remarks: Centers at; Hallett, Okla. and Lebo, Kans.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheet, scale 1 : 1,000,000

Precipitation data and mass curves: (Number of Sheets)

- Form 5001-C (Hourly precip. data) ---------- 38
- Form 5001-B (24-hour " ") ---------- -
- Form 5001-D (" " " ") ---------- 23
- Miscl. precip. records, meteorological data, etc. ---------- 1
- Form 5002 (Mass rainfall curves) ---------- 49

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

Data and computation sheets:

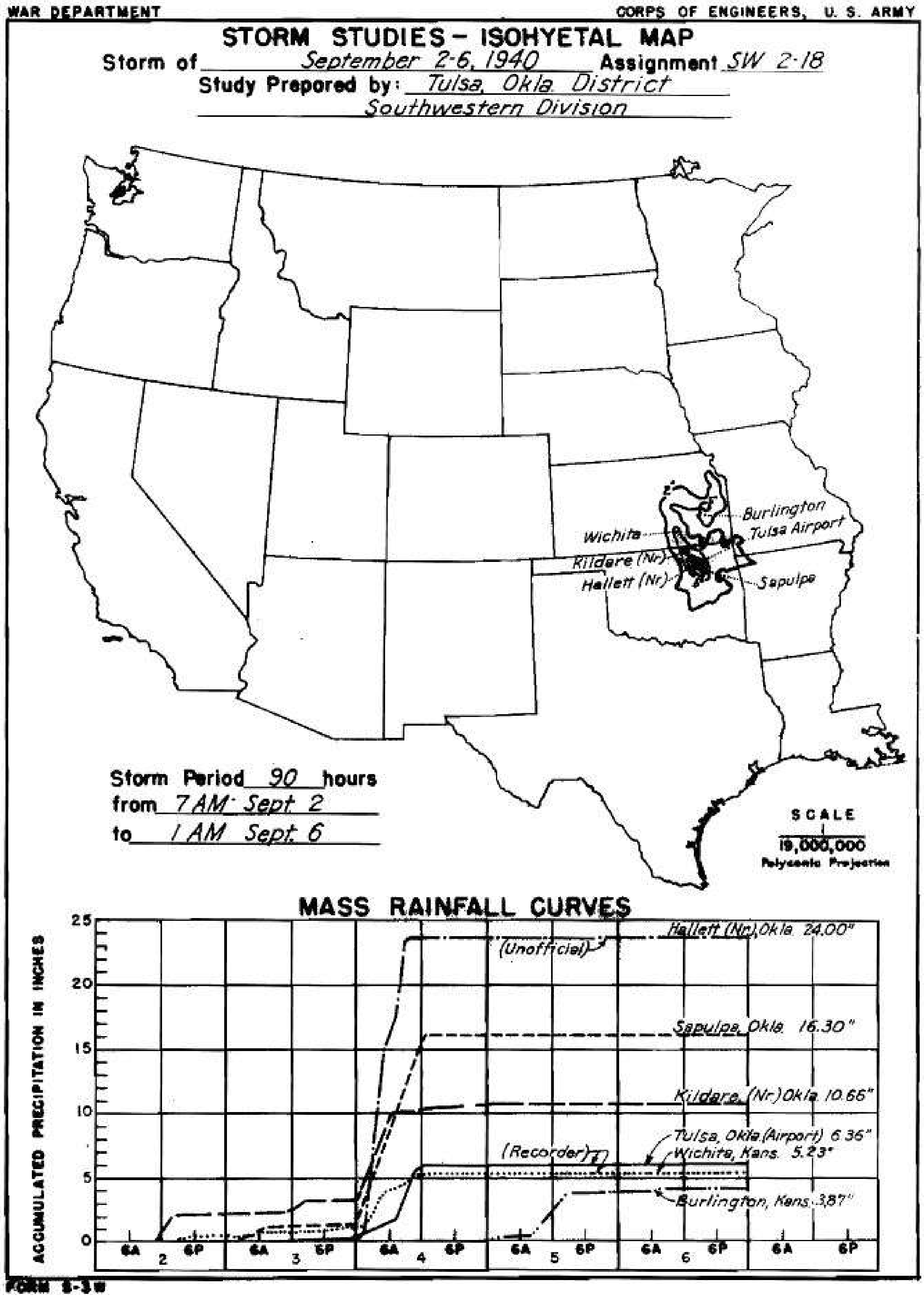
- Form S-10 (Data from mass rainfall curves) ---------- 9
- Form S-11 (Depth-area data from isohyetal map) ---------- 3
- Form S-12 (Maximum depth-duration data) ---------- 11
- Maximum duration-depth-area curves ---------- 1
- Data relating to periods of maximum rainfall ---------- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	54	90		
Max. Station	18.9	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0		
10	18.4	23.4	23.6	23.6	23.6	23.6	23.6	23.6	23.6		
100	14.7	19.2	19.4	19.6	19.7	19.8	19.8	19.8	19.8		
200	12.5	17.6	17.8	18.0	18.1	18.2	18.3	18.3	18.3		
500	9.7	15.4	15.6	15.7	15.8	16.1	16.2	16.2	16.2		
1,000	7.9	13.3	13.4	13.6	13.7	14.0	14.1	14.1	14.1		
2,000	6.2	10.3	10.5	10.7	10.9	11.1	11.3	11.3	11.3		
5,000	4.3	7.3	7.4	7.5	7.7	7.8	7.9	8.0	8.0		
10,000	3.0	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.9		
15,000	2.4	4.4	4.5	4.7	4.7	4.8	4.9	5.1	5.1		
20,000	2.0	3.9	4.1	4.2	4.3	4.4	4.5	4.6	4.6		

Form S-2

Appendix G: Table G.35: Depth-area-duration values for Hallett, OK September 2, 1940



Appendix G: Figure G.42 and Figure G.43: Total storm isohyetal analysis and mass curve chart for Hallett, OK September 2, 1940

Engle, TX, AWA 83

June 29, 1940

Storm Type: MCC

Storm Name:	USACE GM 5-11-Engle, TX	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	6/28-30/1940	
AWA Analysis Date:	12/17/2013	

Temporal Transposition Date	15-Jul	
	Lat	Long
Storm center location	29.68 N	97.01 W
Storm Rep dew point location	29.46 N	98.44 W
Transposition dewpoint location	35.09 N	94.76 W
Basin location	35.31 N	93.23 W

Moisture Inflow Direction:	WSW @ 90	miles
Grid Point Elevation	400	feet
Storm Center Elevation	350	feet
Storm Rep Analysis Duration	12	hours

The storm representative dew point is	76.5 F	with total precipitable water above sea level of		3.07	inches.
The in-place maximum dew point is	80.0 F	with total precipitable water above sea level of		3.60	inches.
The transpositioned maximum dew point is	81.0 F	with total precipitable water above sea level of		3.76	inches.
The in-place storm elevation is	350	which subtracts	0.08	inches of precipitable water at	76.5 F
The in-place storm elevation is	350	which subtracts	0.105	inches of precipitable water at	80.0 F
The transposition basin elevation at	400	which subtracts	0.12	inches of precipitable water at	81.0 F
The inflow barrier/basin elevation height is	400	which subtracts	0.12	inches of precipitable water at	81.0 F

The in-place storm maximization factor is	1.17
The transposition/elevation to basin factor is	1.04
The barrier adjustment factor is	1.00
The total adjustment factor is	1.22

Notes: Storm rep Td reanalyzed using surafce observations. Storm rep Td taken from the 12hr average at KSKF and KRND.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	11.0	17.9	18.6	18.8	22.7	22.7	22.7	22.7	22.7
100 sq miles	10.1	16.5	17.7	17.9	21.3	21.3	21.3	21.3	21.3
200 sq miles	9.1	15.6	16.8	17.1	20.7	20.7	20.7	20.7	20.7
500 sq miles	7.4	13.6	15.3	15.8	19.7	19.7	19.7	19.7	19.7
1000 sq miles	6.3	11.7	13.9	14.4	18.5	18.5	18.5	18.5	18.5
2000 sq miles	5.2	9.7	12.2	12.7	16.8	16.8	16.8	16.8	16.8
5000 sq miles	3.9	7.1	9.1	9.7	13.0	13.0	13.0	13.0	13.0
10000 sq miles	2.9	5.3	6.8	7.3	10.0	10.0	10.0	10.0	10.0
20000 sq miles	2.0	3.5	4.6	5.0	7.3	7.3	7.3	7.3	7.3
50000 sq miles	-	-	-	-	-	-	-	-	-

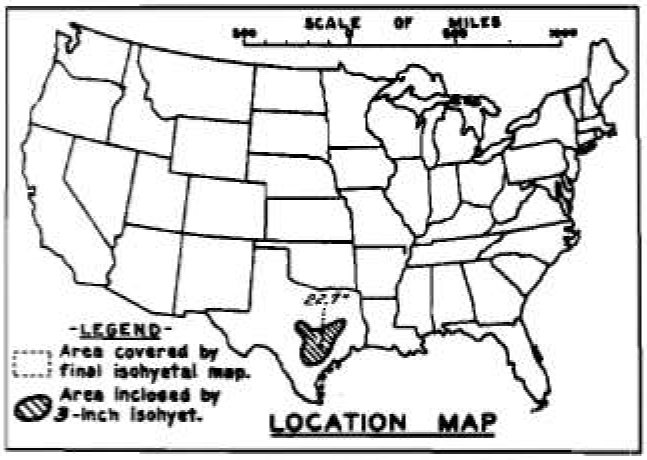
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	13.4	21.8	22.7	22.9	27.7	27.7	27.7	27.7	27.7
100 sq miles	12.3	20.1	21.6	21.8	26.0	26.0	26.0	26.0	26.0
200 sq miles	11.1	19.0	20.5	20.9	25.2	25.2	25.2	25.2	25.2
500 sq miles	9.0	16.6	18.7	19.3	24.0	24.0	24.0	24.0	24.0
1000 sq miles	7.7	14.3	17.0	17.6	22.6	22.6	22.6	22.6	22.6
2000 sq miles	6.3	11.8	14.9	15.5	20.5	20.5	20.5	20.5	20.5
5000 sq miles	4.8	8.7	11.1	11.8	15.9	15.9	15.9	15.9	15.9
10000 sq miles	3.5	6.5	8.3	8.9	12.2	12.2	12.2	12.2	12.2
20000 sq miles	2.4	4.3	5.6	6.1	8.9	8.9	8.9	8.9	8.9
50000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE GM 5-11-Engle, TX**		
Storm Date(s)	6/28-30/1940		
Storm Type	MCC		
Storm Location	29.68 N	97.01 W	
Storm Center Elevation	350		
Precipitation Total & Duration (10 sq mi)	22.7 inches 30 hours		
Storm Representative SST	76.5 F	12	
Storm Representative SST Location	29.46 N	98.44 W	J
In-place Maximum SST	80.0 F		80
Moisture Inflow Vector	WSW @ 90		
In-place Maximization Factor	1.17		
Temporal Transposition (Date)	15-Jul		
Transposition Dewpoint Location	35.09 N	94.76 W	J
Transposition Maximum SST	81.0 F		81
Transposition Adjustment Factor	**1.04**		
Grid Point Elevation	400		
Highest Elevation in Basin	14,344		
Inflow Barrier Height	xx		
Elevation Adjustment Factor	**1.00**		
Total Adjustment Factor	**1.22**		

Appendix G: Table G.36: Storm spreadsheet for Engle, TX June 29, 1940

STORM STUDIES – PERTINENT DATA SHEET



Storm of 28-30 June 1940
Assignment GM 5-11
Location Texas
Study Prepared by:
Southwestern Division
Galveston District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 3-18-46
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 8-26-47
Remarks: Center at Engle, Texas
Dewpt. 77° - Ref. Pt. 200 SE
Grid J-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheet, scale 1:1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	53
Form 5001-B (24-hour " ")	69
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	13
Form 5002 (Mass rainfall curves)	70

PART II

Final isohyetal maps, in 1 sheets, scale 1:1,000,000

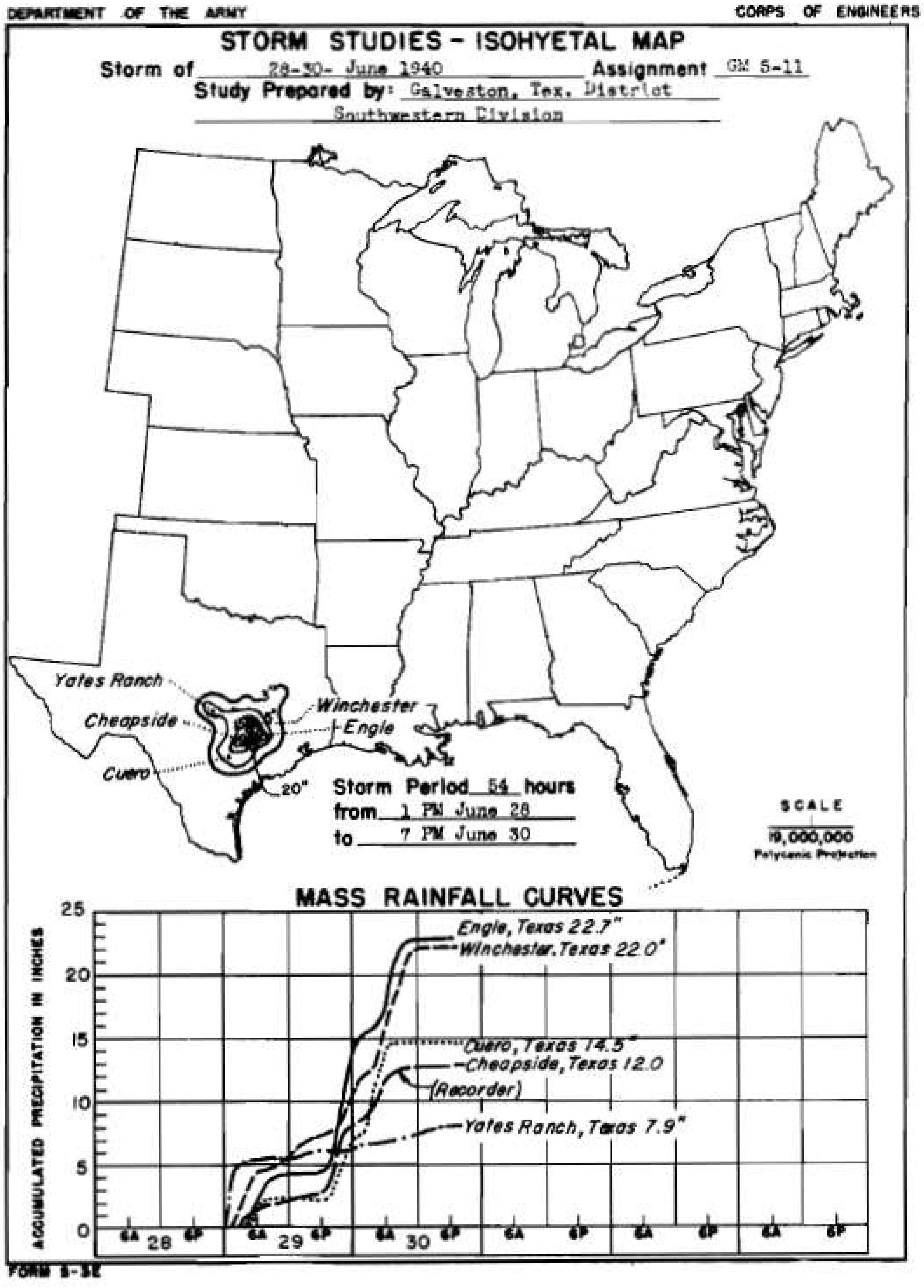
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	5
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	54			
10	11.0	17.9	16.6	18.8	22.7	22.7	22.7	22.7			
100	10.1	16.5	17.7	17.9	20.2	21.3	21.3	21.3			
200	9.1	15.6	16.8	17.1	19.3	20.7	20.7	20.7			
500	7.4	13.6	15.3	15.8	17.5	19.7	19.7	19.7			
1,000	6.3	11.7	13.9	14.4	15.7	18.5	18.5	18.5			
2,000	5.2	9.7	12.2	12.7	13.7	16.6	16.8	16.8			
5,000	3.9	7.1	9.1	9.7	10.7	12.9	13.0	13.2			
10,000	2.9	5.3	6.8	7.3	8.2	9.8	10.0	10.2			
20,000	2.0	3.5	4.6	5.0	5.9	7.0	7.3	7.5			
25,500	1.7	2.9	3.9	4.3	5.1	6.1	6.5	6.6			

Form S-2

Appendix G: Table G.37: Depth-area-duration values for Engle, TX June 29, 1940



Appendix G: Figure G.44 and Figure G.45: Total storm isohyetal analysis and mass curve chart for Engle, TX June 29, 1940

Bebe, TX, AWA 84

June 30, 1936

Storm Type: MCC

Storm Name:	USACE GM 5-6-Bebe, TX	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	6/30-7-4/1936	
AWA Analysis Date:	12/17/2013	

Temporal Transposition Date: 15-Jul

	Lat	Long
Storm center location	29.33 N	97.68 W
Storm Rep dew point location	27.90 N	97.50 W
Transposition dewpoint location	33.88 N	93.04 W
Basin location	35.31 N	93.23 W

Moisture Inflow Direction:	SSE @ 100	miles
Grid Point Elevation	400	feet
Storm Center Elevation	300	feet
Storm Rep Analysis Duration	24	hours

The storm representative dew point is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The in-place maximum dew point is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The transpositioned maximum dew point is	80.5 F	with total precipitable water above sea level of			3.68	inches.
The in-place storm elevation is	300	which subtracts	0.08	inches of precipitable water at	78.0 F	
The in-place storm elevation is	300	which subtracts	0.09	inches of precipitable water at	79.5 F	
The transposition basin elevation at	400	which subtracts	0.11	inches of precipitable water at	80.5 F	
The inflow barrier/basin elevation height is	400	which subtracts	0.12	inches of precipitable water at	80.5 F	

The in-place storm maximization factor is	1.07
The transposition/elevation to basin factor is	1.04
The barrier adjustment factor is	1.00
The total adjustment factor is	1.11

Notes: Used USACE storm studies storm rep Td and inflow vector and did not adjust for EPRI 12-hr average Td values.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	14.0	16.0	16.8	18.0	21.0	21.0	21.0	21.0	21.0
100 sq miles	12.7	14.4	14.9	16.1	18.9	19.4	20.2	20.2	20.2
200 sq miles	12.2	13.8	14.3	15.4	18.2	18.6	19.3	19.3	19.3
500 sq miles	11.5	13.0	13.4	14.4	16.7	17.2	17.8	17.8	17.8
1000 sq miles	10.9	12.3	12.6	13.4	15.4	15.8	16.5	16.5	16.7
2000 sq miles	10.1	11.4	11.6	12.2	13.8	14.3	14.9	14.9	15.2
5000 sq miles	8.1	9.1	9.6	10.0	11.2	11.9	12.5	12.5	13.1
10000 sq miles	5.7	6.9	7.6	8.0	9.2	10.2	10.8	10.8	11.5
20000 sq miles	4.0	5.1	5.6	6.1	7.5	8.5	9.1	9.2	10.0
50000 sq miles	2.3	3.1	3.6	4.1	5.4	6.3	7.0	7.2	7.9

Adjusted Storm Depth-Area-Duration

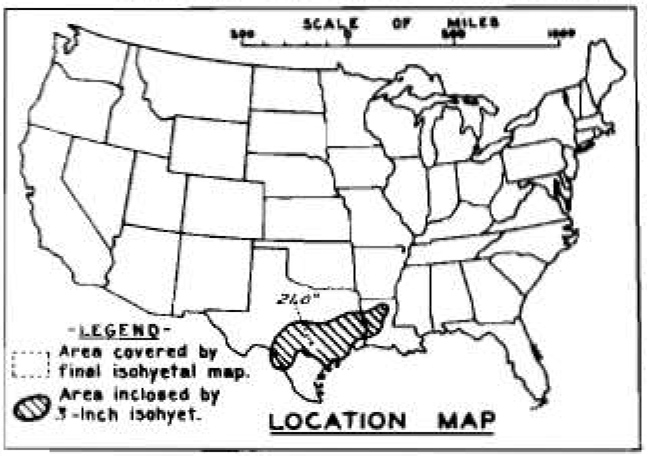
	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
10 sq miles	15.5	17.7	18.6	20.0	23.3	23.3	23.3	23.3	23.3
100 sq miles	14.1	16.0	16.5	17.9	21.0	21.5	22.4	22.4	22.4
200 sq miles	13.5	15.3	15.9	17.1	20.2	20.6	21.4	21.4	21.4
500 sq miles	12.8	14.4	14.9	16.0	18.5	19.1	19.7	19.7	19.7
1000 sq miles	12.1	13.6	14.0	14.9	17.1	17.5	18.3	18.3	18.5
2000 sq miles	11.2	12.6	12.9	13.5	15.3	15.9	16.5	16.5	16.9
5000 sq miles	9.0	10.1	10.6	11.1	12.4	13.2	13.9	13.9	14.5
10000 sq miles	6.3	7.7	8.4	8.9	10.2	11.3	12.0	12.0	12.8
20000 sq miles	4.4	5.7	6.2	6.8	8.3	9.4	10.1	10.2	11.1
50000 sq miles	2.6	3.4	4.0	4.5	6.0	7.0	7.8	8.0	8.8

Storm or Storm Center Name	**USACE GM 5-6-Bebe, TX**		
Storm Date(s)	6/30-7-4/1936		
Storm Type	MCC		
Storm Location	29.33 N	97.68 W	
Storm Center Elevation	300		
Precipitation Total & Duration (10 sq mi)	21.0 inches 48 hours, 18" in 24hrs		
Storm Representative SST	78.0 F	**24**	
Storm Representative SST Location	27.90 N	97.50 W	J
In-place Maximum SST	79.5 F		79.5
Moisture Inflow Vector	SSE @ 100		
In-place Maximization Factor	**1.07**		
Temporal Transposition (Date)	15-Jul		
Transposition Dewpoint Location	33.88 N	93.04 W	J
Transposition Maximum SST	80.5 F		80.5
Transposition Adjustment Factor	**1.04**		
Grid Point Elevation	400		
Highest Elevation in Basin	14,344		
Inflow Barrier Height	xx		
Elevation Adjustment Factor	**1.00**		
Total Adjustment Factor	**1.11**		

Appendix G: Table G.38: Storm spreadsheet for Bebe, TX June 30, 1936

DEPARTMENT OF THE ARMY — CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



LOCATION MAP

Storm of 27 June - 4 July 1936
Assignment GM 5-6
Location Mexico, Texas and La.
Study Prepared by:
Southwestern Division
Galveston District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 3/17/47
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 7/21/48
Remarks: Center at Bebe, Texas
Dewpt. 78° - Ref. Pt. 100 SSE Grid J-16

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet , scale 1: 1,000,000

Precipitation data and mass curves:	(Number of Sheets)
Form 5001-C (Hourly precip. data)	25
Form 5001-B (24-hour " ")	71
Form 5001-D (" " " ")	-
Miscl. precip. records, meteorological data, etc.	28
Form 5002 (Mass rainfall curves)	71

PART II

Final isohyetal maps, in 1 sheet , scale 1: 1,000,000

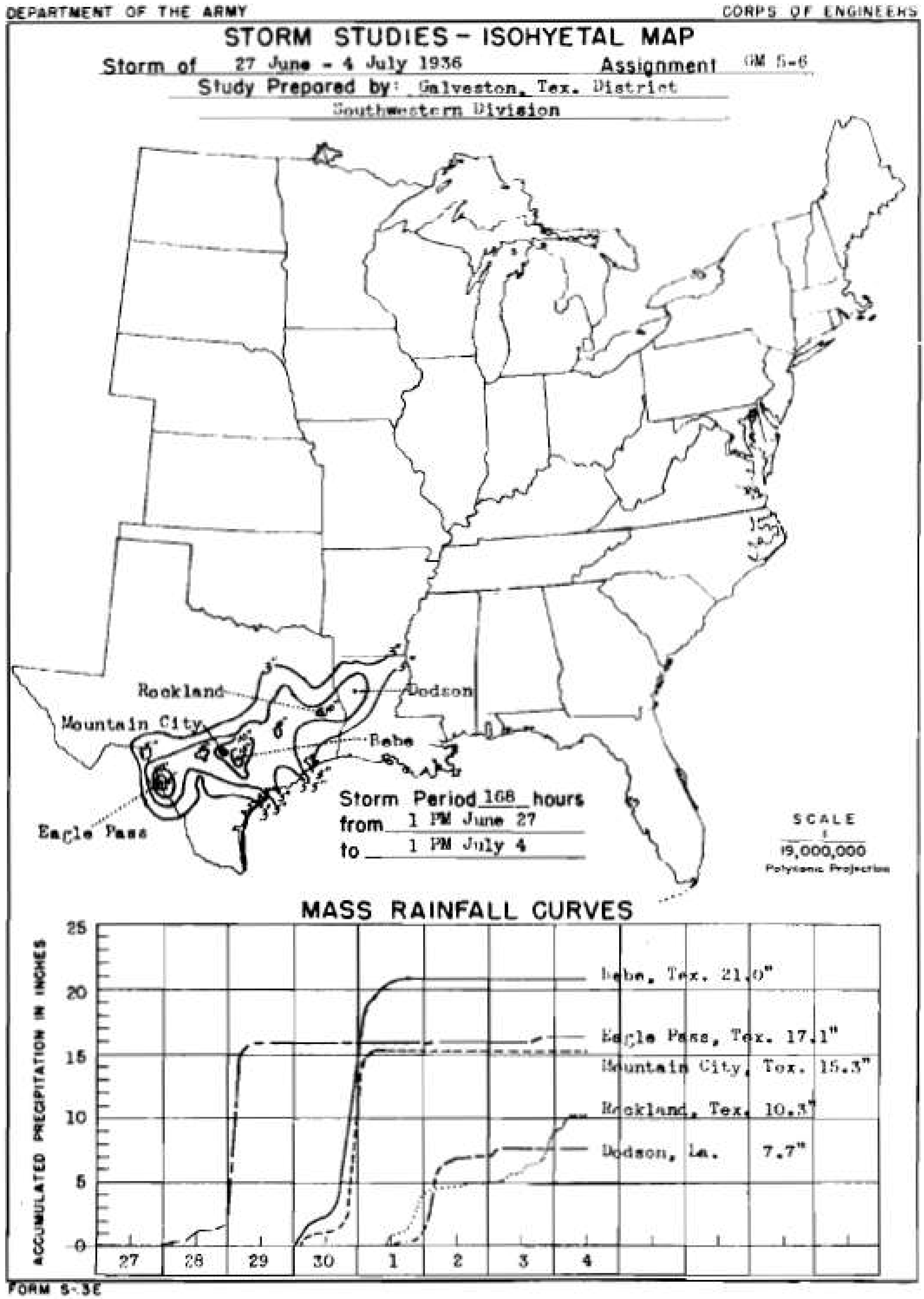
Data and computation sheets:	
Form S-10 (Data from mass rainfall curves)	4
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	8
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	72	96	120	168
10	14.0	16.0	16.8	18.0	18.8	20.8	21.0	21.0	21.0	21.0	21.0
100	12.7	14.4	14.9	16.1	17.0	18.4	18.9	19.4	20.2	20.2	20.2
200	12.2	13.8	14.3	15.4	16.2	17.7	18.2	18.6	19.3	19.3	19.3
500	11.5	13.0	13.4	14.4	14.8	16.2	16.7	17.2	17.8	17.8	17.8
1,000	10.9	12.3	12.6	13.4	13.6	14.9	15.4	15.8	16.5	16.5	16.7
2,000	10.1	11.4	11.6	12.2	12.4	13.4	13.8	14.3	14.9	14.9	15.2
5,000	8.1	9.1	9.6	10.0	10.2	10.9	11.2	11.9	12.5	12.5	13.1
10,000	5.7	6.9	7.6	8.0	8.3	8.9	9.2	10.2	10.8	10.8	11.5
20,000	4.0	5.1	5.6	6.1	6.6	7.2	7.5	8.5	9.1	9.2	10.0
50,000	2.3	3.1	3.6	4.1	4.6	5.0	5.4	6.3	7.0	7.2	7.9
100,000	1.2	1.8	2.3	2.8	3.0	3.4	3.8	4.6	5.3	5.7	6.3

Form S-2

Appendix G: Table G.39: Depth-area-duration values for Bebe, TX June 30, 1936



Appendix G: Figure G.46 and Figure G.47: Total storm isohyetal analysis and mass curve chart for Bebe, TX June 30, 1936

Neosho Falls, KS, AWA 61

September 12, 1926

Storm Type: MCC

Storm Name:	USACE SW 2-1-Neosha Falls, KS	**Storm Adjustment for ANO Grid Point 1**
Storm Date:	11-Sep-1926	
AWA Analysis Date:	12/16/2013	

Temporal Transposition Date: 25-Aug

	Lat	Long
Storm Center Location	38.08 N	95.70 W
Storm Rep Dew Point Location	31.35 N	93.80 W
Transposition Dew Point Location	36.00 N	90.58 W
Grid Point Location	35.31 N	93.23 W

Moisture Inflow Direction	SSE @ 475	miles
Grid Point Elevation	350	feet
Storm Center Elevation	1,000	feet
Storm Rep Analysis Duration	6	hours

The storm representative dew point is	75.0 F	with total precipitable water above sea level of		2.85	inches.
The in-place maximum dew point is	80.5 F	with total precipitable water above sea level of		3.68	inches.
The transpositioned maximum dew point is	79.5 F	with total precipitable water above sea level of		3.52	inches.
The in-place storm elevation is	1,000	which subtracts	0.25	inches of precipitable water at	75.0 F
The in-place storm elevation is	1,000	which subtracts	0.28	inches of precipitable water at	80.5 F
The transposition basin elevation at	350	which subtracts	0.29	inches of precipitable water at	79.5 F
The Grid point/inflow barrier height is	1,000	which subtracts	0.29	inches of precipitable water at	79.5 F

The in-place storm maximization factor is	1.31
The transposition/elevation to basin factor is	0.95
The barrier adjustment factor is	1.00
The total adjustment factor is	1.24

Notes: DAD values taken from USACE SW 2-1. Storm representative dew point value was based on maximum 6-hr Td values between September 1, 1926 at WBAN 93936 and 12945.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	13.6	13.8	14.0	14.0	14.0	14.0	14.0	14.0	14.0
10 sq miles	13.4	13.7	13.9	13.9	13.9	13.9	13.9	13.9	13.9
100 sq miles	12.2	12.5	12.7	12.7	12.7	12.7	12.7	12.7	12.7
200 sq miles	11.4	11.7	11.9	12.0	12.0	12.0	12.0	12.0	12.0
500 sq miles	9.5	10.0	10.2	10.2	10.2	10.2	10.2	10.2	10.2
1000 sq miles	7.9	8.5	8.8	8.8	8.8	8.8	8.8	8.8	8.8
2000 sq miles	6.4	7.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3
5000 sq miles	4.3	5.1	5.3	5.3	5.3	5.3	5.3	5.5	5.5
10000 sq miles	2.9	3.8	3.9	4.0	4.0	4.0	4.2	4.3	4.4
20000 sq miles	1.7	2.6	2.7	2.8	2.8	2.8	2.9	3.3	3.5

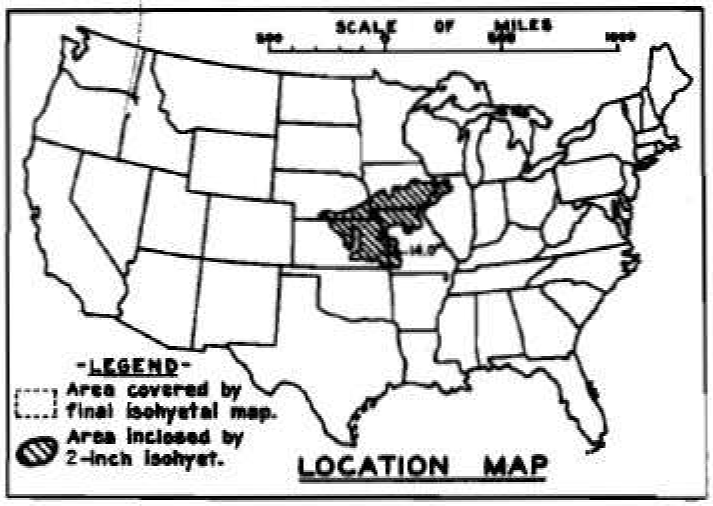
Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	16.9	17.1	17.4	17.4	17.4	17.4	17.4	17.4	17.4
10 sq miles	16.6	17.0	17.3	17.3	17.3	17.3	17.3	17.3	17.3
100 sq miles	15.2	15.5	15.8	15.8	15.8	15.8	15.8	15.8	15.8
200 sq miles	14.2	14.5	14.8	14.9	14.9	14.9	14.9	14.9	14.9
500 sq miles	11.8	12.4	12.7	12.7	12.7	12.7	12.7	12.7	12.7
1000 sq miles	9.8	10.6	10.9	10.9	10.9	10.9	10.9	10.9	10.9
2000 sq miles	8.0	8.8	9.1	9.1	9.1	9.1	9.1	9.1	9.1
5000 sq miles	5.3	6.3	6.6	6.6	6.6	6.6	6.6	6.8	6.8
10000 sq miles	3.6	4.7	4.8	5.0	5.0	5.0	5.2	5.3	5.5
20000 sq miles	2.1	3.2	3.4	3.5	3.5	3.5	3.6	4.1	4.3

Storm or Storm Center Name	**USACE SW 2-1-Neosha Falls, KS**			
Storm Date(s)	9/11/26			
Storm Type	MCC-Thunderstorm Complex			
Storm Location	38.08 N	95.70 W		
Storm Center Elevation	1,000			
Precipitation Total & Duration	14.00 Inches 18-hours			
Storm Representative Dewpoint	75.0 F	6		
Storm Representative Dewpoint Location	31.35 N	93.80 W	Aug	Sep
Maximum Dewpoint	80.5 F		79.5	78.5
Moisture Inflow Vector	SSE @ 475			
In-place Maximization Factor	**1.31**			
Temporal Transposition (Date)	25-Aug			
Transposition Dewpoint Location	36.00 N	90.58 W	Aug	Sep
Transposition Maximum Dewpoint	79.5 F		81	77
Transposition Adjustment Factor	**0.95**			
Grid Point Elevation	350			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.24**			

Appendix G: Table G.40: Storm spreadsheet for Neosho Falls, KS September 12, 1926

STORM STUDIES – PERTINENT DATA SHEET



Storm of September 11-16, 1926
Assignment S W 2 - 1
Location Kans. Nebr. Iowa Mo.
Study Prepared by:
Southwestern Division
Tulsa District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 1/31/41
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 6/5/45
Remarks: Center near Neosho Falls, Kans.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 2,500,000
Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data) ---------- 8
Form 5001-B (24-hour " ") ---------- -
Form 5001-D (" " " ") ---------- 6
Miscl. precip. records, meteorological data, etc. ---------- 2
Form 5002 (Mass rainfall curves) ---------- 17

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000
Data and computation sheets:

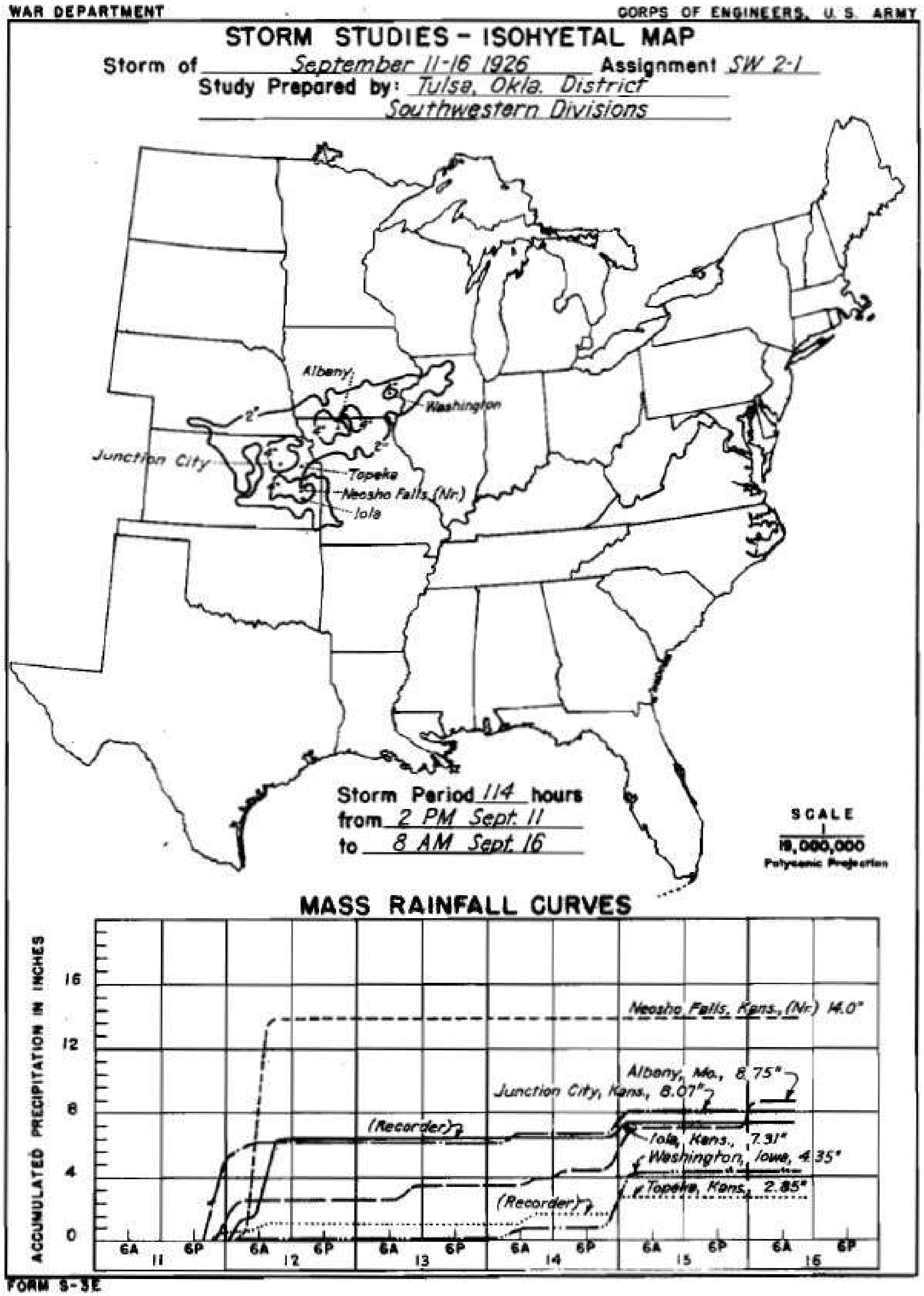
Form S-10 (Data from mass rainfall curves) ---------- 10
Form S-11 (Depth-area data from isohyetal map) ---------- 2
Form S-12 (Maximum depth-duration data) ---------- 6
Maximum duration-depth-area curves ---------- 1
Data relating to periods of maximum rainfall ---------- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	114
Max. Station	13.6	13.8	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
10	13.4	13.7	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9
100	12.2	12.5	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
200	11.4	11.7	11.9	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
500	9.5	10.0	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.4	10.4
1,000	7.9	8.5	8.8	8.8	8.8	8.8	8.8	8.8	8.8	9.0	9.0
2,000	6.4	7.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.6	7.6
5,000	4.3	5.1	5.3	5.3	5.3	5.3	5.3	5.5	5.5	5.8	5.8
10,000	2.9	3.8	3.9	4.0	4.0	4.0	4.2	4.3	4.4	5.0	5.0
20,000	1.7	2.6	2.7	2.8	2.8	2.8	2.9	3.3	3.5	4.4	4.5
30,000	1.2	2.0	2.1	2.2	2.2	2.2	2.3	2.8	3.0	4.1	4.2

Form S-2

Appendix G: Table G.41: Depth-area-duration values for Neosho Falls, KS September 12, 1926



Appendix G: Figure G.48 and Figure G.49: Total storm isohyetal analysis and mass curve chart for Neosho Falls, KS September 12, 1926

THRALL, TX AWA 77

September 9, 1921

Storm Type: Tropical

Storm Name:	USACE GM 4-12-Thrall, TX	**Storm Adjustment for ANO Grid Point 1**	
Storm Date:	9/9-10/1921		
AWA Analysis Date:	12/17/2013		

Temporal Transposition Date 25-Aug

	Lat	Long
Storm center location	30.59 N	97.30 W
Storm Rep SST location	27.00 N	97.30 W
Transposition SST location	31.72 N	93.23 W
Basin location	35.31 N	93.23 W

Moisture Inflow Direction:	S @ 250	miles
Grid Point Elevation	400	feet
Storm Center Elevation	550	feet
Storm Rep Analysis Duration	12	hrs

The storm representative SST is	77.0 F	with total precipitable water above sea level of			3.14	inches.
The in-place maximum SST is	78.0 F	with total precipitable water above sea level of			3.29	inches.
The transpositioned maximum SST is	79.5 F	with total precipitable water above sea level of			3.52	inches.
The in-place storm elevation is	550	which subtracts	0.15	inches of precipitable water at	77.0 F	
The in-place storm elevation is	550	which subtracts	0.155	inches of precipitable water at	78.0 F	
The transposition storm elevation at	400	which subtracts	0.12	inches of precipitable water at	79.5 F	
The moisture inflow barrier height is	N/A	which subtracts	0.12	inches of precipitable water at	79.5 F	

The in-place maximization factor is	1.05
The transposition factor is	1.08
The elevation/barrier adjustment factor is	1.00
The total adjustment factor is	1.14

Notes: USACE analyzed storm rep Td of 77 and in place max of 78. Because this apparantly correctly captured the storm moisture, no adjustment was made to move from the 12-hr persisting to the 12hr average dew points.

Observed Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	22.4	29.8	35.0	36.5	37.2	37.6	37.6	-	-
100 sq miles	19.6	26.2	30.7	31.9	32.6	32.9	32.9	-	-
200 sq miles	17.9	24.3	28.7	29.7	30.4	30.7	30.8	-	-
500 sq miles	15.4	21.4	25.6	26.6	27.3	27.6	27.7	-	-
1000 sq miles	13.4	18.8	22.9	24.0	24.6	24.9	25.1	-	-
2000 sq miles	11.2	15.7	19.5	20.6	21.2	21.5	21.6	-	-
5000 sq miles	8.1	11.1	14.1	15.0	15.9	16.2	16.3	-	-
10000 sq miles	5.6	7.7	9.7	10.7	11.8	12.1	12.2	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
10 sq miles	25.5	33.9	39.8	41.5	42.3	42.8	42.8	-	-
100 sq miles	22.3	29.8	34.9	36.3	37.1	37.4	37.4	-	-
200 sq miles	20.4	27.6	32.6	33.8	34.6	34.9	35.0	-	-
500 sq miles	17.5	24.3	29.1	30.2	31.0	31.4	31.5	-	-
1000 sq miles	15.2	21.4	26.0	27.3	28.0	28.3	28.5	-	-
2000 sq miles	12.7	17.9	22.2	23.4	24.1	24.4	24.6	-	-
5000 sq miles	9.2	12.6	16.0	17.1	18.1	18.4	18.5	-	-
10000 sq miles	6.4	8.8	11.0	12.2	13.4	13.8	13.9	-	-
20000 sq miles	-	-	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE GM 4-12-Thrall, TX**				
Storm Date(s)	9/9-10/1921				
Storm Type	MCC				
Storm Location	30.59 N	97.30 W			
Storm Center Elevation	550				
Precipitation Total & Duration (10 sq mi)	39.7 inches 36 hours, 38.2" in 24 hours				
Storm Representative SST	77.0 F				
Storm Representative SST Location	27.00 N	97.30 W	A	S	
In-place Maximum SST	78.0 F		79	79	AWA
Moisture Inflow Vector	S @ 250		78	78	Sunshine Atlas
In-place Maximization Factor					
Temporal Transposition (Date)	25-Aug				
Transposition Dewpoint Location	31.72 N	93.23 W	A	S	
Transposition Maximum SST	79.5 F		80.5	77.5	AWA
Transposition Adjustment Factor					
Average Basin Elevation	400				
Highest Elevation in Basin					
Inflow Barrier Height	N/A				
Elevation Adjustment Factor					
Total Adjustment Factor	**1.14**				

Appendix G: Table G.42: Storm spreadsheet for Thrall, TX September 9, 1921

WAR DEPARTMENT CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET

Storm of 8-10 Sept. 1921
Assignment GM 4-12
Location Central Texas
Study Prepared by:
Southwestern Division
Galveston District Office
& Hydrometeorological Section

Part I Reviewed by H. M. Sec. of Weather Bureau, 8/20/45
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 11/7/46
Remarks: Center near Thrall (Taylor) Texas

DATA AND COMPUTATIONS COMPILED
PART I

Preliminary isohyetal map, in 1 sheet, scale 1:1,000,000
Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	7
Form 5001-B (24-hour " ")	23
Form 5001-D (" " " ")	2
Miscl. precip. records, meteorological data, etc.	30
Form 5002 (Mass rainfall curves)	35

PART II

Final isohyetal maps, in 1 sheet, scale 1:500,000
Data and computation sheets:

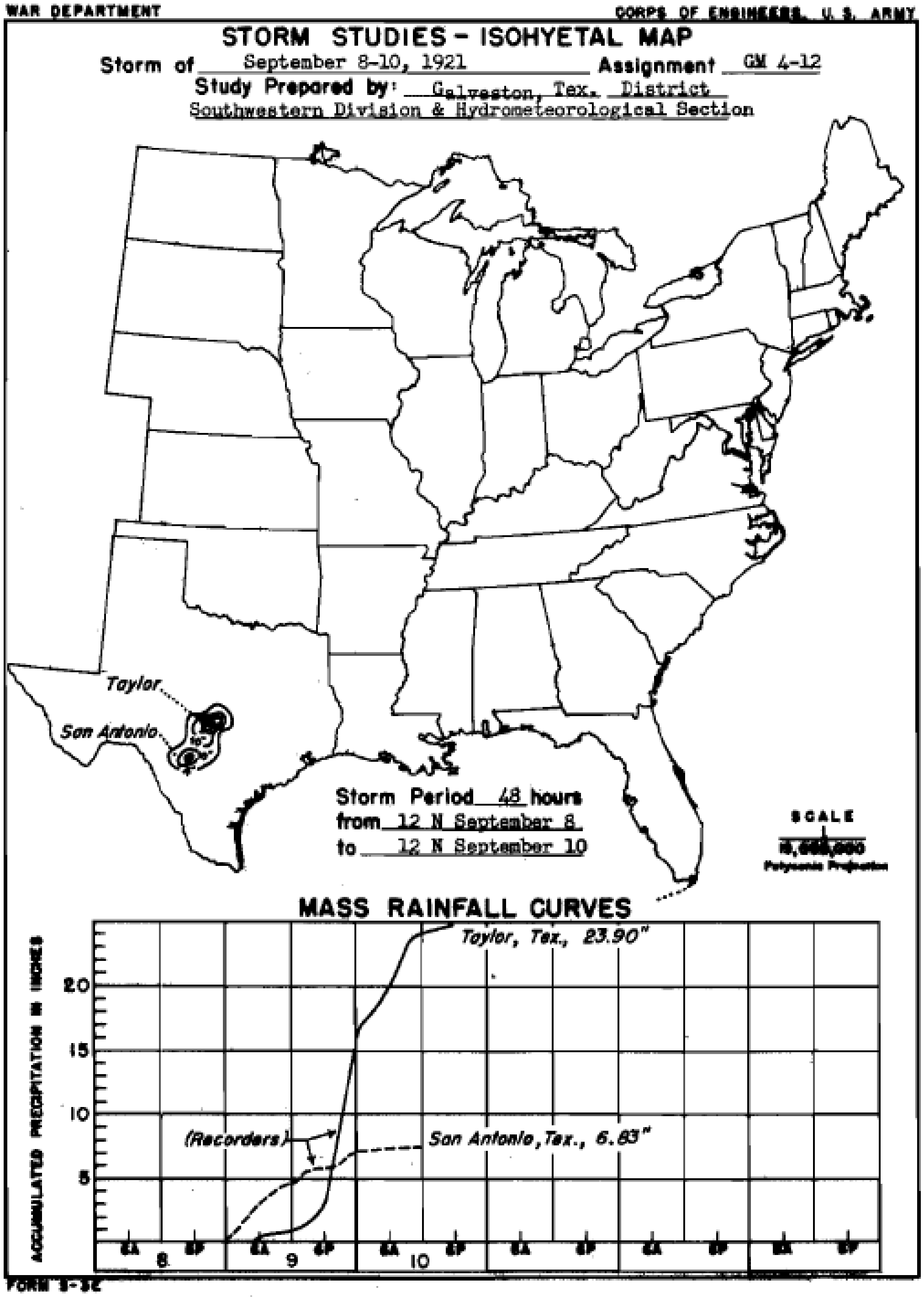
Form S-10 (Data from mass rainfall curves)	2
Form S-11 (Depth-area data from isohyetal map)	2
Form S-12 (Maximum depth-duration data)	38
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	—

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48				
Max. Station	23.4	31.8	36.4	38.2	39.2	39.7	39.7				
10	22.4	29.8	35.0	36.5	37.2	37.6	37.6				
100	19.6	26.2	30.7	31.9	32.6	32.9	32.9				
200	17.9	24.3	28.7	29.7	30.4	30.7	30.8				
500	15.4	21.4	25.6	26.6	27.3	27.6	27.7				
1,000	13.4	18.8	22.9	24.0	24.6	24.9	25.1				
2,000	11.2	15.7	19.5	20.6	21.2	21.5	21.6				
5,000	8.1	11.1	14.1	15.0	15.9	16.2	16.3				
10,000	5.6	7.7	9.7	10.7	11.8	12.1	12.2				
12,500	4.7	6.7	8.4	9.4	10.3	10.7	10.9				

Form S-2

Appendix G: Table G.43: Depth-area-duration values for Thrall, TX September 9, 1921



Appendix G: Figure G.50 and Figure G.51: Total storm isohyetal analysis and mass curve chart for Thrall, TX September 9, 1921

Bonaparte, IA, AWA 70

June 10, 1905

Storm Type: MCC

Storm Name:	**USACE UMV 2-5-Bonaparte, IA**		**Storm Adjustment for ANO Grid Point 2**
Storm Date:	**June 9, 1905**		
AWA Analysis Date:	**12/16/2013**		

Temporal Transposition Date	**30-Jun**	
	Lat	**Long**
Storm Center Location	**40.77 N**	**91.75 W**
Storm Rep Dew Point Location	**38.52 N**	**91.81 W**
Transposition Dew Point Location	**40.48 N**	**92.64 W**
Grid Point Location	**34.50 N**	**95.50 W**

Moisture Inflow Direction	**S @ 155**	miles
Grid Point Elevation	**550**	feet
Storm Center Elevation	**1,500**	feet
Storm Rep Analysis Duration	**12**	hours

The storm representative dew point is	**77.0 F**	with total precipitable water above sea level of			**3.14**	inches.
The in-place maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The transpositioned maximum dew point is	**80.0 F**	with total precipitable water above sea level of			**3.60**	inches.
The in-place storm elevation is	**1,500**	which subtracts	**0.39**	inches of precipitable water at	**77.0 F**	
The in-place storm elevation is	**1,500**	which subtracts	**0.43**	inches of precipitable water at	**80.0 F**	
The transposition storm elevation at	**550**	which subtracts	**0.30**	inches of precipitable water at	**80.0 F**	
The Grid Point/inflow barrier height is	**1,000**	which subtracts	**0.30**	inches of precipitable water at	**80.0 F**	

The in-place maximization factor is	**1.15**
The transposition factor is	**1.04**
The elevation/barrier adjustment factor is	**1.00**
The total adjustment factor is	**1.20**

Notes: DAD values taken from USACE UMV 2-5. Added 7° to the USACE analyzed storm rep dew point based on guidance from EPRI, Nebraska, TRWD.

Observed Storm Depth-Area-Duration

	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.0**	**10.2**	**12.1**	-	-	-	-	-	-	-
10 sq miles	**2.0**	**10.0**	**12.0**	-	-	-	-	-	-	-
100 sq miles	**1.9**	**9.2**	**11.5**	-	-	-	-	-	-	-
200 sq miles	**1.8**	**8.9**	**11.3**	-	-	-	-	-	-	-
500 sq miles	**1.8**	**8.5**	**10.7**	-	-	-	-	-	-	-
1000 sq miles	**1.7**	**8.0**	**10.0**	-	-	-	-	-	-	-
2000 sq miles	**1.6**	**7.2**	**9.1**	-	-	-	-	-	-	-
5000 sq miles	**1.3**	**5.8**	**7.3**	-	-	-	-	-	-	-
10000 sq miles	**1.0**	**4.4**	**5.6**	-	-	-	-	-	-	-
20000 sq miles	**0.7**	**3.0**	**3.9**	-	-	-	-	-	-	-

Adjusted Storm Depth-Area-Duration

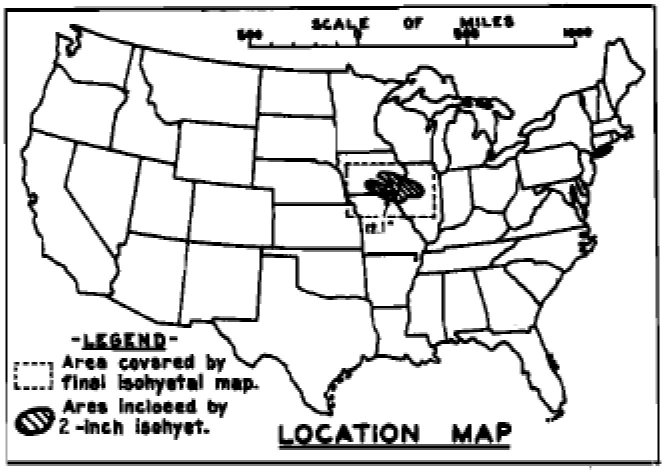
	1 Hours	6 Hours	12 Hours	18 Hours	24 Hours	30 Hours	36 Hours	48 Hours	60 Hours	72 Hours
1 sq miles	**2.4**	**12.2**	**14.5**	-	-	-	-	-	-	-
10 sq miles	**2.4**	**12.0**	**14.4**	-	-	-	-	-	-	-
100 sq miles	**2.3**	**11.0**	**13.8**	-	-	-	-	-	-	-
200 sq miles	**2.2**	**10.7**	**13.6**	-	-	-	-	-	-	-
500 sq miles	**2.2**	**10.2**	**12.8**	-	-	-	-	-	-	-
1000 sq miles	**2.0**	**9.6**	**12.0**	-	-	-	-	-	-	-
2000 sq miles	**1.9**	**8.6**	**10.9**	-	-	-	-	-	-	-
5000 sq miles	**1.6**	**7.0**	**8.8**	-	-	-	-	-	-	-
10000 sq miles	**1.2**	**5.3**	**6.7**	-	-	-	-	-	-	-
20000 sq miles	**0.8**	**3.6**	**4.7**	-	-	-	-	-	-	-

Storm or Storm Center Name	**USACE UMV 2-5-Bonaparte, IA**			
Storm Date(s)	9-Jun-1905			
Storm Type	MCC			
Storm Location	40.77 N	91.75 W		
Storm Center Elevation	1,500			
Precipitation Total & Duration	12.10 Inches 12-hours USACE UMV 2-5			
Storm Representative Dew Point	77.0 F	12		
Storm Representative Dew Point Location	38.52 N	91.81 W		
Maximum Dew Point	80.0 F			
Moisture Inflow Vector	S @ 155			
In-place Maximization Factor	**1.15**			
Temporal Transposition (Date)	30-Jun			
Transposition Dew Point Location	40.48 N	92.64 W	Jun	July
Transposition Maximum Dew Point	80.0 F		79	81
Transposition Adjustment Factor	**1.04**			
Grid Point Elevation	550			
Highest Elevation in Basin	14,344			
Inflow Barrier Height	1,000			
Elevation Adjustment Factor	**1.00**			
Total Adjustment Factor	**1.20**			

Appendix G: Table G.44: Storm spreadsheet for Bonaparte, IA June 10, 1905

WAR DEPARTMENT   CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES – PERTINENT DATA SHEET



Storm of June 9 – 10, 1905
Assignment U M V 2 – 5
Location S.E. Ia. and W.Cent.Ill
Study Prepared by:
Upper Mississippi Valley Division

Rock Island District Office
Part I Reviewed by H. M. Sec. of Weather Bureau, 6/20/40
Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 6/22/44
Remarks: Centers at:
Bonapart (Near), Ia., and Le Harpe, Ill.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1 : 2,500,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)	8
Form 5001-B (24-hour " ")	-
Form 5001-D (" " " ")	6
Miscl. precip. records, meteorological data, etc.	4
Form 5002 (Mass rainfall curves)	19

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000

Data and computation sheets:

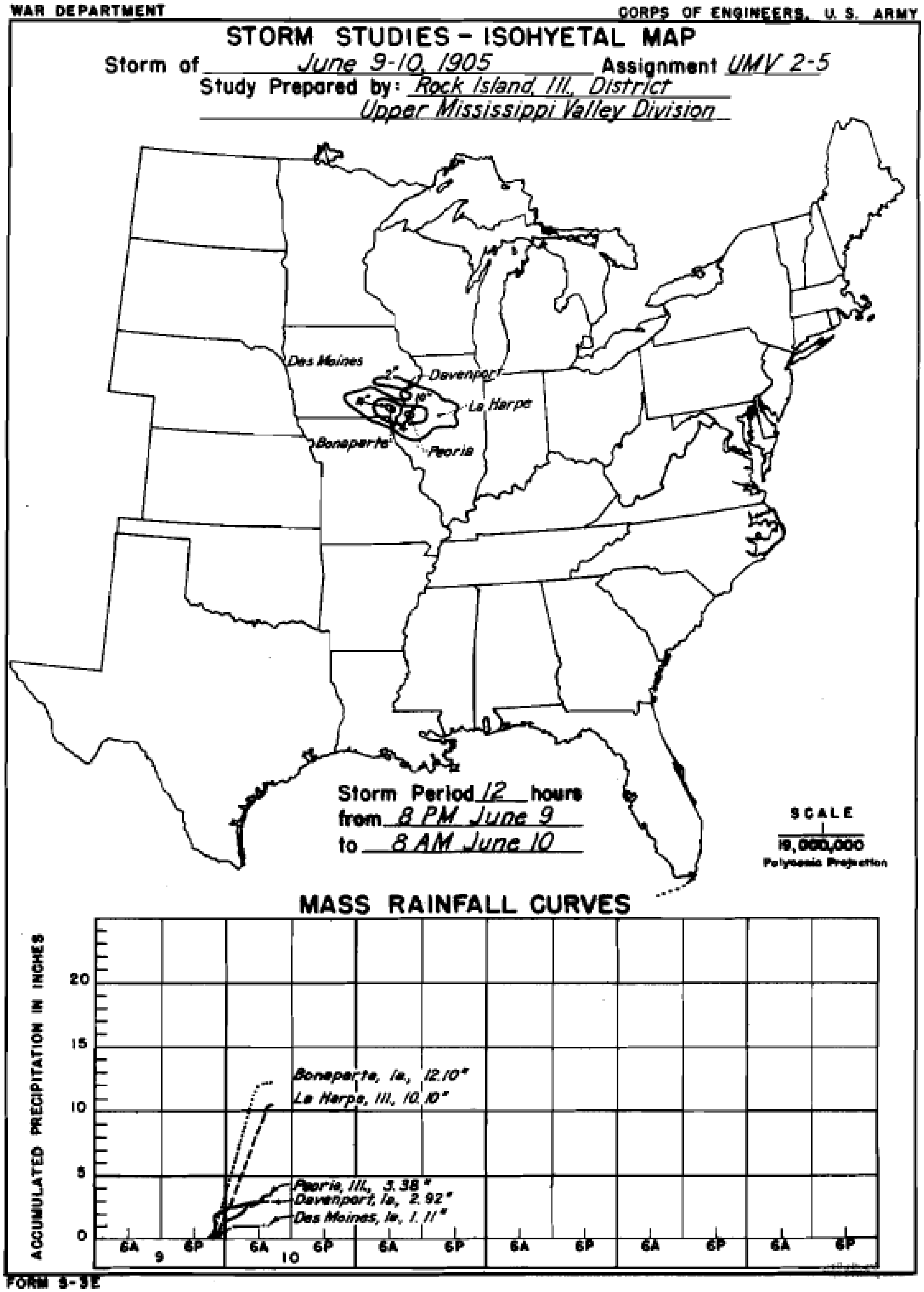
Form S-10 (Data from mass rainfall curves)	2
Form S-11 (Depth-area data from isohyetal map)	1
Form S-12 (Maximum depth-duration data)	6
Maximum duration-depth-area curves	1
Data relating to periods of maximum rainfall	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	1	2	3	4	5	6	7	8	10	12	
Max. Station	2.0	4.0	6.0	8.0	9.9	10.2	10.8	11.4	11.9	12.1	
10	2.0	4.0	5.9	7.9	9.7	10.0	10.5	11.2	11.8	12.0	
100	1.9	3.7	5.6	7.2	8.7	9.2	9.8	10.5	11.3	11.5	
200	1.8	3.6	5.5	7.0	8.4	8.9	9.5	10.2	11.1	11.3	
500	1.8	3.5	5.2	6.6	7.8	8.5	9.1	9.7	10.5	10.7	
1,000	1.7	3.4	4.9	6.2	7.4	8.0	8.6	9.0	9.8	10.0	
2,000	1.6	3.1	4.5	5.6	6.7	7.2	7.8	8.1	8.8	9.1	
5,000	1.3	2.5	3.5	4.5	5.2	5.8	6.2	6.5	7.0	7.3	
10,000	1.0	1.9	2.7	3.4	3.9	4.4	4.8	5.0	5.4	5.6	
20,000	0.7	1.3	1.7	2.1	2.5	3.0	3.1	3.3	3.7	3.9	

Form S-2

Appendix G: Table G.45: Depth-area-duration values for Bonaparte, IA June 10, 1905



Appendix G: Figure G.52 and Figure G.53: Total storm isohyetal analysis and mass curve chart for Bonaparte, IA June 10, 1905