

Secondary Identification and /or Statement of Cooperation

This is the Title on the Title Page for the Quick Hitter Flood Documentation Report Manuscript

By Author, Author, and Author

Report Series XXXX–XXXX

U.S. Department of the Interior

U.S. Geological Survey

U.S. Department of the Interior

SALLY JEWELL, Secretary

U.S. Geological Survey

Suzette M. Kimball, Acting Director

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Conversion Factors

Inch/Pound to SI

|  |  |  |
| --- | --- | --- |
| Multiply | By | To obtain |
| Length | | |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| Area | | |
| square mile (mi2) | 259.0 | hectare (ha) |
| square mile (mi2) | 2.590 | square kilometer (km2) |
| Flow rate | | |
| foot per second (ft/s) | 0.3048 | meter per second (m/s) |
| cubic foot per second (ft3/s) | 0.02832 | cubic meter per second (m3/s) |

This is the Title on Page One for the Quick Hitter Flood Documentation Report Manuscript

By Author, Author, and Author (Authors)

# Abstract

Flooding occurred in a broad area from X to Y during September, 2013. As much as YY inches of rain fell in a 2 day period as a low pressure system positioned over XXXXX steered Pacific moisture in the flood area resulting in precipitation through parts of XXXXX and YYYYYYYY. . XX U.S. Geological Survey streamgages observed peaks of record. Add more things of interest here, but keep it short.

# Introduction

Excessive heavy rainfall resulted in major flooding in parts of XXX, YYY, and ZZZ (figure 1) during September, 2013, including the Colorado Front Range, a geographic area immedaiately adjacent and east of the foothills to the Colorado Rockies. Some areas experienced more than XX inches of rainfall in a seven day period (reference here, 2013). The bulk of the rainfall fell in a 36 hours period from September 11 to XXXXX city. These floods resulted in at least XX fatalities (New York Times Newspaper). Damages will likely be over $3 Billion (USAToday Newspaper).

1. Map of the areas in XXXXXXXX where floods occurred in September 2013

The YYYYYY physiographic regions has experienced flooding, sometimes catostprophic, in the past. Examples include the 1976 flood on the Makeitup River in XXXX, a flood that killed XX people (reference, 19XX) and the 1997 Anytown, Anystate flood which caused an estimated $200 Million in damages including to the PoDunk State University (PoDunk State University, 2007). Typical flooding in the mountain/foot hills portion of this region has rapid onset due to the steep gradients and narrow channel valleys and results in large amounts of erosion and damage (fig. 2) . Once out into the flatter plains topography of this region (fig. 3), the flooding becomes widespread as the”backwater” effect of numerous fast moving high-gradient tributary streams dumping water out into the lower gradient plains streams and rivers results in slower movement of the flood waters and increased flood heights.

1. Flood damage (photo from damage in a mountainous/foot hills region)
2. Aerial photograph of the widespread flooding on the LongSlowFlood River near the mouth of RapidFlood Creek

The U.S. Geological Survey (USGS) collects and disseminates streamflow data at over 8,000 streamgages nationwide. In Anystate1, Anystate2, and Anystate3, the USGS operates XXX streamgages in cooperation with numerous local, state, and federal agencies. In addition, other agencies in Anystate1 operate streamgages. Streamflow data collection serves a variety of purposes including flooding. Leading up to and during flooding, streamflow data is vital for flood warning, forecasting, and emergency management. The long-term systematic streamflow data is used to do mitigate for floods in the design or repair of infrastructure (for example, road, bridges, reservoirs, and pipelines) , houses, and buldings.

## Purpose and Scope

The purpose of this report is to document the peak streamflows and stages for those rivers and streams in Anystate1, Anystate2, and Anystate3 impacted by flooding during September 2013. This includes both USGS streamgages as well as selected non-USGS streamgages. The 2013 flood peak flows are placed into context by ranking the 2013 floods with the annual peak flood for the period of record at each streamgage as well as historic floods that might precede the systematic records.

## Study Area

The streamgage data (peak stage and streamflow) documented in this report are located in the LARGERIVER1 basin, which drains large portions of ANYSTATE1, ANYSTATE2, and ANYSTATE3. The LARGERIVER basin has headwater streams along the eastern slope of the HIGHMOUNTAIN RANGE flowing through the foothills and into the main stem LARGERIVER1 River which runs in an northeasterly direction through the Plains area (fig. 1). Ground elevations range from greater than 10,000 in the eastern slope of the Rockies to around 4500 feet as the South Platte moves inot Nebraka. Land use types in the study area include: forest and wooodlands, grass and rangelands, and urban. Some of the streams are bordered by lands used by the oil and gas industry for extraction and storage of petrochemicals.

# General Weather Conditions and Precipitation Causing Flooding

A slow-moving, near-stationary, low-pressure system over the Cornflake Basin (southwest of ANYSTATE1) pulled a strong plume of monsoonal tropical moisture from the Pacific Ocean off western Mexico and as time progressed, the circulation pattern brought additional moisture from the Gulf of Mexico on easterly and southeasterly flows (Lukas, 2013) (fig. 4). These easterly and southeasterly flows resulted in upslope flows in the Front Range and propelled the moisture against the foothills. The presence of a stalled cold front assisted with additional lift, resulting in rainfall over a very large area (roughly from Colorado Springs north to Fort Collins). Rainfall amounts exceeded 15 inches in some locations from September 9 -15, 2013 (fig. 5), with the majority of it falling in a 36-hour period from the afternoon of September 11, 2013 through early morning September 13, 2013. Boulder County was hit with just over 9 inches on September 1, with total rainfall for the storm of up to 17 inches by September 15 . Boulder County has an average annual precipitation of 20.7 inches . Maximum the maximum 24-hour rainfall (worst case 24-hour rainfall ) along the Colorado Front Range was determined from NEXRAD rainfall data by National Weather Service (National Weather Service, Written Communication, September 17, 2013).

1. Moisture sources and flow for the September 2013 precipitation causing flooding in eastern STATE1 (adapted from Lucas, 2013)
2. Isohyets of rainfall for September 9-15, 2013

# Methods

In this report, streamflow data refer to both stage and volumetric streamflow (streamflow). These data were collected either systematically at streamgages or from periodical/intermittent field observations of streamflow at locations where no streamgage is present.

USGS streamgages operate autonomously by collecting data at some frequency (typically either 5 or 15 minutes) dependent on watershed size and cocommitant flashiness of the stream. The typical streamgages automatically makes observations of stage data. The stage data are collected using a variety of methods (float, submersible pressure tranducer, non-submersible pressure transducer, or non-contact radar). Although stage data are important, streamflow is often more important for such purposes as streamflow forecasting, water quality loading, flood frequency analysis, and flood mitigation planning. Derivation of streamflow from stage data at a streamgage requires periodic measurements of streamflow for the construction of a relation that will convert the stage data to streamflow data. In most cases the relation is a simple stage-streamflow rating curve (rating curve) (fig. 7).On site direct measurements are done by USGS personnel (fig. 8) making physical observations of stream velocity and stream depth to determine streamflow (Turnipseed and Sauer, 20XX) . After construction of the rating curve, continued periodic measurements of streamflow are required at various stages to calibrate the rating curve. The rating curve allows for the determination of the streamflow from the stage data when USGS personnel are not physically present at the streamgage to make a streamflow measurement.

1. Rating curve for Big Thompson River at Loveland, Colorado (USGS Streamgage 06741510)
2. USGS hydrographer making a direct streamflow measurement at XXXXXXXXXXXXX

In some cases, direct measurements of streamflow during a flood are not possible or impractical. In those instances, indirect measurement methods are used (Benson and Dalrymple, 1967), whereby water surface profiles determined by high water marks and channel geometry are used in hydraulic equations based on the principles of conservation of energy, conservation of momentum, and continuity to compute the peak streamflow for that particular flood. The high water marks and channel geometry are determined by field survey (fig. 8). USGS assigns uncertainty/accuracy estimates to each indirect measurement based on the hydraulic and geometry conditions found at each field site (Benson and Dalrymple, 1967; Matthai, 1967; Bodhaine, 1968; Dalrymple and Benson, 1967; and Hulsing, 1967).

1. U.S. Geological Survey field crews conducting surveys of high-water marks and channel geometry as part of an indirect determination of streamflow

Agencies besides USGS also collect streamflow data. For the most part, these data are collected using methods and standards similar to those used by USGS. However, any non-USGS data reported in this report has not been quality assured by USGS and thus the collecting agency is identified. Any questions regarding methods of data collection for non-USGS data should be referred to the collecting agency.

# Peak Streamflows and Stages

Peak streamflow and stage during the 2013 floods for XXX locations in the Anyriver basin are listed in table 1 (at the end of this report), with their locations shown in figure 1. The streamgages and periodic/intermittent sites included in table 1 were chosen because: 1) the 2013 peak streamflow for that location ranked in the top 5 peak flows for the period of record, 2) the site was a periodic/intermittent location where the peak streamflow was determined, or 3) the site was included to allow comparison with past major floods. Data is included in table 1 from both USGS and from other agencies.

1. Peak streamflows and stages at selected streamgages in the South Platte Basin during the 2013 floods

The rank for the 2013 streamflow peak at selected streamgages for the period of record are presented in table 1. XX USGS streamgages had peaks of record for streamflow and YY had peaks that ranked in the top 5 for the period of record. The peak stage and streamflow are not always conincident in time for the locations in this report, particularly for those streams and rivers that have hydraulic loops (due to such hydrodynamic factors) that result in the peak stage not coinciding with the peak streamflow particularly that can happen in lower gradient streams (Holmes and others, 2013).

The majority of the flood peaks occurred on September 12 or 13, 2013, depending on the size and location of the watershed, with larger watersheds peaking later than the smaller watersheds. For those streams in the Colorado Front Range and Plains, which are lower gradient and receive flow from the headwaters, peak streamflow and stage occurred for the most part later in the day on September 12 into September 13, 2013.

# Comparison to Past Floods

Talk about comparison to past floods. If time does not allow, eliminate this section.

# Summary

During September 2013, flooding on numerous streams and rivers in the eastern STATE1, western STATE2, and southern STATE3 resulted in in XX fatalities and $3 Billion in damages. The floods were the result of excess rainfall, with rainfall amounts of as much as XX inches in a seven day period, and YY inches at Boulder, STATE1 in the 36 hour period from September 11 through early morning September 13, 2013. The majority of the flood peaks occurred on September 12 and 13, 2013.

Peak streamflow and stage data, collected by USGS and other agencies, are documented in this report. Peak streamflow records were broken at XX USGS streamgages, with YY USGS gages having September 2013 peaks in the top 5 for the period of record. If you have the section on historic flood comparision, then discuss the historic context of this flood for a sentence or so to end this summary paragraph……

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