COLORADO
Department of Transportation
Division of Transportation Development

RESEARCH BRIEF
Applied Research and Innovation Branch

PROJECT TITLE
Eastern Colorado Crest-Stage Network, 2018 through 2020

STUDY TIMELINE
July 2017 – December 2021

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FURTHER RESOURCES
1) https://www.usgs.gov/centers/colorado-water-science-center/science/eastern-colorado-crest-stage-gage-network
2) https://doi.org/10.5066/F7P55KJN
3) https://waterdata.usgs.gov/nwis/inventory/?site_no=06752285
4) https://waterdata.usgs.gov/nwis/inventory/?site_no=06756350
5) https://waterdata.usgs.gov/nwis/inventory/?site_no=06758400
6) https://waterdata.usgs.gov/nwis/inventory/?site_no=06760230
7) https://waterdata.usgs.gov/nwis/inventory/?site_no=06822210
8) https://waterdata.usgs.gov/nwis/inventory/?site_no=06822550
9) https://waterdata.usgs.gov/nwis/inventory/?site_no=06822585
10) https://waterdata.usgs.gov/nwis/inventory/?site_no=06822700
11) https://waterdata.usgs.gov/nwis/inventory/?site_no=06826680
12) https://waterdata.usgs.gov/nwis/inventory/?site_no=06855001

Eastern Colorado Crest-stage Gage Network, 2018-2020

Introduction

Reliable peak-streamflow information is critical for the proper design of infrastructure (bridges and dams) and the development of floodplain inundation maps. At gaged sites, where sufficient long-term streamflow data have been collected, statistics are available using data in the U.S. Geological Survey (USGS) National Water Information System (NWIS) database or other sources of flood information. However, estimates also are needed at ungaged sites where site-specific streamflow data are not available. Additionally, in areas with short periods of record and few streamgages, large uncertainties may occur in the regional-regression equations used for estimating streamflow. Additional flood information will improve the reliability of the regional-regression equations in eastern Colorado. Flood-frequency characteristics of Colorado rivers and streams are needed by agencies such as the Colorado Department of Transportation (CDOT) for bridge and hydraulic structure design and by public agencies and private entities for flood studies. Flood-frequency regression equations commonly are used at ungaged sites where no measured streamflow data are available. As a result, on July 5, 2017, CDOT Applied Research and Innovation Branch approved Research Study R218.06 which was a three-year collaborative effort between CDOT and the U.S. Geological Survey. Research Study R218.06 was titled *Eastern Colorado Crest-Stage Network, 2018 through 2020* and was an extension to Research Study R215.06 that had ended in 2016 which was titled *Eastern Colorado Crest-Stage Network, 2015 through 2016*. Research Study R218.06 provided three years of flood data at 10 sites in eastern Colorado. The locations of the 10 crest-stage gage sites are shown in figure 1 and were collaboratively selected by CDOT and USGS based on location, access, and previous data availability.

Methodology or Action Taken

The objective of this study was to collect peak-streamflow data at the 10 sites in eastern Colorado identified in figure 1 using crest-stage gages for water years (October 1 to September 20) 2018-2020. The scope of this effort for each site each year includes survey levels, water level data collection, data entry, streamgage records, publication of peak streamflow, and site maintenance. Each site was located on an ephemeral stream that crossed through a culvert under a highway or county road. At each site, two crest-stage gages were installed, one was located approximately one culvert width upstream of the culvert entrance and the second was located approximately one culvert width downstream of the culvert exit to facilitate the computation of flood discharge. A crest-stage gage is a device that is used to economically record peak stage of a flood event. Typically, a crest-stage gage (figure 2) is comprised of a steel pipe fixed in a vertical position that is vented using several intake holes in the bottom of the pipe. When a flood occurs, the pipe fills to the flood stage level outside the pipe. The flood stage level is recorded by a pressure transducer mounted at a known elevation and cork dust deployed at the bottom of the pipe provides a replicate record of the peak stage. Once the peak stage is recorded, the

peak discharge can be determined using the culvert indirect discharge method. Crest-stage gages require less infrastructure to operate and do not require telemetry, which results in cost savings over traditional streamgages. Pressure transducers allow for a complete stage record to be collected instead of simply the peak stage. Installing crest-stage gages equipped with pressure transducers provided an economic alternative to installing and operating traditional streamgages particularly in ephemeral streams common in eastern Colorado because the cork dust method simply leaves evidence of the peak water level that occurred during a flood and does not provide information on duration or timing of the peak. The crest-stage gages with pressure transducers and cork dust were be operated seasonally during late spring, summer, and early fall when the peak streamflow is most likely to occur. The crest-stage gages were still operated during late fall, winter, or early spring with traditional cork dust only because this time of year most streams in eastern Colorado are dry.

Conclusions or Next Steps

At the end of 2020, it was determined to extend the project scope through 2021 and collect an additional year of data at no cost. At the end of each water year, peak-streamflow data were analyzed and published in the USGS NWIS Website (https://doi.org/10.5066/F7P55KJN), the USGS National online database for water data. The crest-stage gage records and peaks at each of the 10 sites were first analyzed, checked, and reviewed prior to publication. In addition, maps, pictures of the sites, and the peak-streamflow data has been published online through 2021 and are accessible from the project webpage at https://www.usgs.gov/centers/colorado-water-science-center/science/eastern-colorado-crest-stage-gage-network. In the future, Paleoflood data (geologic and paleobotanical evidence to determine the ages and magnitudes of floods that occurred before collection of observational records) could be collected at each site to enhance the data for potential future flood frequency studies. For this data collection effort to be most effective, crest-stage gage operation will need to continue for a period of 4 additional years or more, beyond the scope of this project and the previous one. USGS regional flood-frequency studies in Colorado have required sites to have 10 years of record to be included in the flood-frequency analyses. This is a generally accepted USGS statistical threshold, and these sites will ultimately need 10 years of data collection before they will be available for use in the next flood frequency study.

Potential Impacts and Benefits

The primary benefit of this study was additional peak-streamflow data in eastern Colorado. In the future, if data collection continues, these data could be used to update the regional-regression equations in Colorado, which could greatly benefit from improved accuracy of flood-frequency estimates. Additional data would allow water managers, planners, engineers, and scientists to reduce the prediction errors of flood-frequency estimates, which could lead to more cost-efficient design of bridges and hydraulic structures and better definition of flood-inundation maps. Crest-stage gages provide commonly needed hydrologic information that is scientifically-defensible. These data were collected in a uniform, non-biased manner and can be used in flood-frequency analysis.

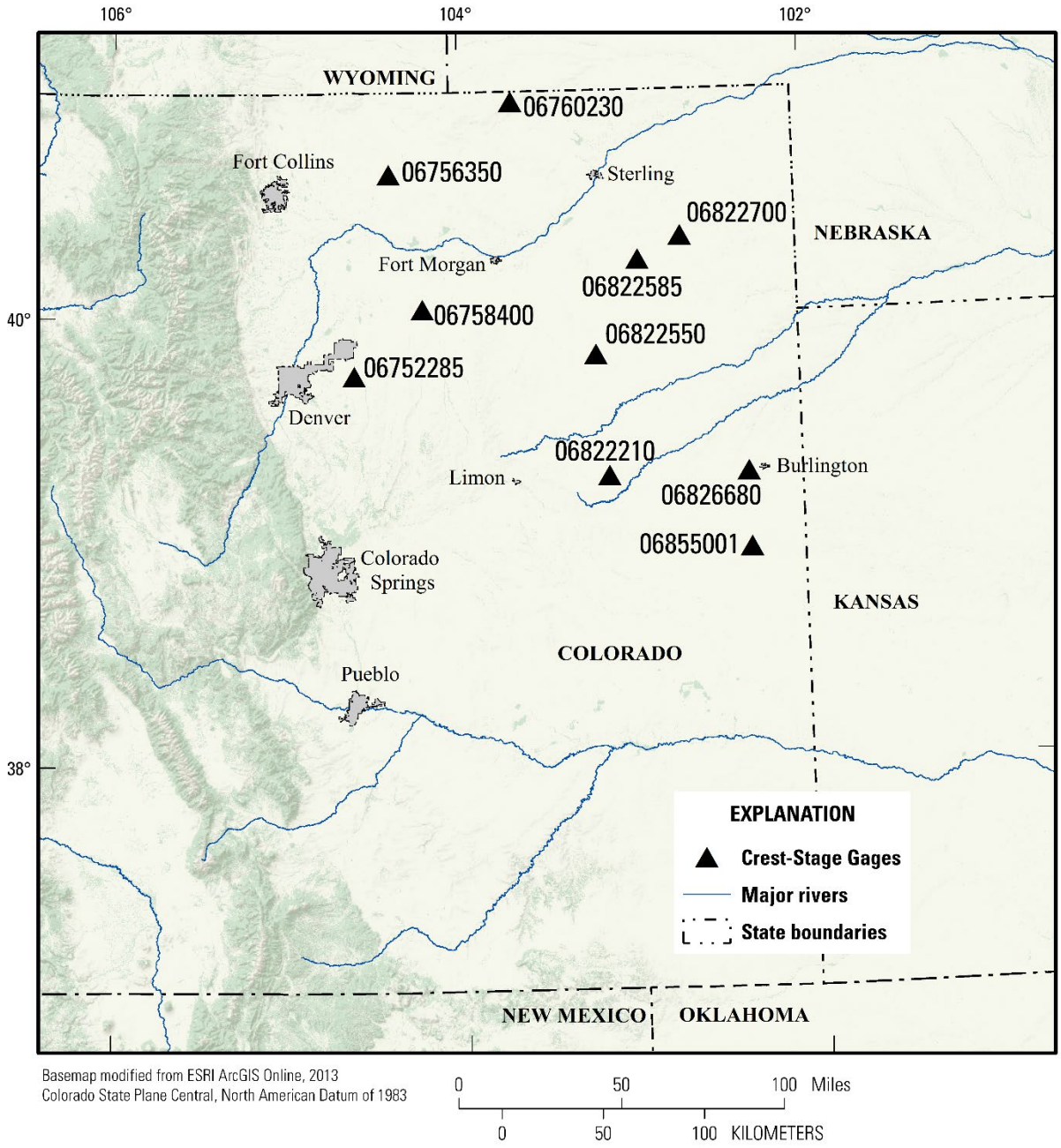

Figure 1. The location of the 10 crest-stage gages in eastern Colorado with the USGS station number with the Foothills region to the west of 104° longitude and the Plains hydrologic region to the east of the -104° longitude.

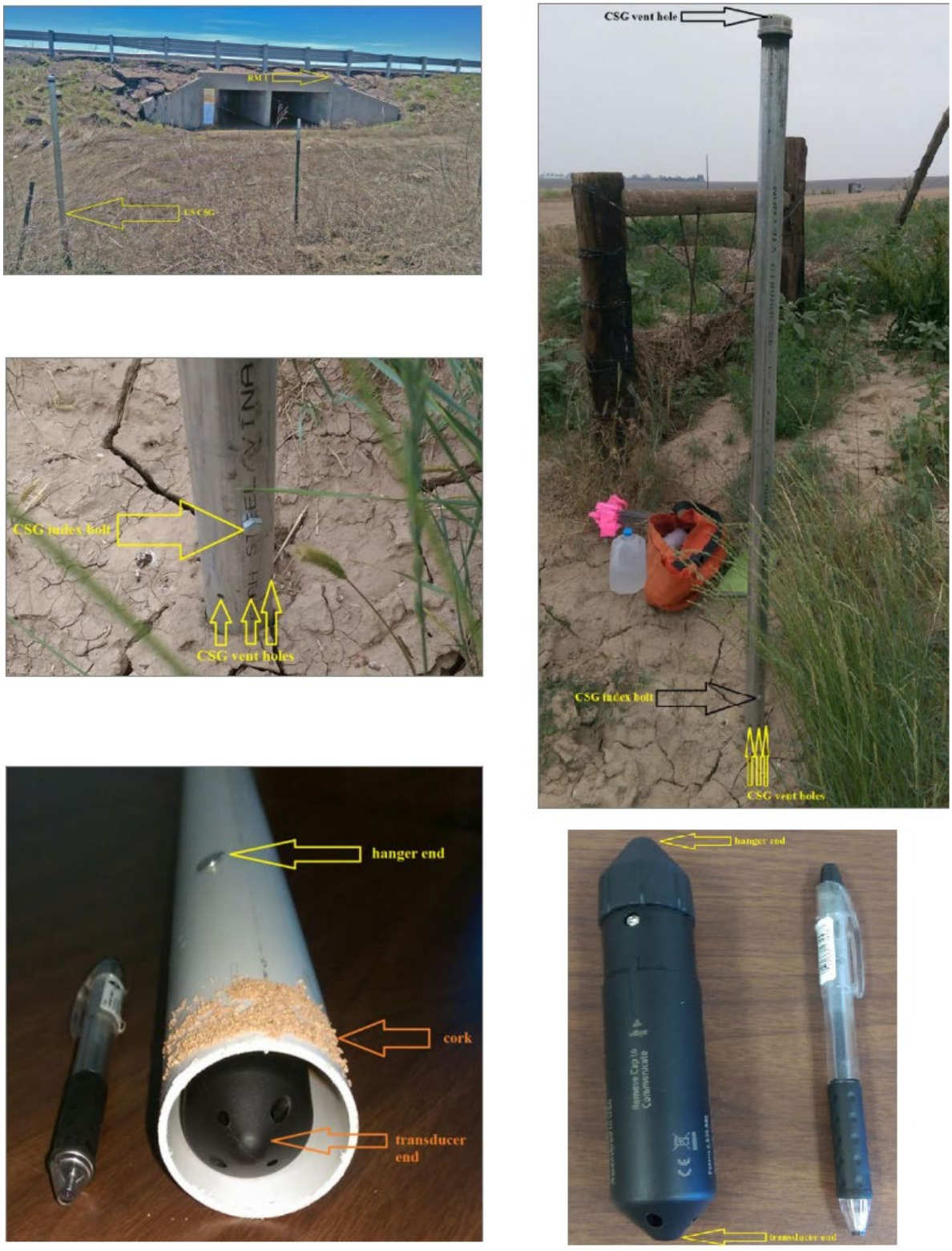

Figure 2. The typical crest-stage gage setup with cork dust and a pressure transducer.