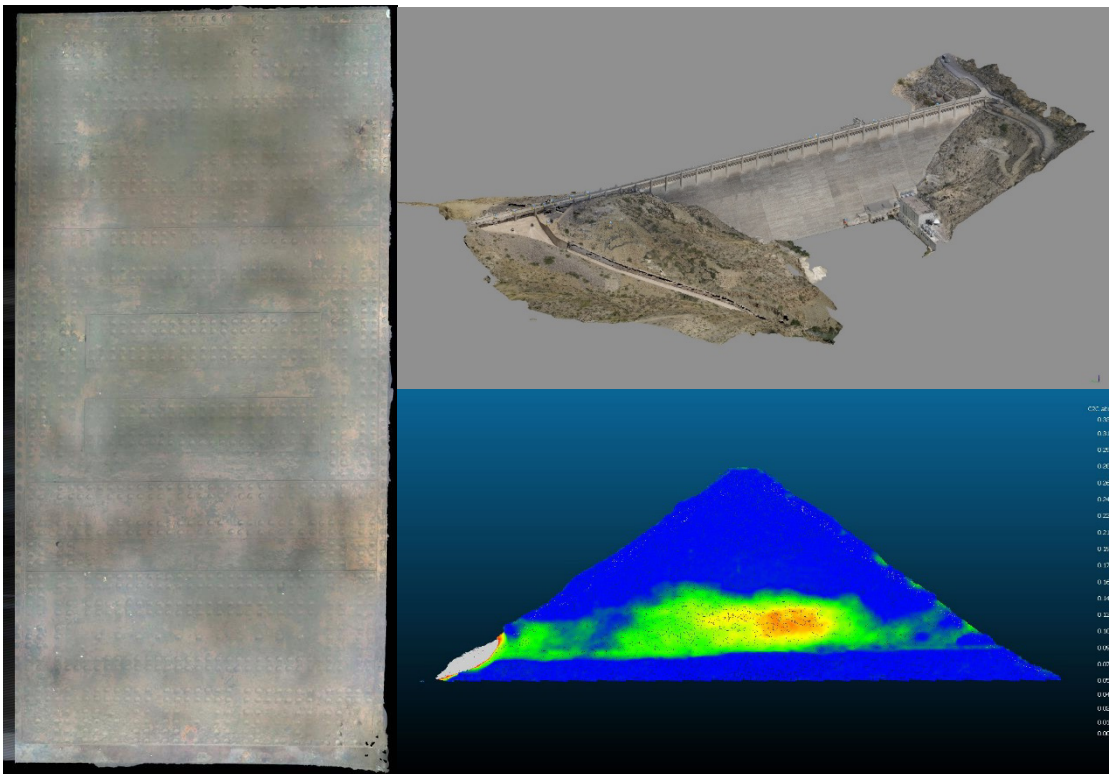
RECLAMATION

Managing Water in the West

Photogrammetry Users Group

Research and Development Office
Science and Technology Program
(Final Report) ST-2016-4549-01



U.S. Department of the Interior
Bureau of Reclamation
Research and Development Office

September 2016

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Executive Summary

This report describes the activities of the Reclamation Photogrammetry Users Group. The Photogrammetry Users Group was organized in response to growing interest in the use and applications of photogrammetry. Four webinars over the past 9 months were presented with topics on condition assessment, topographical maps, unmanned aerial systems, and geological scour. The webinars were open to anyone by invitation and allowed ideas and knowledge sharing.

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Overview

In FY2015, Eric Peterson, with the Trinity River Restoration Program in Weaverville, CA, began a photogrammetry user's group to help advance understanding and applications for photogrammetry. The knowledge led to the development of a report titled Whitepaper on Structure from Motion (SfM) Photogrammetry: Constructing Three Dimensional Models from Photography [1]. In FY2016, the effort was carried on at the Technical Service Center (TSC) in Denver. A total of four webinars were hosted. Participant numbers ranged between 9 and 16 for each webinar which were offered publically. This report summarizes the topic of each webinar.

Webinar #1

The first webinar was held on April 11, 2016 and featured the results of two photogrammetry applications. The first was the photogrammetric processing of imagery taken from underwater remotely operated vehicle (ROV) high definition (HD) video of the intake structure at Trinity Dam. The second application was using photogrammetry to provide a difference model before and after an earthen embankment failure test performed in the hydraulic laboratory in Denver.

For the Trinity Dam project, frames were removed from the ROV HD video of the upstream face of the fixed wheel gate over 1,700 feet inside of the intake tunnel that was over 200 feet deep. The ROV offset from the gate was about 2-3 feet and the width of the video about 3-4 feet. Photogrammetric processing was performed to build a 3D model of the gate and the result was a high resolution orthophoto mosaic (see Figure 1). The mosaic was used by Reclamation inspectors to identify corrosion [2].

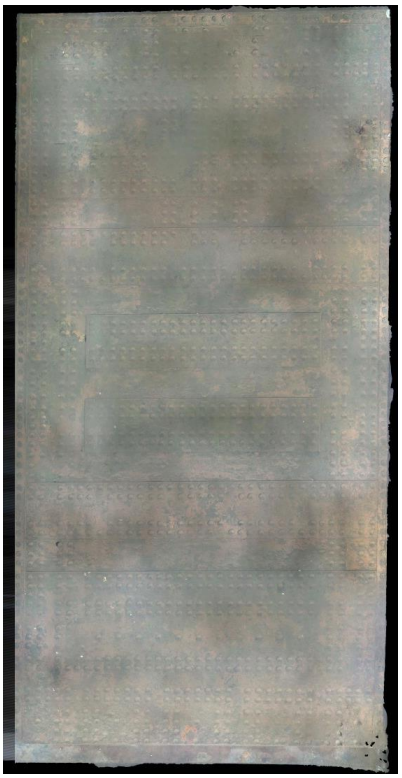

Figure 1: Trinity Intake Fixed Wheel Gate Orthophoto

The interior scour and erosion process that undermines earthen embankment is not well understood. A model embankment was constructed with the cross section of the embankment visible through a reinforced clear acrylic sheet. Photogrammetric data was collected before and after the testing to determine the amount of material removed. A difference model between the two surfaces shows where the material has been removed (see Figure 2).

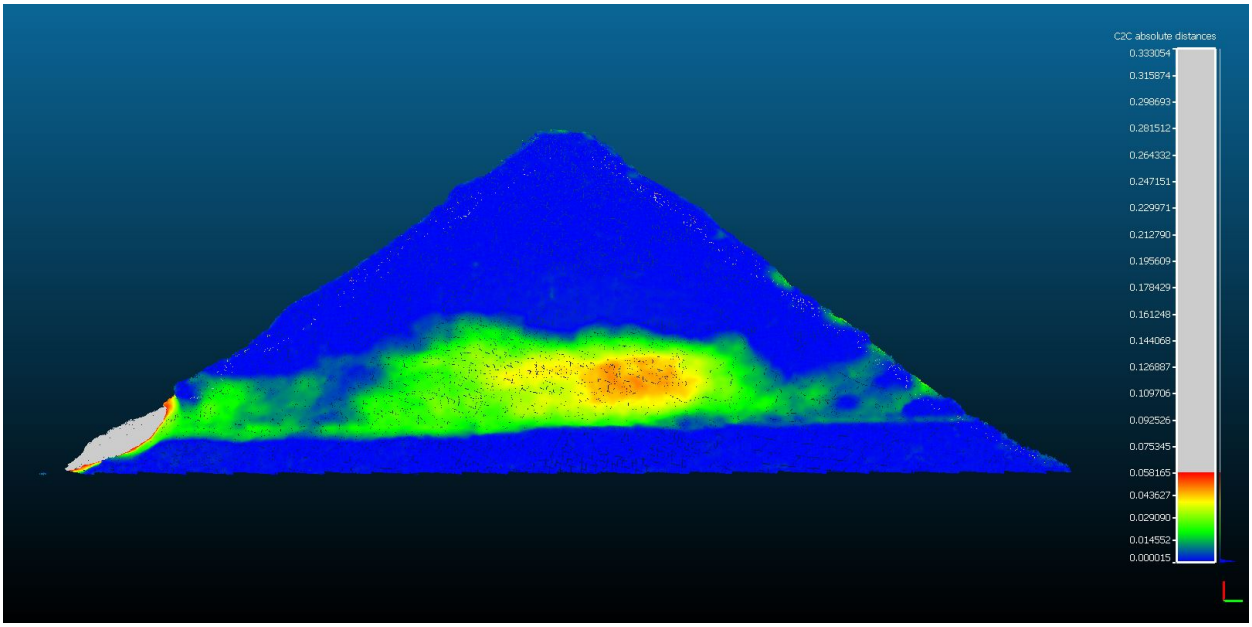

Figure 2: Difference Model Showing Material That Was Removed

Webinar #2

On June 23, 2016, the second webinar was broadcast and featured the results from the Grand Coulee Drum Gate Pier Analysis. Grand Coulee is considering design alternatives for a floating bulkhead that can seal against the drum gate pier and approach apron noses so that maintenance and/or repair can be performed on the drum gates during high pool. The bulkhead seal has a tolerance of $1/10^{th}$ of a foot. Photogrammetric analysis was performed to determine the profile of the pier nose and whether the seal will be able to effectively mate against it. Figure 3 shows the results from Gate 1 piers. The green area represents the part of the pier that is closest to the tip and the red shows the area that is near 0.1 feet away from the tip. The grey area is greater than 0.1 feet away [3].

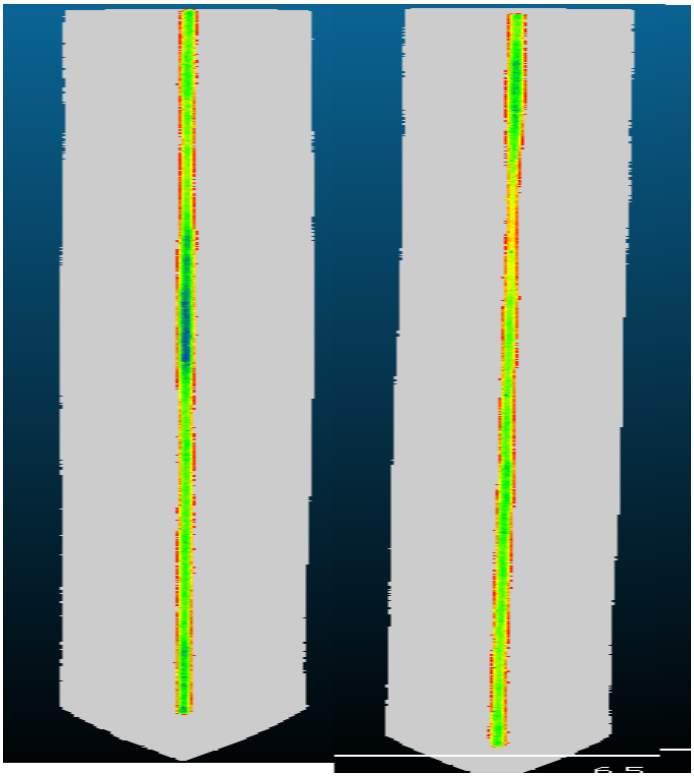

Figure 3: Grand Coulee Drum Gate Pier Profile Analysis

Webinar #3

Webinar #3 was held on August 18, 2016. The topic presented was the Elephant Butte aerial data collection and photogrammetry. The presentation covered how an unmanned aerial system (UAS) was contracted and used to obtain optical and infrared (IR) photogrammetric data (see Figures 4 and 5). The model was georeferenced to create a topographical map of the dam and surrounding areas. The results demonstrated that UAS captured data can be used to develop detailed model of the Reclamation facilities for inspection, analysis and design [4].

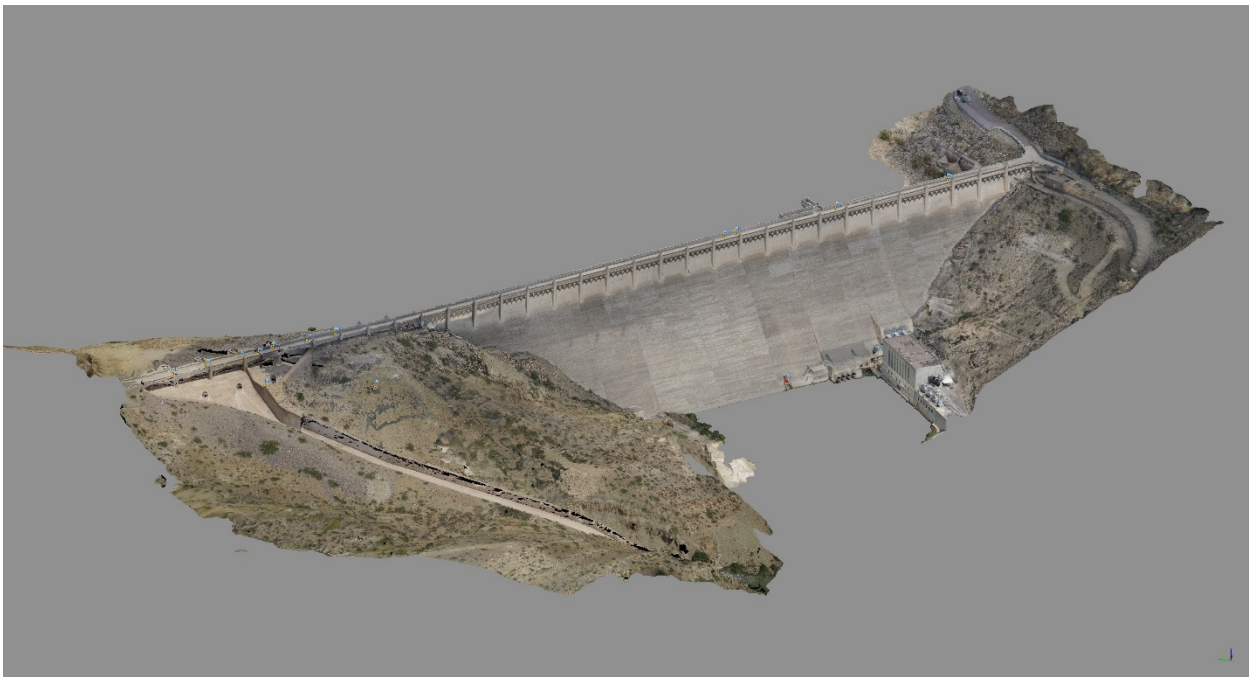

Figure 4: Georeferenced 3D Model of Elephant Butte Dam

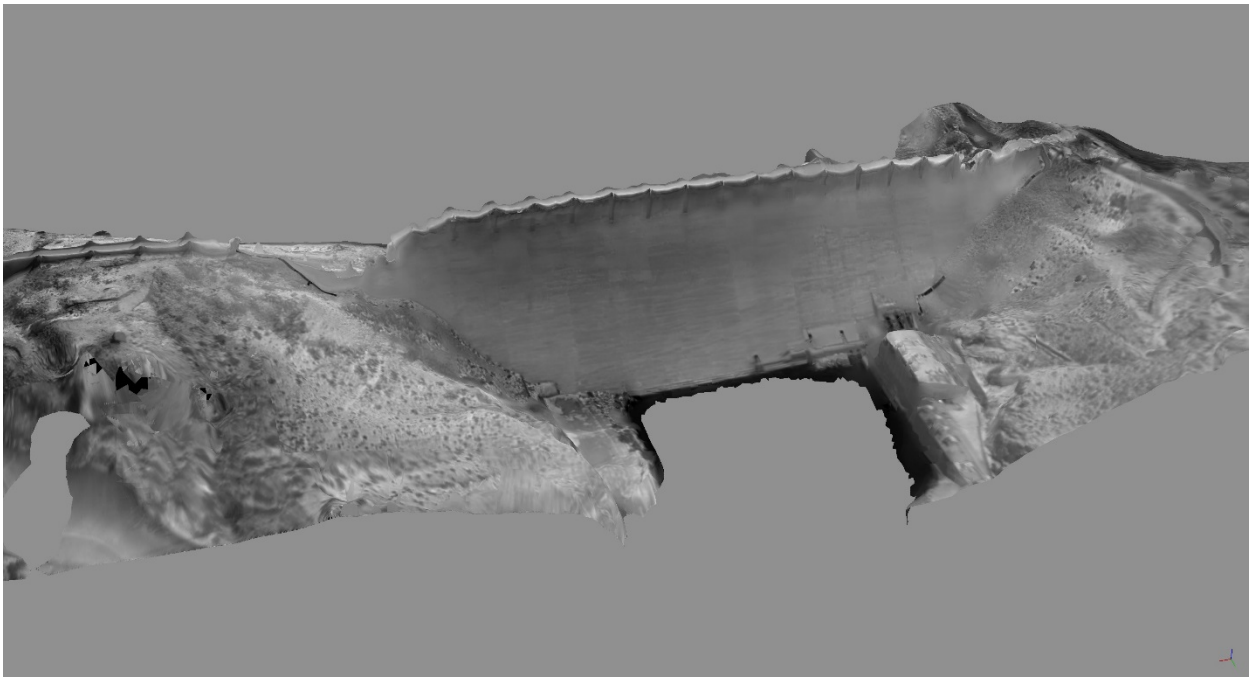

Figure 5: 3D Model of Elephant Butte Dam using IR Data

Webinar #4

The last webinar of the year was held on September 8, 2016 and featured a guest speaker: Bryan Simpson. Mr. Simpson is a Professional Geologist and Professional Engineer with the Geology and Geotechnical Support group at the Technical Service Center (TSC) in Denver. His group was among the first to adopt

photogrammetry as a cost effective workflow solution for many geological studies. Simpson presented work that was performed at Thief Valley Dam to determine the extent of scour on the rock abutments (see Figure 6) [5].

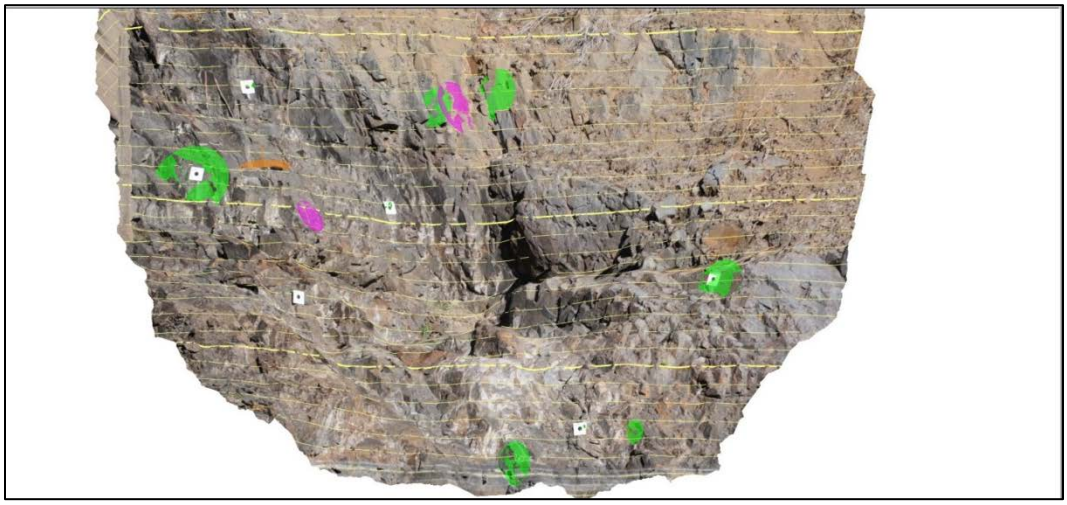

Figure 6: Photogrammetric Model of the Thief Valley Dam Left Abutment

References

[1] E. B. Peterson, M. Klein and R. L. Stewart, "Whitepaper on Structure from Motion (SfM) Photogrammetry: Constructing Three Dimensional Models from Photography," US Bureau of Reclamation, Denver, 2015.

[2] M. Klein, "Photogrammetric Processing from Remotely Operated Vehicle (ROV) Data: Trinity Dam Intake Tunnel," US Bureau of Reclamation, Denver, 2016.

[3] M. Klein, "Grand Coulee Drum Gate Pier Profile Photogrammetric Analysis," US Bureau of Reclamation, Denver, 2016.

[4] M. Klein, "Photogrammetric Processing from Unmanned Aerial System (UAS) Data: Elephant Butte Dam," US Bureau of Reclamation, Denver, 2016.

[5] J. C. Malama, "Thief Valley Dam Scour Potential Evaluation," US Bureau of Reclamation, Denver, 2015.