**ATTACHMENT A**

**Horseshoe Draw Watershed Monitoring Plan Results – September 2017**

As part of grant projects Hereford NRCD monitored the project effectiveness by measuring the amount of sediment retained behind the erosion control structures. The monitoring was performed to help ensure the scientific reliability of the data.

Unmanned aerial vehicle (UAV) data acquisition was used to assure repeatability of monitoring results at fine spatial resolution, which is a critical attribute for monitoring rapidly changing and difficult to access ecosystems. By using a UAV to capture images from the air, the Hereford NRCD was able to efficiently identify and monitor surface conditions and processes.

1. **General method of data analyses:**

Low elevation aerial photogrammetry data was collected upon completion of the construction project in June 2017. That baseline data was used to compare changes to the watershed in September 2017.

2. **Specific parameters and measurements**:

   a. Survey grade subcentimeter ground control targets were placed throughout the drainage for georeferencing the imagery in order to calculate change detection to plus or minus 2 inches throughout the project area.
   b. Field measurements were collected with a survey grade UAV, including overlapping true color photographs for processing into a 3D digital terrain model. The high-resolution aerial imagery provided sufficient detail to monitor the project. Digital stereo imagery of the detention structure was gathered.
   c. The digital photogrammetry data collected by the UAV was used to capture changes in the erosion control structure's stability, progress of head cutting and sedimentation, and more. The sediment data can be used to calculate water quality data including levels of *E. coli* retained behind the erosion control structures.

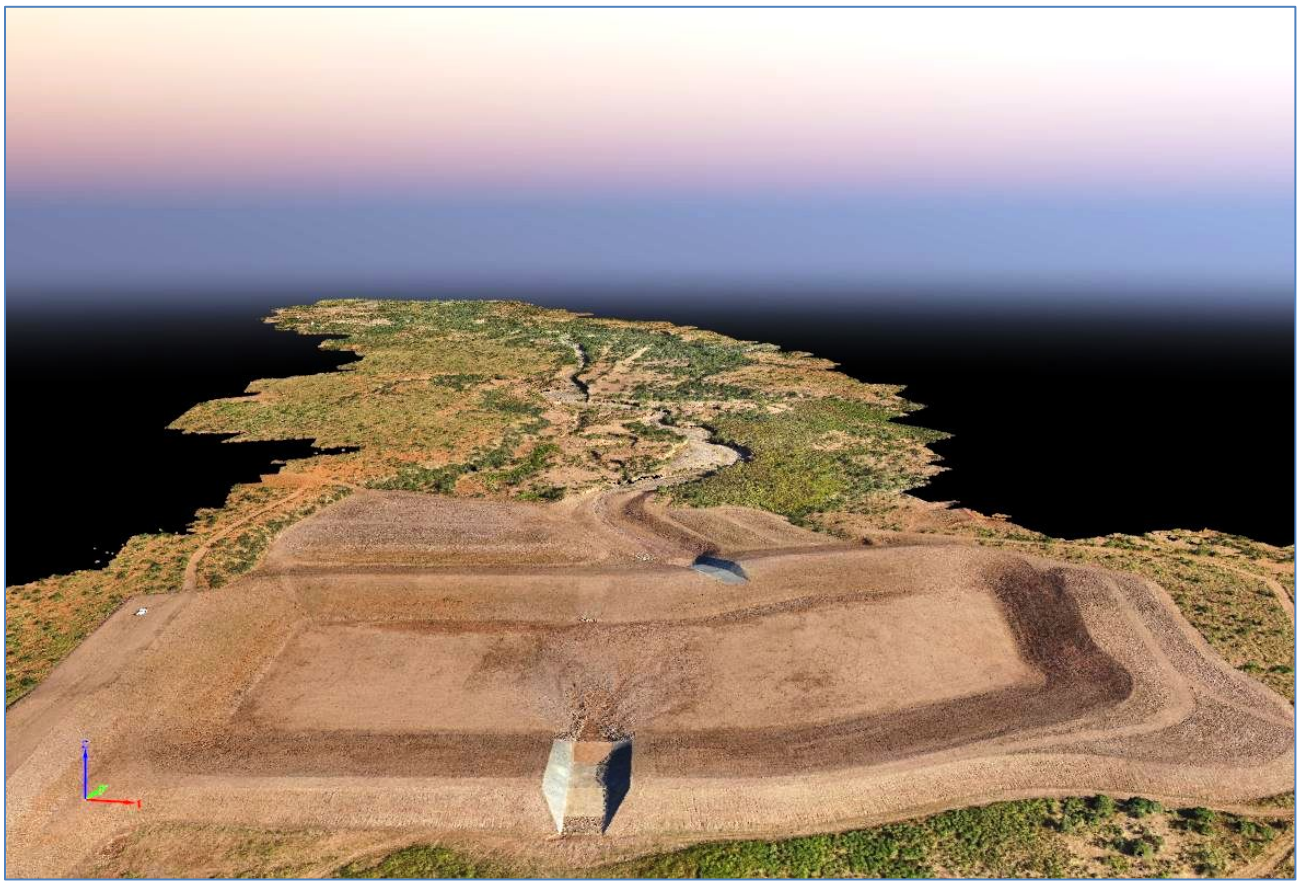

**Figure 1. Horseshoe Draw True Color 3D Point Cloud Data**

## 3. Monitoring Results

Change detection mapping was done by postprocessing data in Pix4D and Polyworks 3D software. The change detection map below shows increased in sediment in green (deposition) and decreases in sediment in red. 1374.5 cubic yards of sediment were retained by the erosion control structures.

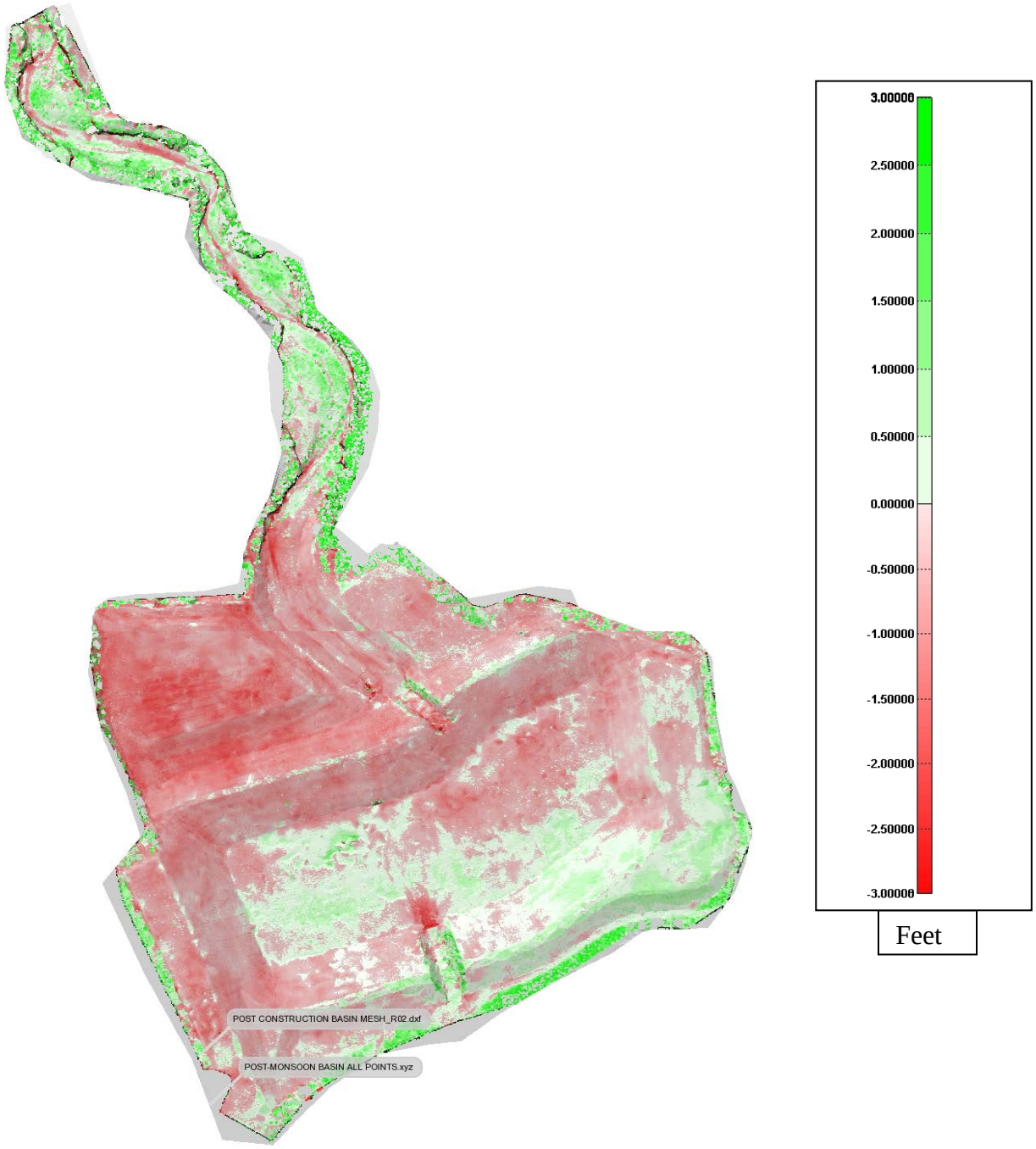


**Figure 2. Horseshoe Draw Change Detection Monitoring Results**

# Cut/Fill Report

**Generated:** 2017-09-28 09:42:31

**By user:** Rich

**Drawing:** Y:\2017 UAV Projects\HORSESHOE DRAW POST MONSOON\AUTOCAD\Y:\2017 UAV Projects\HORSESHOE DRAW POST MONSOON\AUTOCAD\BASIN VOLUME CALCS.dwg

**Volume Summary**

| Name | Type | Cut Factor | Fill Factor | 2d Area (acres) | Cut (Cu. Yd.) | Fill (Cu. Yd.) | Net (Cu. Yd.) |
|---|---|---|---|---|---|---|---|
| Surface4 | full | 1.00 | 1.00 | 9.386 | 1759.40 | 3133.92 | 1374.51<Fill> |

**Totals**

| | 2d Area (acres) | Cut (Cu. Yd.) | Fill (Cu. Yd.) | Net (Cu. Yd.) |
|---|---|---|---|---|
| Total | 9.386 | 1759.40 | 3133.92 | 1374.51<Fill> |

* Value adjusted by cut or fill factor other than 1.0

**Figure 3. Volume (Cut/Fill Report)**

**Figure 4. Basin Area Used for Volume (Cut/Fill) Report**