

Case Study

Little Round Top Revealed

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GeoCue Group recently partnered with the National Park Service (NPS) in a pilot project to assess culturally significant areas within Gettysburg National Military Park using small unmanned aerial systems (sUAS). The area of interest (AOI) for this project was the western face of Little Round Top (Figure 1). Little Round Top was the location of a defensive stand by the Union army during the Civil War Battle of Gettysburg. On July 2, 1863, Confederate forces attempted to capture Little Round Top—the left flank of the Union line (Pfanz 1987). This fight included the famous bayonet charge led by the Union Army's 20th of Maine Volunteer Infantry Regiment, under the command of lieutenant colonel Joshua Chamberlain, who captured and repelled the advancing Confederate Army's 15th of Alabama (Desjardin 1995). The Confederate attack was ultimately unsuccessful. The Union Army would use the hill to counterattack and as an artillery battery position later in the Battle (Hall 2003).

The AOI for this project was prepared by the removal of large amounts of vegetation using a controlled burn. This allowed for a more thorough assessment than past surveys and increased the area visible to the sUAS camera sensor. The flights performed on site resulted in the creation of a geographically accurate orthomosaic and 3D point cloud, which allowed the NPS to more precisely quantify and catalogue earthworks and stonewalls dating back to the Civil War Era.



Figure 1 - Western Face of Little Round Top

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The western face of Little Round Top comprises approximately 52 acres and is surrounded by asphalt pavement. The site includes earthworks, stonewalls and erected monuments. Moving from west to east, the site increases in elevation. The western side of the AOI has a small stream network and is marshy. The center of the site is very rocky with little vegetation present (due to the controlled burn). The eastern side of the site is rocky with some vegetation (mostly trees) unaffected by the controlled burn. The AOI is depicted in the map of Figure 2.

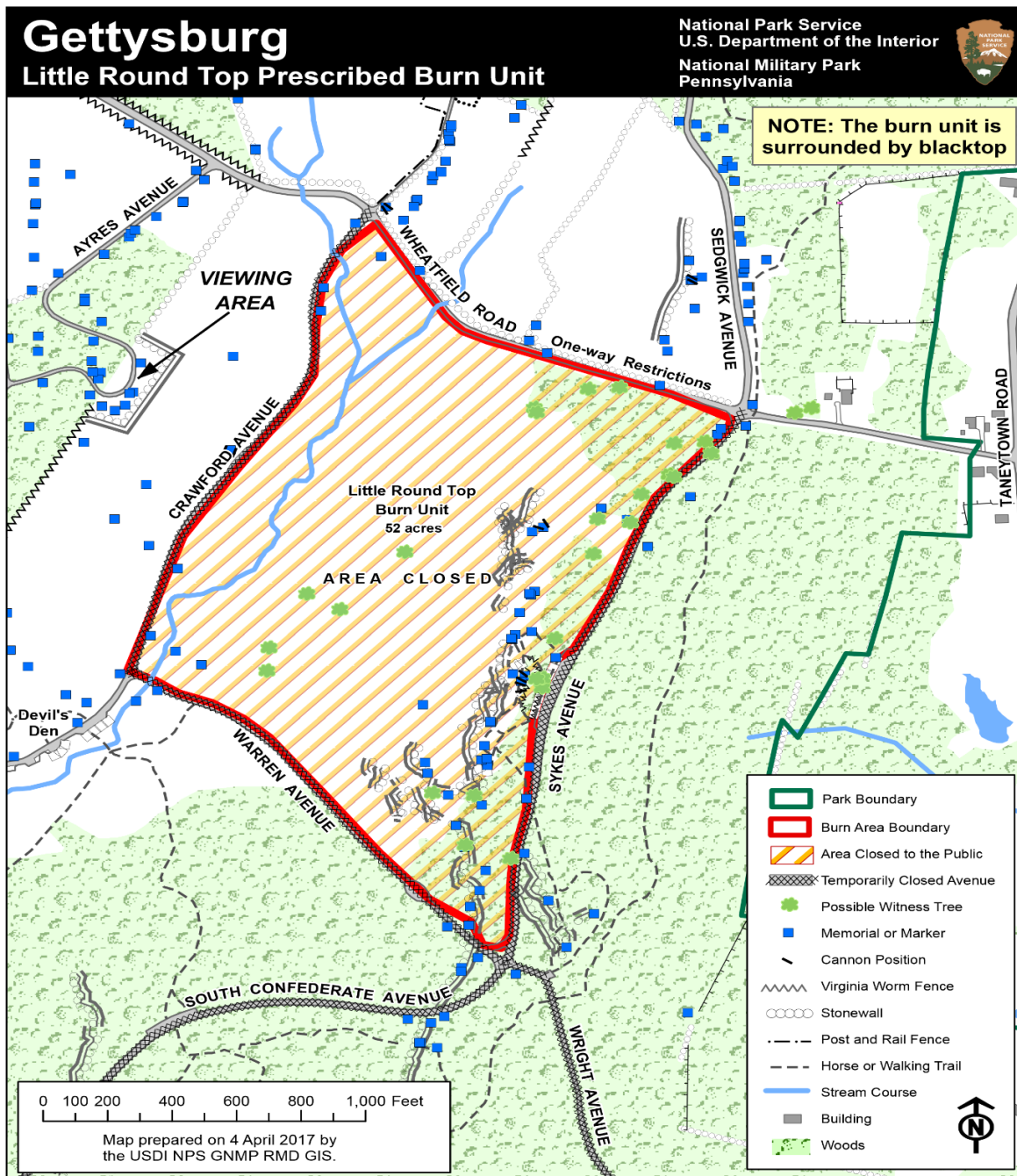


Figure 2 - NPS map of prescribed burn area

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The equipment and software used for data collection and processing are detailed below.

Equipment:

- Global Navigation Satellite System (GNSS) Real Time Kinematic (RTK) base station and rover
- SenseFly eBee RTK
- DJI Inspire 2
- Ground Control Point (GCP) targets fabricated by GeoCue

Software:

- Mission Planning – Emotion 3 and DJI Ground Station Pro
- Data Processing – PhotoScan (Point cloud, orthomosaic generation)
- Accuracy testing, data analysis and product generation – GeoCue LP360



Figure 3 - Measuring Checkpoints



Figure 4 - Checkpoint Tile

Twenty-nine checkpoints were placed and measured inside the AOI to verify the accuracy of the drone collected data (Figure). These checkpoints are 1-foot square tiles with a 4-block, black and white checkerboard pattern (Figure). The locations of these points were collected using the GNSS rover.

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Figure 3 - GNSS base station

The drone of choice for the bulk of the mission was the SenseFly eBee RTK (Figure). A GNSS base station was connected to a laptop and synced with the eBee telemetry radio to have Real Time Kinematic (RTK) positioning during the flights (Figure). RTK allows the drone to communicate with the base station constantly to correct the recorded camera position to within a few centimeters. A total of 4 flights were performed over the AOI to ensure maximum overlap (Figure 8). The flights were performed at an above ground level (AGL) altitude of 390 ft (approximately 120 m).

Because the eBee cannot fly below 120 m (the camera cycle rate is not fast enough to support the necessary overlap between images), the DJI Inspire 2 was chosen to collect greater detail for specified areas. Flown at 295 ft (90 m), images from the Inspire 2 provided improved resolution and contrast.



Figure 6 – eBee before flight



Figure 7 - eBee control station - laptop connected to GNSS base station

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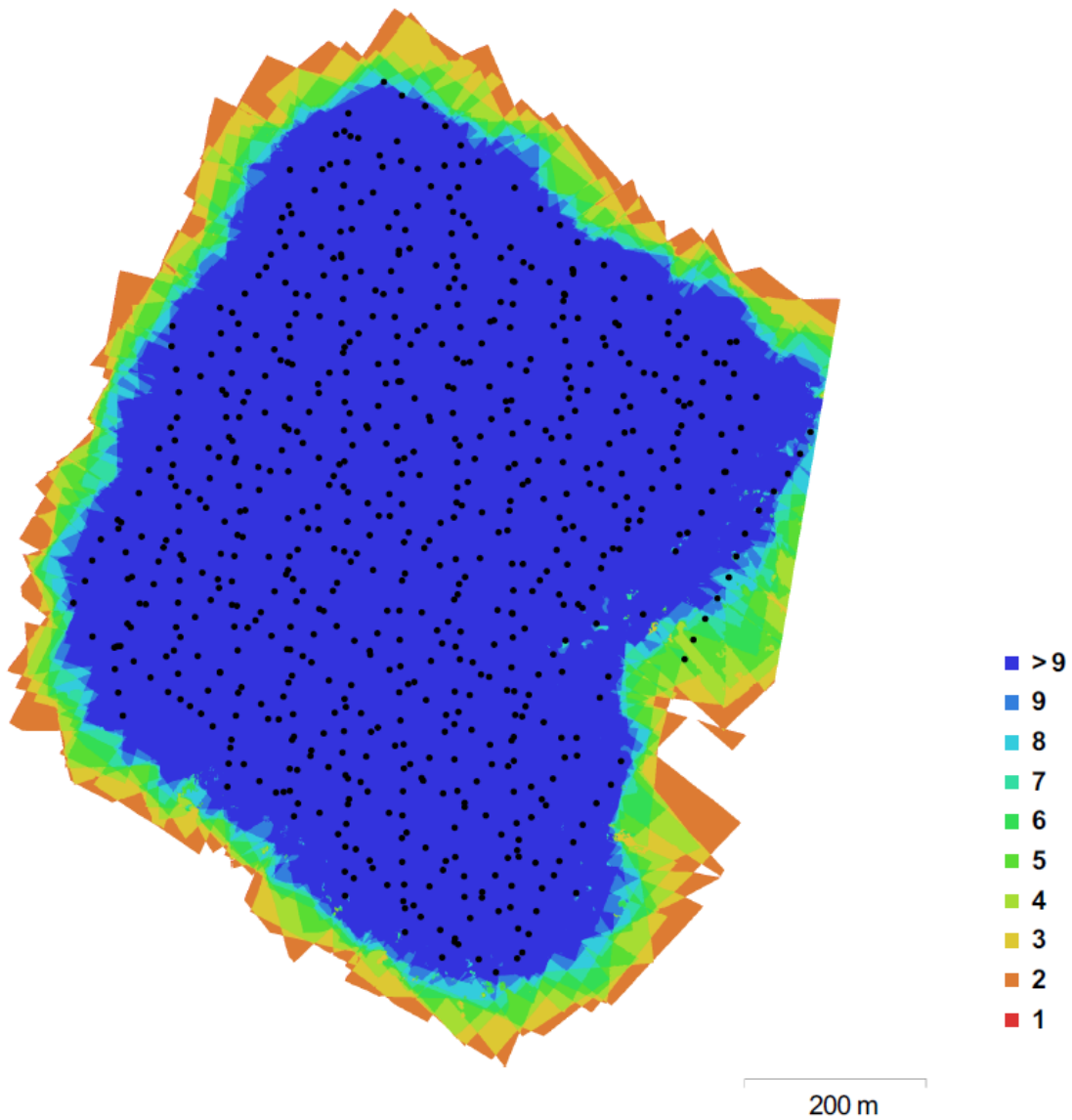


Figure 4 - Amount of photo overlap

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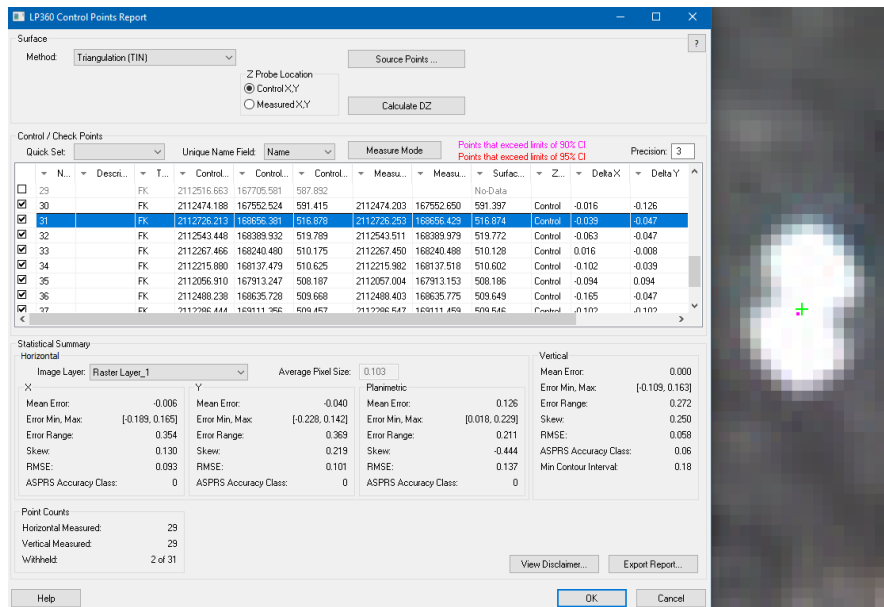


Figure 5 - Control point comparison in LP360

The images taken by the eBee were processed into a detailed, georeferenced orthomosaic (Figure 10) and a 3D point cloud (Figure 11) in the Agisoft PhotoScan software. The checkpoints were used to verify the horizontal accuracy of the orthomosaic and the vertical accuracy of the point cloud using the control points comparison tool in LP360 (Figure 9).

By bringing the orthomosaic into LP360, the planimetric accuracy of previously derived features was identified. Coupled with the detailed orthomosaic, the point cloud introduced many new objects undetected in previous surveys. Using the classification and feature edit tools in LP360, various park resources such as earthworks, stone walls, and railroad beds can be extracted increasing efficiency in the cataloguing process.

Using sUAS systems proved to be an effective solution for an accurate aerial survey of the culturally significant area of Little Round Top. This system could be used in the future to map small strategic areas in other National Park System areas. A special thanks to Curt Musselman, Gettysburg National Military Park Cartographer, for his assistance on this project.

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Figure 6 - Little Round Top Orthomosaic

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Figure 7 - 3D point cloud RGB

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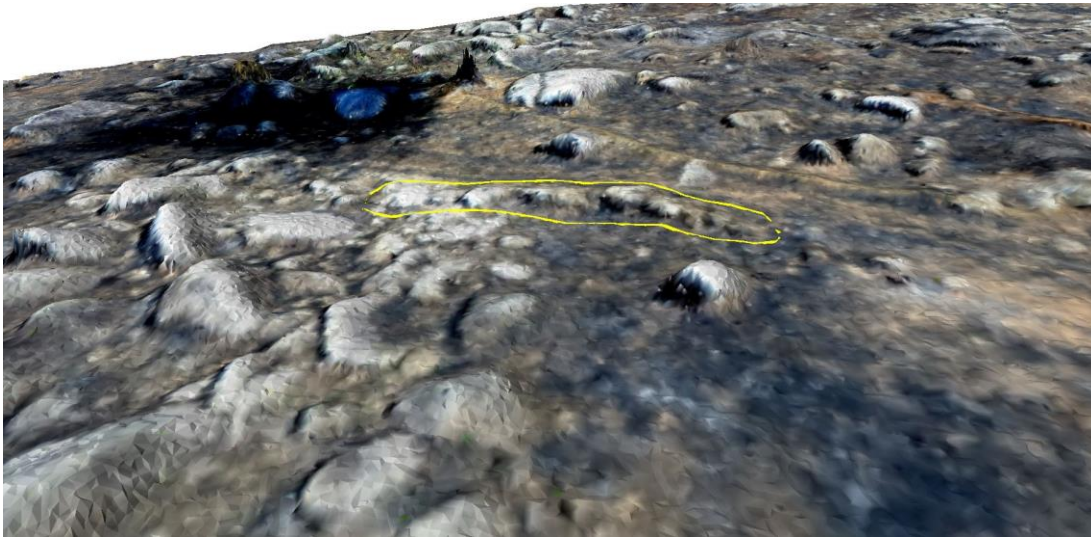


Figure 12 - 3D point cloud RGB TIN surface in LP360 - stone wall

“The NPS was able to identify previously undocumented linear features. The results from the drone flights show that this method could be effective in other areas of the park.” - Curt Musselman, Gettysburg Park Cartographer

References

Pfanz, Harry W. *Gettysburg – The Second Day*. Chapel Hill: University of North Carolina Press, 1987. [ISBN 0-8078-1749-X](#).

Desjardin, Thomas A. *Stand Firm Ye Boys from Maine: The 20th Maine and the Gettysburg Campaign*. Gettysburg, PA: Thomas Publications, 1995. [ISBN 1-57747-034-6](#).

Hall, Jeffrey C. *The Stand of the U.S. Army at Gettysburg*. Bloomington: Indiana University Press, 2003. [ISBN 0-253-34258-9](#).