PLAINFIELD RECREATION ROAD EROSION AND GULLY ALTERNATIVES LIDAR ANALYSIS

A Case Study | November 20, 2018

One of the headcuts across the abandoned railbed seen in a field survey in 2018.

INTRODUCTION

With the increased need for real-time results in today's world, on-foot inspection is not always the best approach for collecting site characterization data. This particular project involves a very dense area with lots of aerial cover, making it hard to traverse on-foot with varying drop off points. ARE acquired the drone service provider AirShark in January 2018. ARE is working alongside Stone Environmental, Friends of the Winooski River, and the Town of Plainfield to complete a hydrologic study and evaluate alternatives to reduce stormwater runoff, erosion, and road damage from a complex drainage area using UAS (drones). The study site involves steep drainage that extends from above Lower Road down to the Winooski River in Plainfield, Vermont with small pockets of development, dense forest, an abandoned railbed, a gravel road, and a riparian wetland. The goal of the project, funded by an Ecosystem Restoration Grant from Vermont Department of Environmental Conservation's Clean Water Initiative Program, is to develop concept designs to address sources of runoff within the 80-acre drainage area causing extensive erosion and damage to Recreation Field Road, as well as significant sediment loading to a riparian wetland area and river.

THE CHALLENGE

The hillslopes of Plainfield Recreation Road are located at the shoreline of glacial Winooski River where the clay is unstable and continues to erode, causing mass failures. The drainage area is cut by an abandoned railbed that alters the natural topography and hydrology in unpredictable ways, making a detailed study necessary. Since the area upslope from Recreation Field is both heavily forested and near a village center, UAS work can be difficult. With the dense forest, there is nowhere to land and take off from within the project area. The hills make it difficult for the flight team to plan a flight path in a way to collect sufficient data and maintain a line of

sight. Part of the planning is scouting and taking terrain profile views to ascertain the area of interest. When mapping a forested area, community outreach and communication with town officials is essential in order to identify operating areas for the flight path. This flight had to be launched from two different locations.

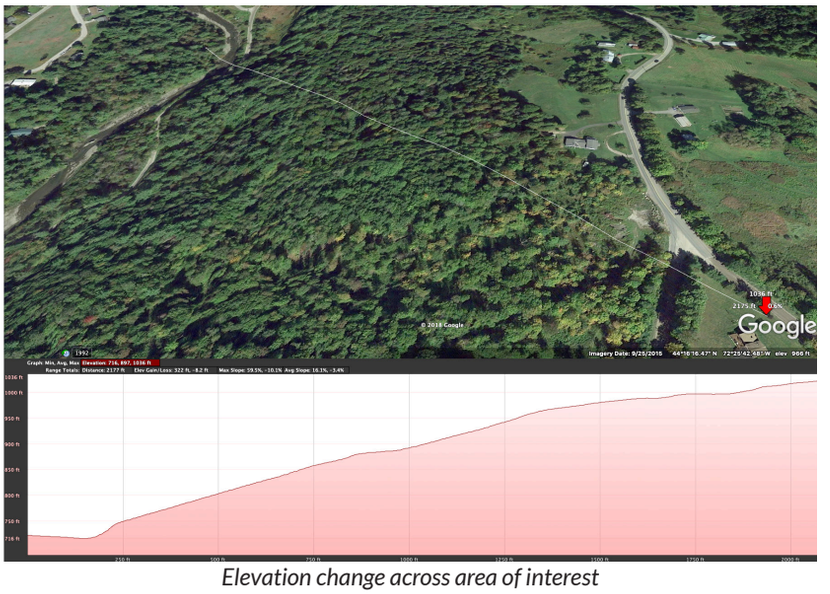
THE PARTNER

ARE is providing LiDAR (light detection and ranging) services for Stone Environmental, which is working with the Friends of the Winooski River and the Town of Plainfield to complete the study. Stone Environmental is an employee-owned company located in Montpelier, Vermont. Stone has a national reputation for being an environmental science and engineering company that provides scientific tools, information, and analyses to help their clients solve complex environmental challenges. Their work and expertise allow creativity and excellence in the workplace and in environmental obstacles. Stone has the ability to extract knowledge from data, specializing in being able to interpret and analyze tremendous amounts of data. They chose ARE to assist in this project to provide better visuals with the UAS's on the erosion that has taken place. The area would have been near-impossible to survey using conventional survey methods, and the final product resolution would not have been suitable for either determining root causes of erosion or conceptual design of improvements.

> *We imported ARE's topographic contours into a publicly accessible web map in ArcGIS Online. The ARE data gave us a solid foundation for completing our fieldwork, and clients were able to access our data and follow progress as it happened in the field. ARE's data allowed us to quickly and effectively target field observations. Once we were done with the fieldwork, we used ARE's data and our observations to define drainage area boundaries and gully profiles and ultimately to set priorities for moving ahead with designs to fix some long-standing erosion and drainage problems.*
>
> *— Amy Macrellis, Stone Environmental*

THE APPROACH

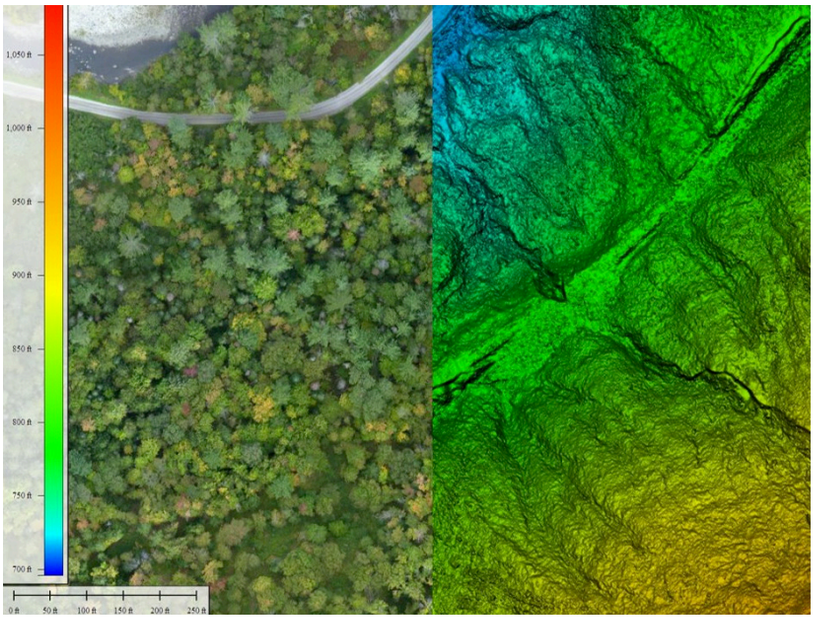
ARE flew from two launch points. The first was Ball Field and the second, on the opposite end of the area of interest, was the yard of a private residence with the homeowner's permission. Between those two points was a 300-ft elevation change, requiring strategic planning in considering flight paths and line of sight to the aircraft. ARE flew with the elevation change, climbing and descending with each pass of the aircraft. ARE planned the terrain analysis using Google Earth to evaluate profile views and elevation change, and on-site scouting prior to take-off.



Elevation change across area of interest

THE SOLUTION

A two-person ARE team was assisted by Gabe Bolin, Senior Engineer, and Amy Macrellis, Senior Water Quality Specialist of Stone Environmental. ARE's LiDAR sensor was able to easily penetrate the dense vegetation and cover the large project area in less than a day. Flying from both sides of the area of interest, our pilots captured data that was used to define the drainage areas for each gully and produce a terrain model for the client. ARE's LiDAR expertise resulted in a topographic survey to define the drainage areas for each gully and allow efficient targeting of field assessments. Community outreach and communication with town officials was essential in locating launch points for the UAS, which was necessary to complete this project.



Left: Colorized LiDAR point cloud *Right: Bare earth terrain model*

THE RESULTS

Information collected from the flight was used to process a high-resolution orthomosaic, as well as generate an orthorectified LiDAR point cloud, roughly 100-points per square meter. Each point in the point cloud contains elevation and location data that can be classified by various categories such as ground, vegetation, man-made structure, and more. From this classified model, ARE created a bare-earth, digital terrain model by filtering out everything besides the ground. From there, a contour map was created to show elevation and visualize the rate of change of the terrain to aid in watershed analysis. Amy Macrellis from Stone Environmental's staff validated ARE's data with field checks and merged the data into Stone's data collection app to verify results on the ground.

By leveraging ARE's LiDAR services, Stone was able to collect challenging site data efficiently and with enough detail to effectively evaluate the steep, 80-acre drainage area. A detailed data analysis revealed the contributing sources of erosion, stormwater runoff, and sedimentation, providing key insights into potential mitigation strategies. The culverts, which used to be maintained through the railbed, failed and the gullies are still adjusting. The lower hillslopes, comprised of lake-bottom clay, is unstable and contributing to erosion and mass failures. In addition, cross-culverts, concentrating flow and conveying runoff across the roads, are draining flow into the gullies, down into the steeper slopes, and ultimately causing significant erosion, road damage, and water quality impacts to nearby wetlands and the Winooski River. Stone Environmental is now working with their partners to prioritize improvements and advance conceptual designs to address the highest-priority issues identified throughout the drainages.