Tools, Tips and Workflows

LP360 Under the Hood: Volumetric Analysis

LP360

B S A U | A W G

Lewis Graham

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This is the third installment in our series on the new Point Cloud Task (PCT) mechanisms introduced in LP360 version 2013.2 released in December of 2013. We have previously discussed the new Input/Output Manager (IOM) and the Conflate tool. We now will cover the Volumetric Analysis tools.

First of all, allow me to mention that we are releasing a Service Pack (SP) for LP360 2013.2 that addresses a few software defects in the release, improves the performance of gridded output computations and provides a much simplified pre-built PCT macro for Volumetrics. It is these macros that we will discuss in this article.

Volumetric analysis functions by computing two surfaces called a "base" and a "hull." A Riemann sum is then computed of the volume between the hull and the base (a Riemann sum is the process of breaking a region into very small chunks and then summing over the chunks). Our online help for LP360 provides a very detailed description of how to use this new set of tools. We allow many different combinations of surface types for both the base and the hull. I will cover the two most popular (or at least what we think will be the most popular!) in this article.

In Figure 1 is depicted a section of a gravel quarry. This is actually a dense point cloud computed by performing dense image matching on highly redundant small unmanned aerial systems (sUAS) imagery. We would like to quickly compute the volume of the stock pile at the center of the image.

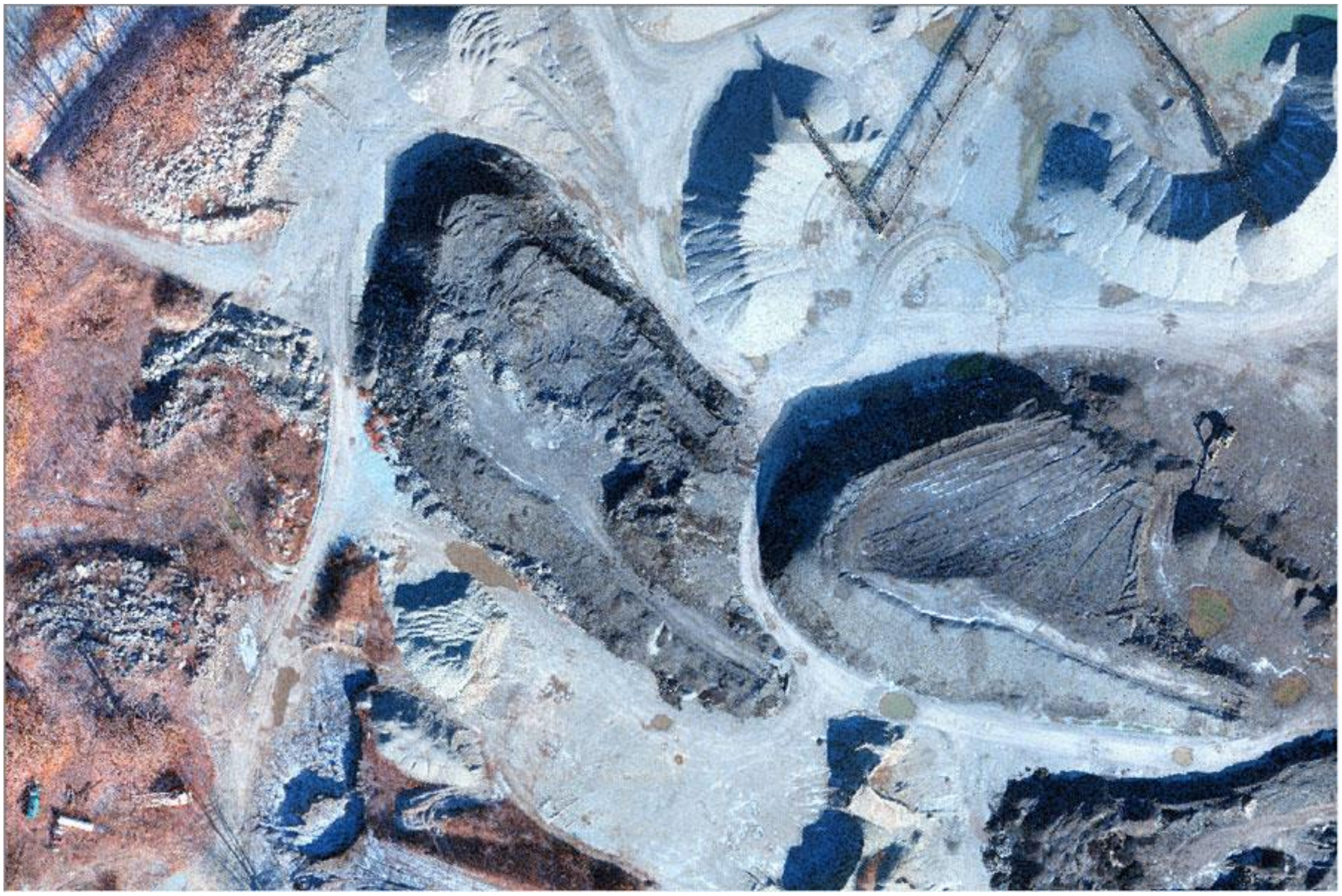

Figure 1: Section of a quarry dense image matching point cloud

The general process is to compute a base (the “floor”) of the volumetric area and then subtract that base from a surface model of the pile. We have several options for computing the base. The first would be from a historical survey of ground points that define the base. The second and more assessable method is to simply create a 3D base polygon by tracing around the base of the pile and allowing LP360 to conflate a z value at each vertex (this was the reason for covering conflation in the last “under the hood”). Note that it would be fairly rare for the base points to all be at the same elevation (perfectly level ground) but we can handle that case as well.

Once a base has been defined, the second step is to define the “hull.” The hull defines the surface of the stockpile. This is generally done by generating a Triangulated Irregular Network (TIN) of all of the points circumscribed (in 2D) by the base. If you are working in regions that are not as clean as the example of Figure 1, you may need to perform a ground classification on the points and filter to ground during the analysis.

The new macro that makes quick work of the command case of computing a volume by digitizing a base is found in the Point Cloud Tasks dialog (the dialog for LP360 for ArcGIS® and LP360 for Windows are essentially identical). The path to activating this dialog is depicted in Figure 2. Note that your list of Point Cloud Tasks and PCT macros will not be the same as mine but, assuming you have installed the Service Pack, you will find a Macro entitled “Volumetric Analysis: Digitized Input.”

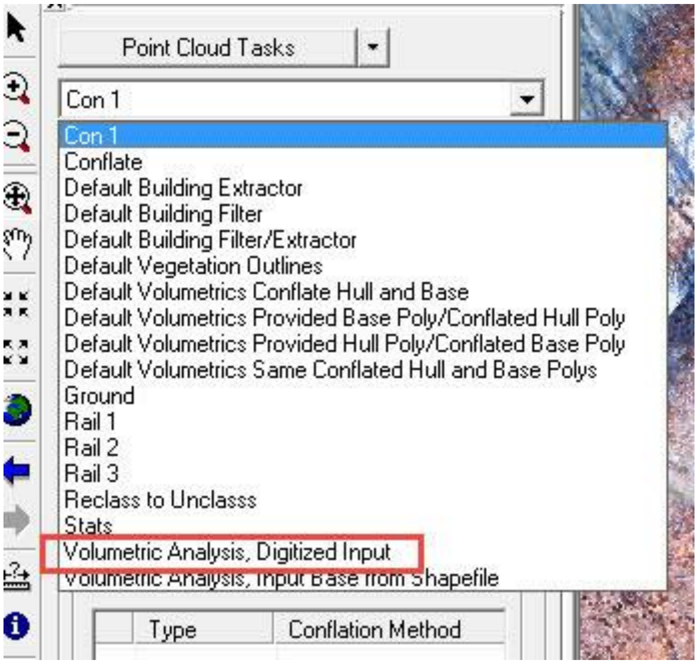

Figure 2: The Stockpile Volumetric tool

The next thing you need to do is set a Project Path for your project. This was described in detail in the Jan 2014 issue of GeoCue Group News. Recall that a project path is simply a top-level directory path that is used in the Input/Output Manager to allow storing and retrieving files. The Project Path is set in Standalone LP360 via the "Files" menu, "Project Settings" selection. In LP360 for ArcGIS®, it is set via the "LP360" drop-down on the main LP360 toolbar. Set the Project Settings path to the location where you would like files stored and retrieved during the volumetric computation (it can be anywhere you like including the Windows Temp directory if you're not interested in saving any results). *Hint – If you save your project settings, this path is saved.*

Once you have selected the Point Cloud Task, you will see the dialog of Figure 3. Note that this is a two-step macro comprising the steps:

- Conflate Base
- Volumetric Analysis

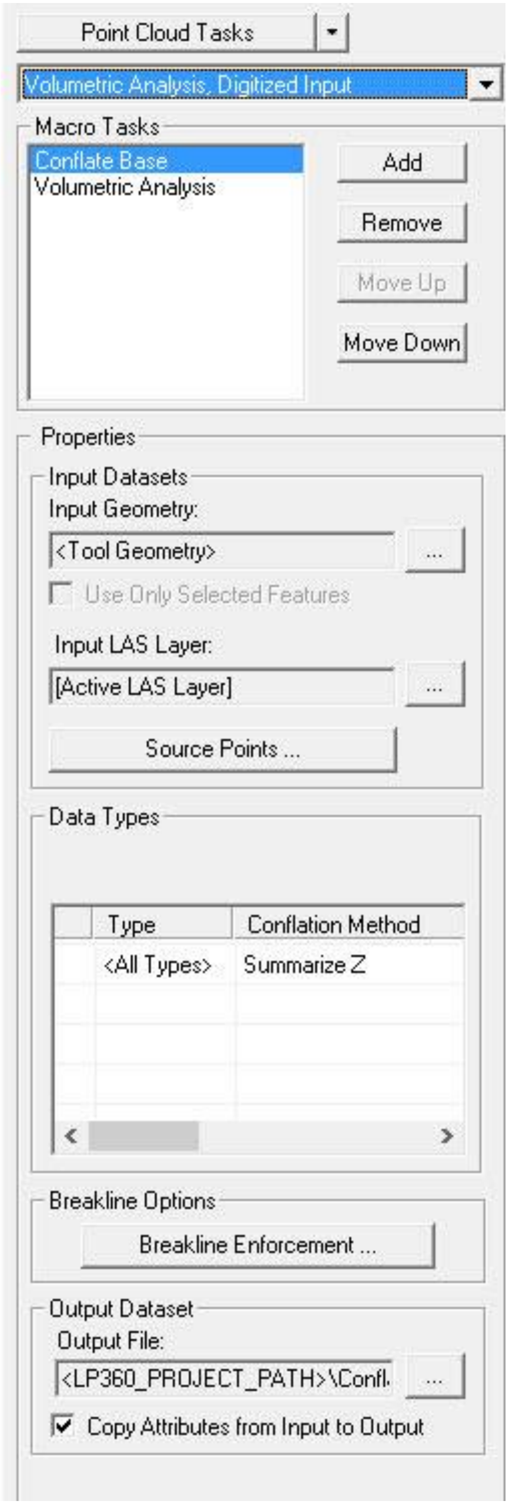

Figure 3: Stockpile Volumetrics PCT

If you have a clean data set (no above ground vegetation or structures) such as that of Figure 1, you really do not have to change any settings in this two-step macro at all. If not, then you may have to set point filters to the "ground" class and perhaps change the conflate method. The default conflate method is "closest point" which simply uses the Z value of the point in the LAS file closest to the points where you digitize vertices. You can change this via the Data Types section of the Conflate Base step, if desired.

One other change you may want to make is to output a volumetric results LAS file (this option requires an Advanced license). This option is located on the "LAS Output" tab of the "Volumetric Analysis" Point Cloud Task (see Figure 4). Simply check the "Output LAS File(s)" option. Make sure you press the "Apply" button at the bottom of the PCT dialog if you make any parameter changes!

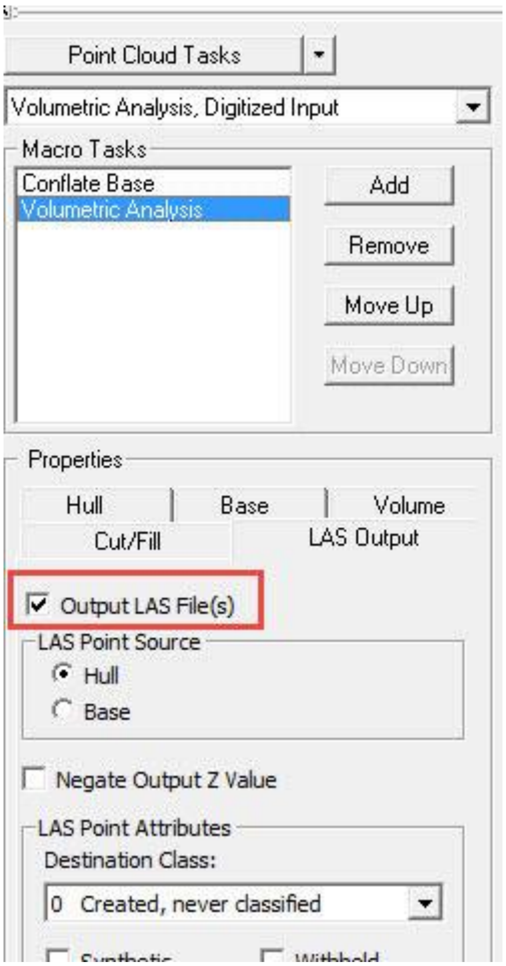

Figure 4: Creating an output Volumetric LAS file

To compute the volume, simply click the Digitize Polygon tool on the PCT toolbar and sketch around the base of the stockpile. Complete the polygon by double clicking the last vertex. As soon as you complete the polygon, the volumetric task will begin computing. You can track the progress by reading the status pane in the lower left corner of the LP360 main window.

When the process completes, you will have up to three new items added to the LP360 Table of Contents (TOC). These items are:

- Cut-Fill LAS – This is a LAS file of the volume. It is added if you selected the LAS option of Figure 4 (again, an Advanced license is required for this output).

- Volume shape file – this is a shape file that represents the base polygon (if you examine its vertices, you will see the Z values that have been conflated from the LIDAR data). Its attributes contain a number of statistics, including the computed volume. Recall that you can read the attribute file (a *.dbf file) directly into Microsoft Excel.
- A Cut and Fill image – this image is very useful to determine the effectiveness of the digitized base or simply the topology of the edges of the stockpile. It will colorize in two colors – one for regions above the base and the other for regions below the base. You can change the colors, if desired, on the Cut/Fill tab of the Volumetrics PCT.

The result of our example is depicted in Figure 5. In the Cut/Fill image, cyan regions are above the base whereas magenta regions are below. Thus we see just a bit of dip around the edge between the base and the stockpile. The red polygon is the base itself. Below the image is the attribute table associated with the volume polygon. Note that the Fill (region below the polygon) is about 37 m3. The Cut (the stockpile itself) has a volume of 33,096 m3.

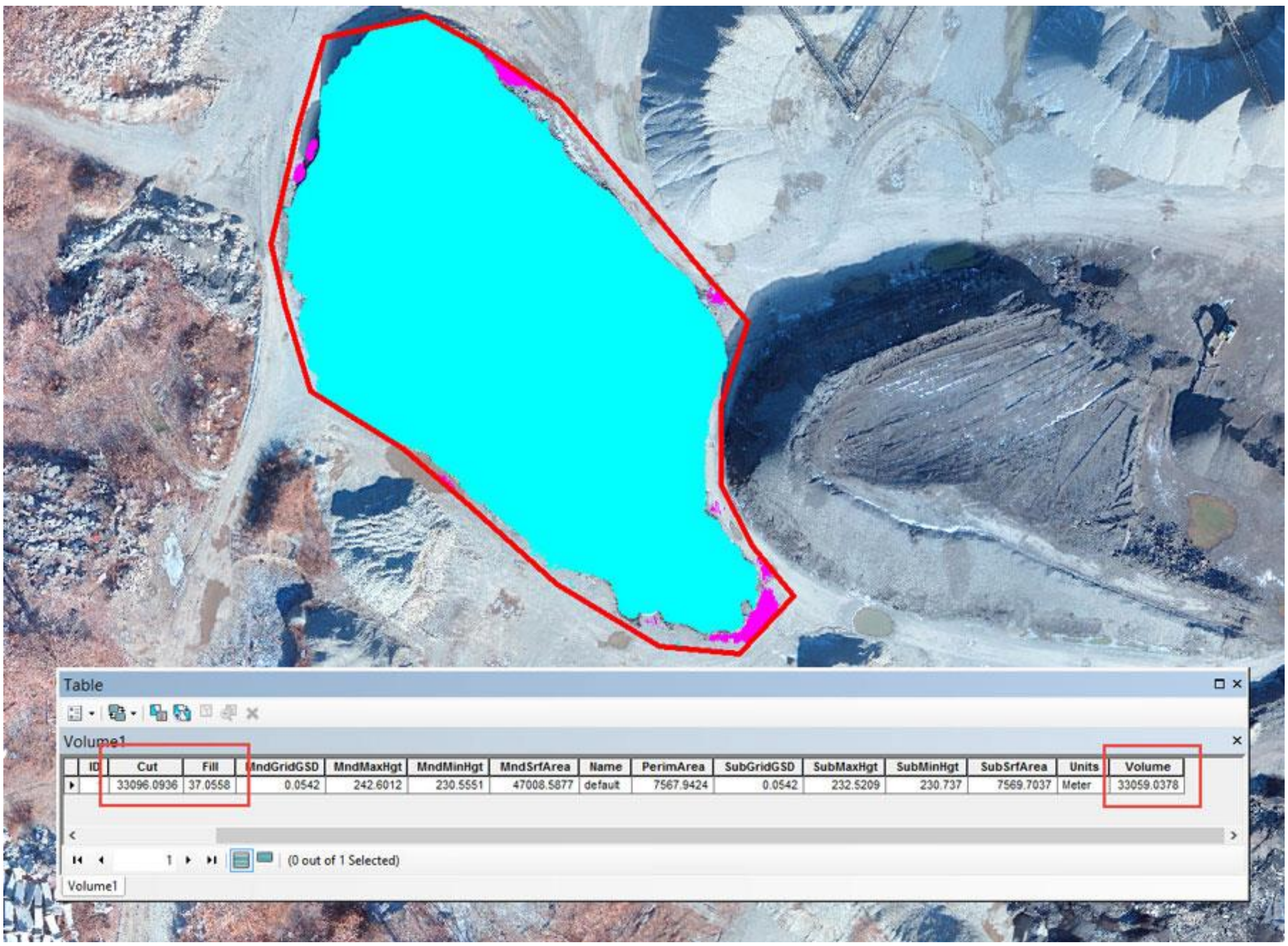

Figure 5: Cut/Fill image and volumetric results

So that is all there is to Volumetric Analysis in LP360! For most standard stockpile measurements, you need only set the project path and digitize a base! It just does not get any easier than this.

A second quick pre-prepared macro allows you to compute, in a batch fashion, the volumes associated with an input set of polygons that define the bases of multiple polygons. This would typically be used for situations where periodic monitoring is occurring and you want to keep the exact same base for each analysis.

I encourage you to experiment with the volume tools. You do not need a special data set to do experiments – simply use a building or some other vertical structure as your volume target.

Until next time – happy computing!