

## Tools

# Volumetrics – Do it Right!

LP360, versions 2014.1 and above



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We have more and more customers computing volumetrics using LP360 in combination with point cloud data sets derived from Dense Image Matching (DIM). Note that I will use DIM to mean both the process of generating a point cloud from a dense set of overlapping images as well as the product point cloud itself. Thus a DIM is a point cloud derived from a dense image matching process such as Pix4D or Agisoft's PhotoScan.

We have discussed the process of performing volumetric analysis in previous versions of GeoCue Group News (and, before that, in LP360 News). In this article I want to address the criticality of quality inspecting the DIM and classifying such that features not intended to be included in volumes, aren't.

I am going to use a gravel stockpile that we recently acquired as part of a quarry mapping mission. This stockpile is shown in Figure 1 (the pile labeled as "2"). Note that there are several items above this stockpile that prevent us from simply using the "Volume from Digitized Polygon" point cloud task in LP360 with no preparation work.



*Figure 1: The Stockpile of interest*

## Tools

# Volumetrics – Do it Right!



Before we get into the details, recall how it is that we compute volumes in the first place. In LP360 we use a triangulated irregular network (TIN) constructed from points and polygons as the surfaces for performing these computations (as well as many other things in LP360!). A TIN allows you to make a solid surface from a “porous” point cloud model. The points are connected via “edges” using an algorithm called the Delaunay triangulation (invented in 1934 by Boris Delaunay!). The edges then form triangles called “facets.” The triangulation process itself has no intelligence other than some rules about which particular choices to make regarding drawing the edges. This means that if some points exist that are not supposed to be included in the surface model, some other mechanism must be used to effect this exclusion. Just as we do with LIDAR data processing, we typically use “classification” to indicate these excluded points.

First let’s have a look at what might happen if we just process the stockpile of Figure 1 with no data preparation. When the Volumetric Analysis Point Cloud Task (PCT) forms a TIN of the surface of the pile, the overhead conveyor will be included in the model. A zoomed in view of this (shaded by elevation to make the defect stand out) is shown in Figure 2. Notice how the edges of the TIN extend from the surface of the stockpile to the conveyor. If we were to proceed with the computation, we would have a volume much larger than that of the gravel portion of the pile.

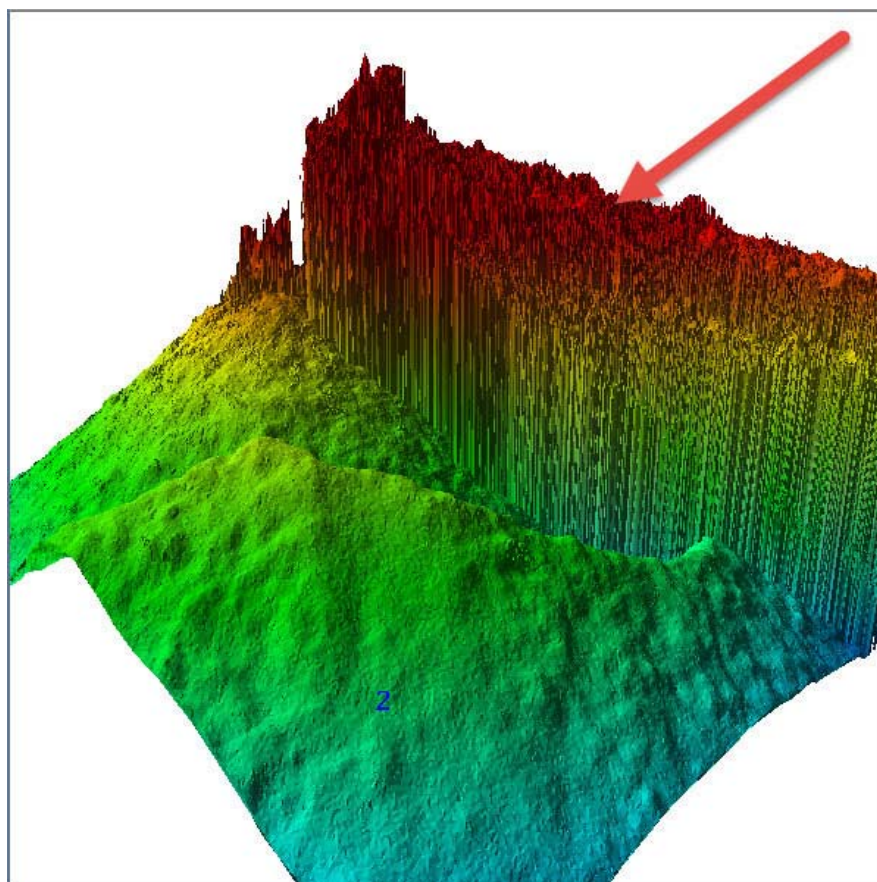


Figure 2: Conveyor included in TIN

## Tools

# Volumetrics – Do it Right!



Fortunately we can address this problem by tagging the points that do not belong to the stockpile through point classification. We can set this up by either defining a special class for the conveyor or using a class that we do not need for other purposes. We will simply use class 6, the Building class, for this purpose. The best approach to classifying in the vertical direction (that is, we want to classify the conveyor into a different category than the stockpile) is to use the profile view. This configuration is depicted in Figure 3. Note the conveyor above the stockpile in the lower section of the figure (pointed out by the red arrow). As an aside, also note how poorly the conveyor itself is modeled in the DIM. If we were looking at high density LIDAR data, the conveyor would have clean, sharply defined edges. This lack of linear feature definition in a DIM is a characteristic of this type data. However, relatively low curvature surfaces such as the stockpile itself are well modeled. Anyway, back to the topic at hand. We need to include the stockpile in our model but exclude the conveyor.

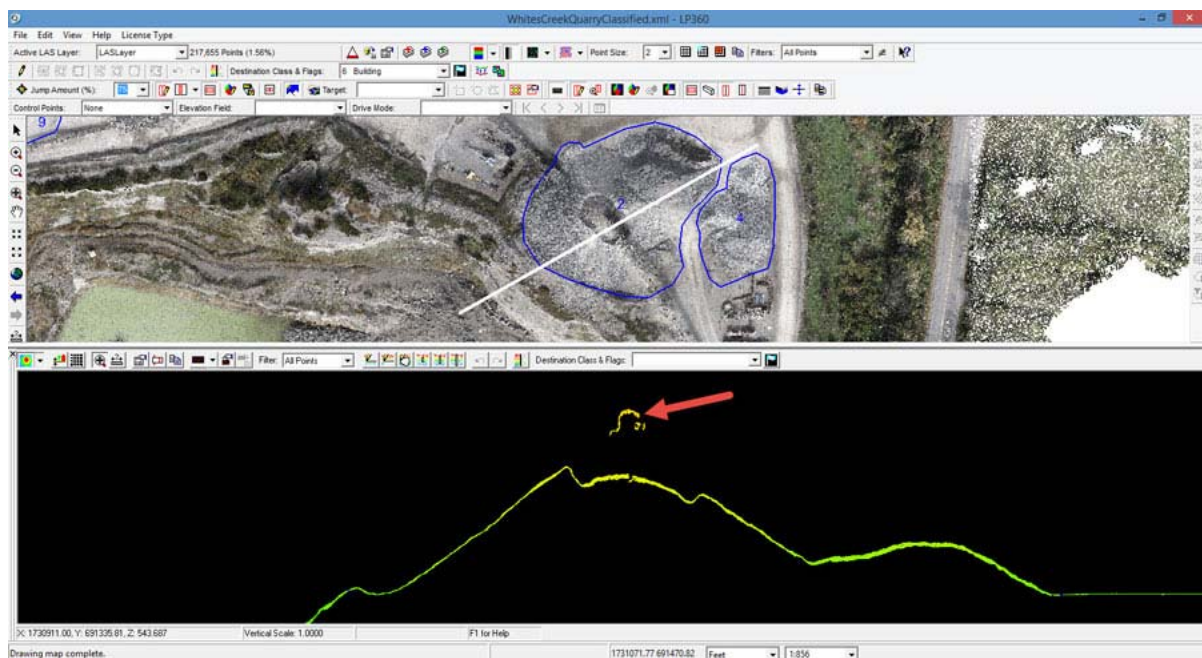


Figure 3: Conveyor above stockpile

Note in Figure 4 how we have set up the profile view for this type of classification. The source class cannot be seen but it is set to include all points. The destination class (green arrow) is set to “Building” and we are using the “classify above line” (blue arrow) tool. As I digitize a line, the points that will be moved to the Building class are highlighted in white (red arrow). Hitting the space bar commits the reclassification. Note that, in the event of an error, you can undo the classification by pressing the Undo button in the main reclassification toolbar.



# Tools

## Volumetrics – Do it Right!

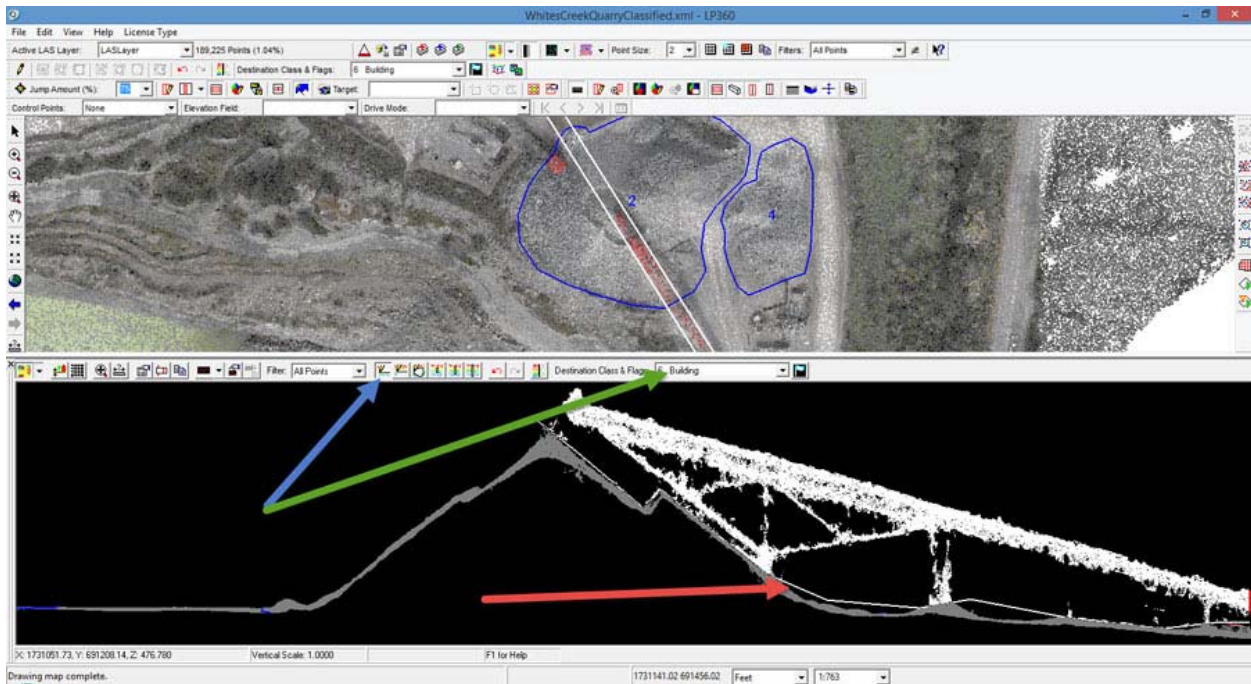


Figure 4: Classifying "above line" to Building

The result of the reclassification is depicted in Figure 5. Note that I am displaying the points by Classification. The color for Unclassified is grey whereas the default color for Building is red (you can change these via the legend settings).

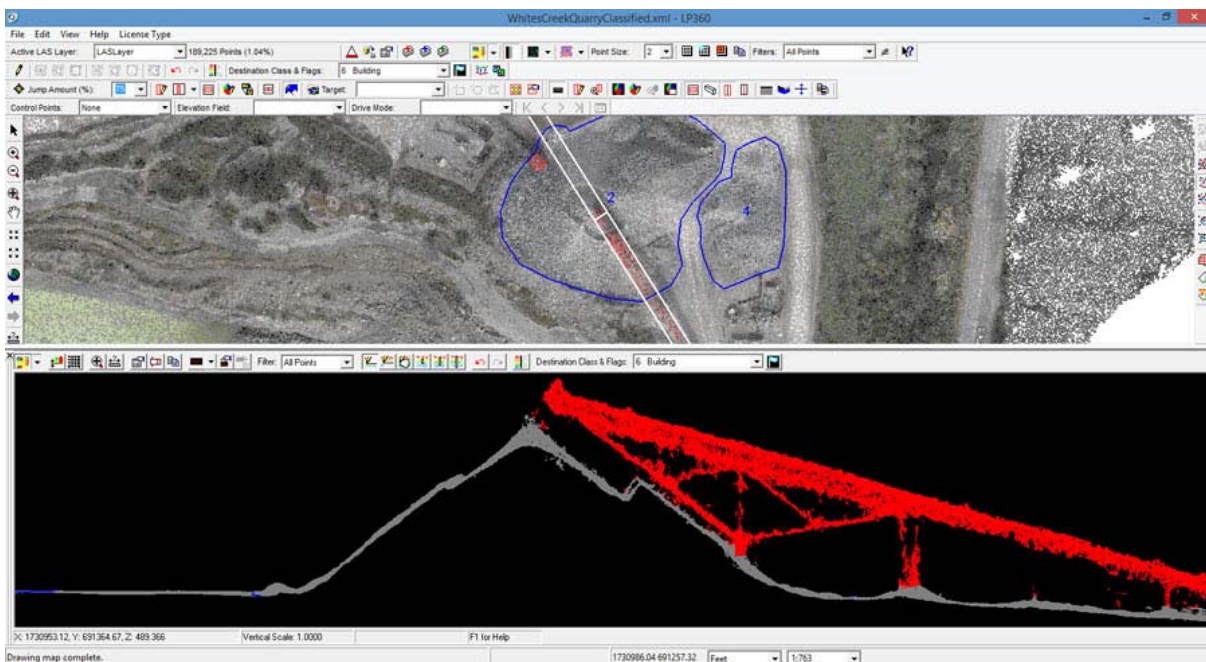


Figure 5: The reclassified conveyor

## Tools

# Volumetrics – Do it Right!



We are not quite ready to do the volume computation. First a Quality Check (QC) step is in order. LP360 has a really cool feature that is custom made for this purpose. In LP360 you can configure separate “channels” for displaying by points and by TIN. In our example, we will configure the 3D View to use the Building class for points and all other points for the TIN. First we select the stockpile area for 3D viewing, set the display mode to Classification and the rendering mode to “Points on TIN.” This configuration is depicted in Figure 6. Note that we have the conveyor points participating in the TIN.

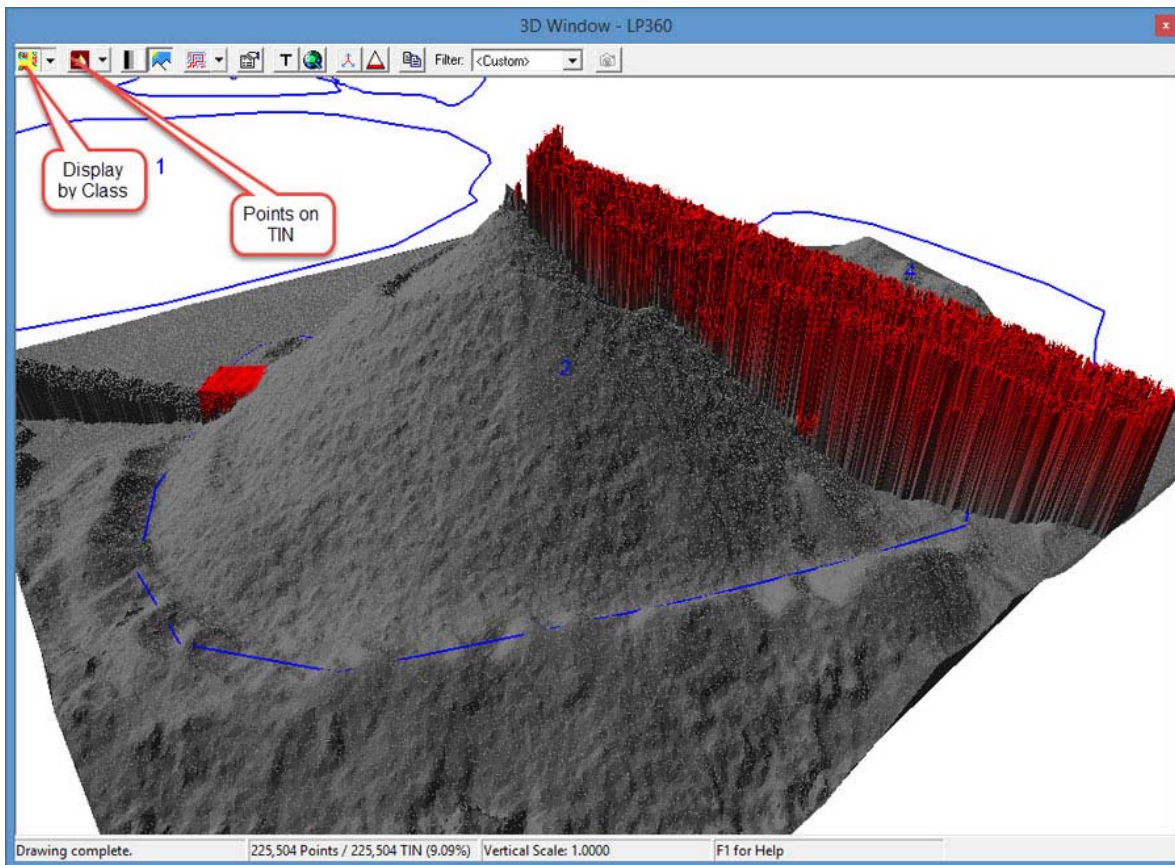


Figure 6: Configuring the 3D View

Next we configure the symbology filter to separate the classes being used in the TIN and Point display. The first setting is the “Display”, “Points Filter” tab. As shown in Figure 7, this tab is configured to separate the Points and TIN display channels (by unchecking the “Use Points Filter for TIN” option) and configuring to allow only the Building points.

# Tools

## Volumetrics – Do it Right!

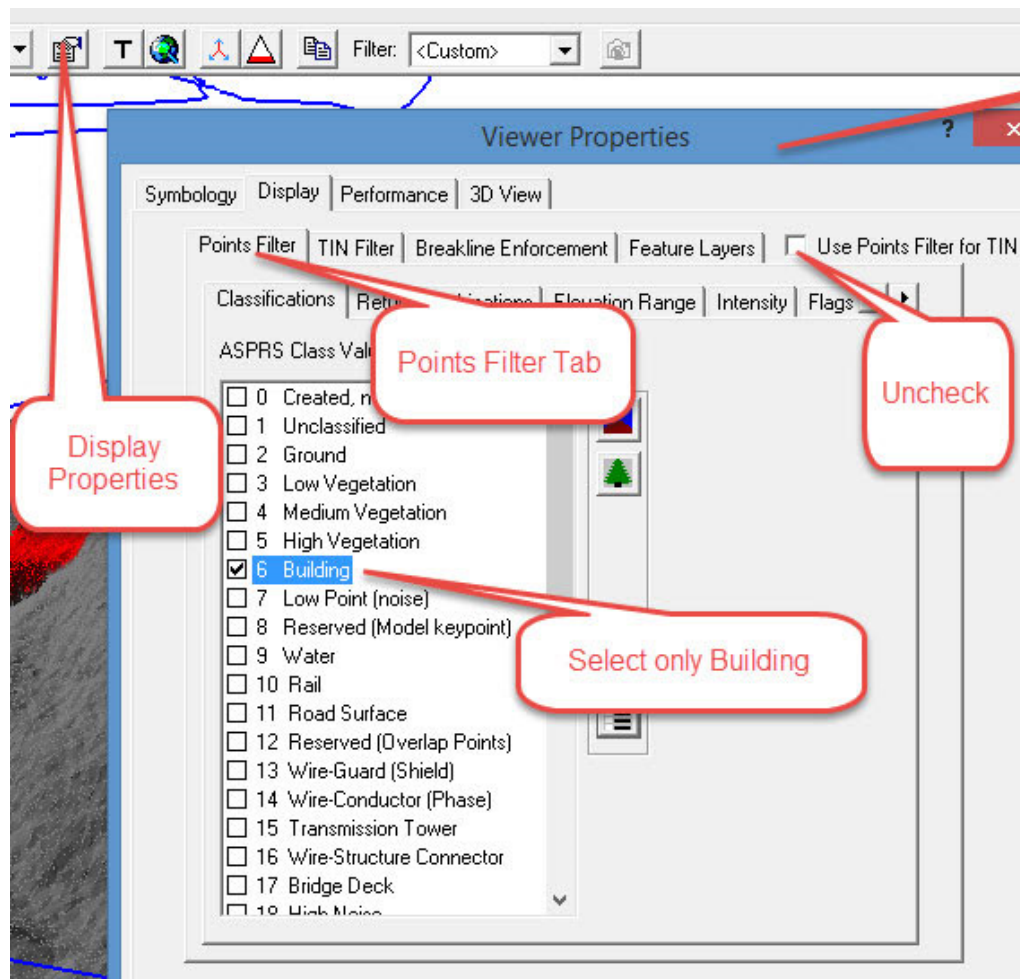


Figure 7: Setting up the Points Filter

Next, the TIN filter tab is configured to show all classes except the Building class (Figure 8). Of course, we could have selected only Class 0 (Created, Never Classified) as the only class since this is the class we are using for the non-conveyor portions of the display.



## Tools Volumetrics – Do it Right!

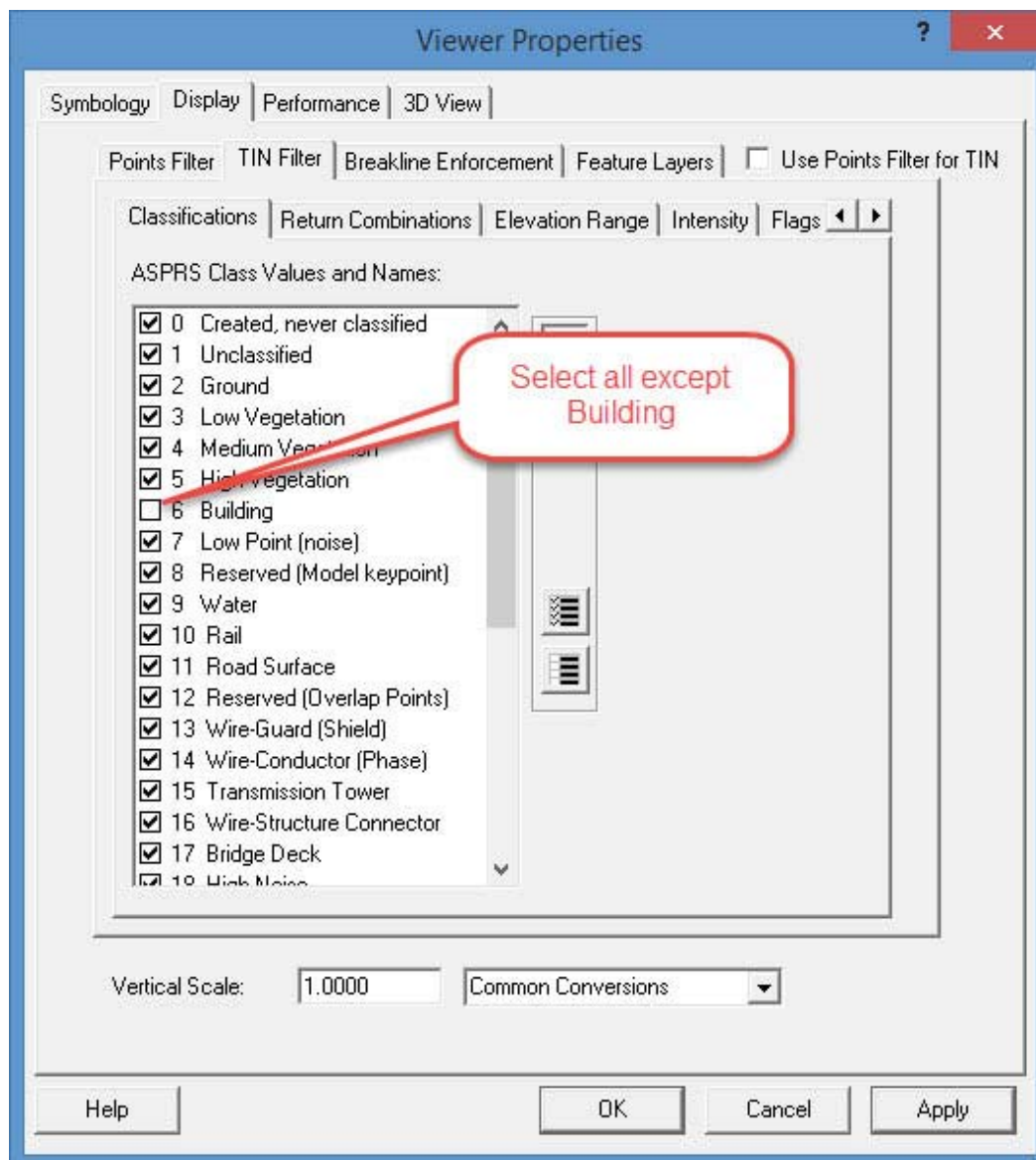


Figure 8: Configure the TIN display filter

After dismissing this dialog by pressing OK (and ensuring the display mode is set to Points on TIN), you should see the 3D view look similar to Figure 9. Here we see the surface rendered in grey (make sure you have enabled Shading in the 3D view) and the points of the conveyor, rendered as points, above and separate from the Surface TIN. Note a bit of noise above the top of the pile. You may want to move a few of these points to the Building class as well to eliminate them from the volume computation. Of course, if you are doing a rigorous classification, you would move these to a Noise class (Classes 7, 18). Also notice that I am displaying the stockpile bases as the blue polygons. I find that I tend to overclassify if I don't have this delineation displayed (I guess I color outside the lines!).

## Tools

# Volumetrics – Do it Right!

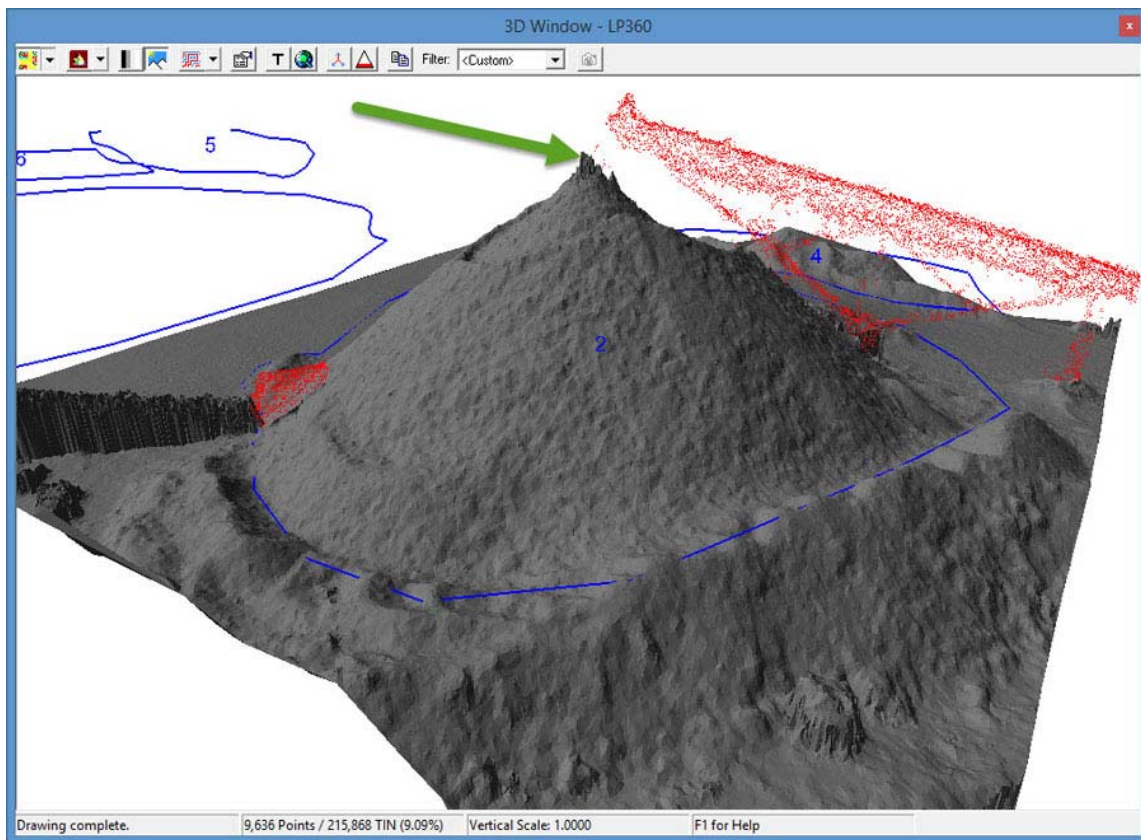


Figure 9: The 3D view Points, TIN rendering

A very nice feature of LP360 is the dynamic linking of windows. This means that as you classify points in the profile window, the 3D window will automatically update to reflect the changes. This makes classifying a very high quality surface for volumetrics (or any other use, for that matter) a very immersive task with immediate quality feedback. As a side note, a three monitor setup is absolutely lovely since you can pull each of the Map, Profile and 3D views from the main application and expand each to fill an entire monitor!

After this classification and quality check, you would compute volumes as normal. The only change from the completely unclassified case is to ensure that you have set the Volume PCT filters to exclude the Building class. Note, very importantly, that it is not usually necessary to classify ground when performing volumetric analysis. My usual approach is to assess the customer deliveries (did the customer specify a classified point cloud), the environment (overhanging features, interfering vegetation, etc.?) and then make classification decisions.

I hope you have found this article useful, not only in providing a bit more insight into volumetric analysis strategies but also some of the inherent power of what might be considered obscure features in LP360. The other obvious conclusion is that LP360 is not just a nice add-on to point cloud generation software but an absolute requirement.