# *Carlson Point Cloud*

Quick Start Guide

Lesson Objectives

In this class, we will be discussing basic procedures to obtain a representative surface model (TIN) of a project site from a point cloud resulting from LiDAR or areal photogrammetry. In addition, common steps to obtain survey data from the point cloud, i.e., virtual surveying, will also be presented. It is important to understand that the lessons through this class are not intended to be fully comprehensive as all point cloud projects pose their own unique set of challenges.
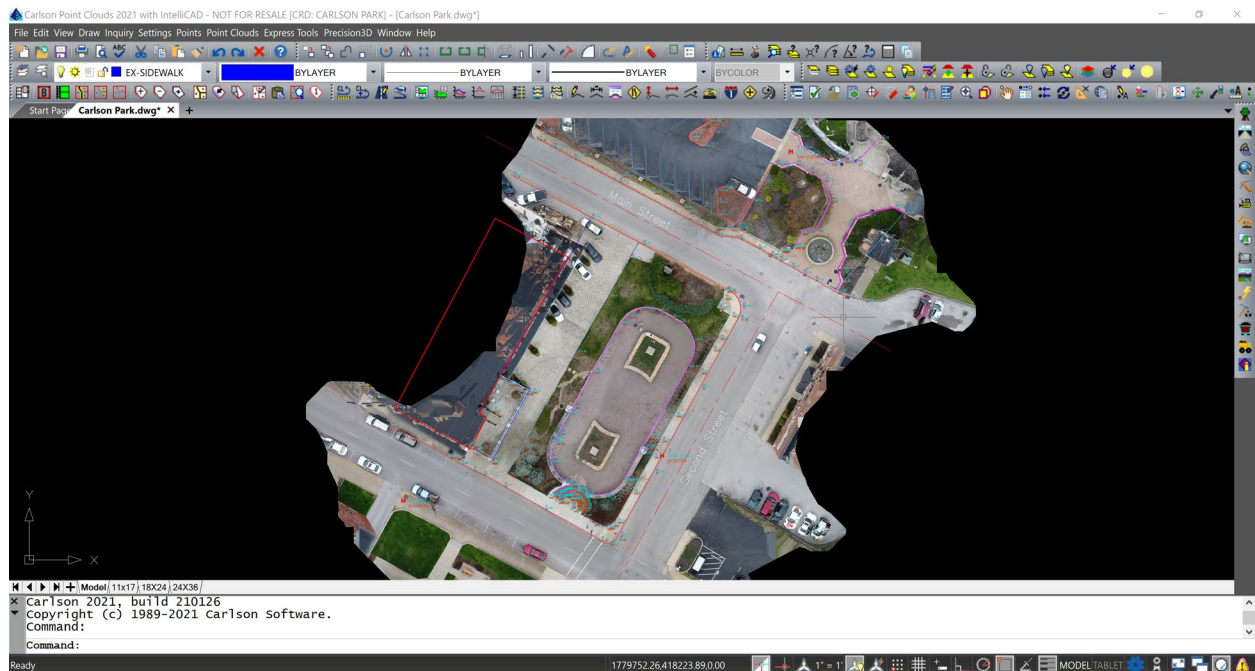
The objectives for this class are:

- Starting a Point Cloud project
- Import/Export point clouds
- Defining a work zone and applying filters
- Creating a TIN and contours in Point Cloud
- Exporting grid points for TIN in CAD
- Creating survey points and line work for field-to-finish

## Carlson Point Cloud Basic Overview

Carlson's Point Cloud Basic module provides the ability to go from field scan to finish plat from large data sets by allowing users to process millions of data points. Filter or decimate points, overlay raster

images, snap to edges and code the descriptions for automated field to finish processing of linework and symbols.
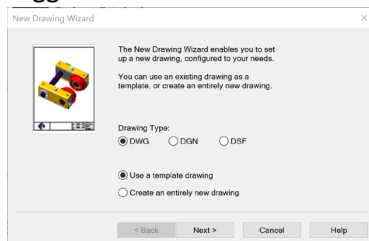
Carlson Project Setup

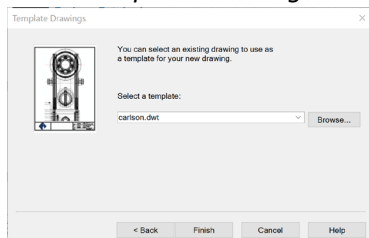Begin by creating a new Carlson project.

- Open *Carlson* by double-clicking the icon on your desktop.
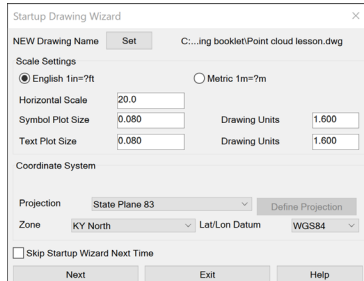- In the *Start Page*, click **New Drawing**.
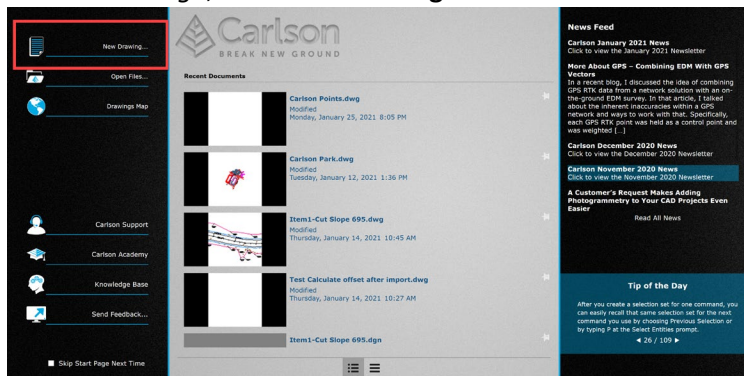
- In the *New Drawing Wizard* dialog, keep *Drawing Type* set to **DWG** and *Use a template drawing* toggled on.
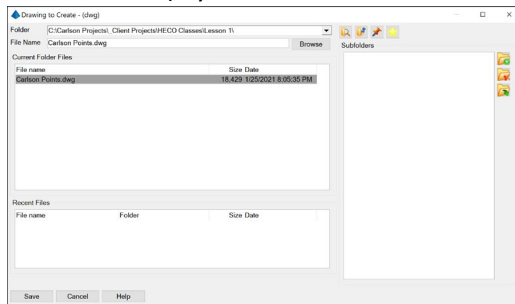

- In the *Template Drawings* dialog, select **carlson.dwt** and click **Finish**.

- In the *Starting Drawing Wizard* dialog, click **Set**.

- You will now create a new directory for the project. In the *Drawing to Create* dialog, click **Browse** and then create a new folder under the *Carlson Projects* directory named **Point Cloud Basic Lesson** (if you haven't done so already).

- In the *File Name* field, type **Point Cloud Lesson** and then click **Save** to return to the *Drawing to Create* dialog and **Save** again to return to the *Wizard*. It is not necessary to type the file extension.
- Notice the *Scale Settings*, the project scale is used to control the symbol height and the plotted height/printed height of the text. This will set the project default and can be changed later if necessary. We will keep the default value of **20**.
  - As a reminder, if the desired plotted text height is 0.08 inches, at a 1:20 scale this text will need to be 1.6 drawing units.
- Set *Projection* set to **State Plane 83** and the *Zone* to **KY North**. If you select None, you can change the projection settings later if necessary.
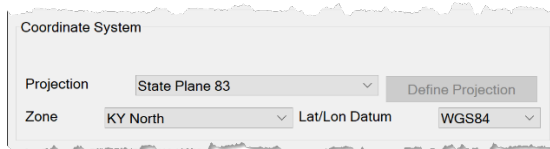
- The *Startup Wizard Data Files* dialog will open.
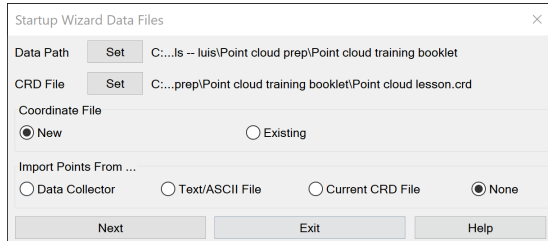
- The *Data Path* allows you to set the location of the different project files if you want to distinguish them.
- The CRD File or Carlson coordinate file is the external file that Carlson uses to store the point data, i.e., point numbers, northings, eastings, elevations and descriptions. Keep the default path and choose **New** to start a new file. CRD files can be used to import the survey data from the field crew using SurvCE/PC.
- Keep *Import Point From* set to **None.**
- Click **Next** to complete the *Wizard*.

Creating a Point Cloud Project

To provide the ability to work with the large amount of data associated with a point cloud, Carlson's Point Cloud will manage the point cloud data through the Point Cloud Manager. You will find all the import, edit, point and line creation, triangulation and export tools in it.
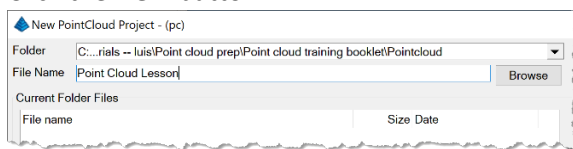
- From *Settings* menu, select **Carlson Menus** → then **Point Clouds Menu**.
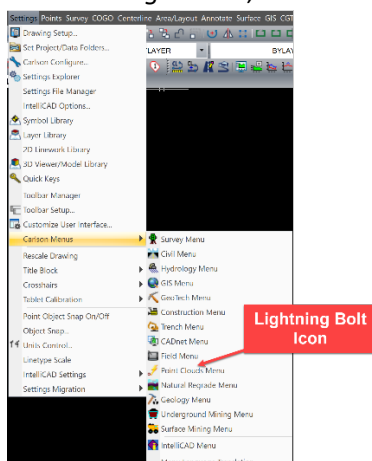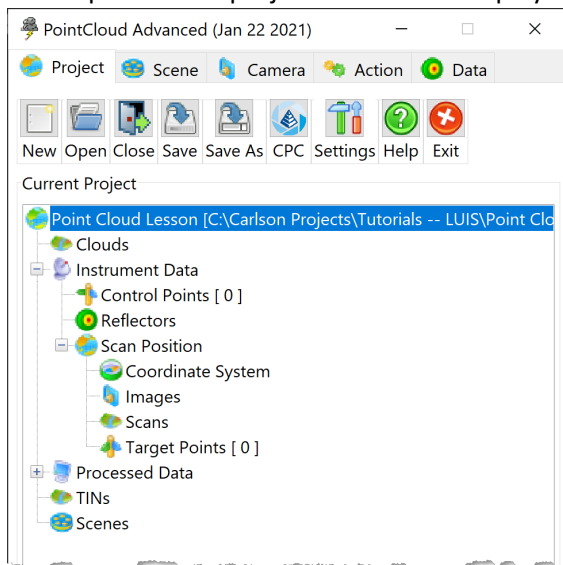

- From the *Point Clouds* menu, select **Project Manager**. The first time Point Clouds is launched, the Point Cloud Manager will open automatically.
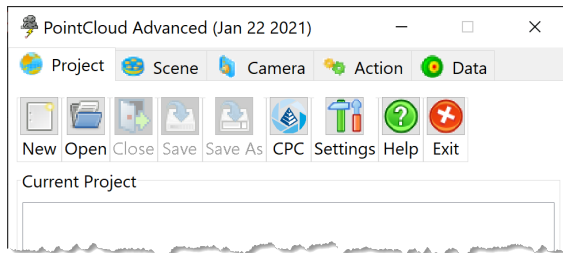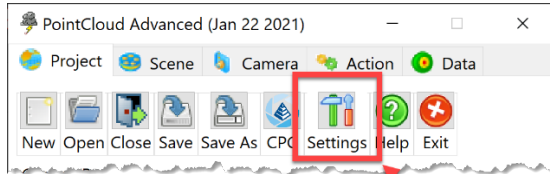
- Click the **New** button.

- Type **Point Cloud Lesson** as the file name, then click **Save**.
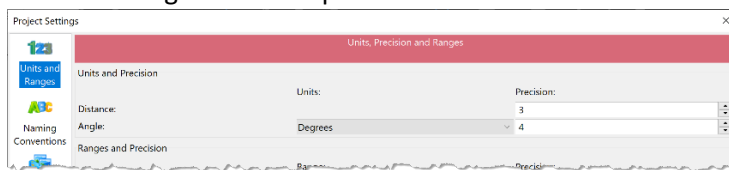- A new point cloud project tree will be displayed in the *Project* tab.

Point Cloud Project Settings

Before we get started, it is good to check the point cloud project settings.
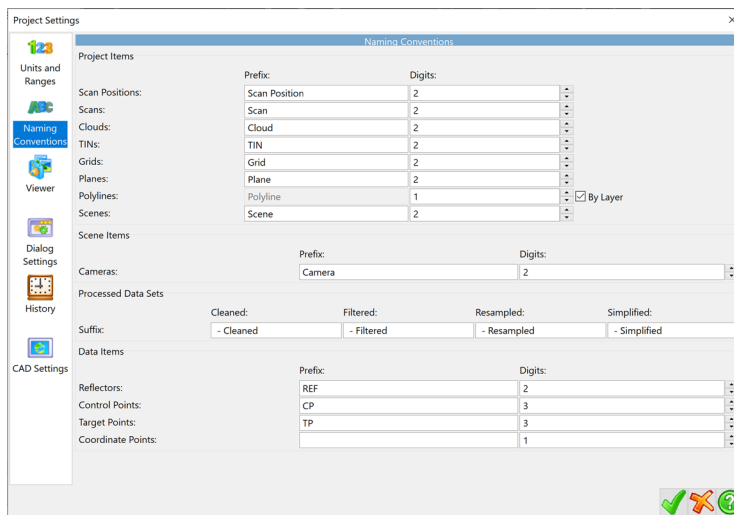
- Click the **Settings** button.

You can change the *Units*' precision.

- *Naming Conventions*, particularly the number of digits and suffixes used as you apply filters and add data.

- And adjust the *CAD Settings*. I recommend **not** checking on the option to automatically draw points, lines and text in CAD as every time you add or edit, your work will be synchronized with the drawing slowing you down. Don't worry, to draw in CAD only takes one click later.
  I do recommend turning on *Use CAD's CRD for PointCloud's Coordinate Points* as this will keep your Carlson project CRD file synchronized.
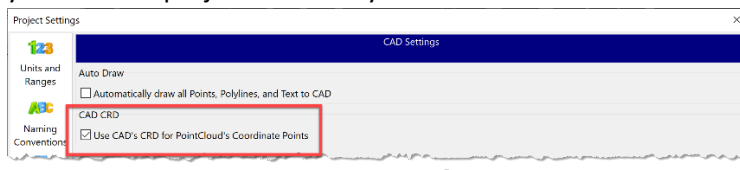
- Click Green check to close and save the changes.

Import the Point Cloud Data

The point cloud data that you will be processing may come from a terrestrial scan, publicly available LiDAR data and aerial photogrammetry data. It is important to know that when working from ground scans, Point Cloud can handle different scanner setups which will allow you to get a true 3D representation of the site. Once these ground scans are registered, they would have obtained a coordinate system and Point Cloud can be used to merge this data. For this lesson we will be using a point cloud obtained from an aerial survey using an unmanned aerial vehicle (UAV).

- In the *Project* tab, **right-click** on **Clouds**. Then select **Import**, and **LiDAR (.las/.laz)**
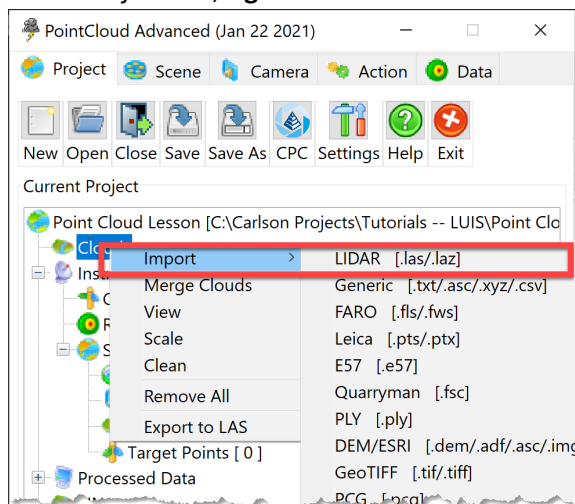

- Select the **dense_point_cloud** file provided in the compressed *Point Cloud Basic Lesson.zip* file. This will open the *Change LAS Projection* window. Note that the number of points that will be imported is listed by the file name.
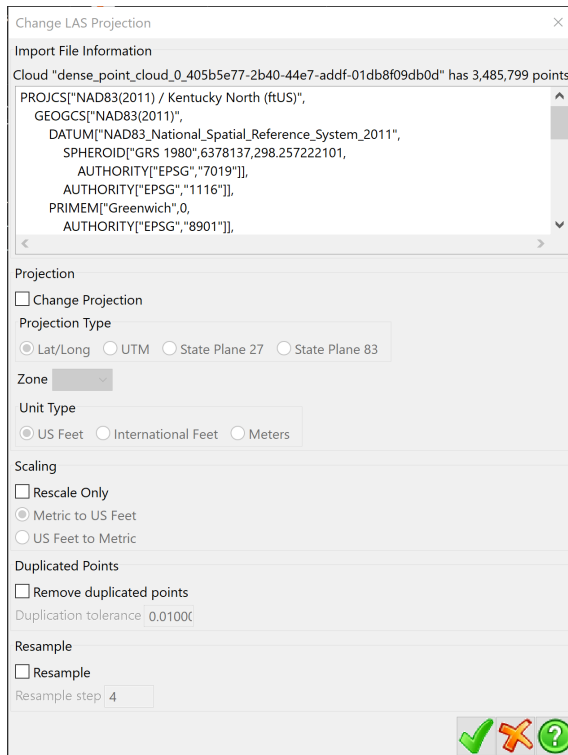
- As our data comes from drone flight images that were processed in Carlson PhotoCapture, our data has all the necessary projection information, unit type and scale. For the purpose of our lesson, we won't run either duplicated points or resampling which are decimation tools (i.e., filters). If your data was classified, an additional window will open prompting to select the classifications that you want to import giving you the option to import as Carlson Point Cloud Regions which can be used to turn on/off their visibility.
- Click **Green check**.
- Notice that the point cloud listed in the Project Manager displays the .las file name. You can rename and simplify. **Right-click** on the point cloud, then select **Rename**. Name it **01- Original Cloud**.
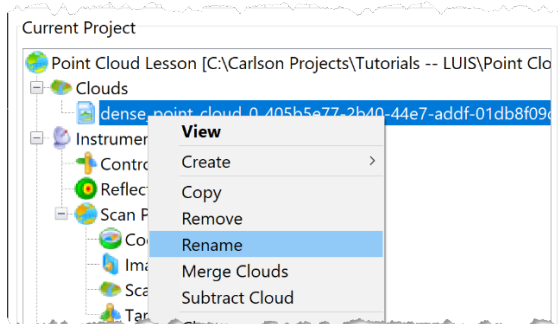
- Lastly, you can check the point cloud properties at any time to get an idea of number of points, position ranges and whether it contains classifications. To do this, **right-click** on the point cloud name and select **Properties**.
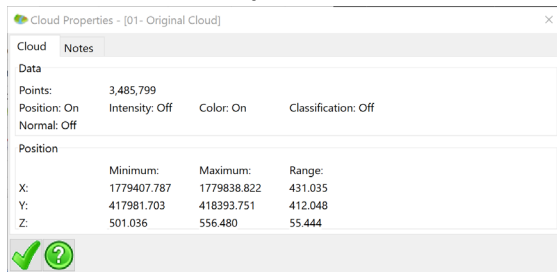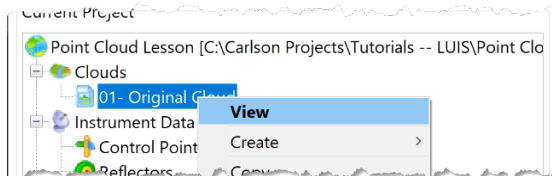

- Click **Green check** to close.

  Note: If you have a subscription to Carlson PhotoCapture, check the Getting Data from PhotoCapture appendix.

Creating Point Cloud Scenes

To begin the editing process, you will need to create "scenes" or views of the cloud. This will allow you to easily view when and where you are making changes. Also, as different filters are applied to decimate (remove points) from the point cloud, new point cloud data and scenes will be created automatically for you.

- **Right-click** on our *01- Original Cloud* and select **View**. Or, you can double-click on the name.

- In the *View Cloud* window, we'll keep the *Action* as **Create new**. The *Color* as **Direct**, which will keep the point colors as they were define by the aerial images. And, change the *Orientation* to **Isometric**.
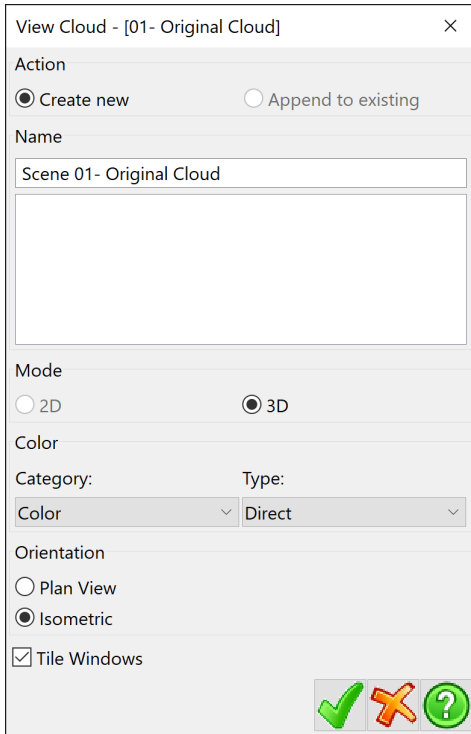
- Click **Green check** to create the scene. Your screen will look somewhat like the image below.
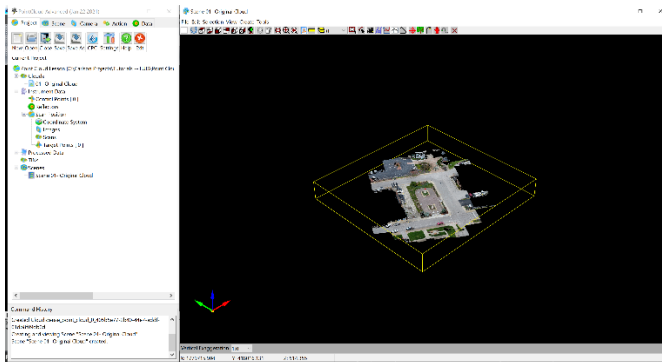
You can navigate the point cloud in the scene window in multiple ways. You can zoom in and out using the middle-button wheel in your mouse. Pressing the middle-button will behave as panning. And, left clicking will allow you to rotate the view just are when you work with Carlson's 3D Viewer. In the toolbar you will find helpful shortcuts to set the view to top, front, perspective, etc. Take a moment to review these tools.

Define the Working Area

As mentioned at the beginning, the goal for this lesson and for many projects is to obtain a representative surface model (TIN) of the project site from the point cloud data. With that in mind, it is a good practice to isolate or create a point cloud that is sub-set of the complete project. To this lesson, we are only concerned with the park and surrounding streets.

- Start by changing the scene view to Top.
- In the *Project Manager*, open the **Action** tab. In this tab, we will use the **Perimeter** tool under *Selection Set*. Using Perimeter Inside, we can draw a boundary to select all the points we are interested for our study.
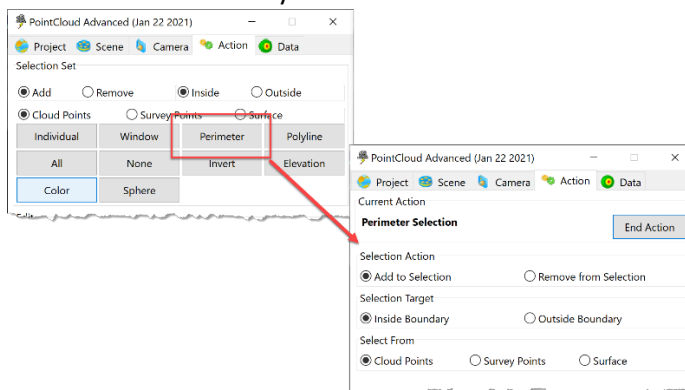
- Select an area similar to the image below that will include only the park and streets we are interested in.
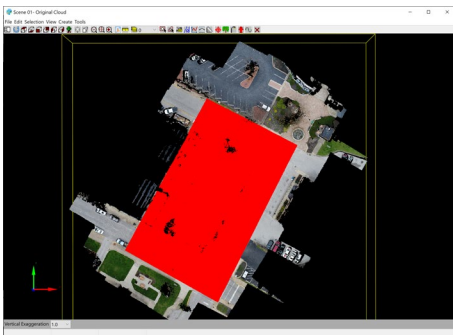
- To create the isolated, work area, from the *Action* tab, click the **Cloud** button in the *Create* section.
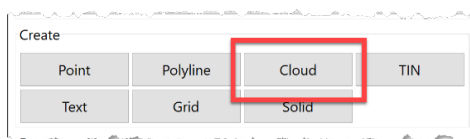
- Name the resulting cloud **02- Working Area**.

- Now, to view the results, **Close** the current scene window. Notice the title is "Scene 01- Original Cloud".
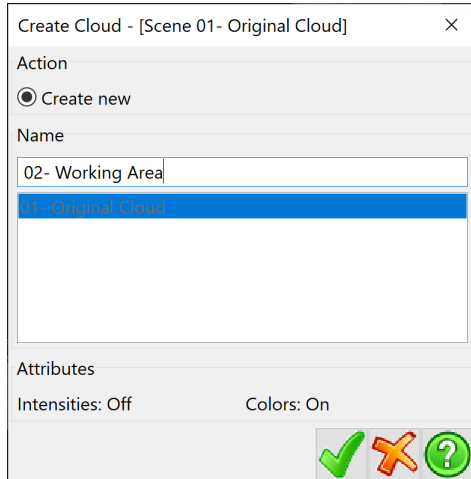- Then, from open the *Project* tab in the *Project Manager* and double-click on the "02- Working Area" cloud. This will create a new scene as discussed earlier. Your window should look similar to the image below.

Clean the Point Cloud Data

Although we isolated the work area in the previous step, a quick review of the new point cloud properties will reveal that we still have close to 2 million points left. And clearly there are still vehicles and other undesired point data in our data, i.e., noise. Therefore, we will start applying different filters to decimate or reduce the point cloud data. As stated earlier, which and how many filters you will want to apply to your project will be a decision you will want to make on a project-by-project basis.

Let's start with the simplest *Clean Cloud* filters, remember though that you can apply the filters multiple times if needed.:

Duplicated Points – this method searches por two or more points that are within the *Distance Threshold* and then will remove them. This method is typically fast and helps reduce much of the redundancy in the data. For example, data collected with a ground scanner will have more points than necessary right next to the scanner.

Isolated Points – searches for points that have less than *Minimum Neighbor Counts* within the threshold and delete them.

Redundant Points – this parametric method is more useful when needing to reduce the flat areas down to one point. It will create a user-defined box and check how the points inside of it fit the plane and/or have a color match.

For this first cleaning lesson, we will apply the three described filter options to give you an opportunity to review the results. But, it is important to know that these three should not be applied simultaneously. We will start by removing duplicated and isolated points.

- From the *Project* tab, **right-click** on "02- Working Area" and select **Clean**.
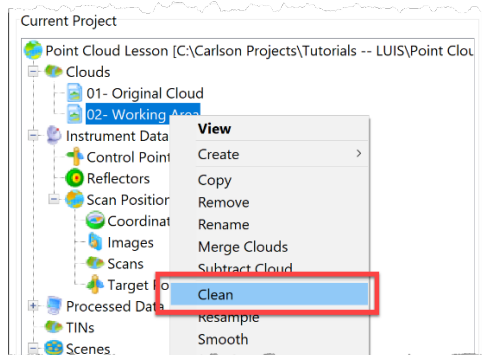
- Make sure the name is set to **02- Working Area – Cleaned**, this will help keep the project's clouds listing sorted in the desired order. Keep **Remove duplicated points** checked, in 3D. And, **Removed isolated points**.
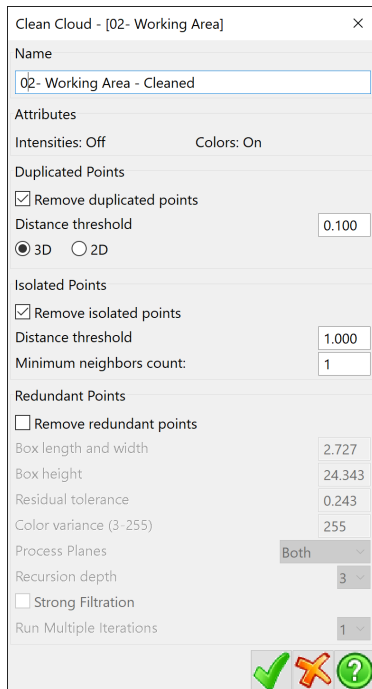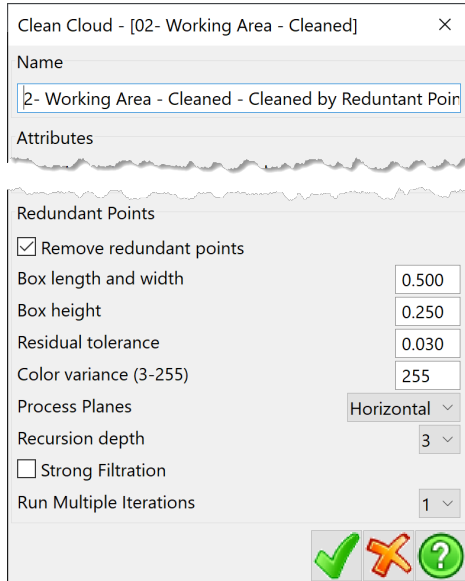
- Click **Green check** to apply the filter. A new point cloud will be generated.
- Close the current scene and open a new scene for the resulting cloud. Check the properties.
- In the *Project* tab, click the **Save** button to save the current status of the project. Note that the Point Cloud program has an auto-save function but it is good practice to save after big changes.


You will notice that the cloud data was reduce by a few more hundred thousand points. Now, you will apply the redundant points cleaning filter.

- **Right-click** on the "02- Working Area – Cleaned" from previous step, and select **Clean** again.
- Name the new cloud **02- Working Area – Cleaned by Redundant Points**.
- **Uncheck** *Remove duplicated points* and *Remove isolated points*.

- Check **Remove redundant points** and use the settings as shown below.

- Click **Green check** to process. Close the current scene and create a new one as before. Check the resulting point cloud properties. You will notice that this last filter reduced the file to a few hundred thousand points.
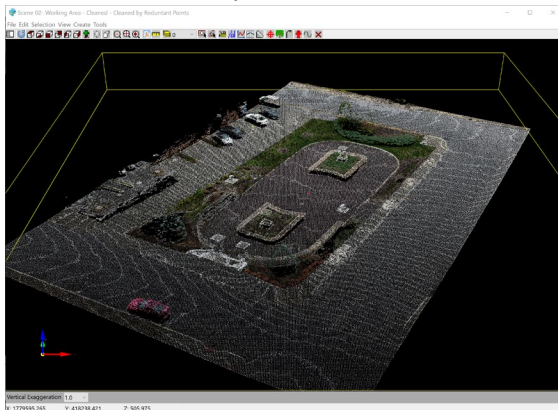
Resampling the Cloud Data

Resampling is another method to decimate the point cloud data. There are two methods:

Step – this method reduces the cloud to 1/Step it's current size. It is fast but at the cost of being less intelligent.

OC-Tree – analyzes the data by using user-defined bounding boxes to search for minimum and maximum numbers of points within the ranges and deleting points. This method may take a few minutes to complete depending on the amount of points in your point cloud data.

As you noticed from the last step when using the Clean filters, our data has been significantly reduced and therefore we won't apply the resampling method.

Applying Bare-Earth Filter

If you navigated the "02- Working Area – Cleaned by Redundant Points" cloud, you noticed that we still have some vehicles and trees in the data. We can automate the removal of these data by applying the Bare-Earth filter.

> **Bare Earth by Profile** – this method works by drawing a 3D line away from the selected position and seeing if it slopes too sharply, removing any vertical segments and keeping any flat segments.

> **Bare Earth by Grid** – works by inspecting the cloud as a grid to find the lowest valid points in each grid cell and keeping only those points.

As every project is different, you may want to apply one or the other filter. For our lesson, the Grid method is more appropriate. But, as an example, if your project is on a hillside, the Profile method may be best.

- **Right-click** on the point cloud and select **Bare Earth by Grid**.
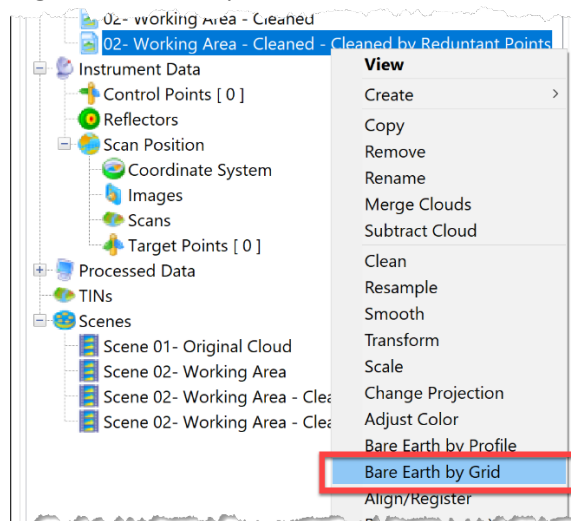
- Name the new cloud **03- Working Area – Bare Earth**. Set the *Cell Size* to **4**, *Pothole Depth* to **0.5** and *Curb Height* to **0.8**.
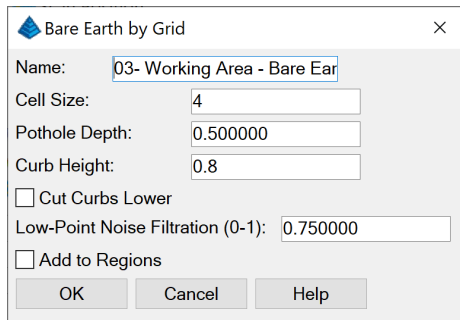
- Click **OK** to apply the filter.
- Close the current scene and create a new one for the resulting "*03- Working Area – Bare Earth*" cloud. If you check the properties, you will find that a few more tens of thousands of points were removed. The resulting cloud should be similar to the image below.
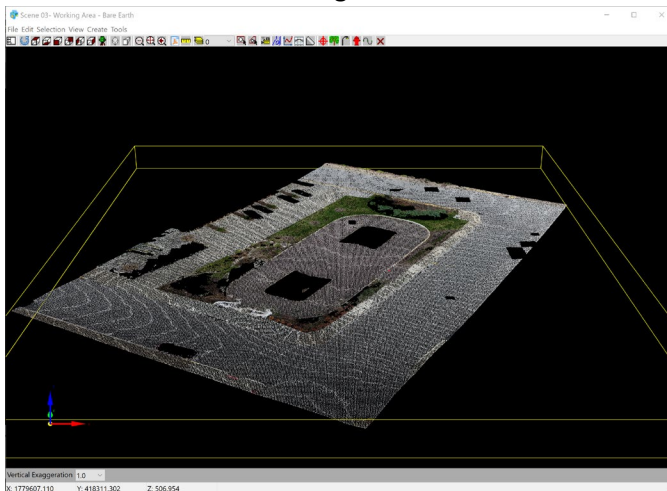

Delete Points Manually

Closer review of the data after applying the bare earth filter will reveal that there are some areas in the project that we can still further clean. For this lesson, we will accomplish this by using the cloud point selection and delete tool. As a reminder, you can re-run any of the filters. Note, that in some cases the current data may be sufficient for your project and no further actions needed.

To illustrate this, we will clean up a small area in one of the planters that wasn't cleaned up:

- In the *Scene* window, change your view such that you can clearly see the targeted area. For example, the one below.
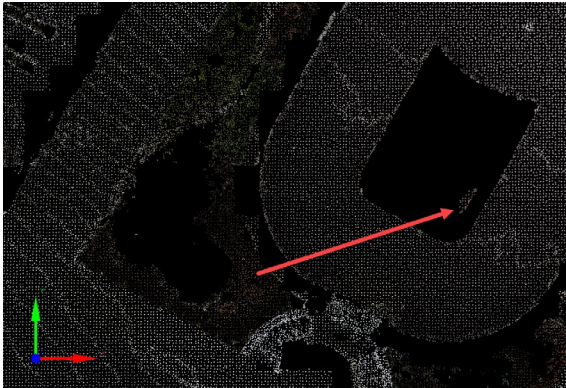
- In the *Action* tab, under *Selection Set*, click the **Window** button.
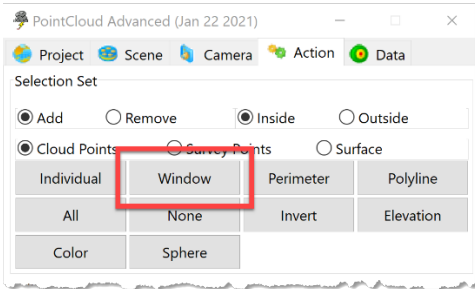
- Use the window selection to select the points you want to delete. Note that you can adjust your view as necessary, whether zooming in/out, rotating, front view, etc.
- With the correct points selected, click the **Delete** button in the *Edit* section.
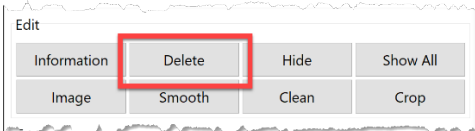

- Repeat as necessary and save when done.

Other tools in the *Selection Set* area allow you to invert selection sets, use polylines (either draw one or use an existing one) and colors to find the targeted points.

## Create Surface Using Remaining Point Cloud Data

With all the filters that we've applied, we reduced the original point cloud to a few hundred thousand points which can be used to create a surface model (TIN), contours, profiles and volume calculations directly in Point Cloud. As stated in the beginning, our intent is to obtain a representative surface model

(TIN) of a project site from a point cloud therefore we can do it now. It is important to know that this isn't the only way as you may prefer to create the surface and contours in CAD – check the Virtual Surveying lesson after this.

- From the *Action* tab, click the **TIN** button in the Create section.
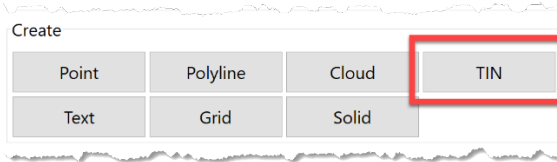
- Select **Export to Carlson TIN**, this will generate a .tin file that can be used by all the Carlson office products. In the Save file window, name it **Point Cloud Lesson.tin**.
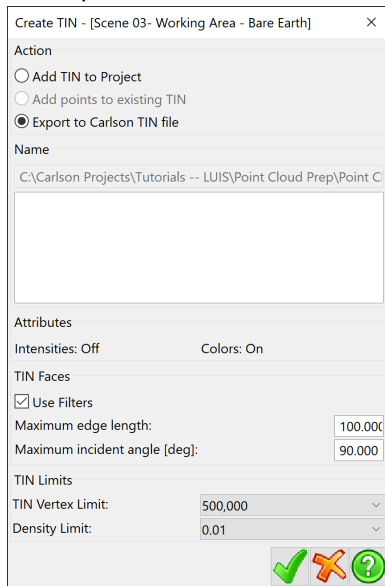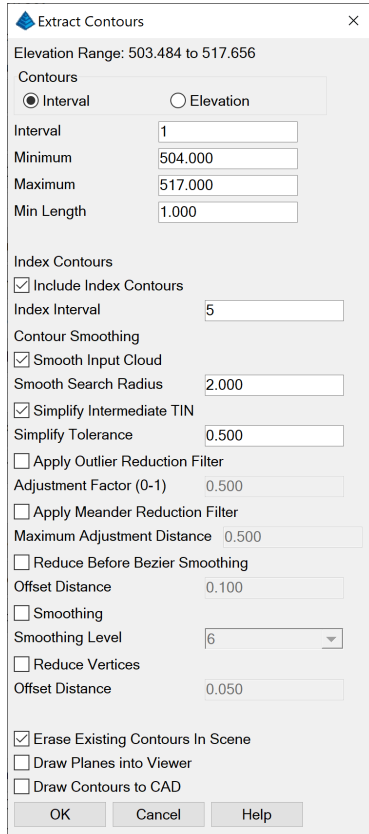

- Click **Green check** to create the surface from the cloud points.

If you want to view the contours, I recommend creating a new scene.
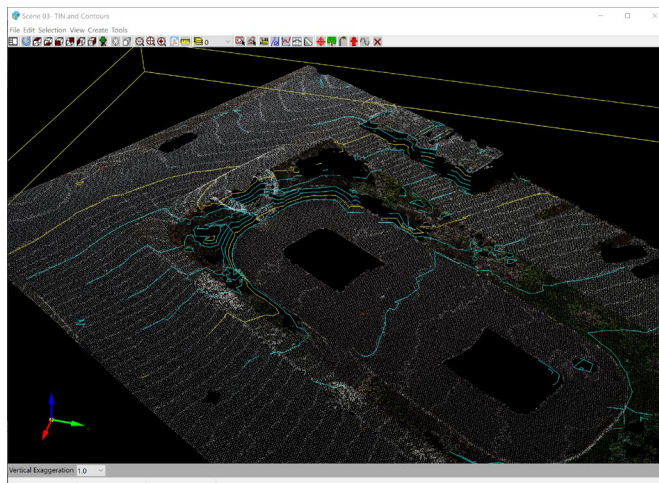
- From the *Action* tab, click the **Contours** button in the *Extract* section.
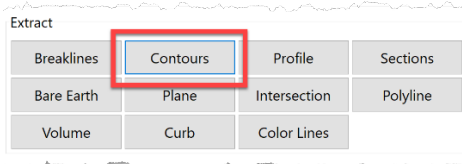
- Choose the contour interval, include index contour and check erase existing contours in scene.

- The contours will be drawn on the scene. Your screen will look similar to the image below.

## Create Points and Lines for Field-to-Finish Processing

Now, let's explore a different method for obtaining the desired surface but this time we will leverage the point and line creation tools found in Point Cloud to create points with descriptors that can be processed in Carlson Survey using Field-to-Finish. Depending on your project scope and preferences, this may be the preferred way to get to our desired surface and contours.

The following steps can be done from any of the scenes/views found in the Point Cloud Manager but for simplicity and explanation purposes we will use the original working area cloud and scene. We will create a group of points with description following the top of curb for one of the streets.

- Close any scenes that you have open.
- Now open **Scene 02 – Working Area**. This scene should have the isolate point cloud with dense data.
- From the *Action* tab, click the **Point** button in the *Create* section.
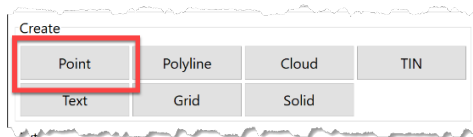
- Under *Snap Mode*, select **Low Point**. The *Active List* should be set to *Coordinate Points*. Set the desired starting *Point Number*.
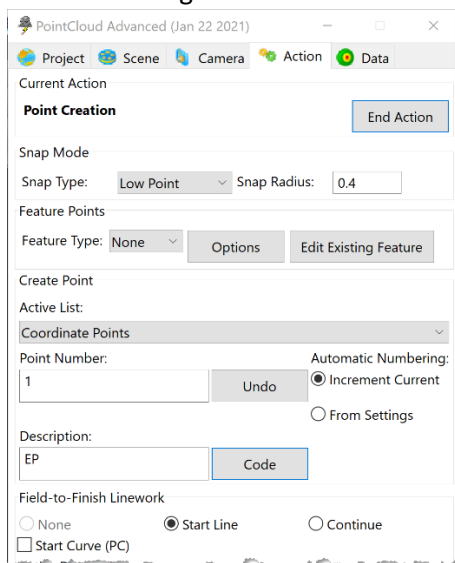

- o If you have a customized or preferred Carlson field code table, click the **Code** button. Then click **Pick FLD File** to browse and select your custom field code table. Once selected, you will see all your codes listed and ready for selection. In this example, you can use the *Carlson.fld* file and select the *EP* code for edge of pavement.

- o Notice the Field-to-Finish setting is set to Start line and there are both an End and Close buttons (same icons as those found in SurvCE/SurvPC).
- In the scene viewer, place your cursor where you want to create the point and then continue selecting other places just as if you were in the field collecting data, i.e., virtual surveying. Your screen may look similar to the image below.


- You will be creating the same codes/lines until you End the line or change codes (just as you would do in the field). To add arcs, toggle *Start Curve (PC)*. Use this to create the arc at the street intersection.
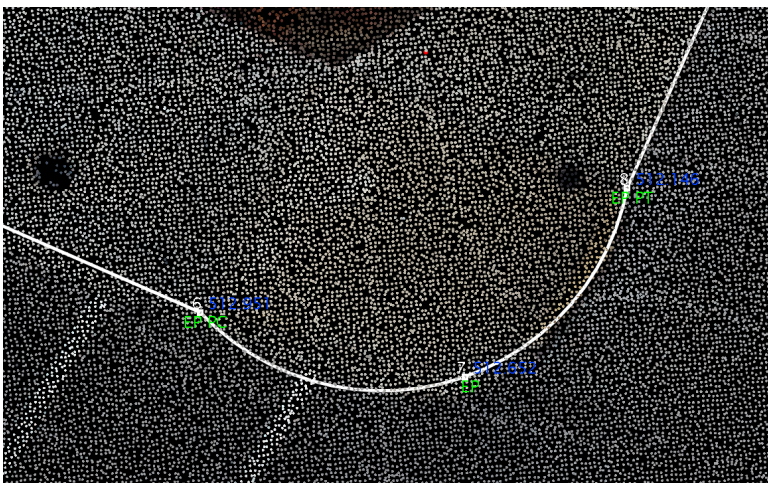

- Continue as necessary.
- Use other codes to place the manholes, light poles, etc. found in the area.
- Once done click **End Action.**
- **Save** the project.

What about lines without placing points?

- From the *Action* tab, select **Polyline**.
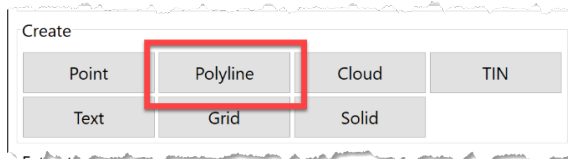
- Notice that the placement options are like points and several options to draw and edit the lines. Difference is that the software will not place points.
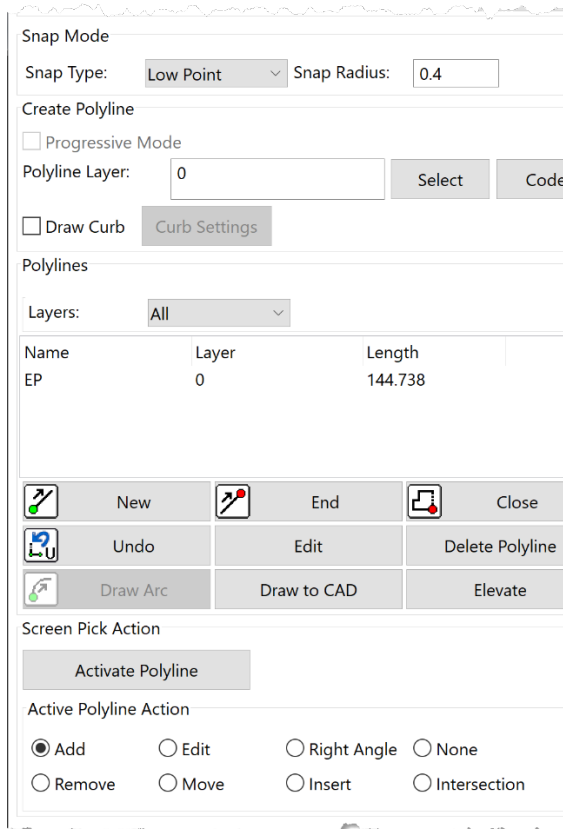

- Click the **End Action** button to close.
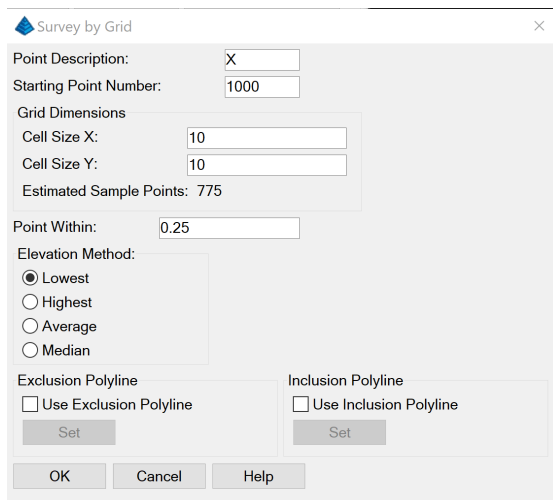- **Save** the project.

Topo Points by Grid

In the lesson above, you followed a virtual survey process to place specific points and generate linework. Now then, to create a group of general topo points Point Cloud has a Survey by Grid option that will automate this process. With that in mind, we spent the time to clean up the point cloud data, thus we'll use the resulting cloud to obtain this final set of points.

- Close the current scenes.
- For the lesson, we will create a new scene from the "03- Working Area – Bare Earth" cloud, name it **Scene 04- Survey by Grid**.
- From the *Action* tab, click the **Point** button n the *Create* section.
- Click the **Survey by Grid** button in the *Automation* section (you may need to scroll down in the window).
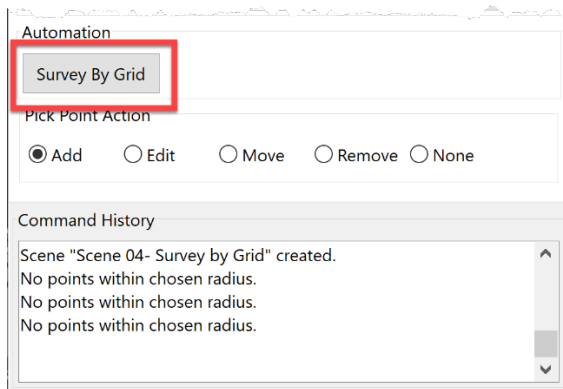
- Use **X** for point description, in the default Carlson field code table, this is the natural ground code. Change starting point number to desired value. Make sure that *Elevation Method* is set to **Lowest**. We don't have either inclusion nor exclusion boundary polylines in this project.
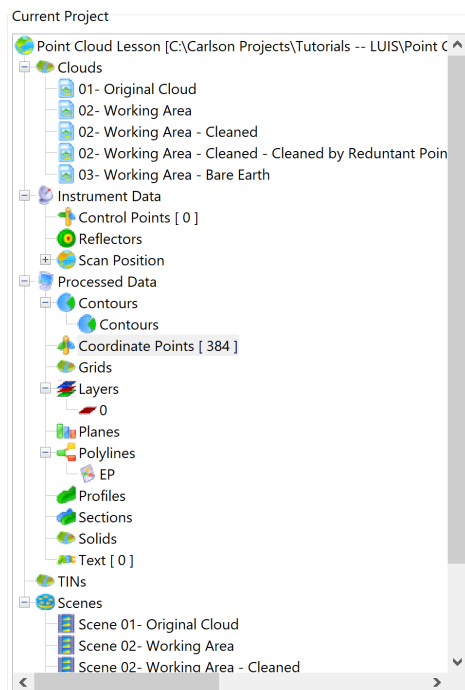
- Click **OK** to place the points. This may take a few minutes depending on the selected area and grid dimensions. The results will be similar to the image below.
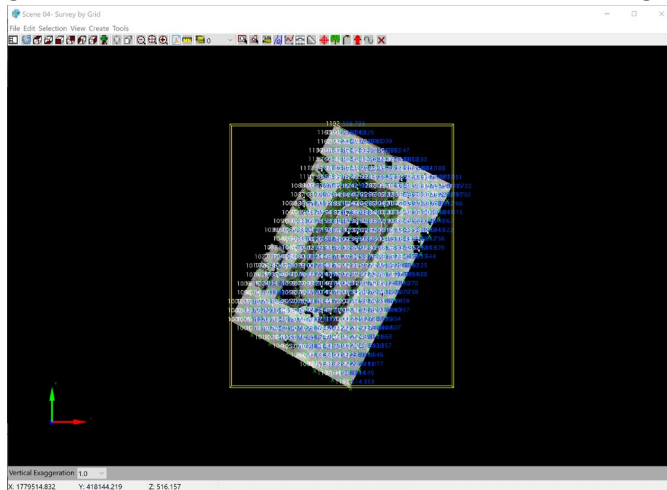
- Click **End Action**.
- **Save** the project.

Notice how the current project now has *Processed Data* listed.

It is good to know that lines and points from the CAD drawing could have been imported as references. Also, if drawing linework, you can upload the layer names/settings from CAD into the Point Cloud Manager to keep everything categorized per your standards.

Drawing the Points and Lines to CAD

Now that we have points and linework, it is time to draw all these entities in CAD. If you used both points and lines, we can do this in two separate steps. First field-to-finish for the points and then draw polylines for remaining linework.
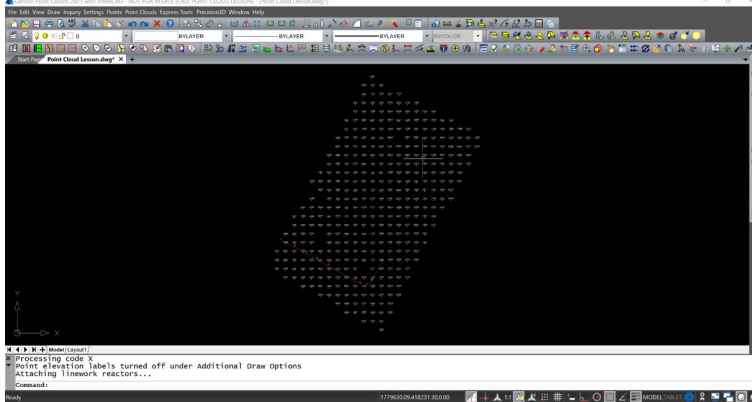
- In the *Project* tab, **right-click** on *Coordinate Points* and select **Field-to-Finish**
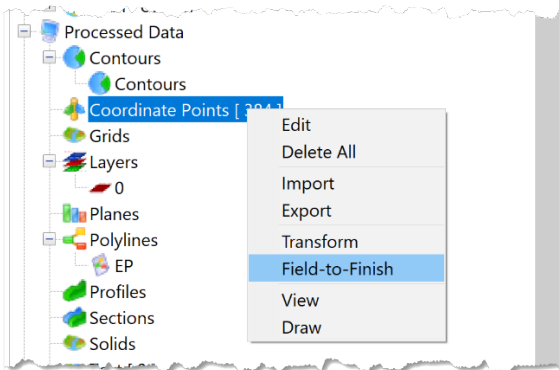
- This will bring up Carlson Survey's *Draw Field to Finish* window. Make sure that you have the correct field code table selected. For our lesson, this would be the *Carlson.fld* code table.
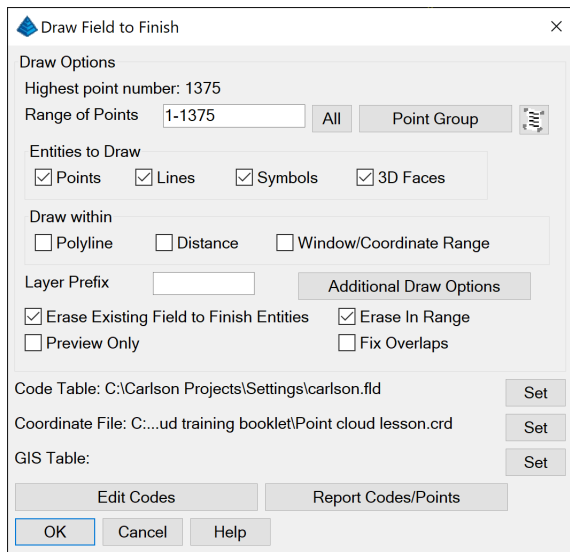
- Click **OK** and the points and lines will be processed in CAD.

- If you drew lines separately, **right-click** *Polylines* in the *Current Project / Processed Data* tree and then **Draw**. Or select a specific set of lines.

Once in CAD, you can use the Carlson Survey/Civil tools to triangulate and contour the surface.

Appendix – Getting Files Directly from Carlson PhotoCapture

If you have a subscription to Carlson PhotoCapture to process you the images from your drone projects, downloading the project data from the web service to your project folder can be simplified.

- From the *File* menu, select **Carlson PhotoCapture**.
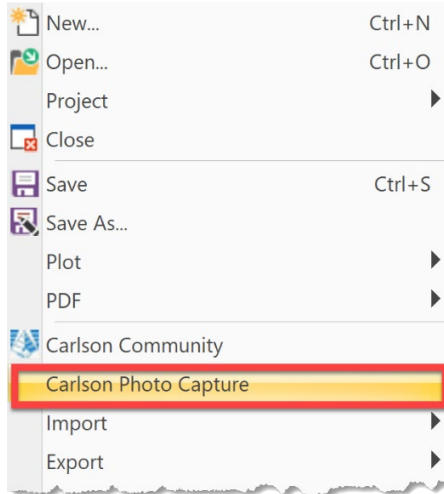
- In the *Carlson Customer Login* window, input your PhotoCapture credentials and click **Login**.
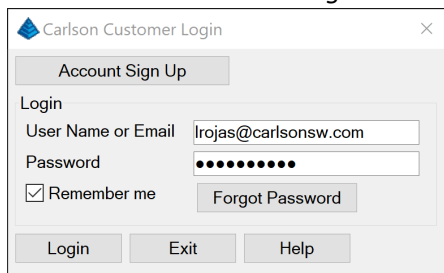
- The *Select PhotoCapture Project* window will display all the projects you have available on the web service. Select the project you will be working with and then click **OK**.
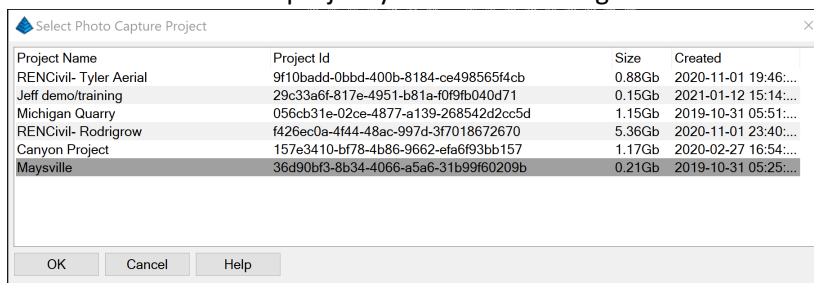
- After a moment, the *PhotoCapture Project Files* window will open with a listing of all the PhotoCapture output files that can be downloaded. You will want to download the orthoimage,

dense point cloud data and project report. **Highlight the files** to download, check **Simplify File Names** and the click **Download**.
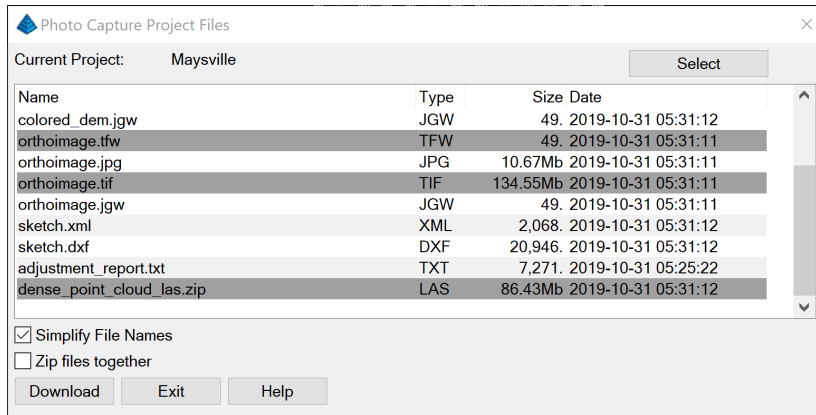
- Once the downloads are complete, click **Finish** in the PhotoCapture Download Queue window.
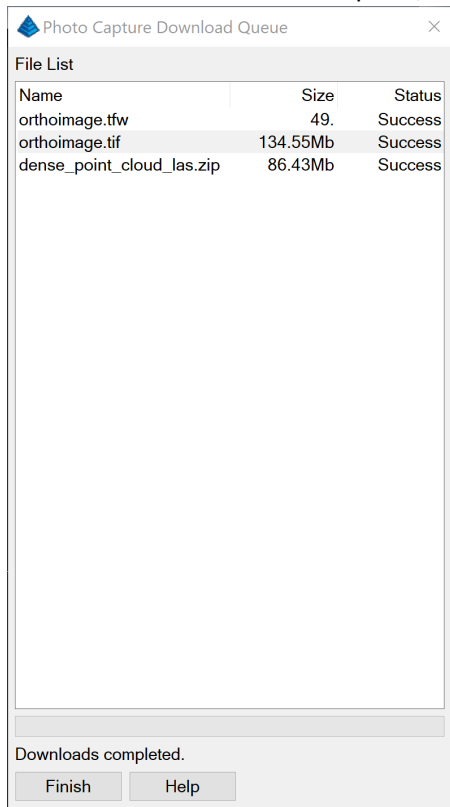
- A report window will open if you want to confirm and save the information regarding the downloaded project.

- The downloaded files will be found in the project folder.

Name	Date modified
PointCloud	2/8/2021 2:29 PM
BareEarthGrid.pcg	2/8/2021 12:21 PM
dense_point_cloud_0.las	10/31/2019 3:24 AM
dense_point_cloud_0_405b5e77-2b40-44...	12/18/2019 6:01 PM
orthoimage.tfw	2/8/2021 5:18 PM
orthoimage.tif	2/8/2021 5:18 PM
orthoimage_7b9b75de-56de-4a97-a726-...	7/20/2020 10:02 AM
orthoimage_7b9b75de-56de-4a97-a726-...	12/18/2019 5:58 PM
Point Cloud Basic Lesson.zip	2/8/2021 10:03 AM
Point Cloud Lesson.bak	2/8/2021 1:24 PM
Point Cloud Lesson.crd	2/8/2021 2:23 PM
Point Cloud Lesson.dwg	2/8/2021 2:30 PM
Point Cloud Lesson.grp	2/8/2021 2:24 PM
Point Cloud Lesson.his	2/8/2021 2:17 PM
Point Cloud Lesson.ini	2/8/2021 4:57 PM