CES469304

Drone Surveying – "Field to Finish"

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Learning Objectives

- Learn how to upload images to ReCap Photo, use GCPs (Ground Control Points) to align images based on real world coordinates.
- Learn how to create a point cloud from data collected with the drone.
- Learn how to import a point cloud into ReCap, InfraWorks, create a surface, generate line work, and classify data.
- Learn how to export data from InfraWorks to Civil 3D and create a working existing condition drawing.

Description

Great, I just received my point cloud data! Now what do I do with it? It is a common question in the infrastructure industry. There is an abundance of software that will assist in the post processing of point clouds into a working/usable format. If you have the AEC Collection you have all you need. Using a "real world infrastructure project" this class will walk you through the step by step process of post processing photogrammetric data collected via drone. Utilizing products available within your AEC Collection (ReCap Photo, ReCap Pro, InfraWorks and Civil 3D) surveyors and designers will be able to generate a working existing condition drawing.

Speaker

Christopher Hinkley has been in the surveying, civil engineering and construction industry for the past 18 years (14 years with Wright-Pierce). Chris holds a couple of degrees; an Associate Degree in Architectural and Civil Engineering Technology and a Bachelor's Degree in Construction Management. He works for a multi-disciplinary firm and leads the civil group in software management, training, implementation and project coordination (with the wastewater group, water group and building systems group). Additional tasks related to the civil group include, survey management/coordination, Part 107 Remote Pilot, preliminary and final design as well as construction administration. He is fully immersed in the Autodesk Community; Civil Futures, InfraWorks Customer Council, Land Development Council, and End of Sprint Demos with the InfraWorks/Civil 3D development teams.

Utilizing the AEC Collection

In order to post process your drone data you should be familiar with the following products:


ReCap Photo

Once you have collected your drone data, i.e. aerial images, you can now upload them to ReCap Photo for post processing.

You will notice under the section **"CREATE 3D"** there are two options for generating your final product; for this example we will choose **"AERIAL"**
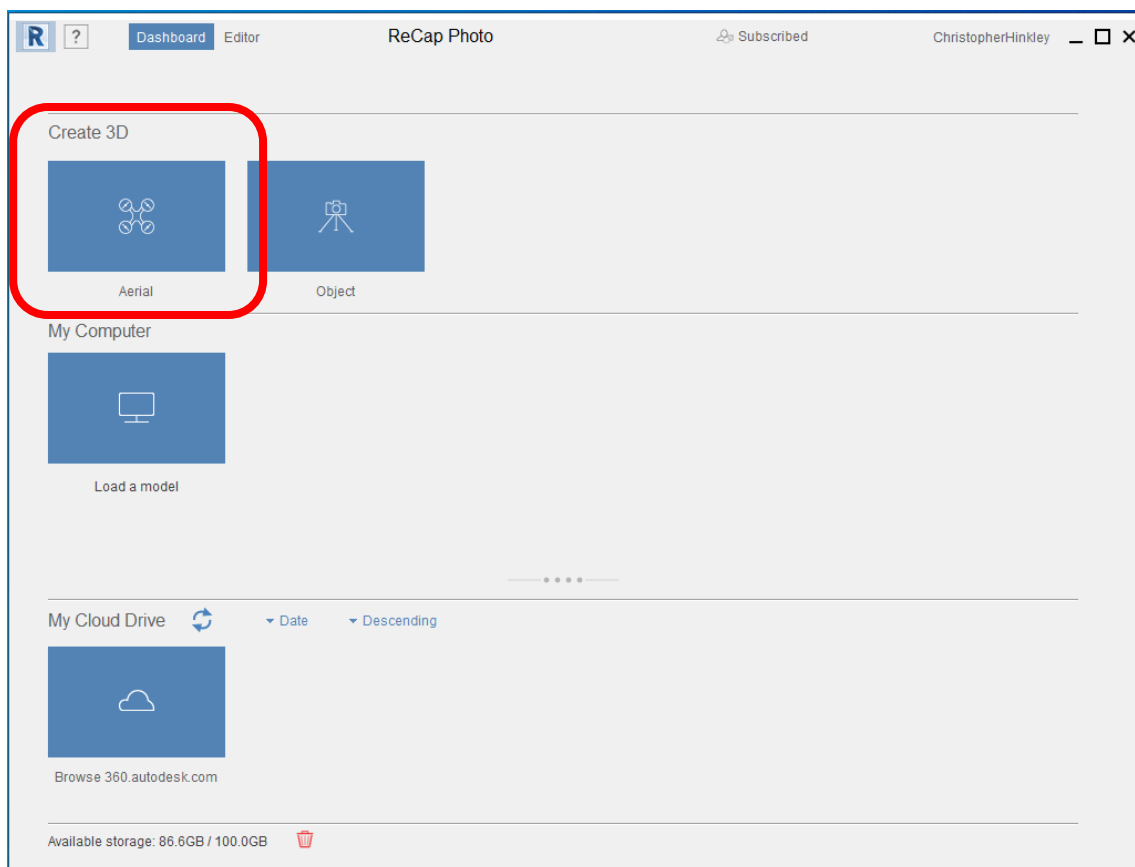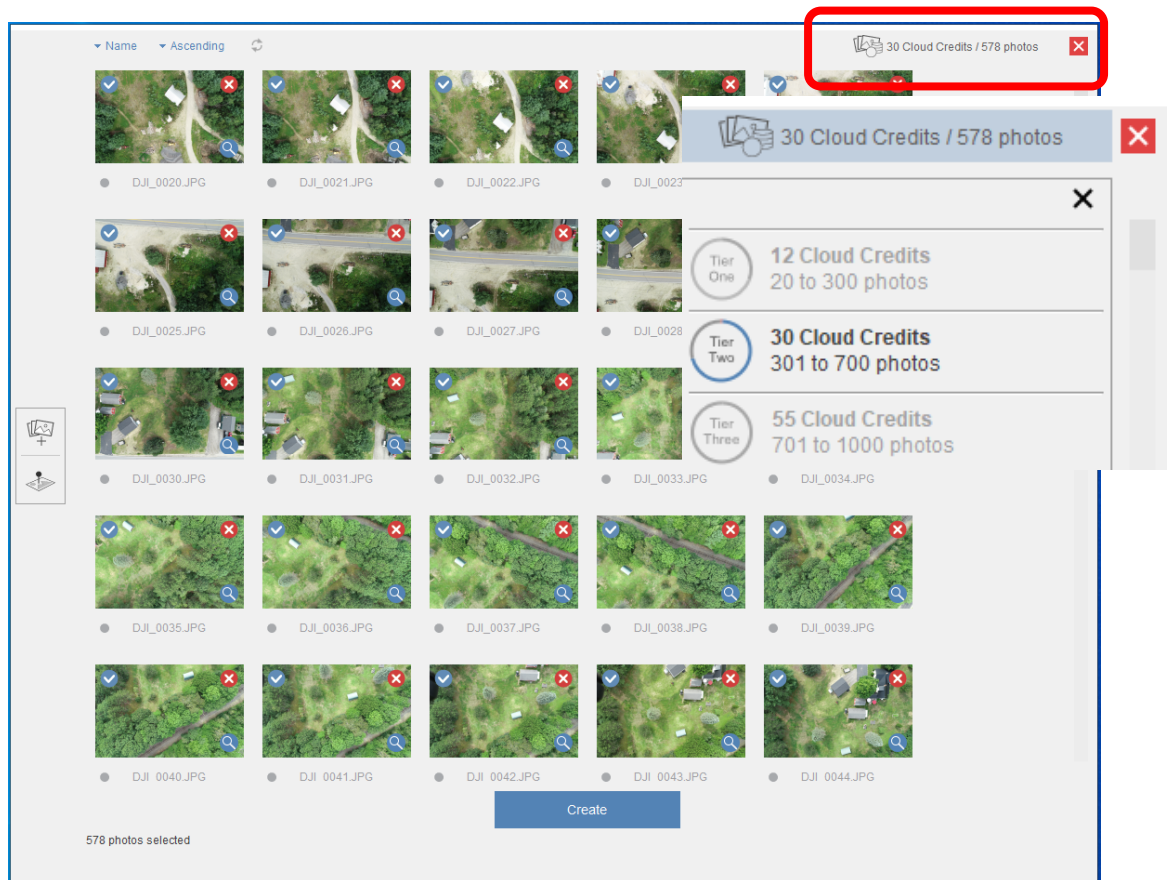
After you choose aerial, you will then be prompted to upload your photos. To do this, simply follow the image instructions and **"CLICK ANYWHERE TO BROWSE FOR FILES OR A FOLDER"**. You will then be prompted to select photo's. Browse to the location where you stored the photo's from your drone flight. You can select the individual photo's or folder location.
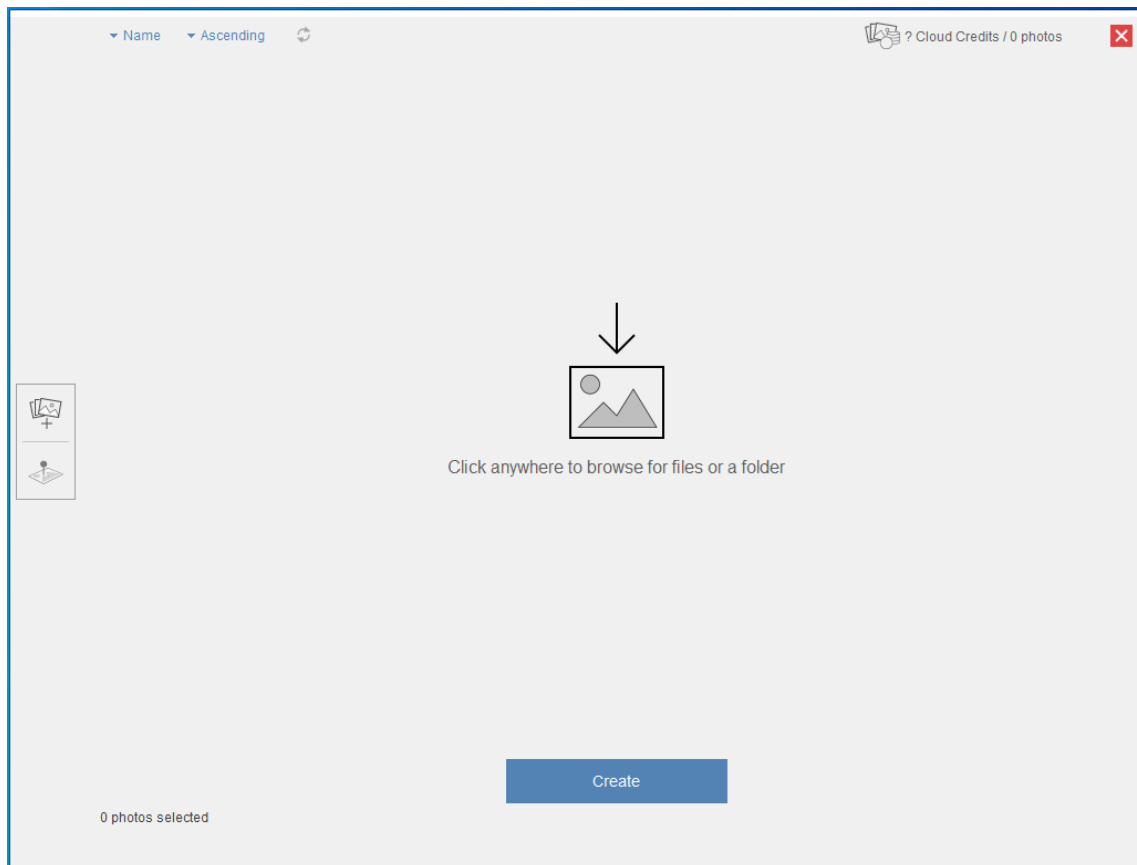
Once your photos have been selected and uploaded you will notice in the upper right-hand corner a reference to **"CLOUD CREDITS".** The cloud credit usage is based on the number of photos you uploaded. Select the **"CLOUD CREDITS"** pull down and you will see how many cloud credits are needed for projects. For this project I have 578 photos, which means I will be using 30 cloud credits.

Cloud Credits
For additional information in regarding cloud credits, you can refer to the Autodesk Knowledge Network (https://knowledge.autodesk.com/customer-service/account-management/users-software/reporting/cloud-credits), your BIM/CAD Manager and/or your reseller.
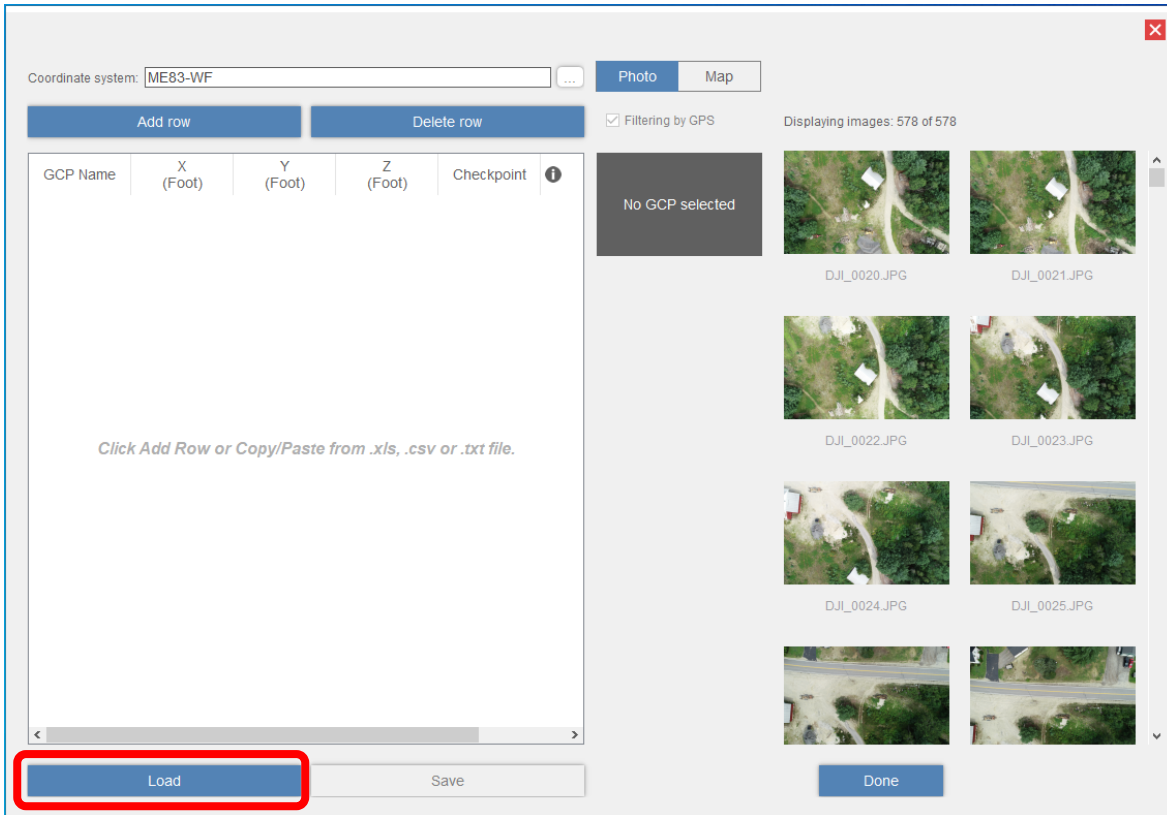
In this dialog box you also have the ability to add Ground Control Points (GCP's). If you used GCP's for your drone flight (as I have in this example), on the left-hand side (highlight with red box) select the **"GROUND CONTROL POINTS"**.
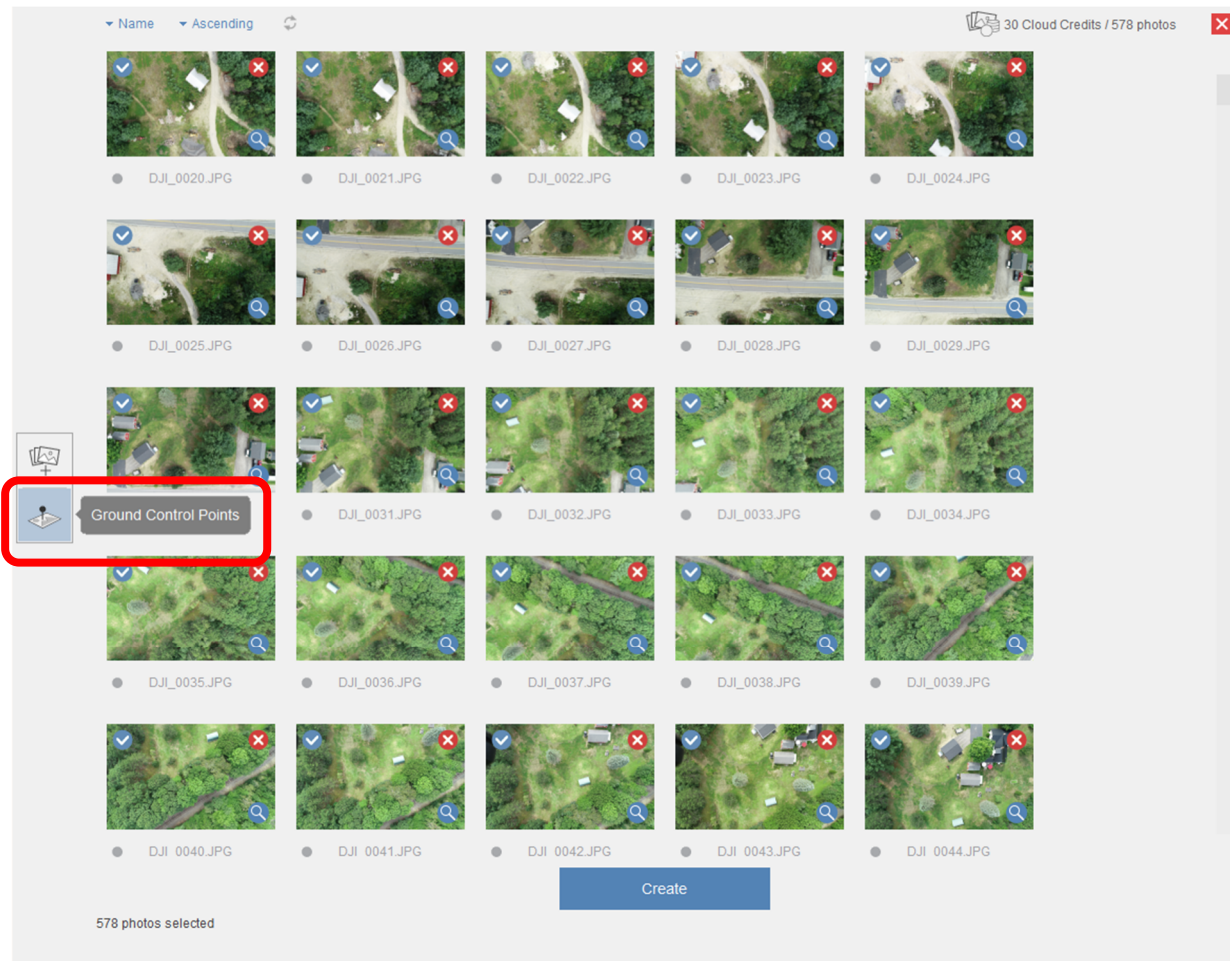
You will want to select the coordinate system you are working in, in the dialog box highlighted below. To do this, select the **"ELIPSIS"** button to the right of the coordinate system line, and a dialog box will appear, and you can search for the coordinate system you are working in. The example is in ME83-WF (NAD83 Maine State Planes, West Zone, U.S. Foot).
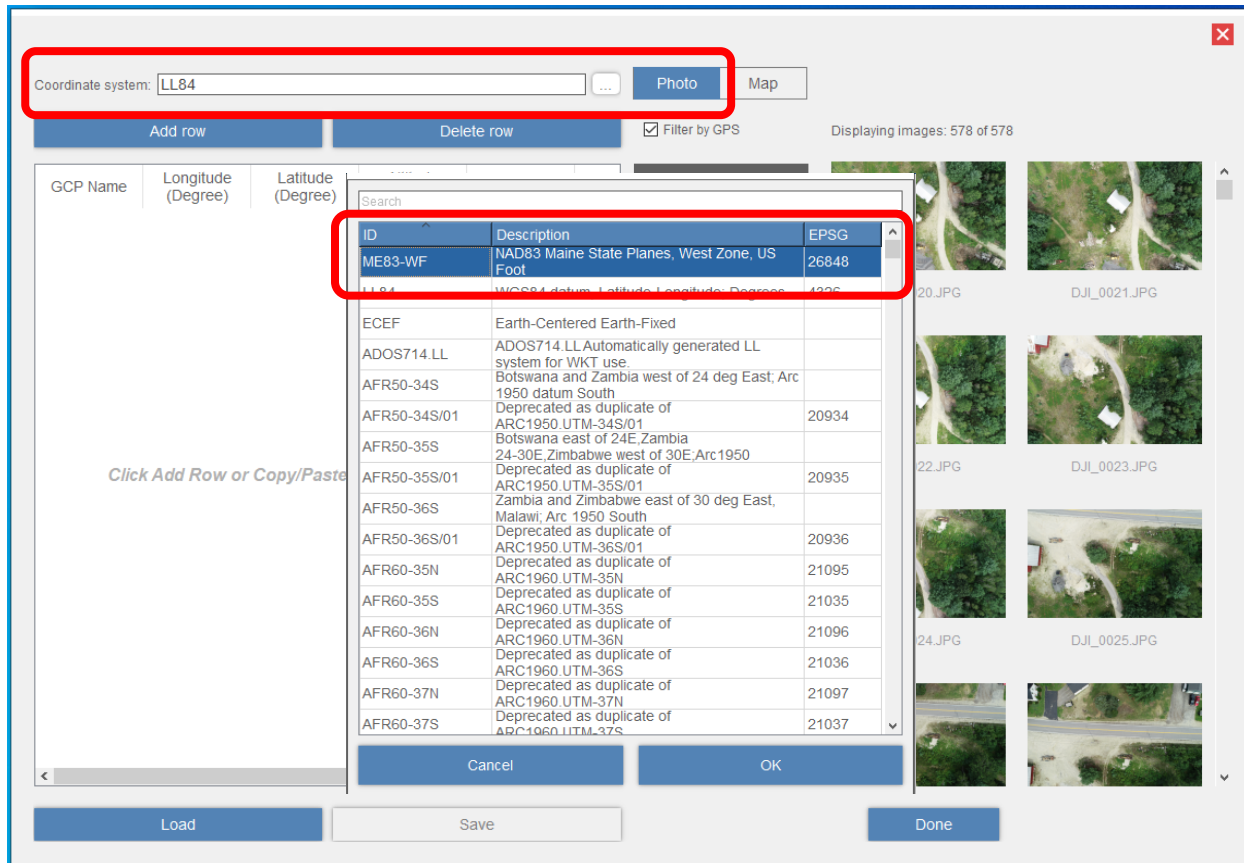
After selecting the proper coordinate system, you will want to load your GCP file (.xls, .csv or .txt file format). Select **"LOAD"** in the lower left-hand corner of the dialog box. You can also, copy and paste the PENZD (Point #, Easting, Northing, Elevation, Description) out of your .txt file or ASCII file and past into the dialog box.

You will want to select a min. of 4 photos (Per ReCap Photo requirements) where the GCP target is clearly visible. I recommend a min of 8 (ideally 10). Find the photo GCP #1 is in, select the appropriate photo from the list, then zoom in and place the marker in the center of the aerial target, select" DONE**.**

You will then be prompted to **"Place GCPs on at least 3 more images".** Repeat the process for the selection of the 3 additional images.

Repeat the steps as necessary for additional GCP's. When you have selected a minimum of 4 images per GCP you will see a **"GREEN CHECK MARK".** This means all requirements have been met. You can now select **"DONE".**
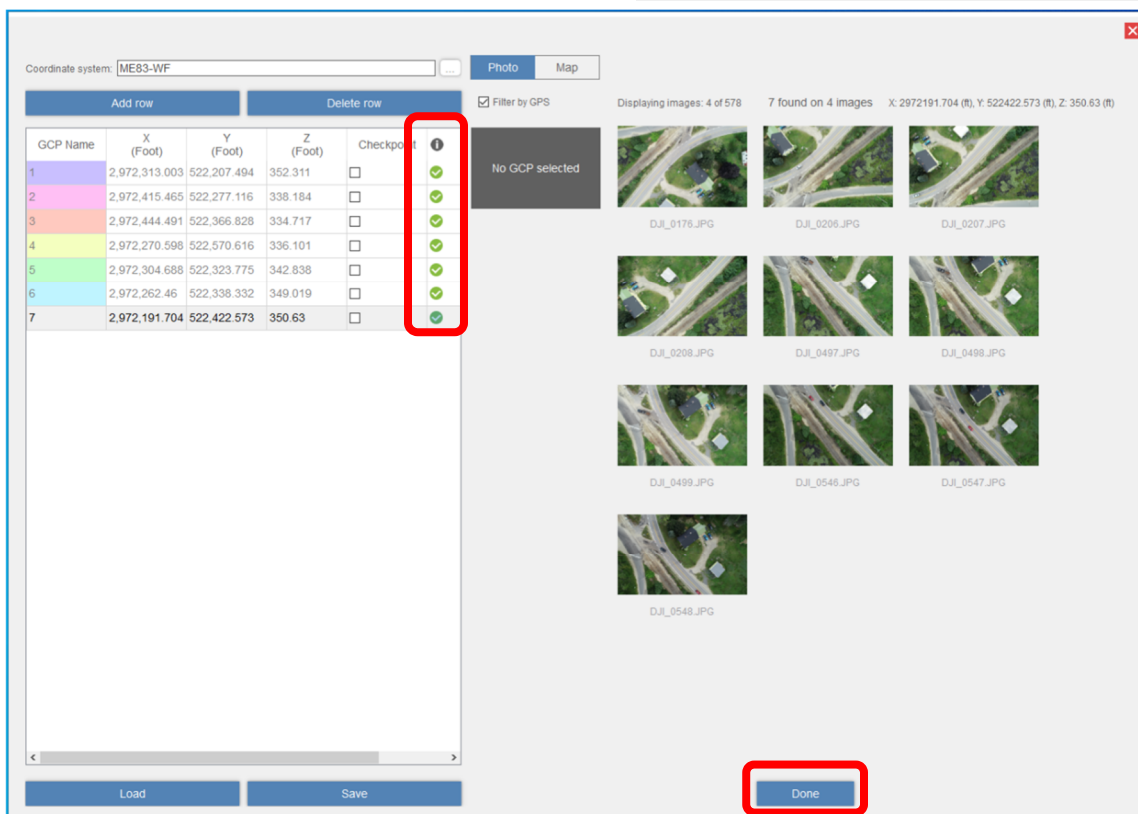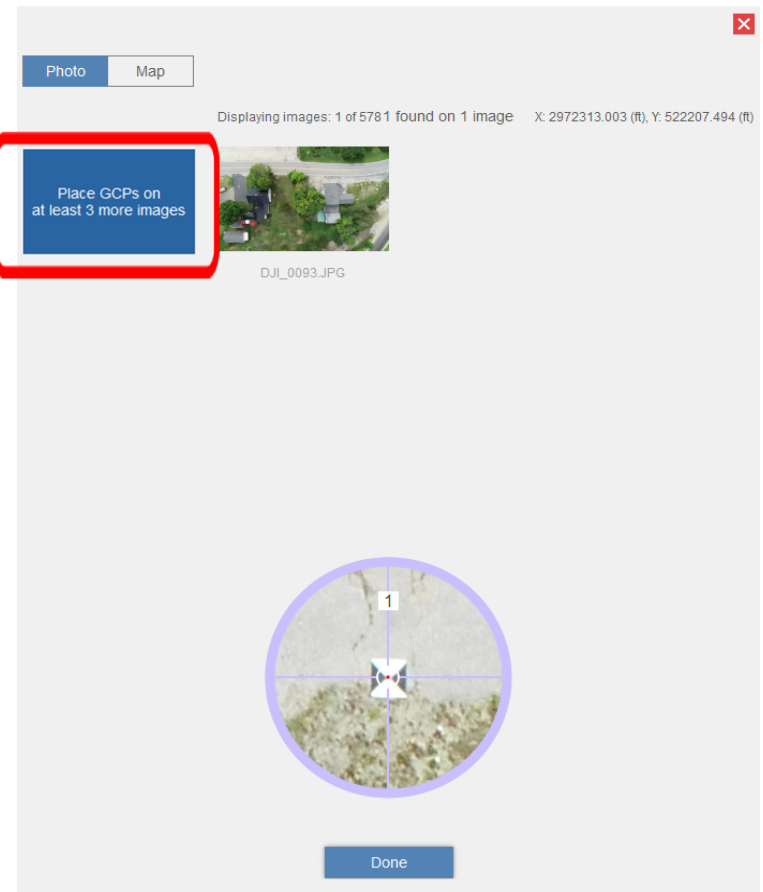
After you have selected, **"DONE"** the program will bring you back to the main screen where you first imported your photos. You will now select **"CREATE".** A dialog box will pop up with parameters for you to set. Enter a **"PROJECT NAME"**, check the boxes for **"3D photo-textured mesh (RCM), 3d point cloud (RCS) and ortho photo and elevation map (GeoTIFF)**. Lastly, make sure you select the coordinate system you are working in. Again, for this example we are working in **"ME83-WF"**. Notice it is showing you the amount of cloud credits you need and the amount available to you. Once you have reviewed your selection click **"START".**
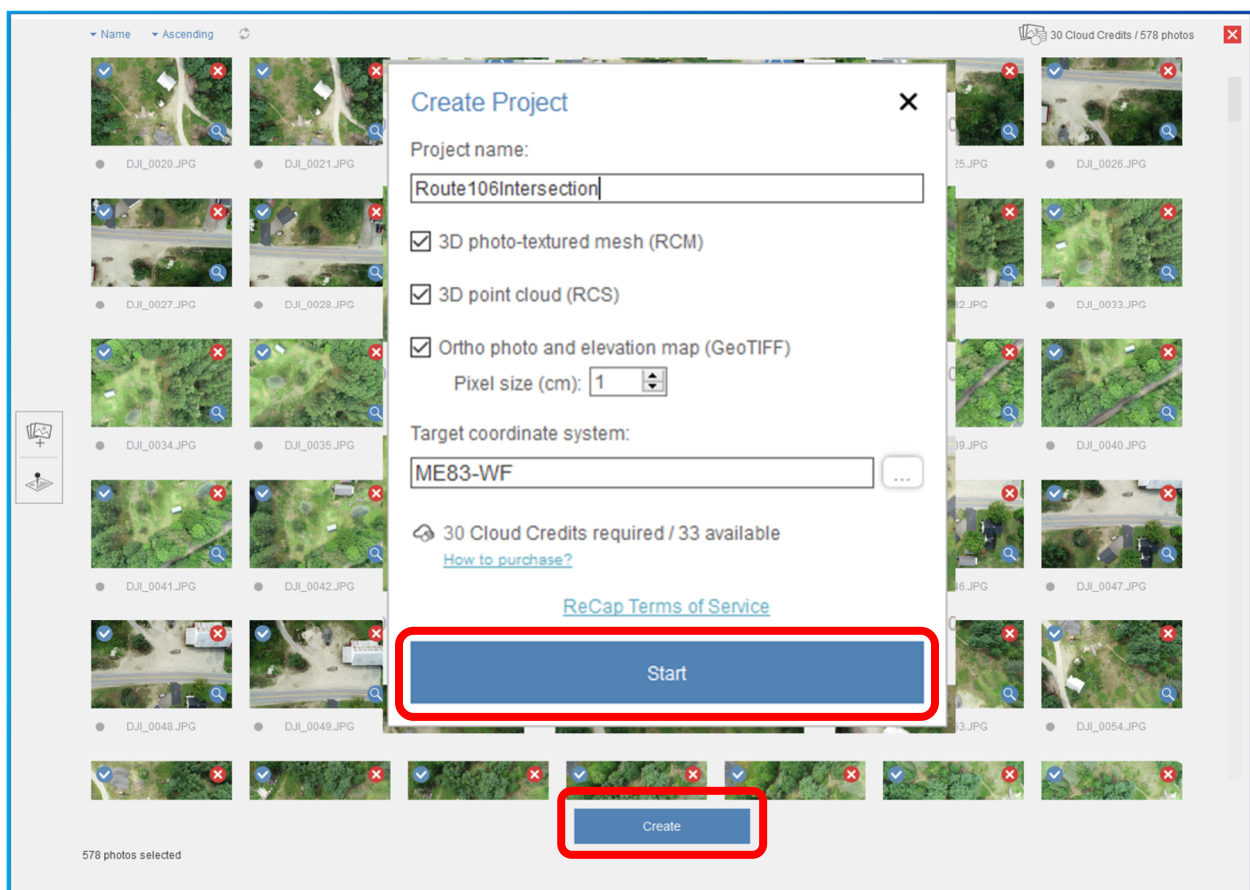
Your project will now begin processing in the cloud.
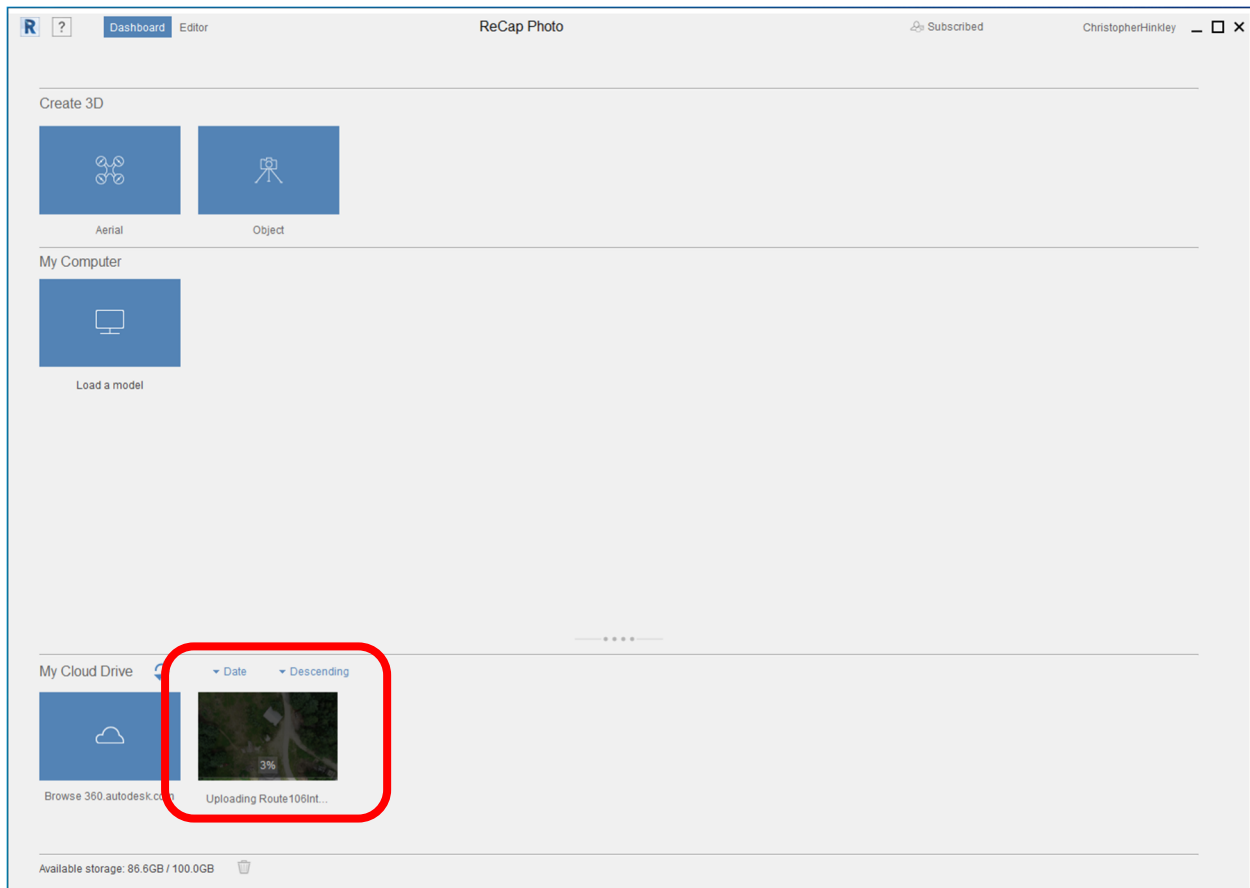
When completed the logged in user will receive an email to their email address. A project of this size (578 photos) typically takes 2 hours and 23 minutes to post process in the cloud.

After you have downloaded the completed project you will see the project folder and imbedded is the data set. The data set consists of a **REPORT, A POINT CLOUD AND A GEOTIFF**. Unzip the folders to the desired location and you are ready to use your data set.
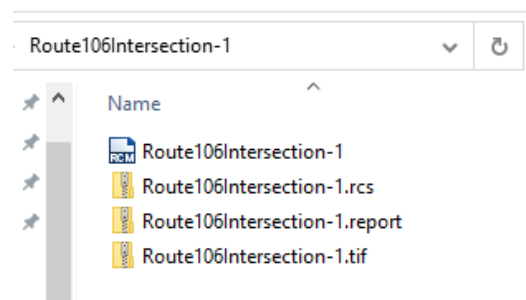
ReCap Pro and InfraWorks

ReCap Pro: Point Cloud Cleanup

You will utilize ReCAP PRO to cleanup the point cloud for use in InfraWorks. Open ReCap, select the "**NEW PROJECT"** icon, then **"IMPORT POINT CLOUD"**.
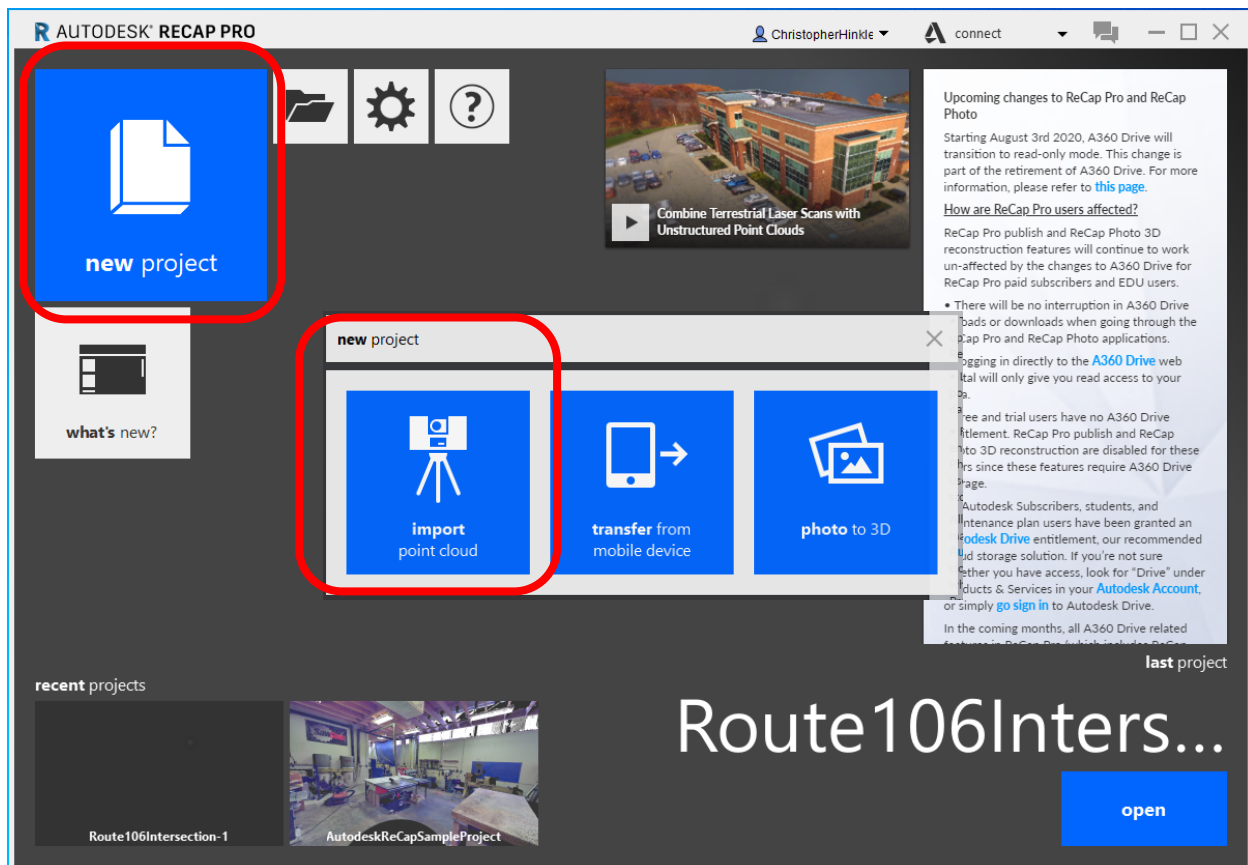
You will then be prompted to give your **"PROJECT NAME AND FILE STORAGE LOCATION"**.
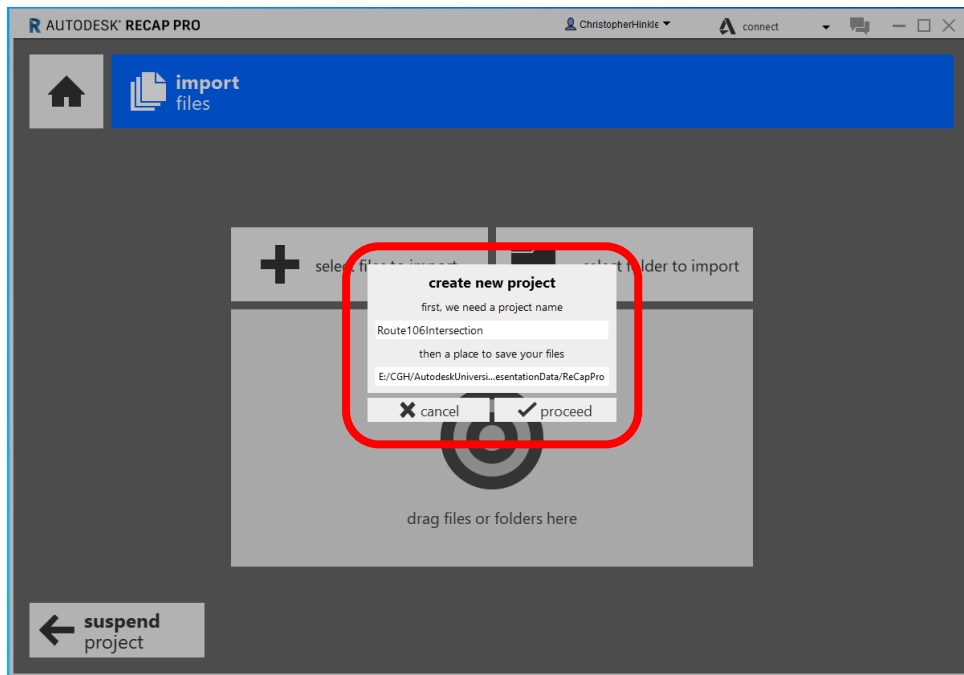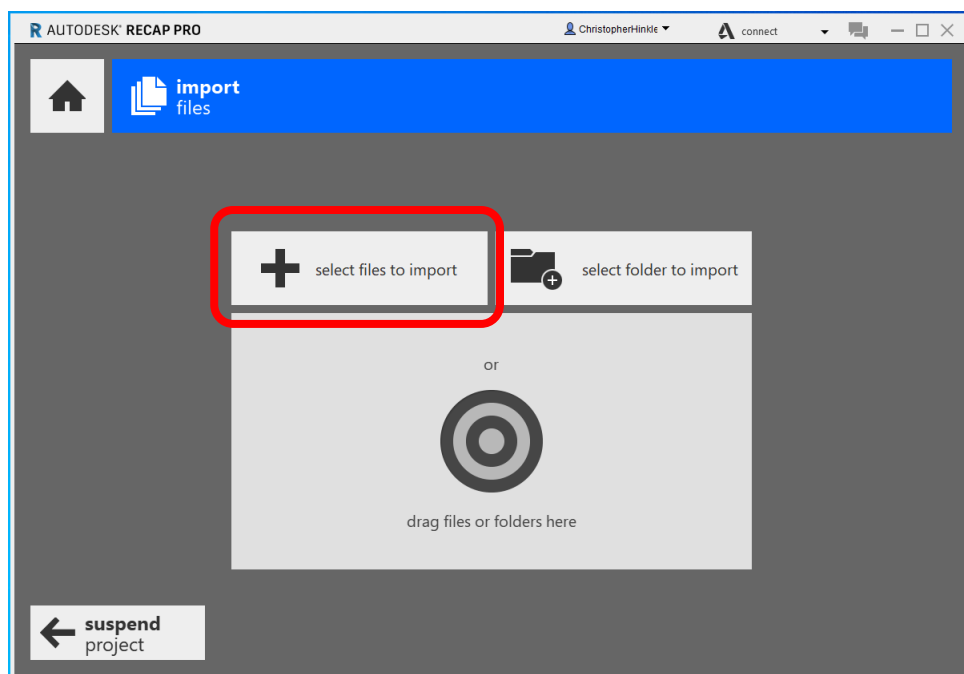

To import your **".RCS"** file you will **"SELECT FILES TO IMPORT".** Browse to the file location and select.

Now that you have selected your file(s) and they are loaded you can proceed to **"LAUNCH PROJECT".**
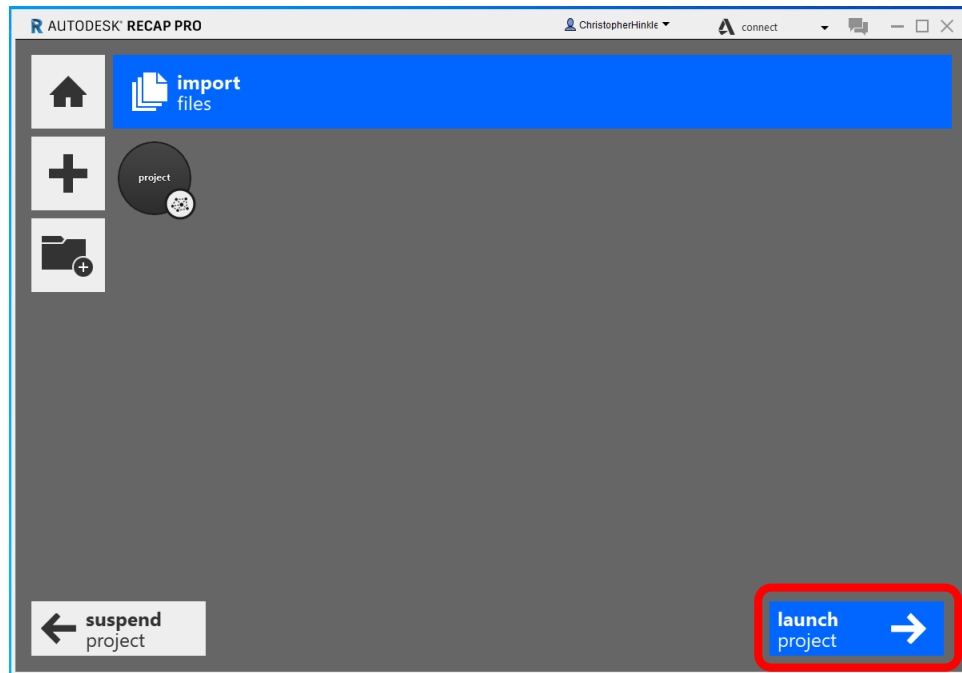
When you first open the .RCS file you will notice the units are in **METERS**, select the settings gear, and you will now be able to set the units to **US FEET** (or appropriate unit for your project).

It's cleanup time! You have tools to choose from when performing cleanup of your point cloud, such as; "**REGION, CROP, DELETE and CLEAR".**

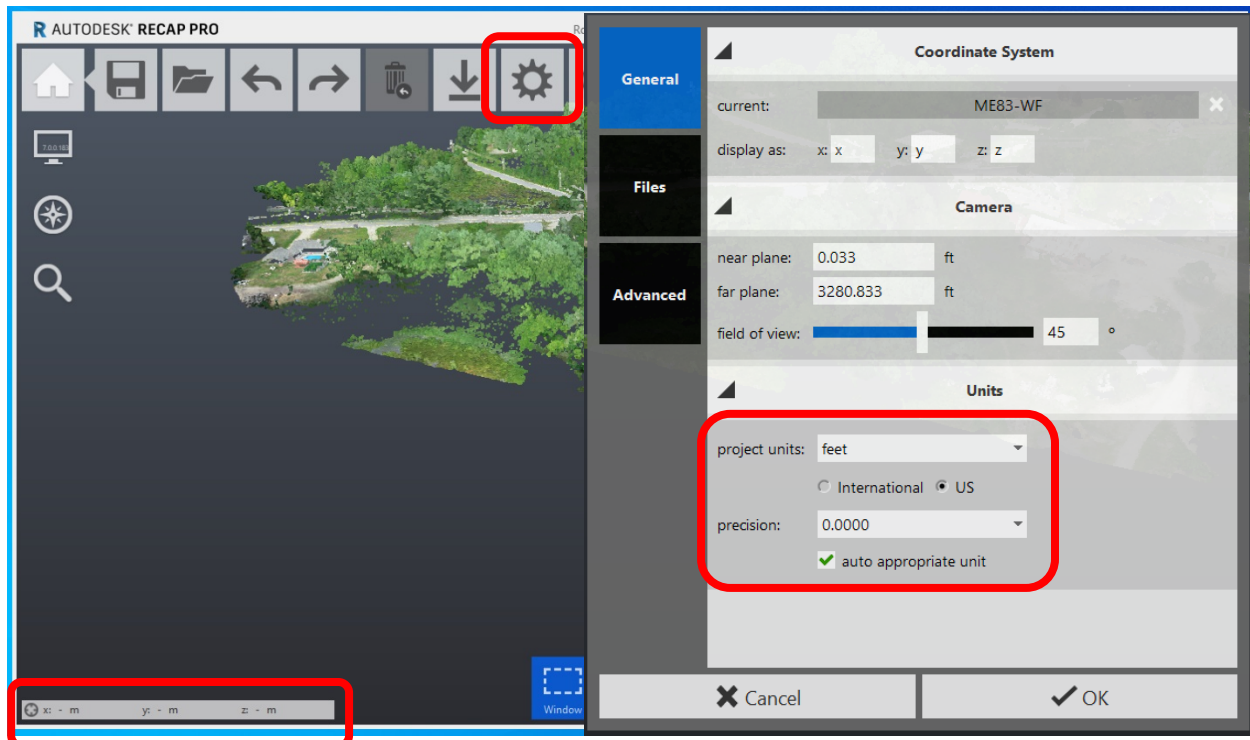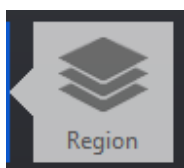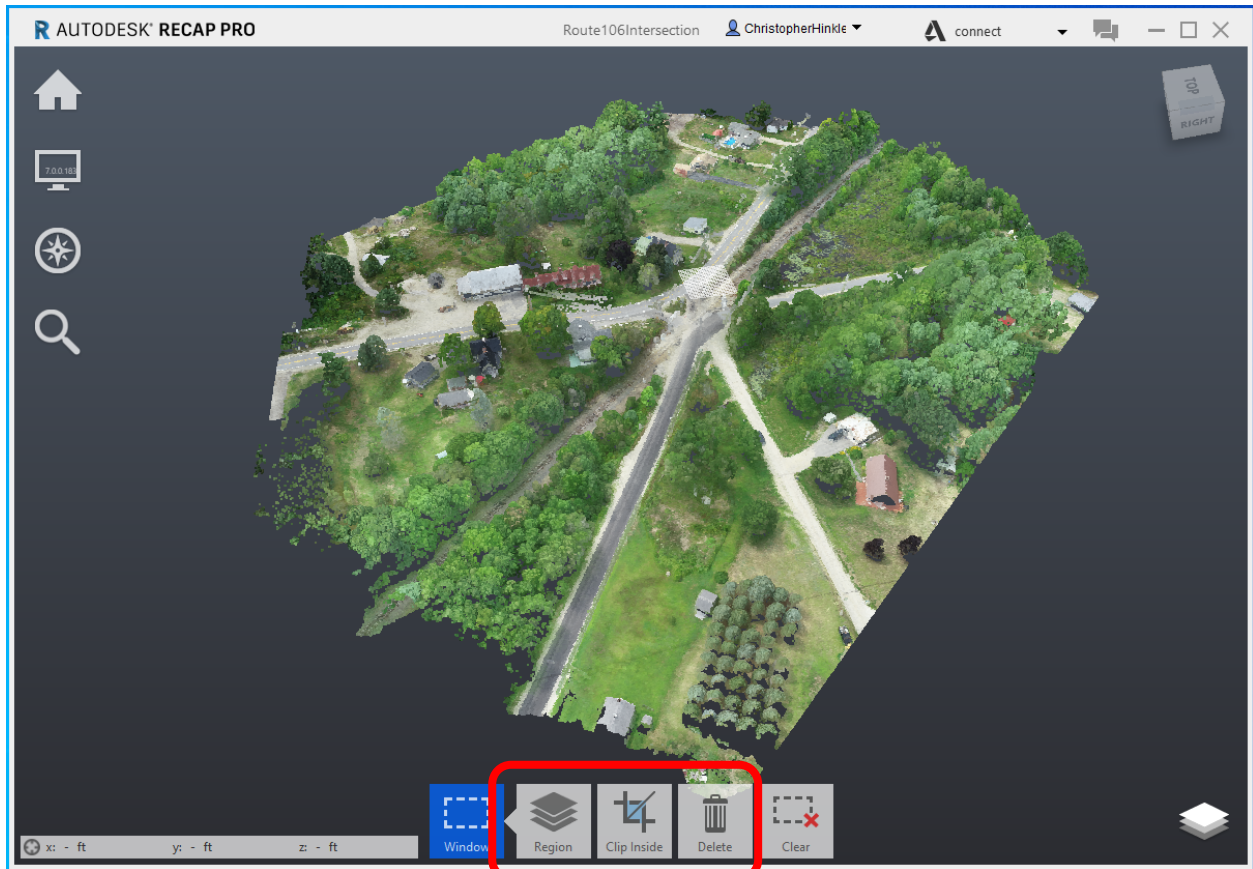Region allows you to select portions of the point cloud, (i.e. trees, utility poles, etc.) and place them on separate layers.
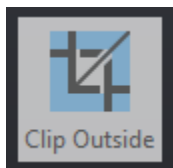
Clipping allows you to select a portion of the point cloud to either keep the interior or exterior (clip outside or inside). This feature will allow you to break apart large point clouds and use only what you need.
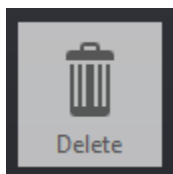
Exactly what it says, select and delete what you don't need or cleanup up the "noise" (i.e. random points not necessary to be included in the point cloud).

When done editing the point cloud **SAVE** and you are now ready to import into InfraWorks. A friendly reminder, you should have a **"MASTER/ORIGINAL"** .RCP file that you have saved off before editing the one to be utilized with your project.

With the recent improvements to the product line, it isn't a must that you bring your point cloud into ReCap before use in InfraWorks. ReCap Pro creates a **".RCS"** file that can be directly imported into InfraWorks. If you don't feel you will need to clean up the point cloud in any fashion, then feel free to eliminate importing your **".RCS"** file into ReCap. Please note, it is highly encouraged that you open the .**"RCS"** file and peek to ensure cleanup isn't necessary, as often cleanup is necessary.

InfraWorks: Import Point Cloud, Create a Surface, Classify Data, Vertical Feature Extraction, and Linear Feature Extraction

Open **InfraWorks** and select **"NEW",** you can either create the project in the cloud or on your local hard drive. For this example, we are going to create the project on our local machine. Once again, make sure your coordinate system is set to what you are using, i.e. **"ME83-WF".** Lastly, select **"DESIGN STANDARDS"** and make sure you are working in either **IMPERIAL or METRIC UNITS** based on your geographic location.
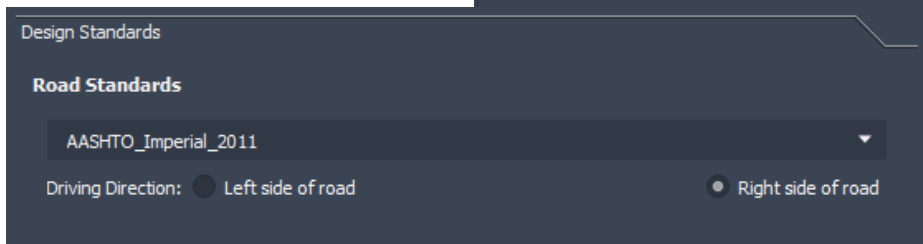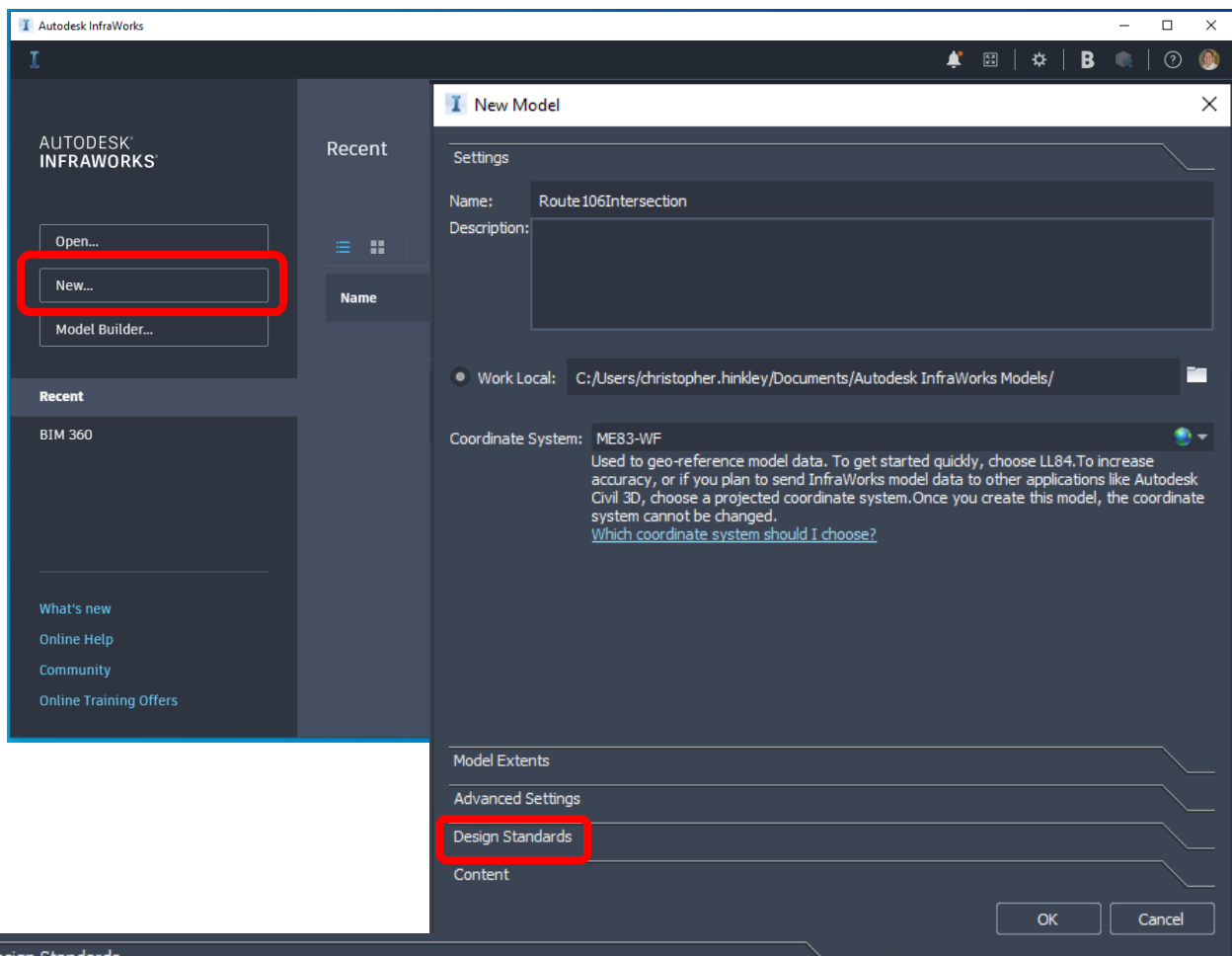
To import your point cloud into InfraWorks select the **"PAPER"** pull down, then select **"POINT CLOUD"**. You will have the option to select either, **.RCS, .RCP, .LAS, and .LAZ.** In this example we are using an .**RCS** file. The point cloud will appear in the dialog box and then you will need to right click on the point cloud and select **"CONFIGURE".** Make sure your settings are correct, i.e. coordinate system and then select **"CLOSE AND REFRESH".** Your point cloud will appear in InfraWorks.
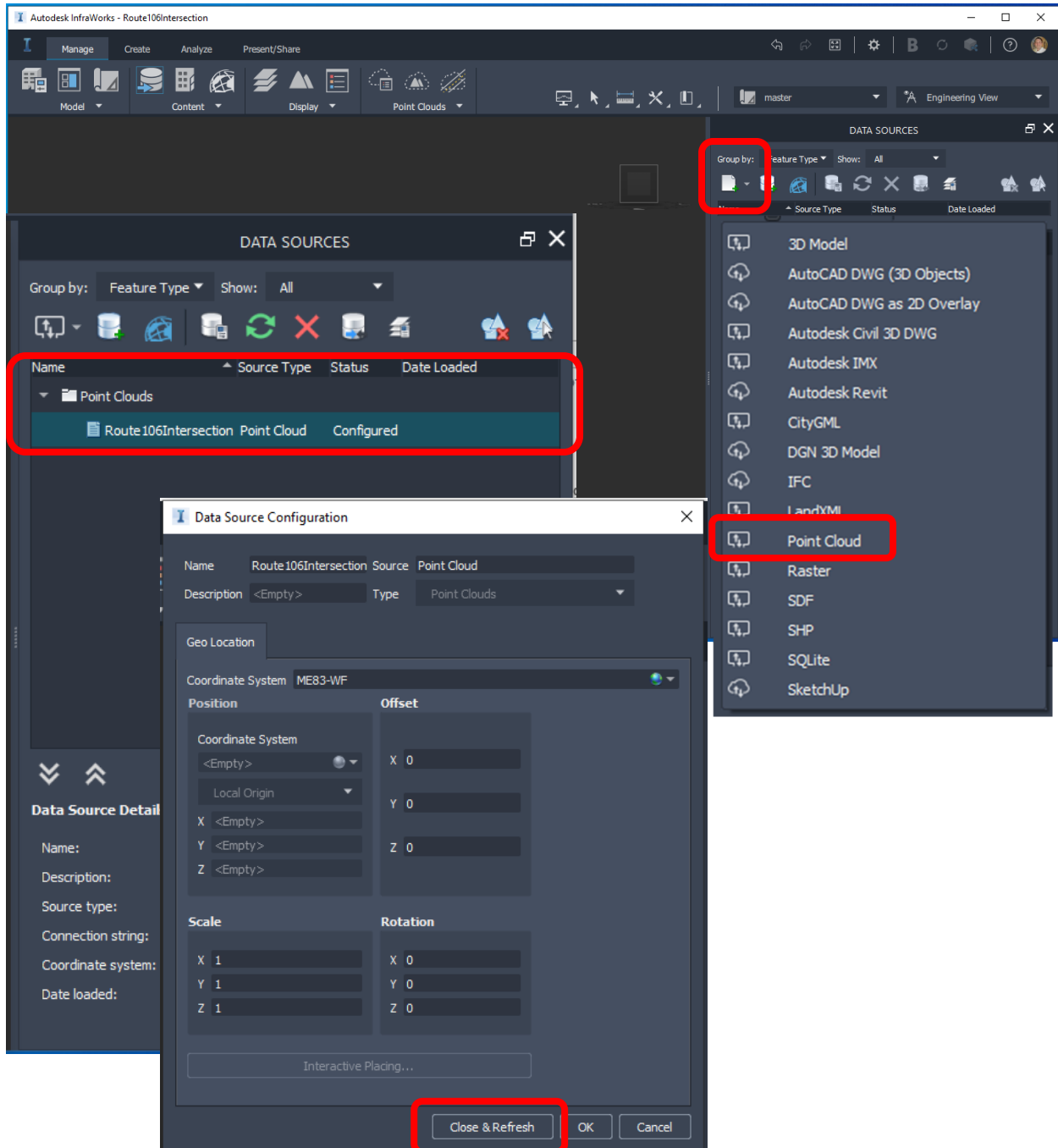
Now that you have your point cloud imported and visible, we will proceed to build a surface, linework and vertical features.

In the ribbon you there are icons depicting point clouds, select the down carrot to expand the menu. Select **"POINT CLOUD TERRAIN".**
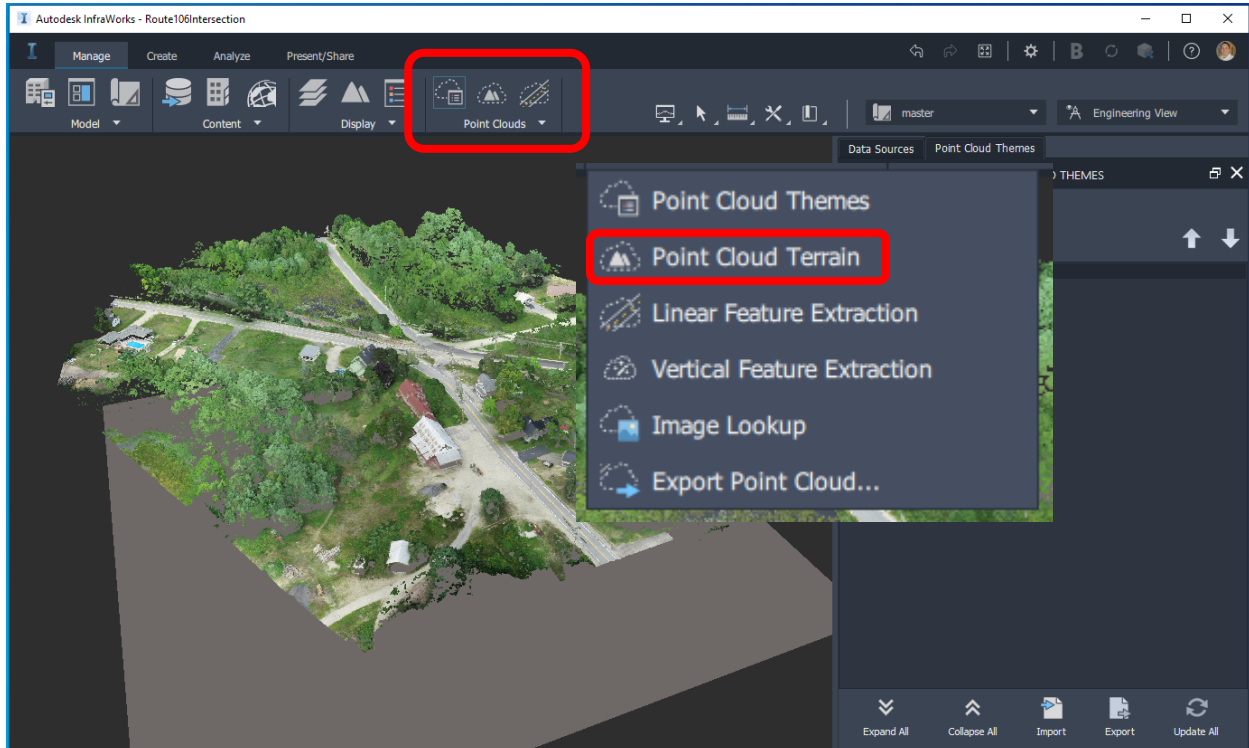
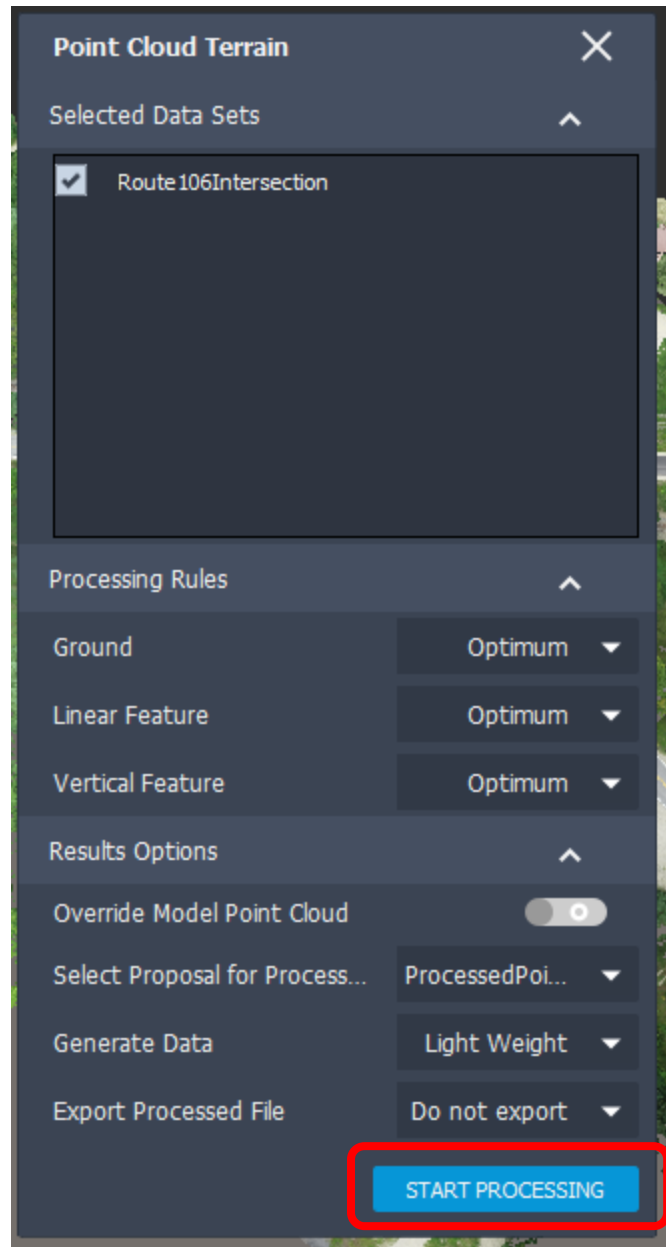This dialog box has all the settings you will need to setup before processing the point cloud terrain. For efficiency purposes you will want to set the **Processing Rules; Ground, Linear Feature and Vertical Extraction to OPTIMUM.** Note, I typically Tun off the **"Override Model Point Cloud"** option. This allows me the ability to reprocess the original point cloud if I am not happy with the results. If you have that setting turned on you will not be able to reprocess the original data set.

Once you have made your adjustments select **"START PROCESSING".**

Point Cloud Terrain   ✕

Selected Data Sets   ⌃

☑   Route106Intersection

Processing Rules   ⌃

Ground   Optimum ▼

Linear Feature   Optimum ▼

Vertical Feature   Optimum ▼

Results Options   ⌃

Override Model Point Cloud   ◉

Select Proposal for Process... ProcessedPoi... ▼

Generate Data   Light Weight ▼

Export Processed File   Do not export ▼

START PROCESSING

For this example project, InfraWorks took approximately 5 to 7 minutes to process the ground data. Process time will vary depending on the settings you choose and the size of the project.

The results are shown below. As you can see, there will still be cleanup involved with the surface data. However, we will adjust those finer details within Civil 3D.
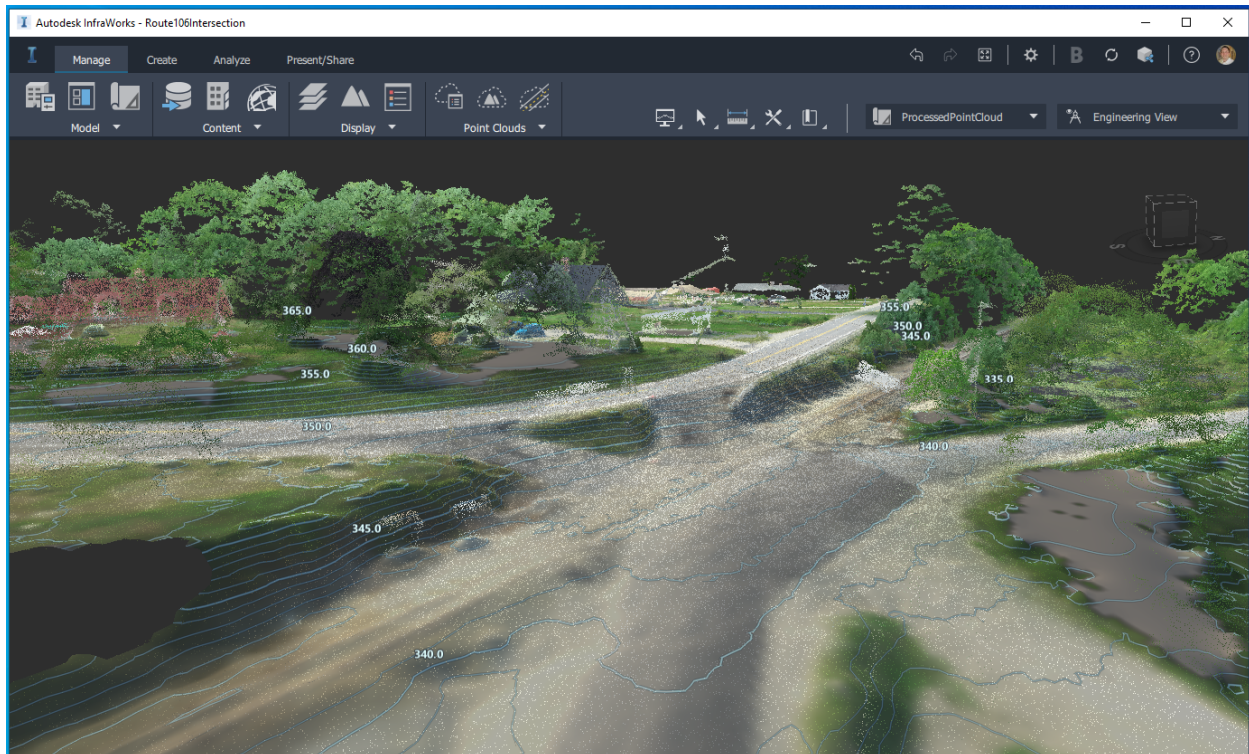
Next, we will want to **"CLASSIFY"** our Data set. Classifying our data set will make the point clusters of points smarter and easier to work with and turn into 3D feature. Under the **"Point Clouds"** menu select, **"POINT CLOUD THEMES"**.
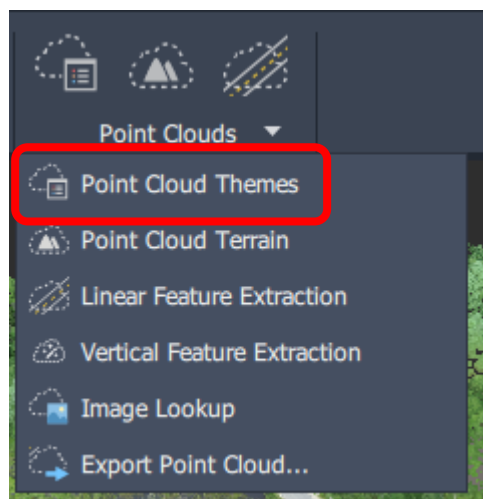
Under "Analysis Type" select **"CLASSIFICATION".** This will put your point cloud data into catagories based on your data set.
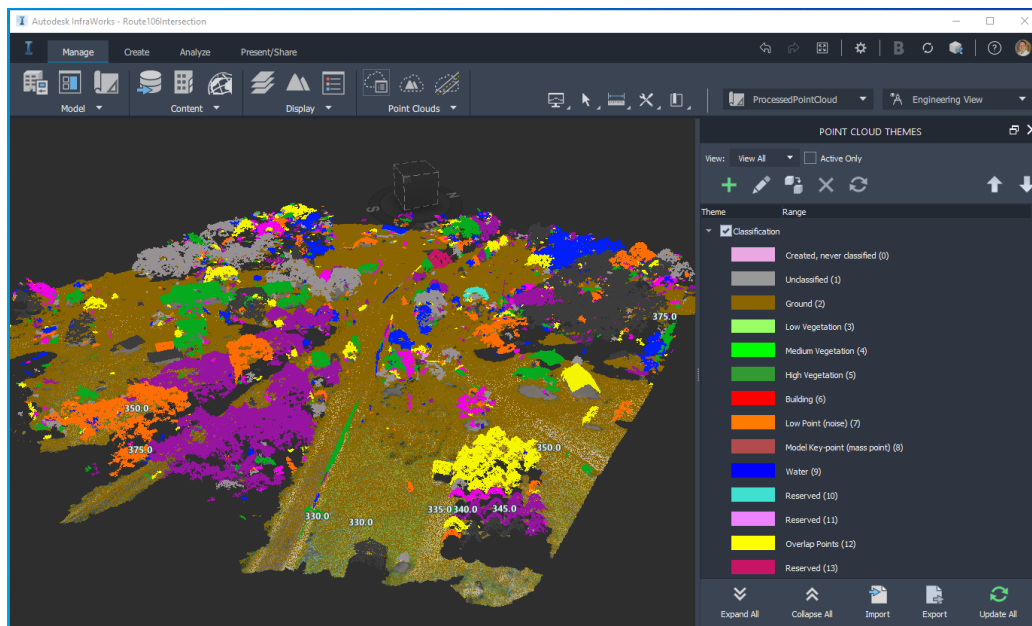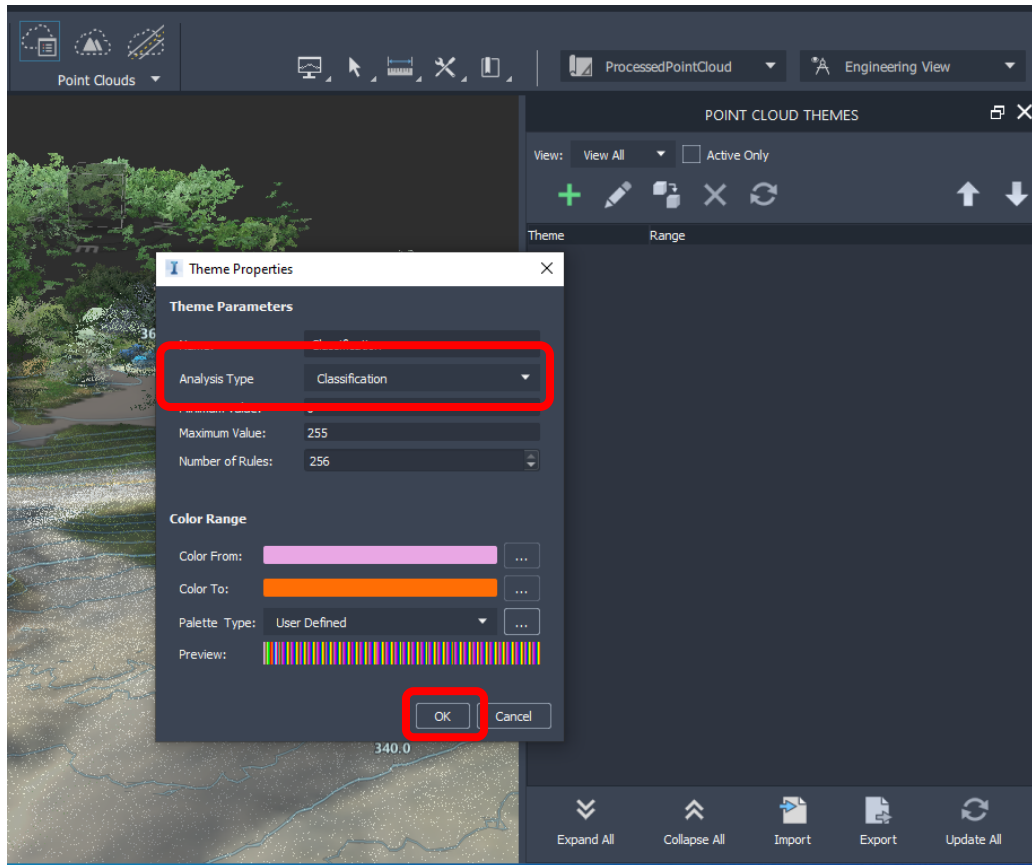
Notice in the colorized point cloud view above, we have brown points for ground and various other features the software attempted to classify automatically. Now we can convert some of these point clusters into actual InfraWorks features, i.e. **"Trees, Street Lights"**, etc...

You will now extract the vertical assets/features out of the point cloud. Select **"POINT CLOUDS**, then **"Vertical Feature Extraction".** You will notice there are 4 categories present, **"Trees, Street Light, Sign, Unknown".** Not all vertical features will be accurately portrayed by the feature extraction. You will need to manually edit those features. In the view below you can see several of the trees were quite accurately extracted, but we have a lot of stop signs to cleanup
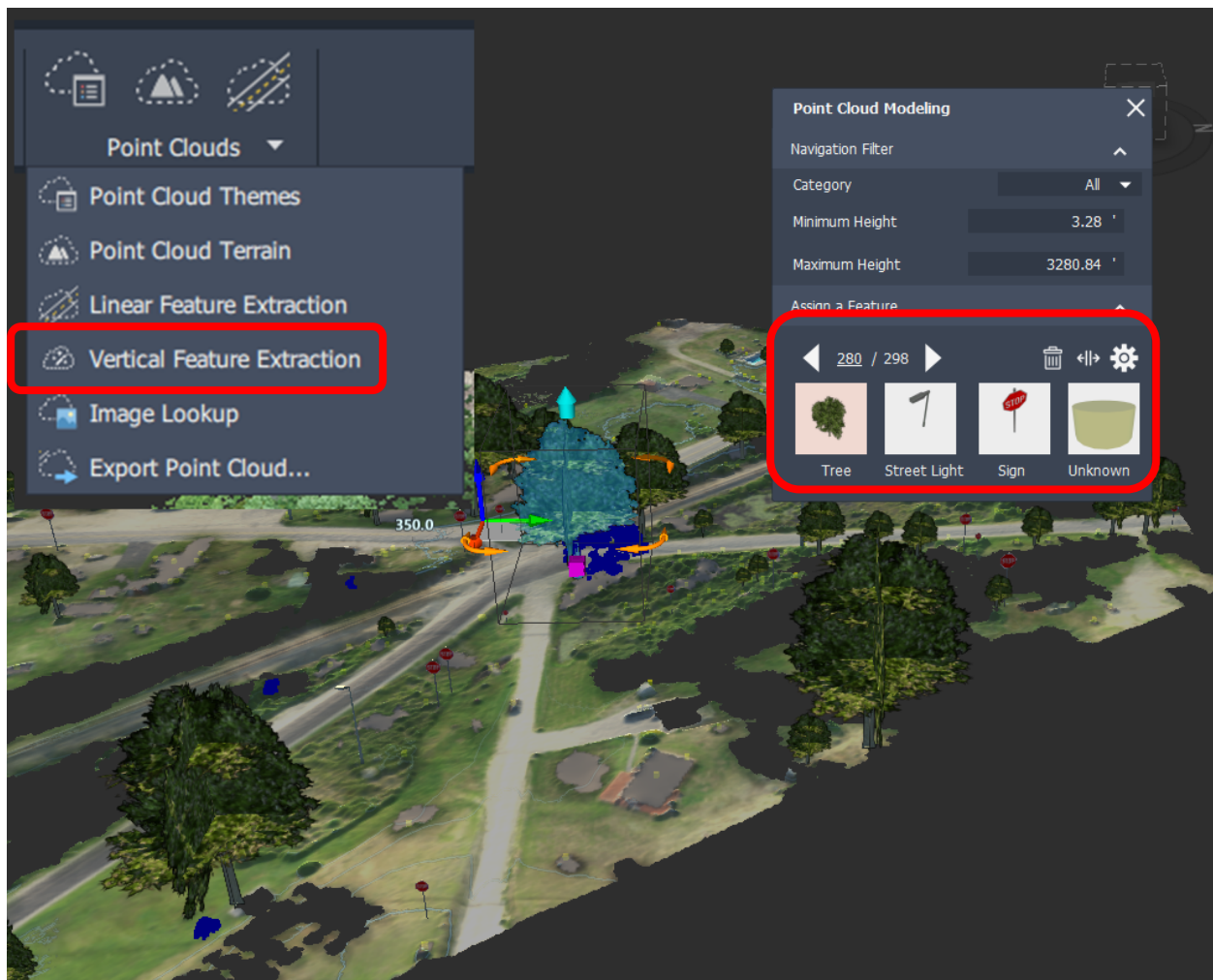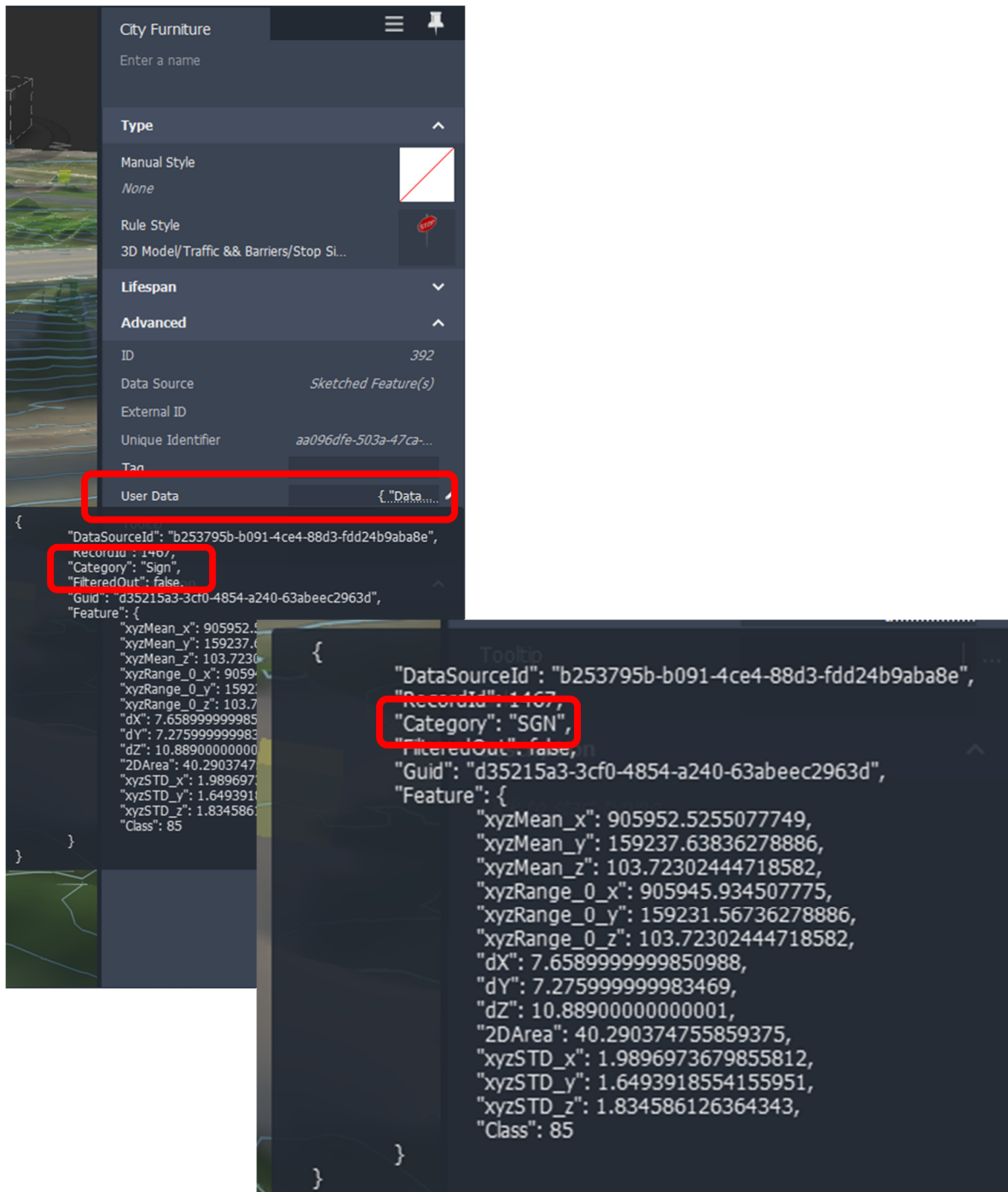
To manually edit the vertical feature you will select the feature, **"i.e. tree (see above)",** change it to a **STOP SIGN** by selecting the stop sign in the **"Point Cloud Modeling"** dialog box. Continue going throught the vertical features one by one until you have completed the task.
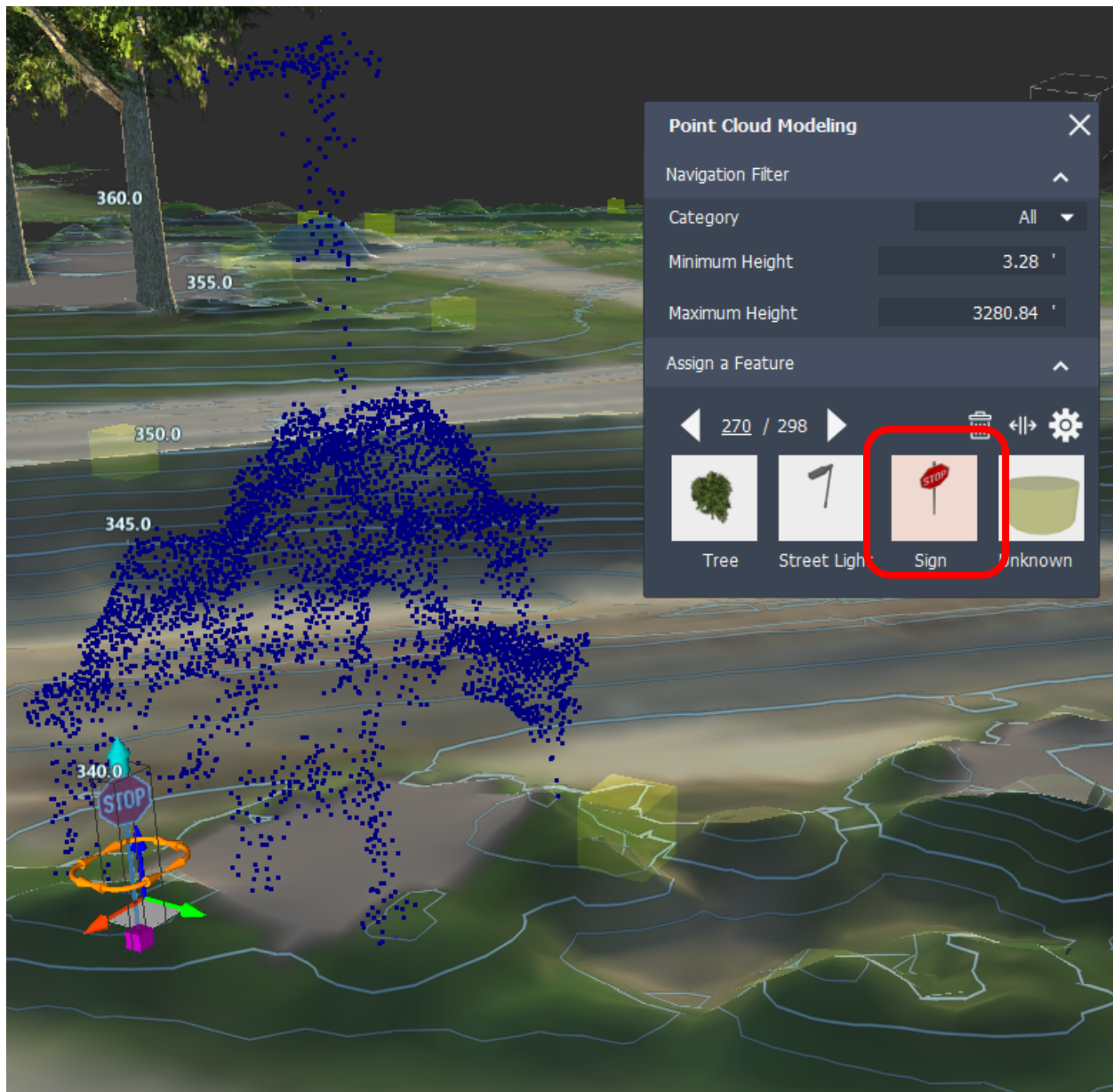
One thing to note, when mining through the vertical data, in order for the **"survey description keys"** to work upon the export from InfraWorks and the import into Civil 3D you will need to go into the **"User Data"** and change the **"Category"** to your description key. In my survey template my sign description key is **"SGN".**
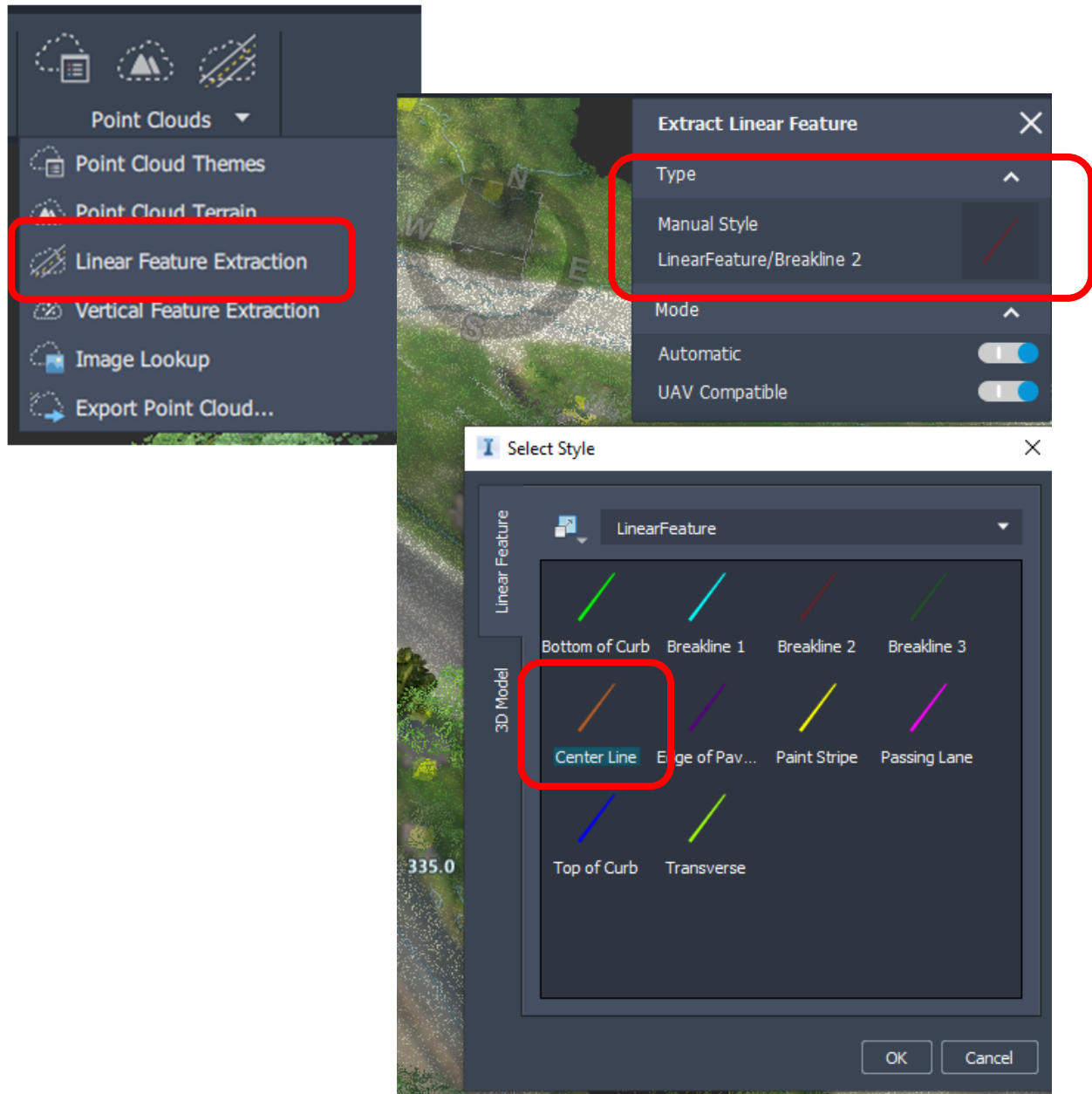
Moving on to the linear feature extraction, i.e. edge of pavement, centerline of road, and paint striping. Select **"POINT CLOUDS**, **"Linear Feature Extraction", "Type"** and then select **"Center Line".**   You can either select "**Automatic or Manual"** for linear feature extraction. I typically select manual for UAV data sets.

You can now begin digitizing along the **"Center Line"** of the road as seen below. When done digitizing the line, **"Double Click"** to end. Repeat the steps to digitize the "**Edge of Pavement".**
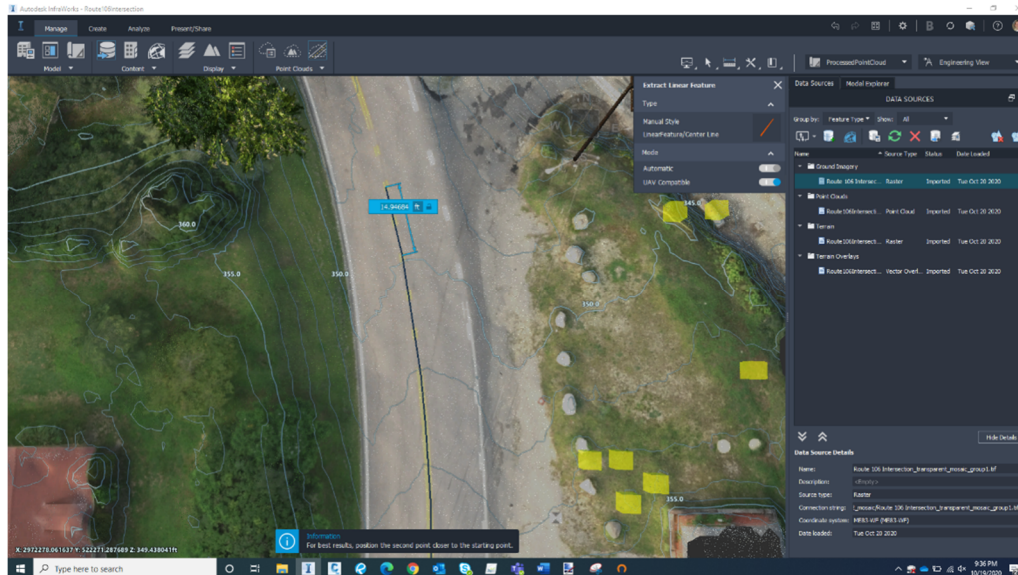
To edit the position of the linear feature you select the linear feature you want to alter (in this example I selected the **"Center Line"**), then right click and select **"Show Cross Section View".**


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In the section view you have the ability to adjust the linear feature; elevation and location from start to end. Below, the two purple dots represent the **"Edge of Pavement"** and the orange open circle represents **"Center Line".**

InfraWorks and Civil 3D

InfraWorks: Exporting Point Cloud Data

If you are happy with the results of the terrain, vertical features and linear features you can now export your data set to a **".CSV" or ".SHP"** file. You will Select **"POINT CLOUDS**, then **"Export Point Cloud".** When you export the project, check the options to export each extracted feature you wish;" Ground **Grid Points Only, Linear Features, and Vertical Features".** Make sure your coordinate system is set and then select **"Start Export".**
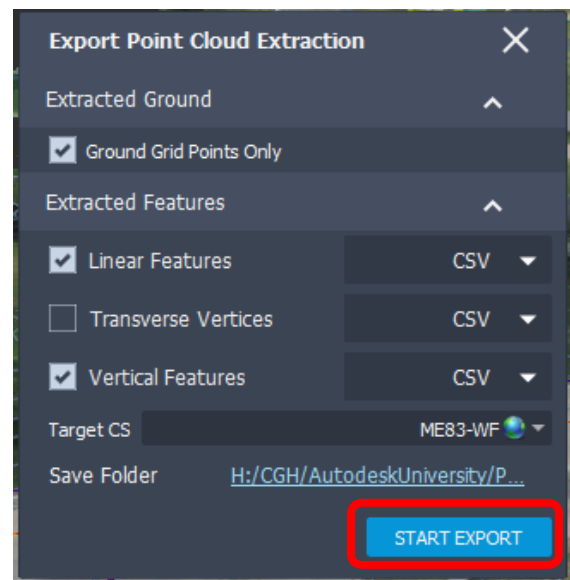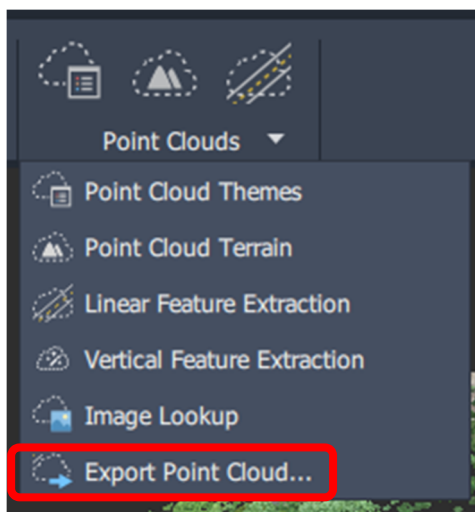
Civil 3D: Drawing Setup, Importing Data from InfraWorks, Creating a surface and Cleanup

Now that you exported all your ground points, vertical features and linear features, you need to import these data files into Civil 3D to create our CAD existing conditions deliverable.

I recommend starting by opening your company's Civil 3D survey template. This template should have a **"Field to Finish"** setup for standard **"On the Ground Topography"**. This means linework codes, survey figures, as well as description keys, so when in the field, the crew can draw what they see and directly import this into Civil 3D with minimal editing. The same can be applied for our drone work.

Before Importing there is some setup that needs to be done. You will want to make sure your existing conditions .dwg is set to the same coordinate system and units you were using in InfraWorks. In this example, you have been using **"ME83-WF, U.S. Survey Feet"**.
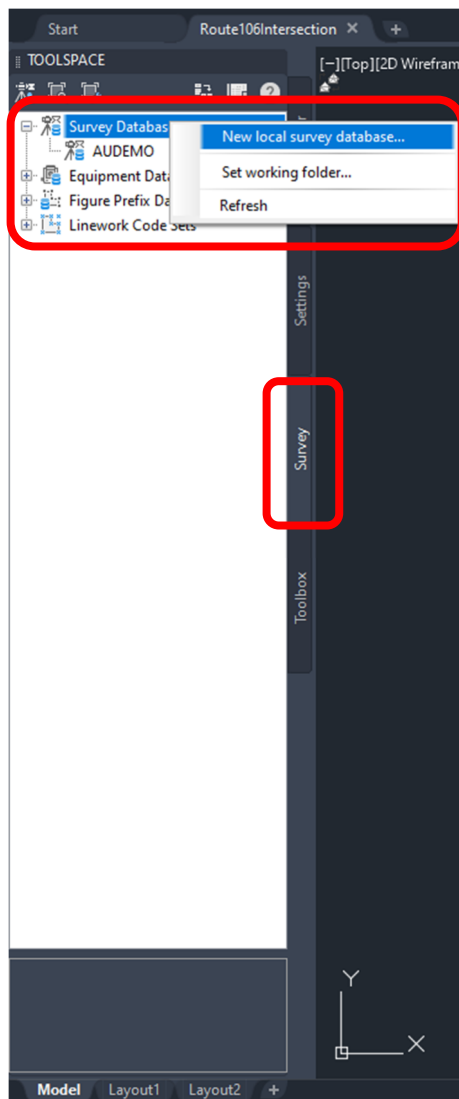
In the tool space you will click on the **"Survey"** tab.

Then right click on **"Survey Database"** and select **"New Local Survey Database"**. The name should be consistent with the project you are working on. In this example it's called **"Route106Intersection".**

One last thing before you start importing, you want to make sure your **"Figure Prefix Database"** and your **"Description Keys"** are setup. To check the "**Figure Prefix Database",** click the + symbol next to it and make sure **"WP"** is bold. To check the **"Description Key Sets"** migrate to the **"Settings"** and expand **"Point"**, then expand **"Description Key Sets".**
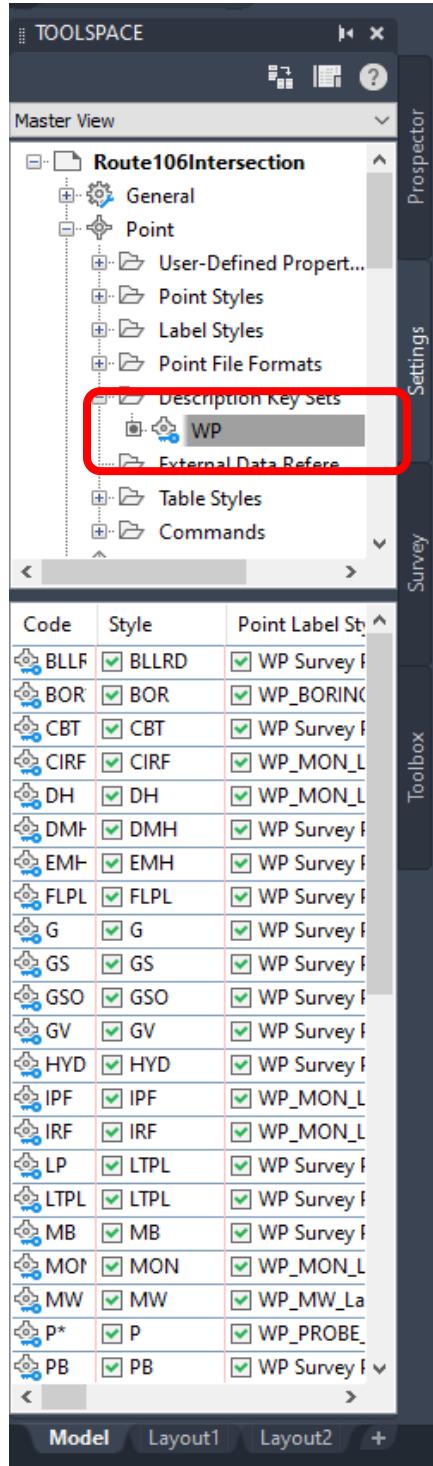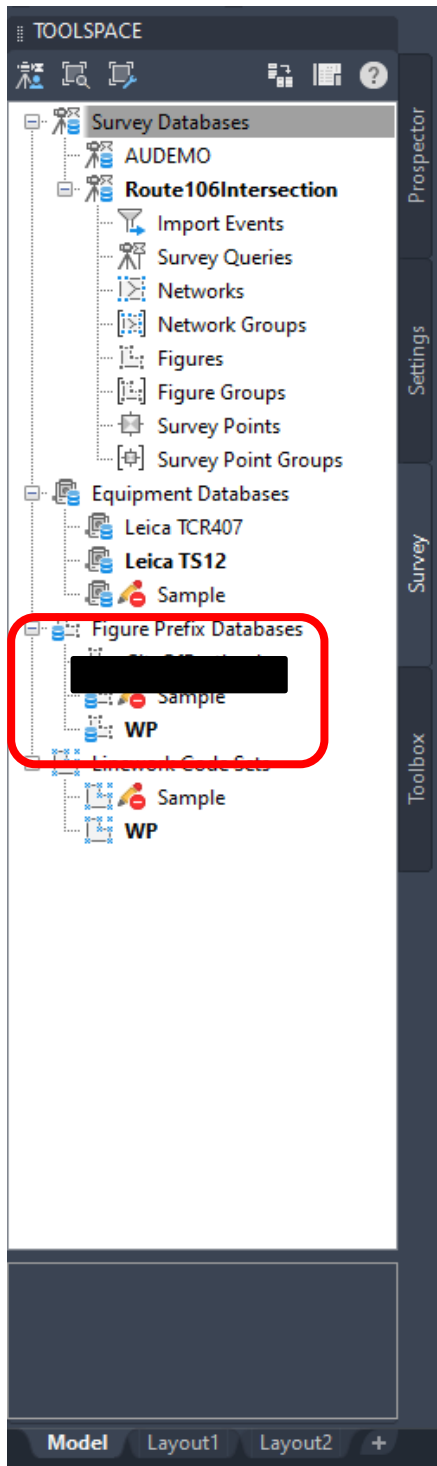

SIDE NOTE: The template I am using has standard **"WP"** nomenclature. Your company will likely have its own nomenclature to define description keys, linework code sets, point style's, etc...

Now that you have checked your setup, you can begin to import your data set from InfraWorks into Civil 3D. Select your project in the survey database, right click, select **"Import"** and then select **"Import Point File"**
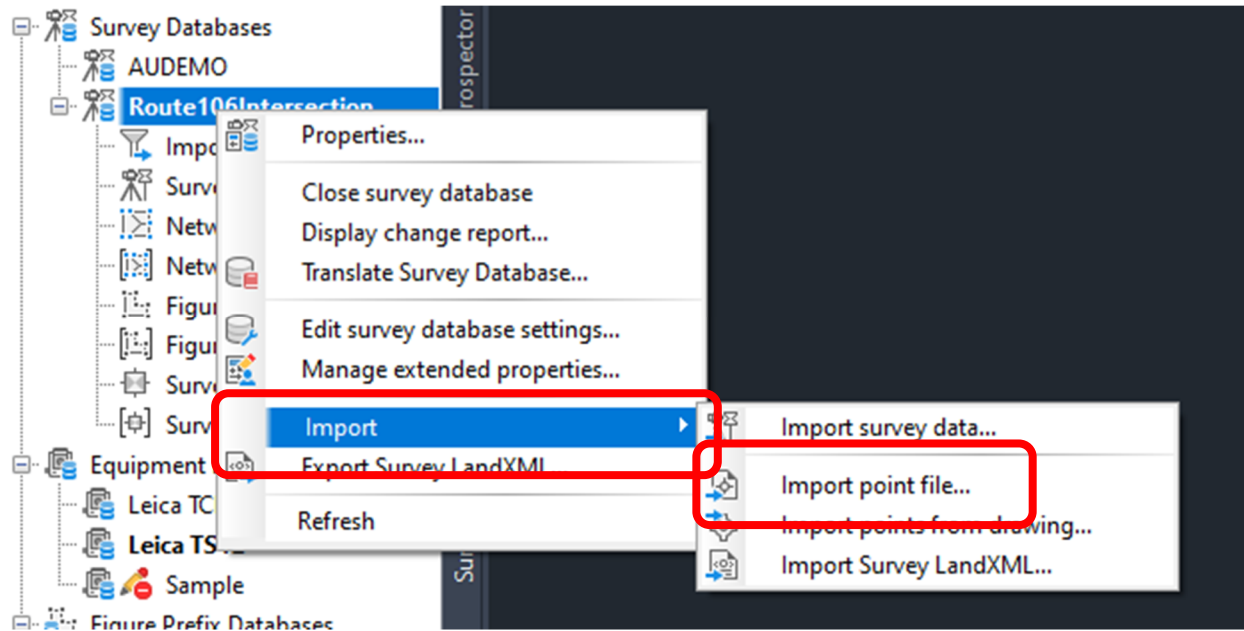
Browse to your file (where you exported your InfraWorks feature to) and import the **"Linearfeature"** csv file first.
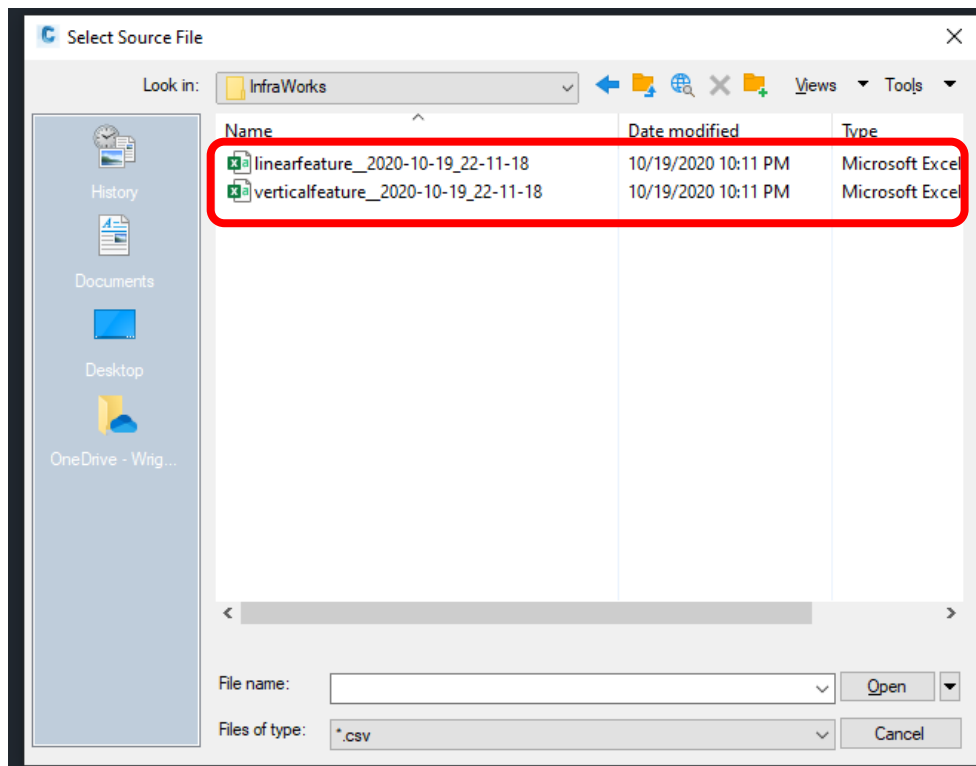
After selecting **"Open"** the **"Import Point File"** dialog box will pop up. Make sure you have the correct point file formation, the **"Current Figure Prefix Database"** set to your standard, **"Process Linework During Import"** checked **"Yes"** and **"Current Linework Code Set"** set to your standard. Lastly, make sure you have checked **"Yes"** to insert figure objects and insert survey points. Once complete then select **"Okay".**
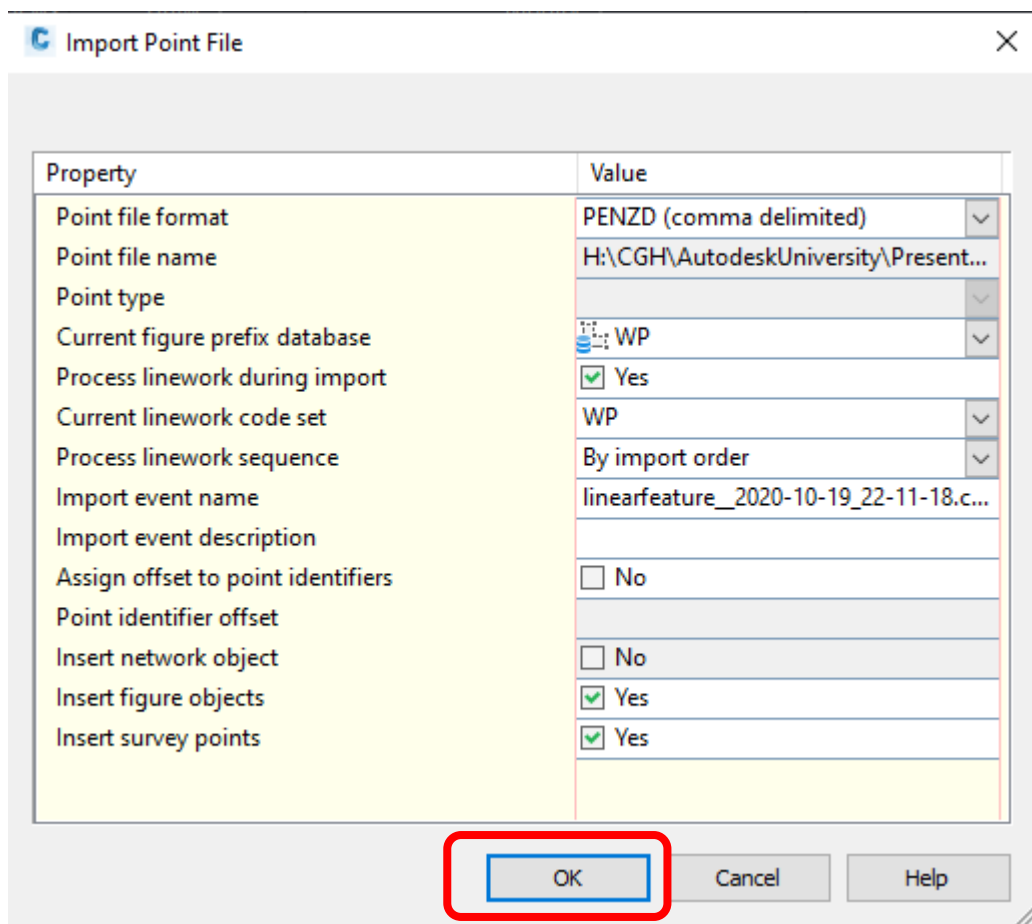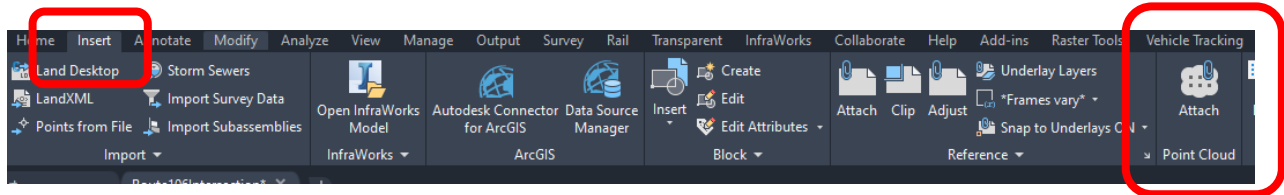
Below is the outcome of importing the **"Linearfeatures"**. The edge of pavement and centerline depicted are survey figures and the vertices are the points.
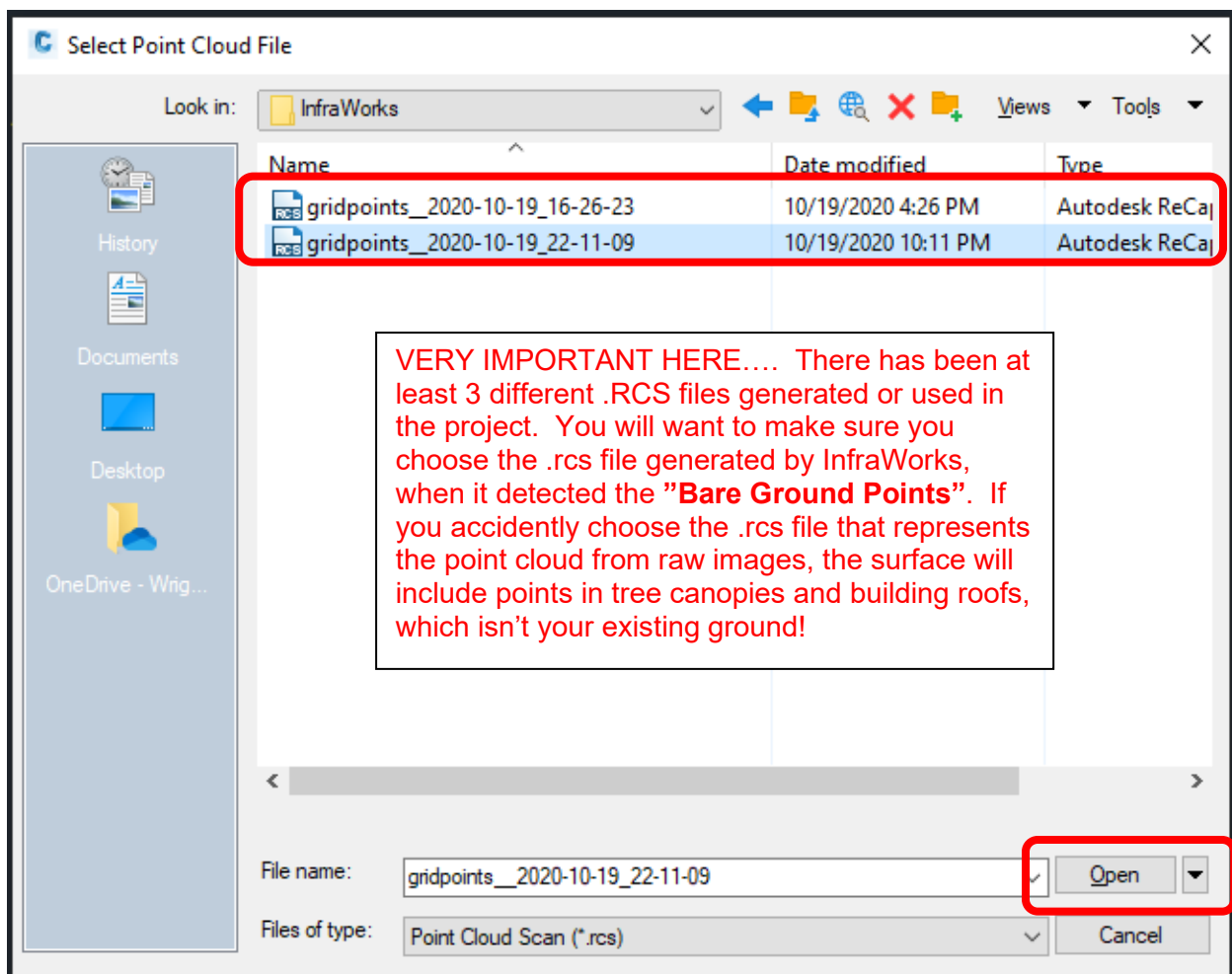
Repeat the process for **"Vertical Features"**. Below you will see the **"Trees, Utility Poles, Light Poles and Signage"** have imported because the description keys matched the **"Category"** in InfraWorks. Any vertical feature that did not have a corresponding description key will come in as a standard survey point.
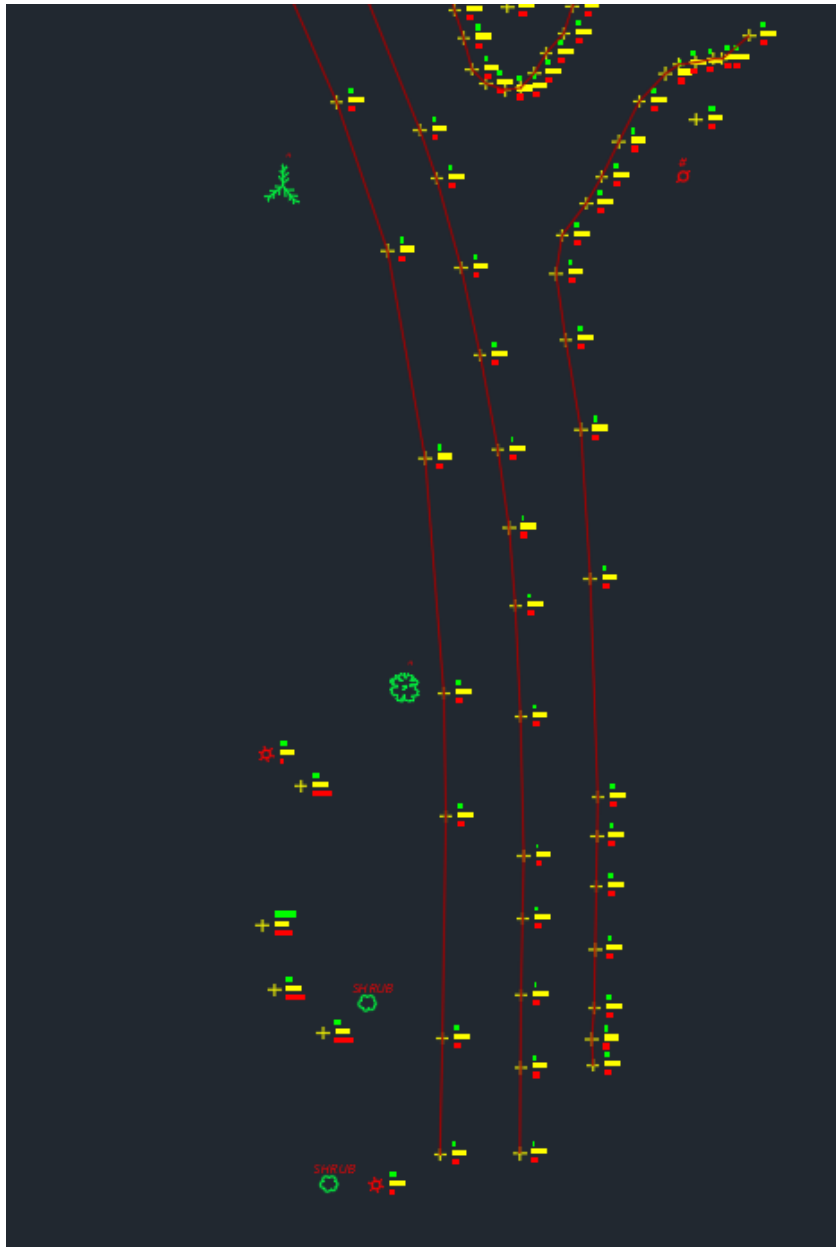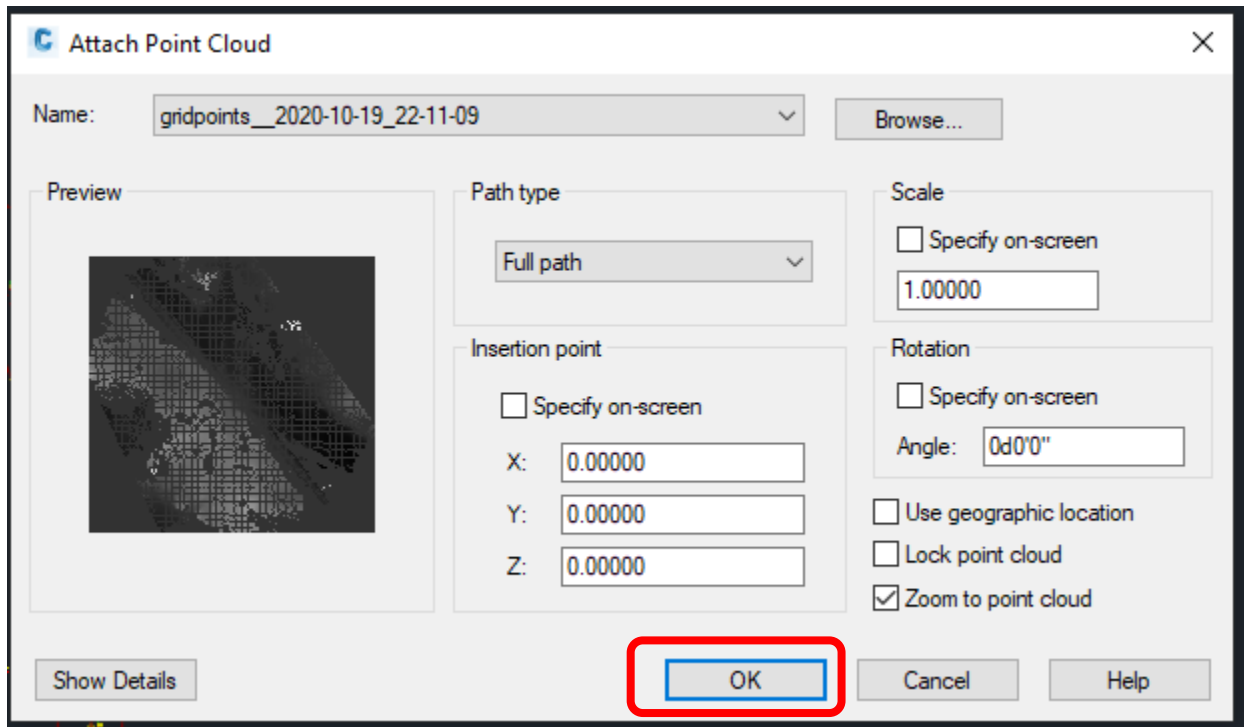
Now it's time to import "**Ground Points**". In the ribbon select the **"Insert Tab",** then select **"Point Cloud Attach"**


Find your point cloud (.rcs file) and select **"Open".**

VERY IMPORTANT HERE…. There has been at least 3 different .RCS files generated or used in the project. You will want to make sure you choose the .rcs file generated by InfraWorks, when it detected the **"Bare Ground Points"**. If you accidently choose the .rcs file that represents the point cloud from raw images, the surface will include points in tree canopies and building roofs, which isn't your existing ground!
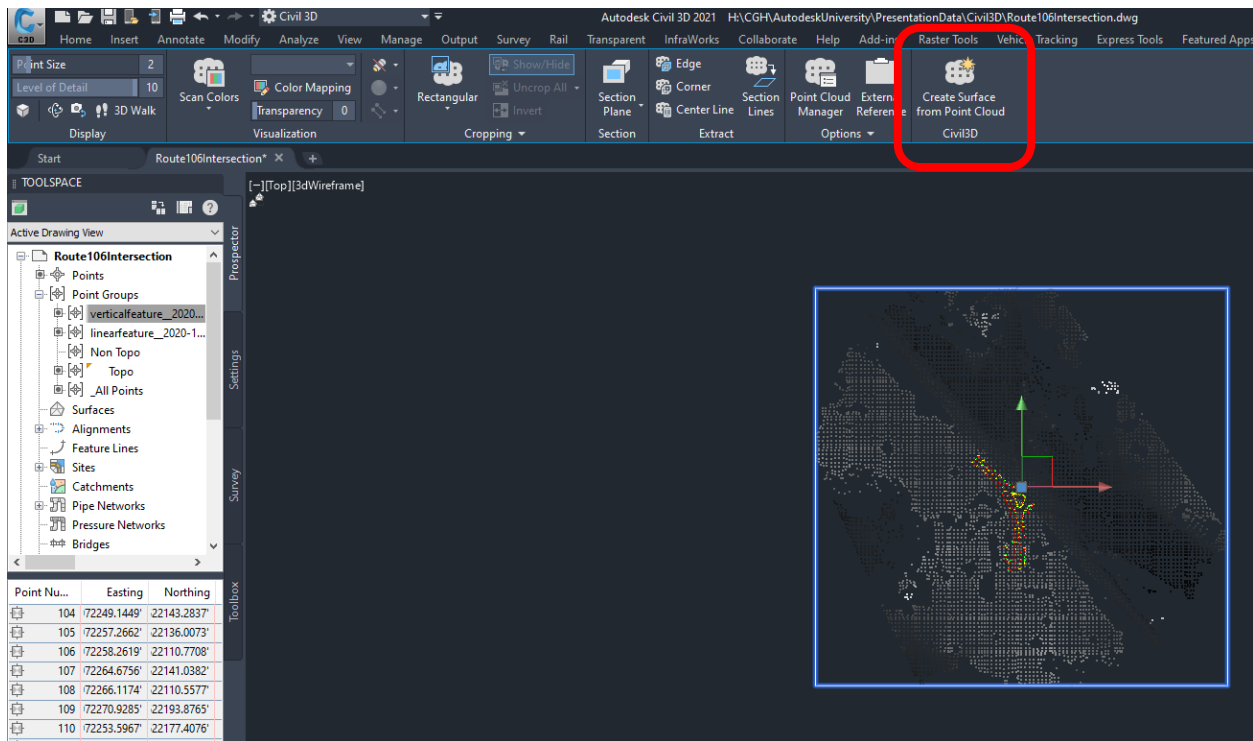
The **"Attach Point Cloud"** dialog box pops up, **"Select OK"**.
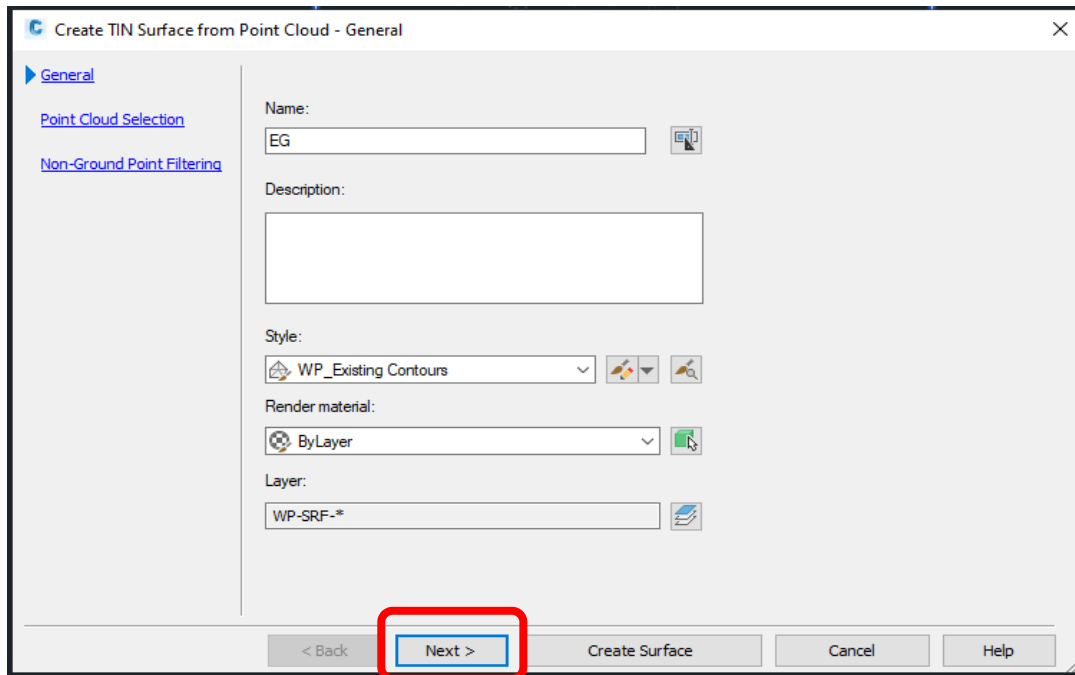

Your point cloud will import into place and look something like this.
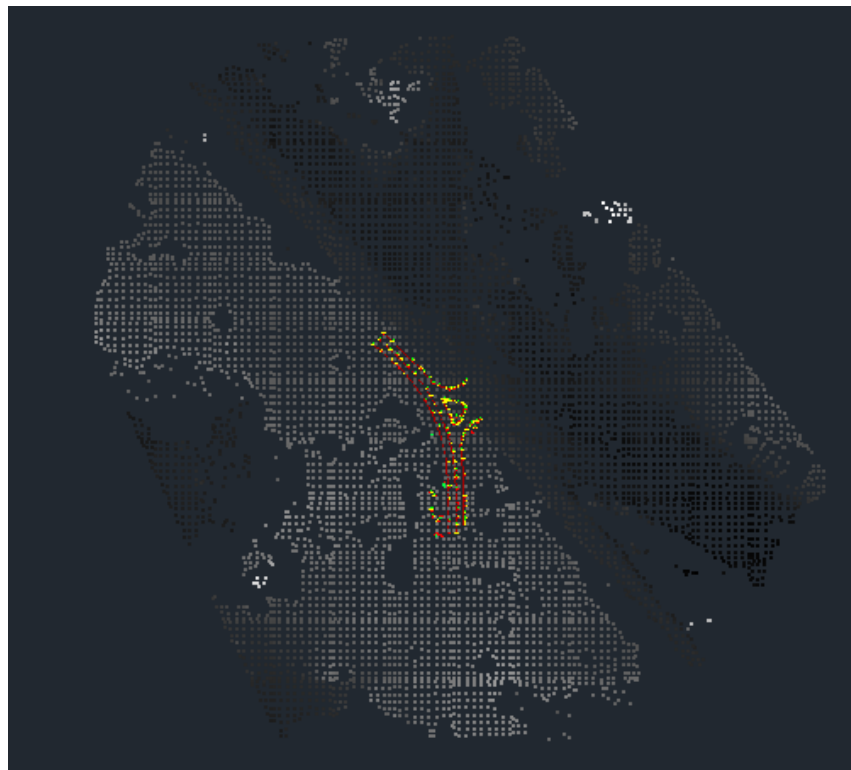
Once you have imported your point cloud you will then **"Create a Surface"**. To do this, Select the point cloud, then in the ribbon, select "**Create Surface from Point Cloud**".

In this dialog box, provide a **"Name"**, then set the style (your company's existing conditions style), and select **"Next".**

Your point cloud selection is depicting **"Points Selected, Percentage and Distance Between.** Select **"Next"**.
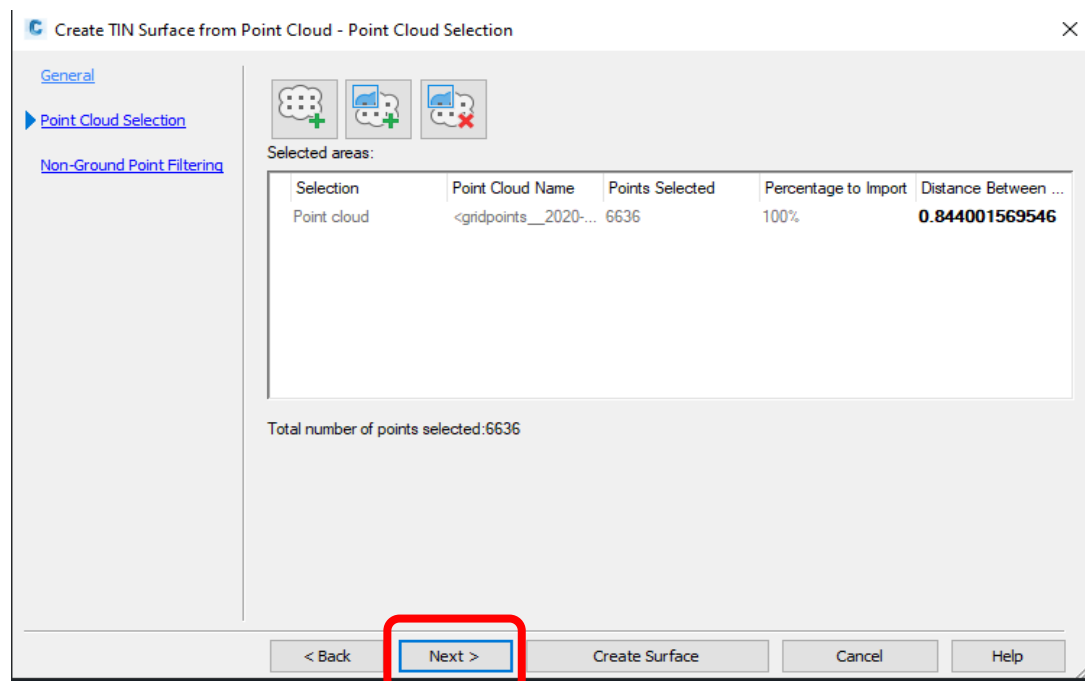
The final dialog for the **"Create TIN Surface from Point Cloud"** is the Non-Ground Point Filtering.

I recommend selecting **"No Filter"**, only because most of the **"Noise"** has already been weeded out in ReCap Pro and InfraWorks. Select **"Create Surface"**
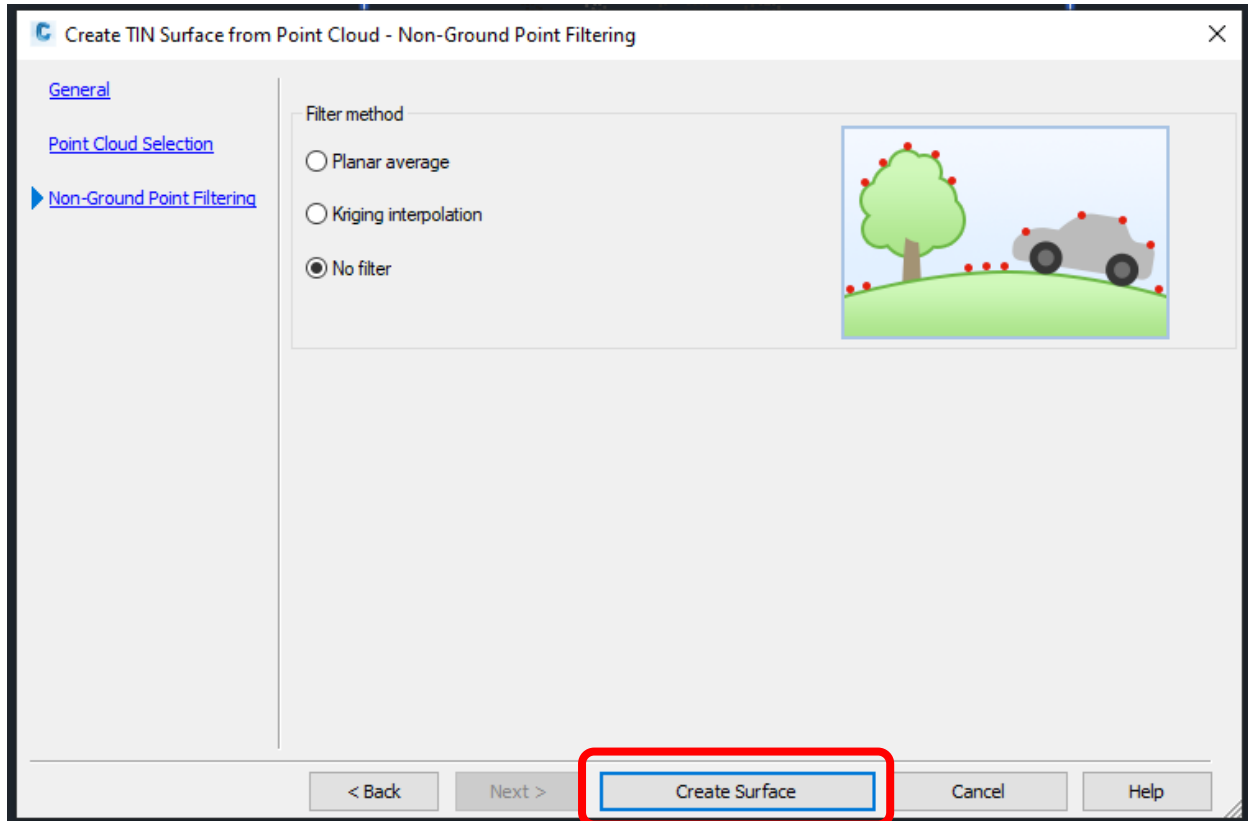
You will get a message after you select create surface (See Below). Depeding on the size of your point cloud is dependant on the amount of time it takes to generate in the background.
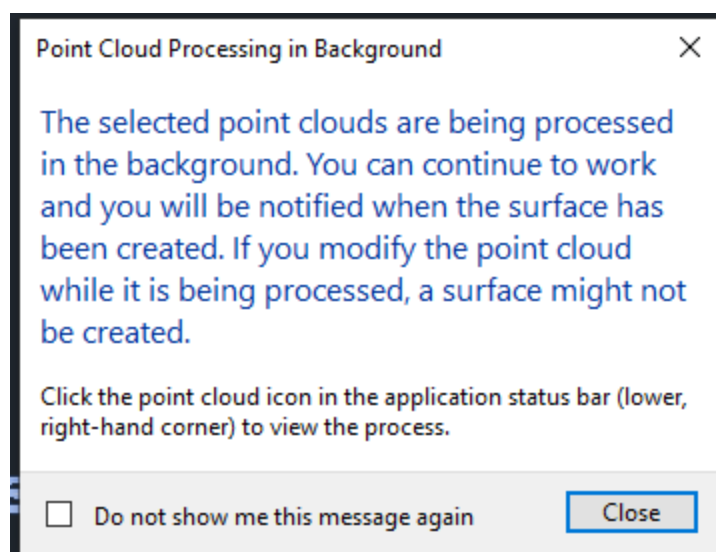
When complete your .dwg should look something like this **(SEE BELOW)**!
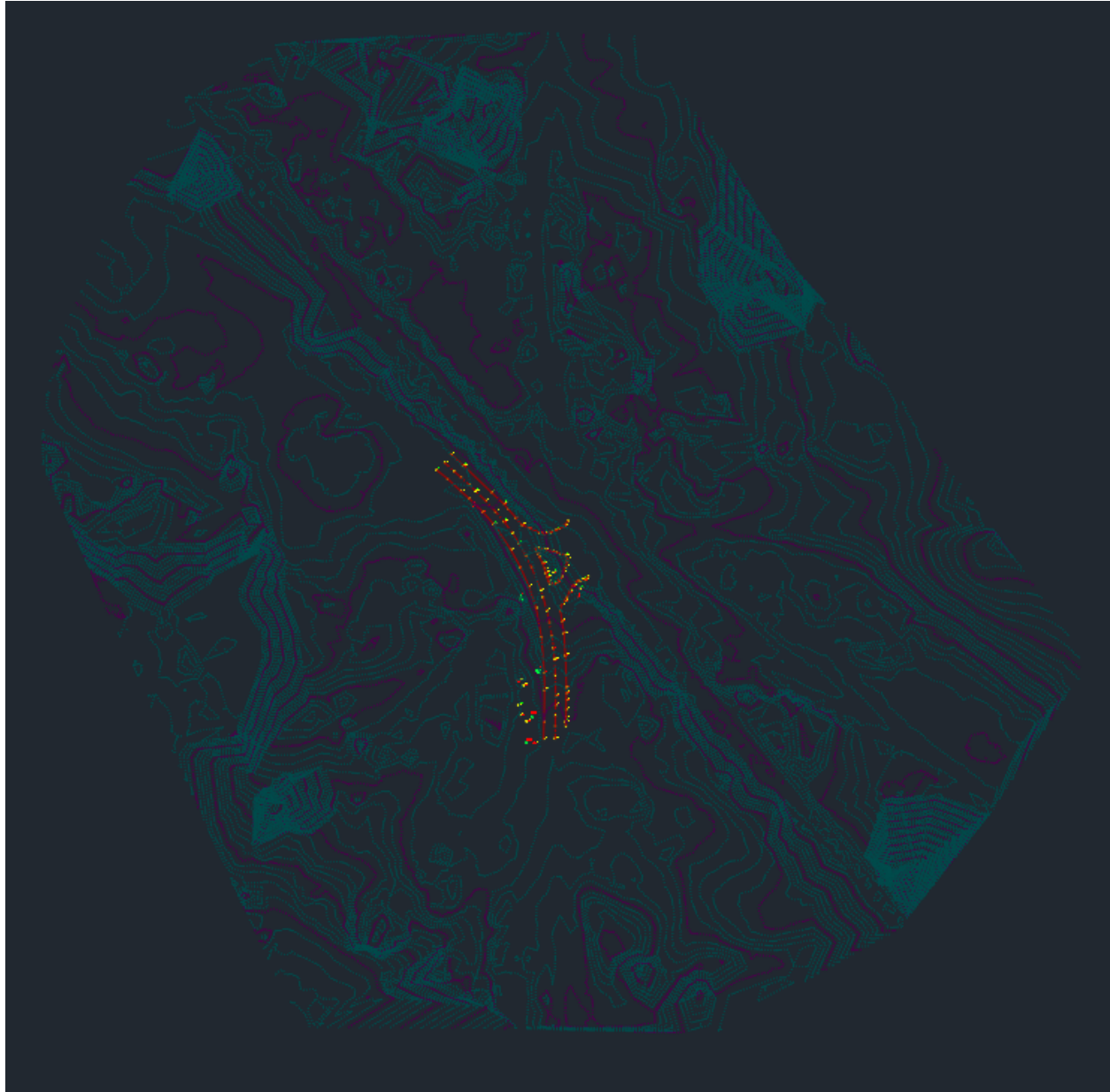
From this point on its **"CLEAN UP"!** Cleanup would consist of adding your survey figures (linear features) as break lines to the surface, adding your point data to the surface, deleting surface points that don't make sense, flipping triangles, importing the ortho image and digitize information that may not have been feasible in InfraWorks, and lastly annotating.

Final Product

With good techniques, practices and experience you should find an existing conditions survey created from these methods can be completed in less time than traditional survey **AND** you have the valuable additional assets of the orthophotos and 3D full color point cloud. These can be very valuable assets that are created at each step, including that conceptual rendering view from InfraWorks where you could add proposed buildings, roads, bridges, etc... These steps can be complete not only **"Field to Finish"** but **"Proposal to As-Built".**

Good Luck! Please feel free to reach out to me with any questions you may have regarding this process! If you wish to have access to the data set feel free to email me
Christopher.Hinkley@wright-pierce.com.