TR18477-L

Using Large Point Clouds for Infrastructure Projects

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Experts assisting us in this Lab:

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- Mr. Angel Espinoza, Sr. Tech Sales Specialist, Autodesk Inc.

Learning Objectives

- Prepare Reality Capture data in ReCap 360
- Import and process large point cloud data in InfraWorks 360
- Use automatically-processed data for terrain and surface generation/analysis in IW360 and Civil 3D
- Use point cloud data for city furniture modeling for design and asset management

Description

Point clouds are a very important component in current infrastructure projects, and it is vital to know how to handle them for successful project execution. This class will provide all the necessary information to import, process, and extract information from point cloud data in Autodesk, Inc., architecture, engineering, and construction products. More specifically, this class will teach surface/terrain generation from high-resolution point cloud data in InfraWorks software and demonstrate how to use it in AutoCAD Civil 3D software. The class will also cover how to model city asset features to create a virtual city model, and how to bring those city assets into a design product (such as AutoCAD Civil 3D software) as COGO points. This class does not have any prerequisite. Any knowledge of InfraWorks software, AutoCAD Civil 3D software, and point clouds will be helpful in understanding the class material. At the end of this class, attendees will be able to use point cloud data with ease and confidence for their modeling and design projects. This session features InfraWorks 360, AutoCAD Civil 3D, and ReCap 360.

Your AU Expert(s)

Ramesh Sridharan has been working with reality capture point clouds, image processing, and machine learning based software development since 2001. With over 15 years of experience, he has successfully driven programs in research and development, technical sales, partner marketing, and customer analysis. He has experience working with customers to understand and set industry workflows which drive the technology forward. He is an expert in pushing technology to its limits and in converting research findings into products that users can apply to real life problems. He is a pioneer in the field of reality capture point cloud product development that can handle and extract information from a large number of 3D datasets. As a Principal Product

Owner in the Product Development Group (PDG) since he joined Autodesk in 2014, Ramesh is responsible for information extraction from Reality Capture for AEC applications. Ramesh is a post graduate of Indian Institute of Technology with a research focus in Image Processing and Artificial Intelligence. You can reach Ramesh at Ramesh.Sridharan@Autodesk.com

Introduction

Points Clouds are becoming more and more vital for many real world projects, especially in the AEC market. Almost all infrastructure projects use reality capture point cloud data directly or indirectly to gather existing and as-built conditions. Given the ubiquitous use of point clouds, having an easy and accurate processing tool is of the utmost importance. The InfraWorks 360 Automatic Terrain Generation tool is a first step towards providing an intuitive point cloud processing tool and bringing "reality" to the reality capture industry.

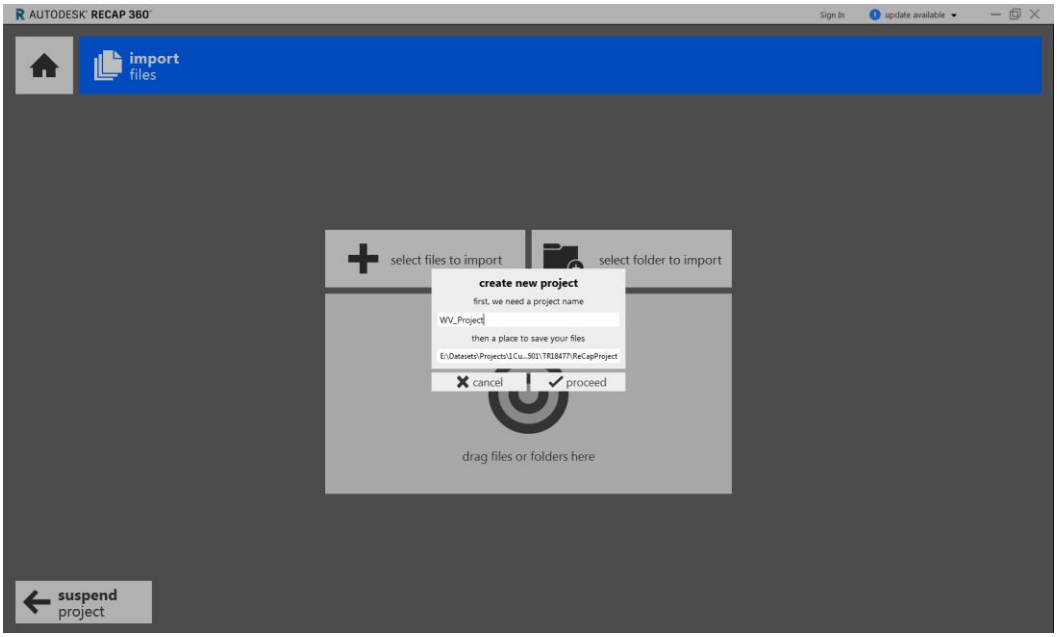
Generally, point cloud data sets are extremely large, and extracting terrain is difficult. Users have to go through the painful task of either removing noise (or non-ground) points manually, or extracting/digitizing breaklines to create a terrain (which is not as information rich as point cloud data). In either case, it is not easy to generate terrain with point clouds and then there is the additional process of triangulating a large number of points. The InfraWorks 360 *Point Cloud Terrain* generation tool takes care of these pain points by filtering noisy data to deliver thin (information rich) point clouds and extract terrain raster. These point clouds can then be used to create triangulated terrain directly or enforce breaklines for more detail. With these thin point clouds, sharing and using point cloud data is no longer science fiction to the point cloud industry.

Here is a workflow of point cloud processing using Autodesk Recap, Infraworks and Civil 3D.

Point Cloud Processing Workflow

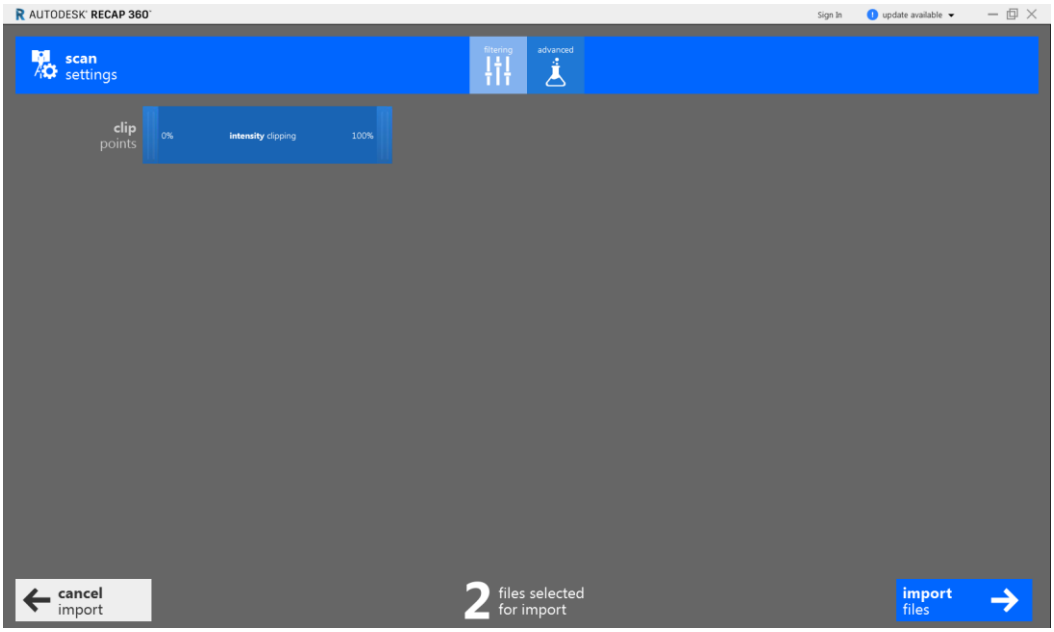
Step 1. Prepare Point Cloud in ReCap

Create new project

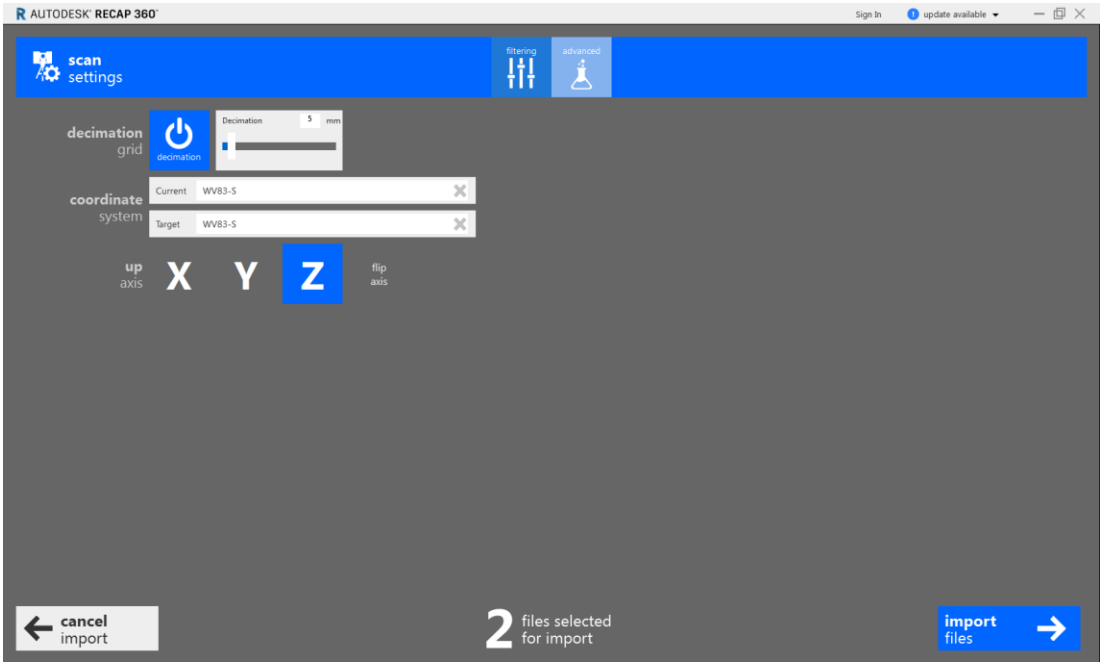


Import point cloud file (.las or .pts or other formats)

- Select desired input file(s) to import



Specify coordinate system information



- Following desired settings update, click “Import Files” and “Index Scans” consequently to index and visualize point clouds in ReCap

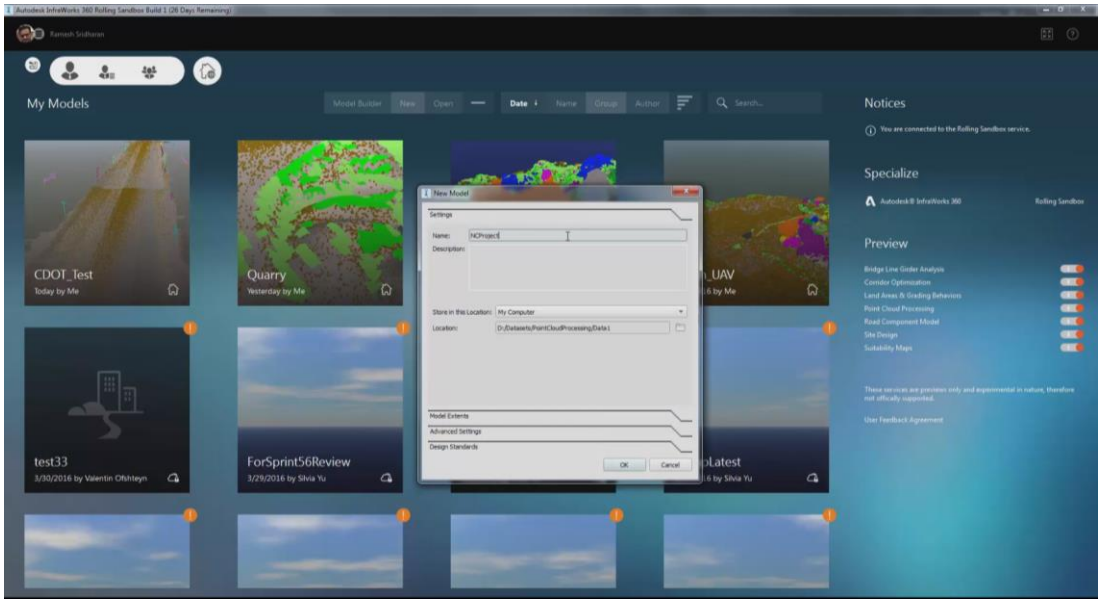
Prepare point cloud as needed

Here are a few examples:

- Crop to project area
- Unify multiple collections to one
- Register terrestrial scans with survey control points

Step 2: Import Point Cloud Data in InfraWorks 360

Create new InfraWorks model



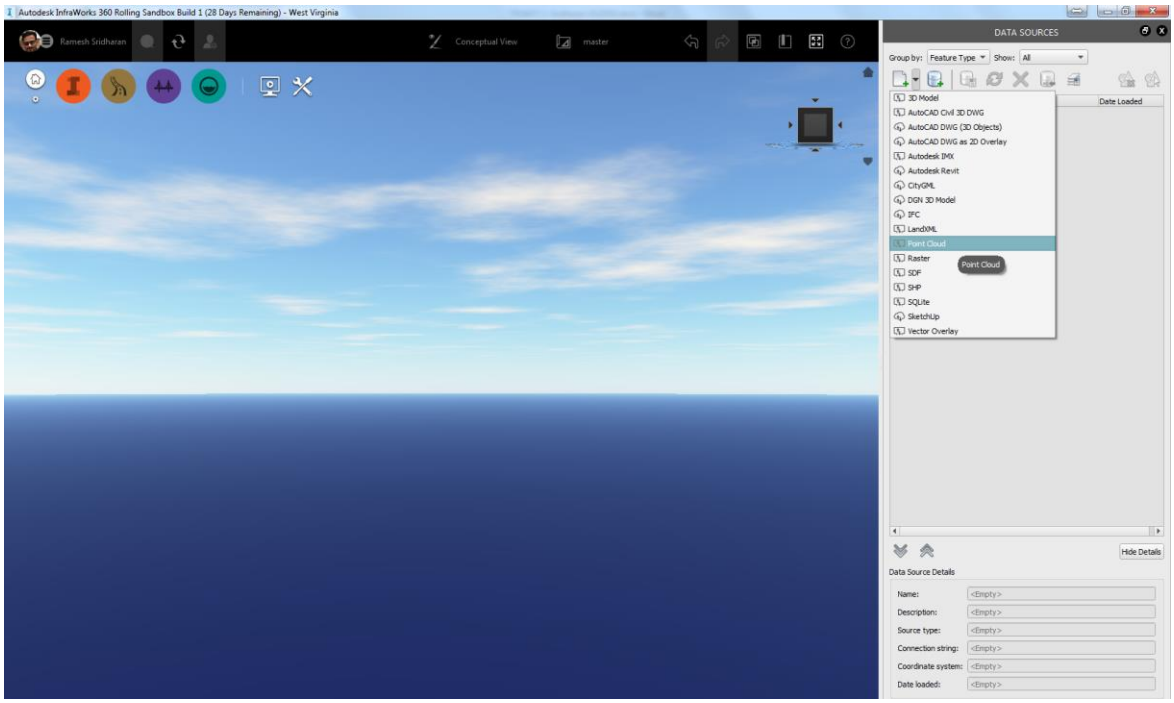
Import point cloud data

Import .RCS or .RCP files from a 3D laser scan—of an object, a topography, a building, or even an entire town. Indexed data from such a scan is called point cloud data and used as a real-world reference for design work. Adjust point size and density for point cloud data in *application options*.

1. Click 
2. On the *Data Sources panel*, do the following:
   - Click  (Add File Data Source).
   - Click Point Cloud.
   - Navigate to the folder where files are stored and select the point cloud file.

     Note: InfraWorks 360 supports RCS and RCP files. If your point cloud data is stored in LAS format, you must convert it to RCS format. You can use Autodesk ReCap to do this. An RCS file is a single point cloud file that can incorporate multiple scan (LAS) files. There may be an accompanying RCP file (a project file that points to the individual scan files and contains information about them).

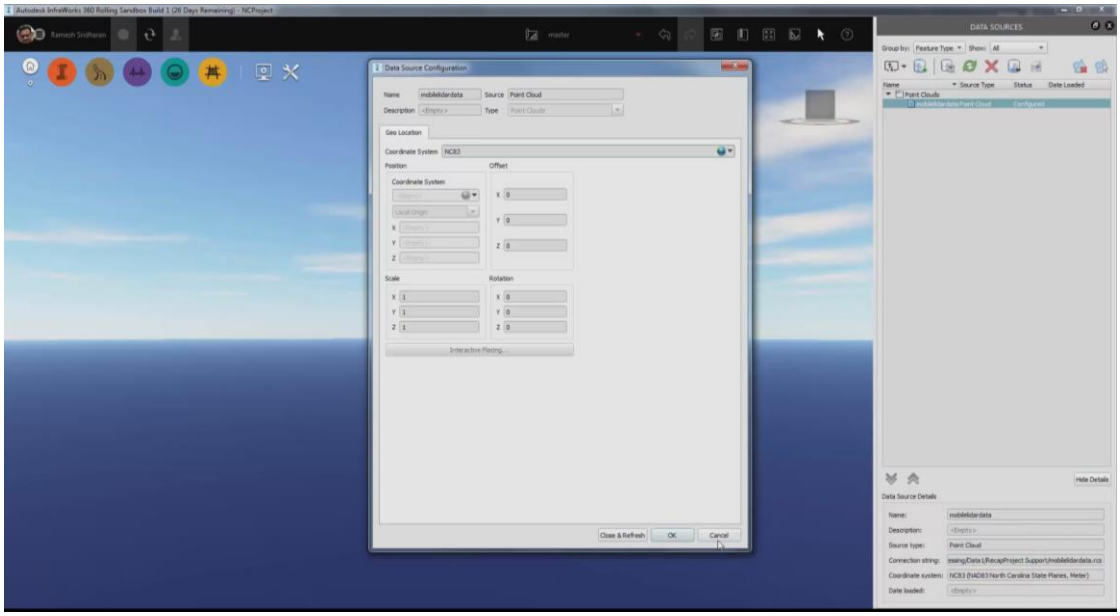
   - Click Open.



3. Double-click the new data source to configure it.
4. Do one of the following:
    - Specify the coordinates for the point cloud data location.
    - Click Interactive Placing.

In the model itself, the point cloud data appears, attached to your cursor. Navigate to the appropriate location and double-click to place it.

Note: If the point cloud data includes geopositioning information and a specified coordinate system, it is imported automatically at the correct position.



5. If desired, adjust the scale, rotation, and offset of the point cloud.
6. Click Close & Refresh.

Step 3: Generate Terrain using Point Cloud Data

After importing point cloud data, you can use that data to generate terrain and extract features in your model. You must run point cloud terrain generation to process the data and extract features before using the Point Cloud Modeling tool.

1. Click  ➤  .
2. Click Point Cloud Terrain.
3. Select the point cloud data set(s) you wish to process.
4. Specify options for the level of detail used in processing the data for the terrain and features. For each of the following options, you can choose from the drop-down list or click ⚙ to specify advanced settings. The default value is set to Optimum for all options.

    - **Ground**: Classify ground surface points; less detail will be smoother.
    - **Linear Feature**: Classify points representing road curbs, guardrails, and other linework.
    - **Vertical Feature**: Classify points representing trees, streetlights, and signs.

5. Specify options for the processed data:

    - **Override Model Point Cloud**: Do not select this option if you want to retain the ability to reprocess the original point cloud data later. If you deselect the option, the processed data is added to the ProcessedPointCloud proposal, which may increase model file size.
    - **Select Proposal for Processed Data**: Accept the default or choose another proposal to save the processed data. This option is available if you did not select “Override Model Point Cloud.”
    - **Generate Lightweight Data**: Select the level of detail for the data. Selecting Lightweight or Keypoints only may improve performance, but may also result in fewer ground points.
    - **Export to RCS**: You can export the processed data as an RCS file for use in other applications. If you select to export the data, you also need to specify where to save the file.

6. Click Start Processing.

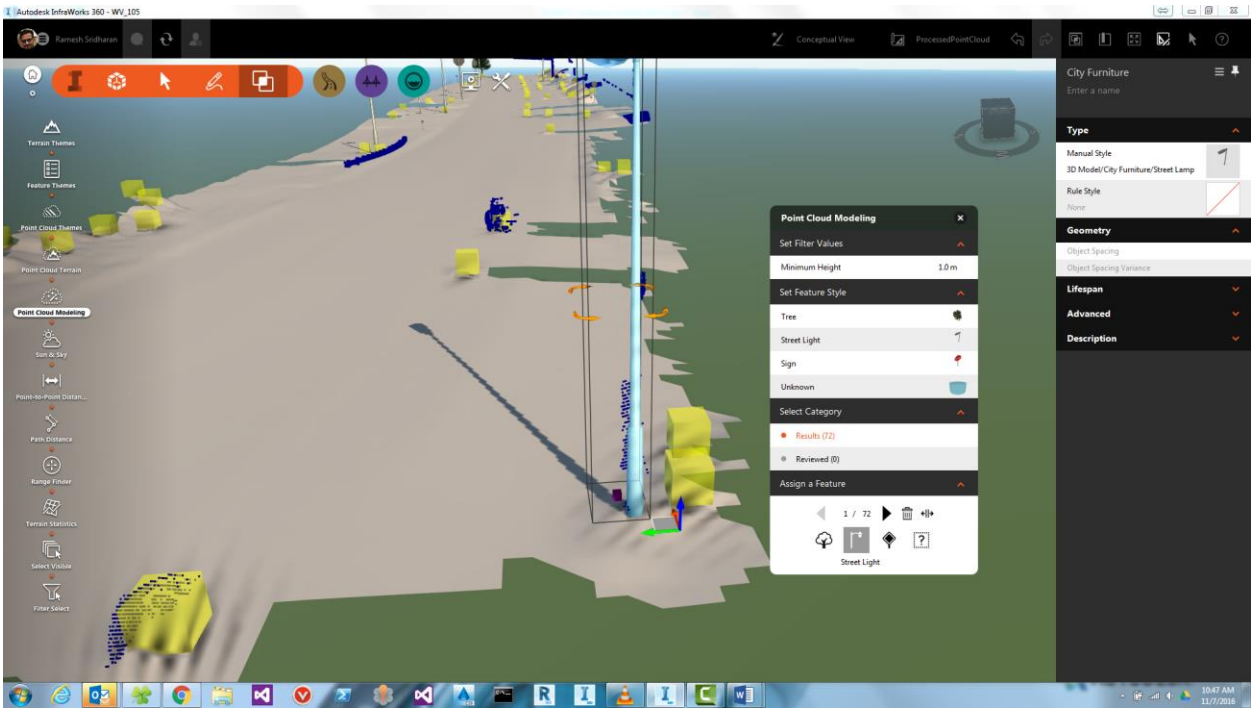
   A status message indicates the processing progress. If you click Cancel, the process is stopped and any data that has already been generated is saved. When the data is processed, the terrain displays in the model.

Step 4: Create City Asset Model from Point Cloud

After processing point cloud data to extract features, assign vertical features as trees, street lights, or signs.

With the Point Cloud Modeling tool, you set the feature styles for trees, street lights, and signs, as well as unknown features. Then, you review the features processed from the point cloud data, and assign features as assets in the model.

1. Click  ➤ 
2. Click Point Cloud Modeling



3. In the first pane (Set Feature Style), you can set feature styles for each of the asset types: tree, street light, sign, and unknown. You may want to set these as defaults and then change as necessary before assigning a specific feature. Click the style image to display the palette, and make your selection.

   Note: If you change the style of one feature, all features assigned to that style will be changed. Say that you assign 3 features as trees set with the Alexandrae style. If you select one of those trees and change the style to a Large Shrub, than all of the Alexandrae trees become large Shrubs. Another option is to assign all trees using the

same style, and individually change the style of selected features using the City Furniture Type property, Manual Style.

4. Under Select Category, select Results. The features in this category were detected during point cloud processing.
5. In the Assign Features pane, use the arrow buttons to navigate to the features and identify each one or accept the machine-recognized feature, if correct. For each feature, do one of the following:
    - If the feature is already recognized correctly, click the next arrow to move to the next feature.
    - If it is unrecognized, click one of the icons to specify the feature as a tree, street light, sign, or unknown.
    - Click  to delete the feature.
    - If more than one feature is grouped together as a single asset, click  to divide the feature, and specify the number of features to create. For example, the process may have grouped 3 trees as a single feature, and you'd like to separate it into 3 separate trees.

As you review and assign features, they are moved to the Reviewed category. You can always select the Reviewed category and view and assign features again if necessary.

Step 5: Utilize Generated Terrain

Use terrain information in InfraWorks (IW)

After the terrain generation process is complete, a new terrain/surface layer displays in the IW model which you can then use directly to create your models.

Use terrain information in Civil 3D

There are two ways to get extracted terrain/surface points to Civil 3D.

IMX Approach

Export IW model as IMX

1. Make sure the data layers you want to include in the export are set to visible in the *Model Explorer*.

   Toggle  next to a feature class to make layers visible (or  to hide layers. Hidden layers are not included in the export.

2. Zoom out to see the area to export.
3. Click  .
4. In the Export To IMX dialog box, specify the area to export:
   - To populate the dialog box fields with the values of a recently executed export operation, click the down arrow next to Start With Recent Export. Select an export operation.

     Recent exports are listed by their target file names.

   - To export the entire model, select Use Entire Model.
   - To specify an area to export, click Define Interactively and do the following:
     1. Click the first point on a bounding box for the data to include.
     2. Stretch the box to include the area you want, then double-click to finalize the selection.
   - To export specific extents, enter values in the minimum and maximum X,Y boxes or click Load Extent From File and browse to a file containing the extents.
5. Select the target coordinate system by doing any of the following:
   - Use the coordinate system shown. This is either the coordinate system assigned to the model or the last coordinate system you selected.

     Note:  uses the best fit CS it can find for the extents of the export area. Check if this target coordinate system matches one suited to the location where you want to use the exported data. If it does not, then choose one from the

coordinate system library. Note also that AutoCAD Civil 3D does not recognize and translate well models using a projection coordinate system such as LL84.

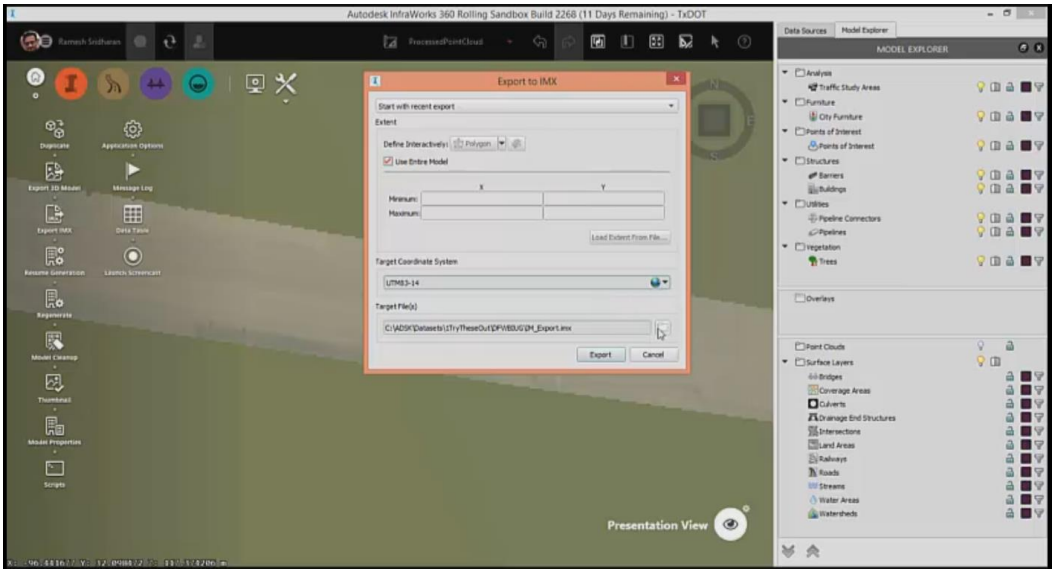
- To select from a coordinate system library, click  .
- To specify a recently-used coordinate system, click the down arrow and select it.

Note: When preparing to exchange model data with AutoCAD Civil 3D, it is recommended that InfraWorks 360 users follow the guidelines in the section on Coordinate Systems and Units in *About Exchanging Data Between AutoCAD Civil 3D and Autodesk InfraWorks*.

6. Specify the name and location for the exported file.

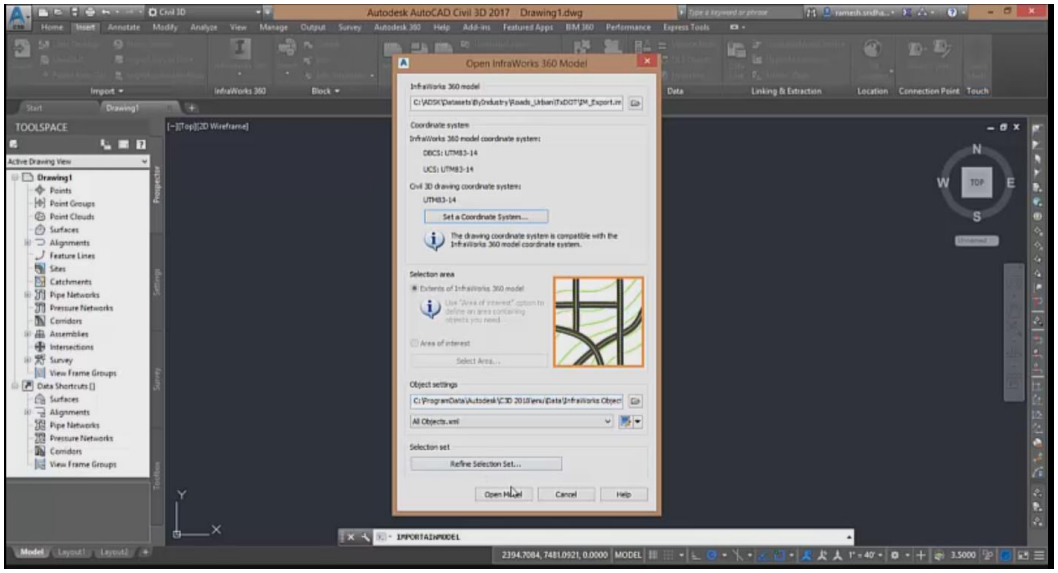
   To change the location, click the folder icon and browse to the desired location.

7. Click Export.

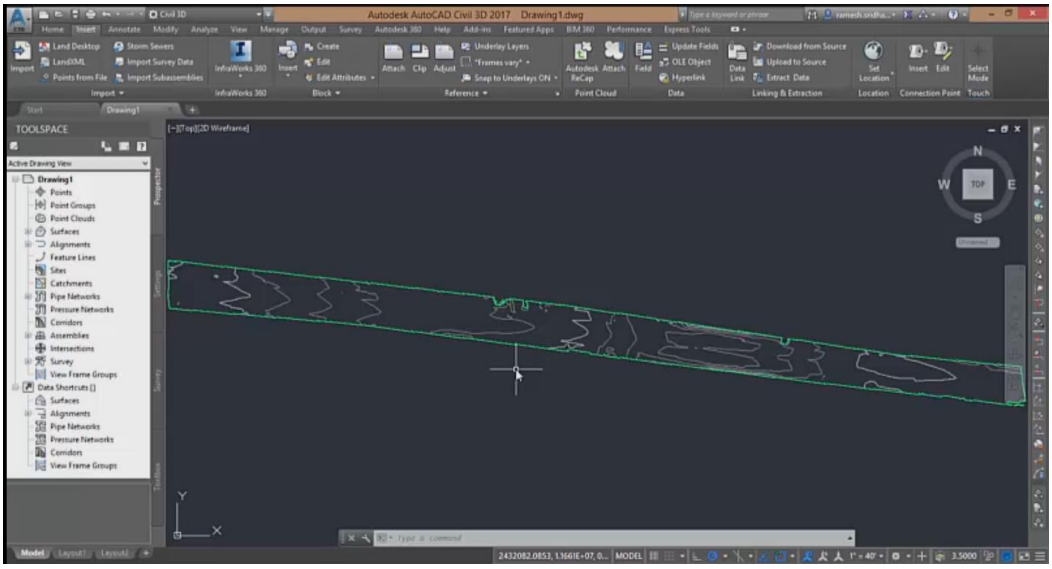


Import IMX in Civil 3D

1. Open a Civil 3D drawing.
2. Click Insert ➤ InfraWorks 360 ➤ Open Infraworks 360 Model.
3. Select the exported IMX file.
4. Assign/select the proper coordinate system.
5. Click OK.



The terrain generated in IW 360 will now be visible in Civil 3D as a surface. You can use that surface as needed in Civil 3D.

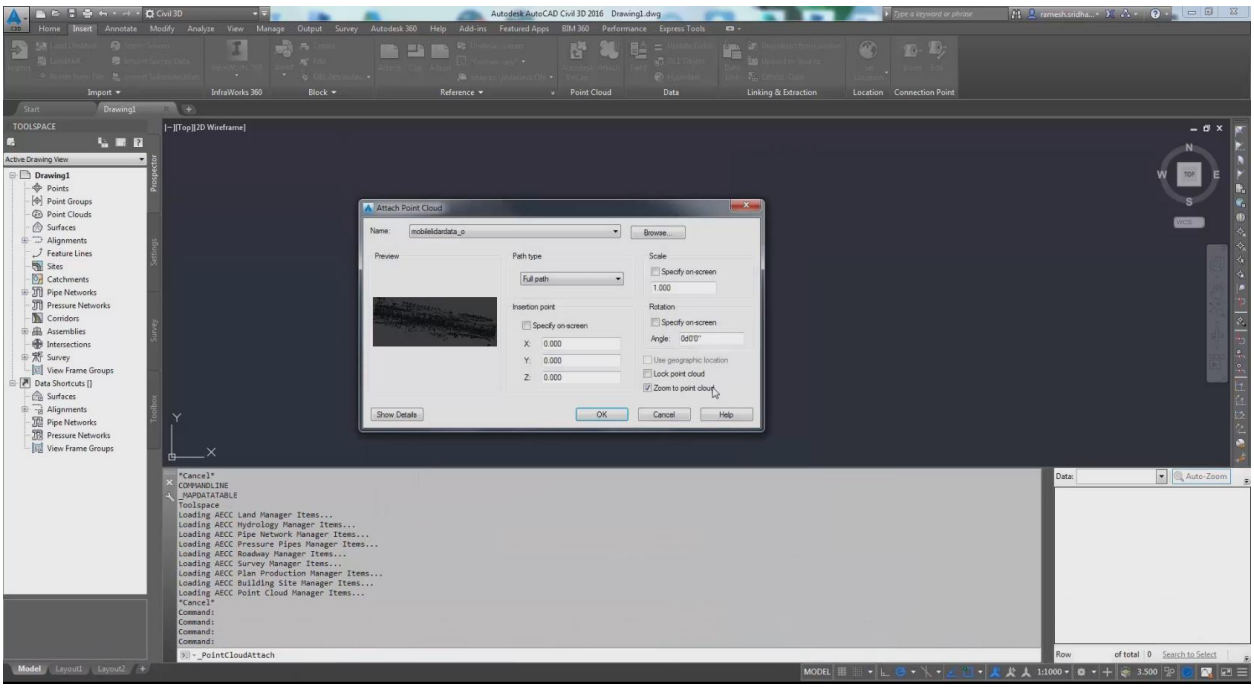


Point Cloud Approach

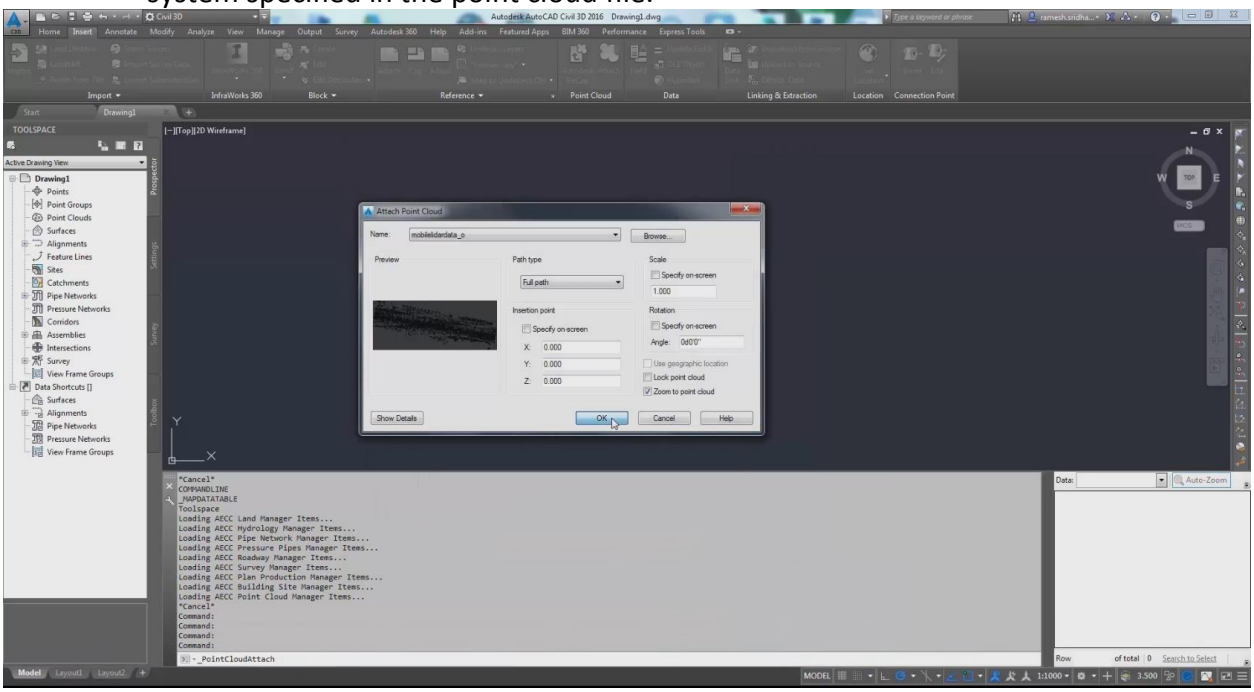
This approach uses the RCS file exported during the terrain generation process.

Import processed RCS in Civil 3D

1. Open a Civil 3D drawing.
2. Click Insert ➤ Point Cloud ➤ Attach.
3. Select the IW-exported RCS file.



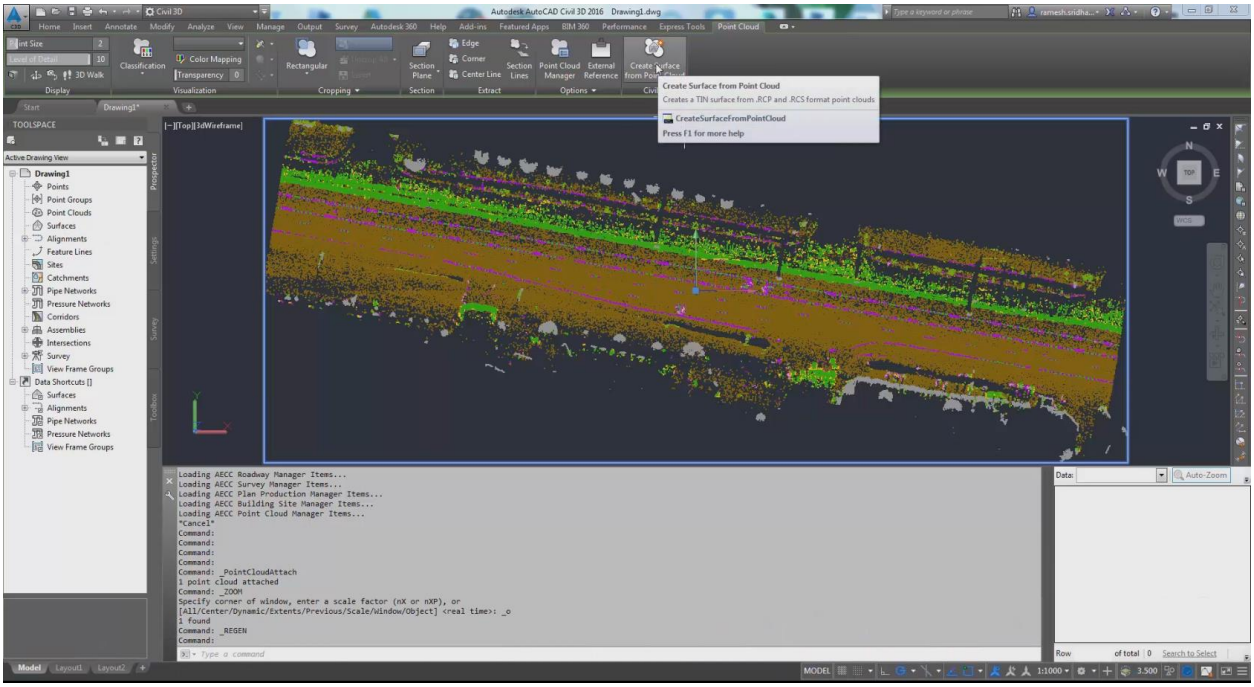
4. In the “Attach Point Cloud” dialog, make sure that the “Specify On Screen” option under “Insertion Point” is **not selected**, so that Civil 3D will use the coordinate system specified in the point cloud file.



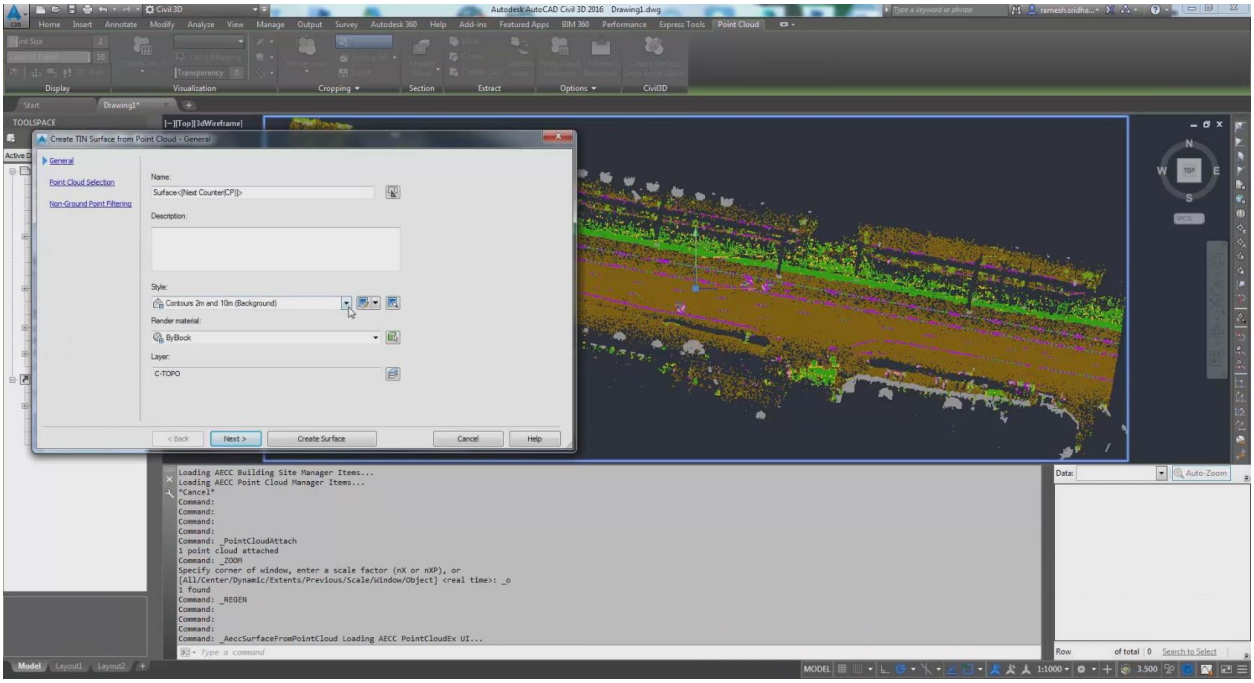
5. Click OK.

Create surface from point cloud

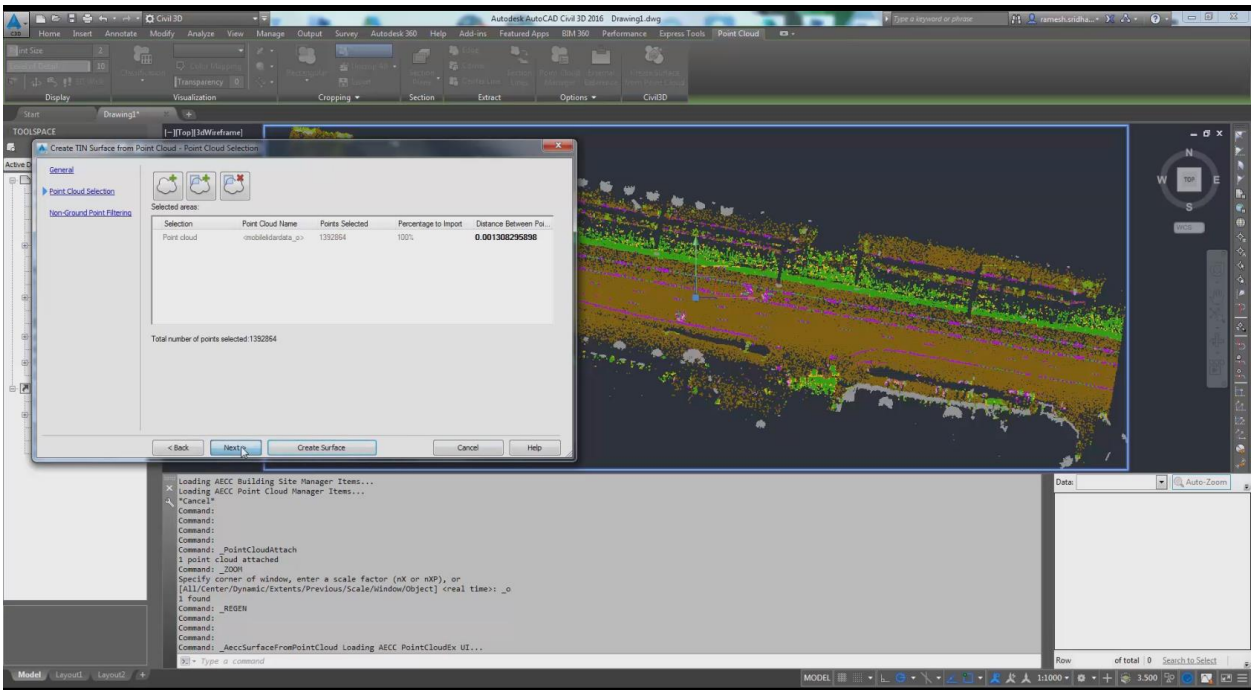
1. Select the attached point cloud.
2. On the Point Cloud tab, click the “Create Surface from Point Cloud” option.



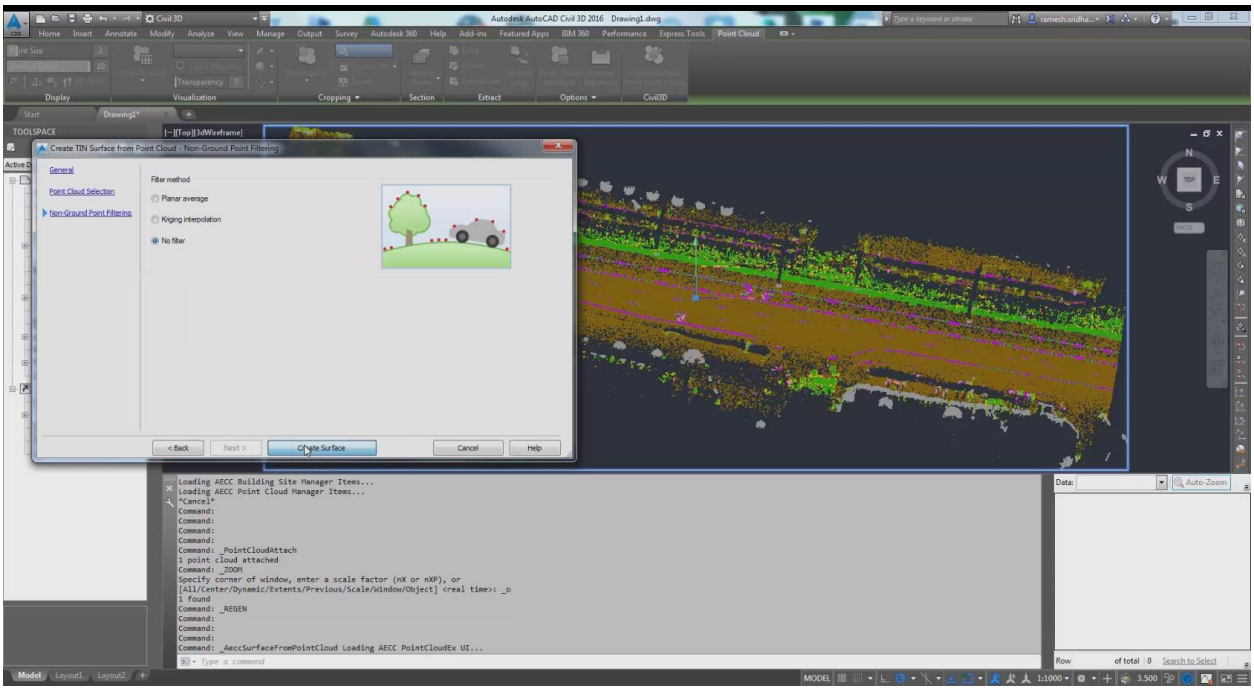
3. In the “Create TIN Surface from Point Cloud – General” dialog, provide the desired surface name and style, and click Next.



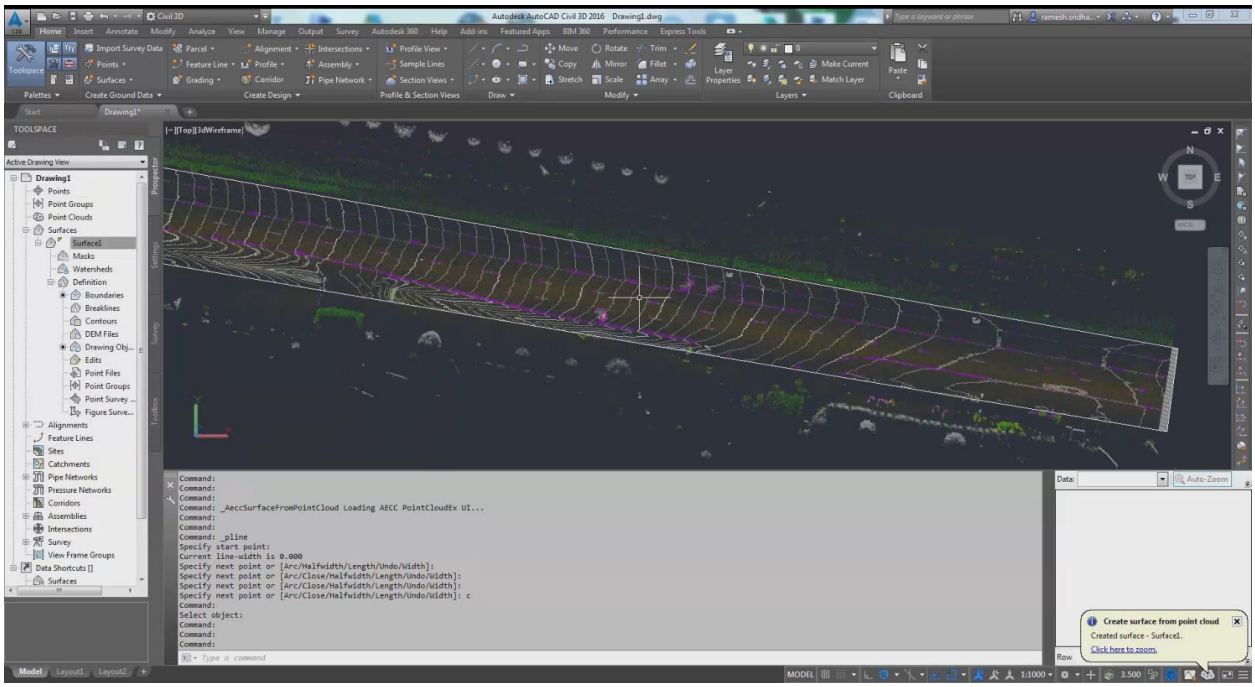
4. In the “Create TIN Surface from Point Cloud – Point Cloud Selection” dialog, provide the desired area or just leave the default, and click Next.



5. In the “Create TIN Surface from Point Cloud – Non-Ground Point Filtering” dialog, choose the desired filter. In this case, choose “No filter” (as processing is already done in IW), and click “Create Surface.”



6. Civil 3D will generate a new surface from the processed point cloud data that can then be used in Civil 3D as needed.



Conclusion

Infraworks 360 is growing up from conceptual tool to detailed design by adding engineering-grade features. Reality capture is undeniably one important factor for capturing existing conditions that is essential for detailed design. As shown here, large high density point cloud reality capture dataset, irrespective of its collection mode like mobile, terrestrial or UAV, can be efficiently processed to remove noise and generate surface/terrain with Infraworks “Point Cloud Terrain” tool. Further the point cloud can be further used to extract city furniture models in Infraworks to generate 3D model that depicts reality very closely. The extracted features can be used in further 3D modeling for various different analysis and scenarios as well as used effectively in design projects as Ex-TOPO feature as well. Terrain Generation tool also export point clouds that carry other information content like linear features that can be used in Civil3D for easy digitization completing all the essential ingredients needed from existing conditions detailed design project.