Exercise 1: Process drone data to model a construction project

How can I print an exercise to PDF format?

Technical note

This exercise requires the download of large amounts of data, and based on your individual system specifications, it can potentially take long periods of time to process the data. It is recommended to briefly review the exercise prior to downloading data. Additionally, please review ArcGIS Drone2Map Help: Hardware resources and performance to verify your specifications and to gauge performance expectations. A solution set or project file of results dataset is available of limited products generated if you determine that your system may take too long to perform the product generation.

Note: Due to individual system variables that cannot be accounted for, the estimated time to complete this exercise (55 minutes) does not include any of the download time for data nor the potential processing time to create the various 2D and 3D products in ArcGIS Drone2Map.

Software Requirements:

- ArcGIS Drone2Map 2023.1
- ArcGIS Pro 3.1

Introduction

ArcGIS is capable of using imagery from many sources, including unmanned aerial vehicles (UAV), or drones. With these sensors, high-resolution imagery can be captured and quickly added to your GIS to provide an updated view of your project site or for use in advanced analysis. Several ArcGIS Reality products can help manage your drone data, as described in the following table.

Managing your drone data with ArcGIS Reality	
Esri product	Capabilities and uses
ArcGIS Reality for ArcGIS Pro	ArcGIS Reality for ArcGIS Pro is an ArcGIS Pro extension that expands ortho mapping capabilities with high-fidelity 2D, 3D, and True Ortho product generation.
Site Scan for ArcGIS	Site Scan for ArcGIS provides the ability to program your drone's flight plan and then create imagery products in a cloud-based workflow.
ArcGIS Drone2Map	ArcGIS Drone2Map provides a desktop-based workflow for creating imagery products from drone data.

All ArcGIS Reality applications can be used to create orthorectified imagery. Depending on the origin of the input imagery and the organization's ArcGIS Reality mapping requirements, the choice of which application to use can vary.

The graphic below outlines the workflow you will use in this exercise to create 2D and 3D imagery products using Drone2Map.

Scenario

In this exercise, you have been provided with recent imagery of a residential development, collected by a drone. Imagine that you are a GIS analyst with the company that is developing the neighborhood. Your task is to use the data to create imagery products. These products will be used to show progress on the development to city officials and the project design and construction teams. You will use ArcGIS Drone2Map to create the imagery products.

Note: The exercises in this course include View Result links. Click these links to confirm that your results match what is expected.

Estimated completion time in minutes: 55 minutes

Expand all steps | Collapse all steps

Step 1: Install ArcGIS Drone2Map

Because you will be using ArcGIS Drone2Map, you will need to install the software before creating imagery products.

a Open a web browser in private or incognito mode.

Note: To learn how to enable private browsing, see this How to Enable Private Browsing on Any Web Browser article. (https://links.esri.com/HowToBrowse | https://www.howtogeek.com/269265/how-to-enable-private-browsing-on-any-web-browser).

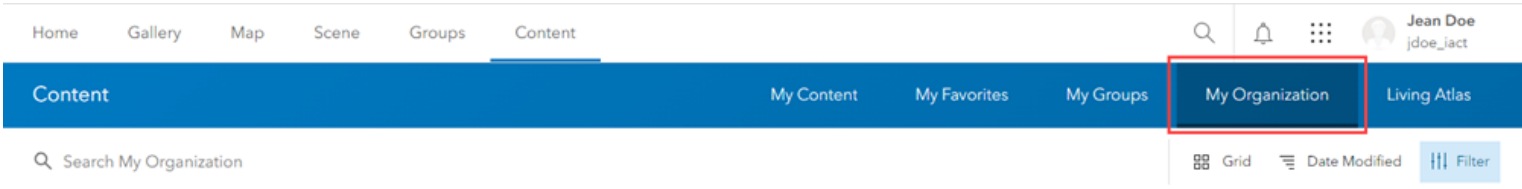
b In the address bar, type **www.arcgis.com** and press Enter.

c Click Sign In.

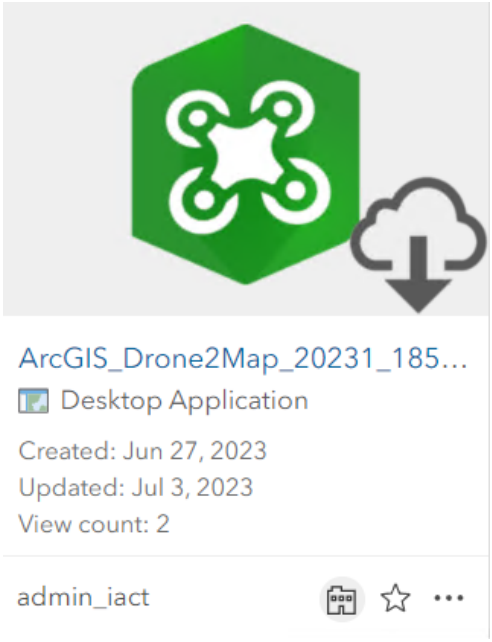
d Under ArcGIS Login, copy and paste or type your MOOC course ArcGIS username and password.

e On the Imagery in Action Home page, click the Content tab.

f Click the My Organization tab, as indicated in the following graphic.



g On the My Organization page, you will see a Desktop Application download button for ArcGIS Drone2Map.



*Step 1g***: Install ArcGIS Drone2Map.*

h Specify a download location for the ZIP file.

Note: ArcGIS Drone2Map requires more than 2 GB of disk space to download, so ensure that your download location has enough space to download and install Drone2Map.

i After the extract is complete, right-click the .exe file and choose Run As Administrator.

j Follow the installation instructions, accept the Master Agreement, and then accept the rest of the defaults.

In this step, you downloaded and installed the Drone2Map software.

Step 2: Download the exercise data files

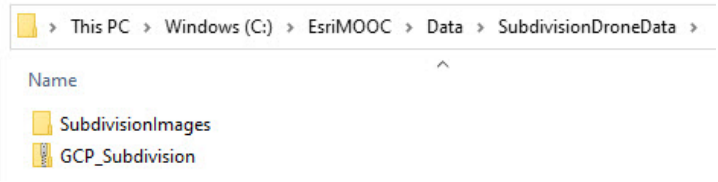
In this step, you will download the exercise data files.

a In the web browser, go to https://links.esri.com/SubdivisionDroneData and download the Subdivision Drone Data ZIP file.

Note: The complete URL to the exercise data file is https://www.arcgis.com/home/item.html?id=f467d134bf564bf3bc7dd7d57922c46f.

The size of this dataset is 333 MB. Be sure that your computer has enough space to download the data.

b Extract the files to the **C:\EsriMOOC\Data** folder.



*Step 2b***: Download the exercise data files.*

c When you are finished, close the web browser and File Explorer.

- Step 3: Input drone data

In this step, you will input the drone data that will be used to create your project.

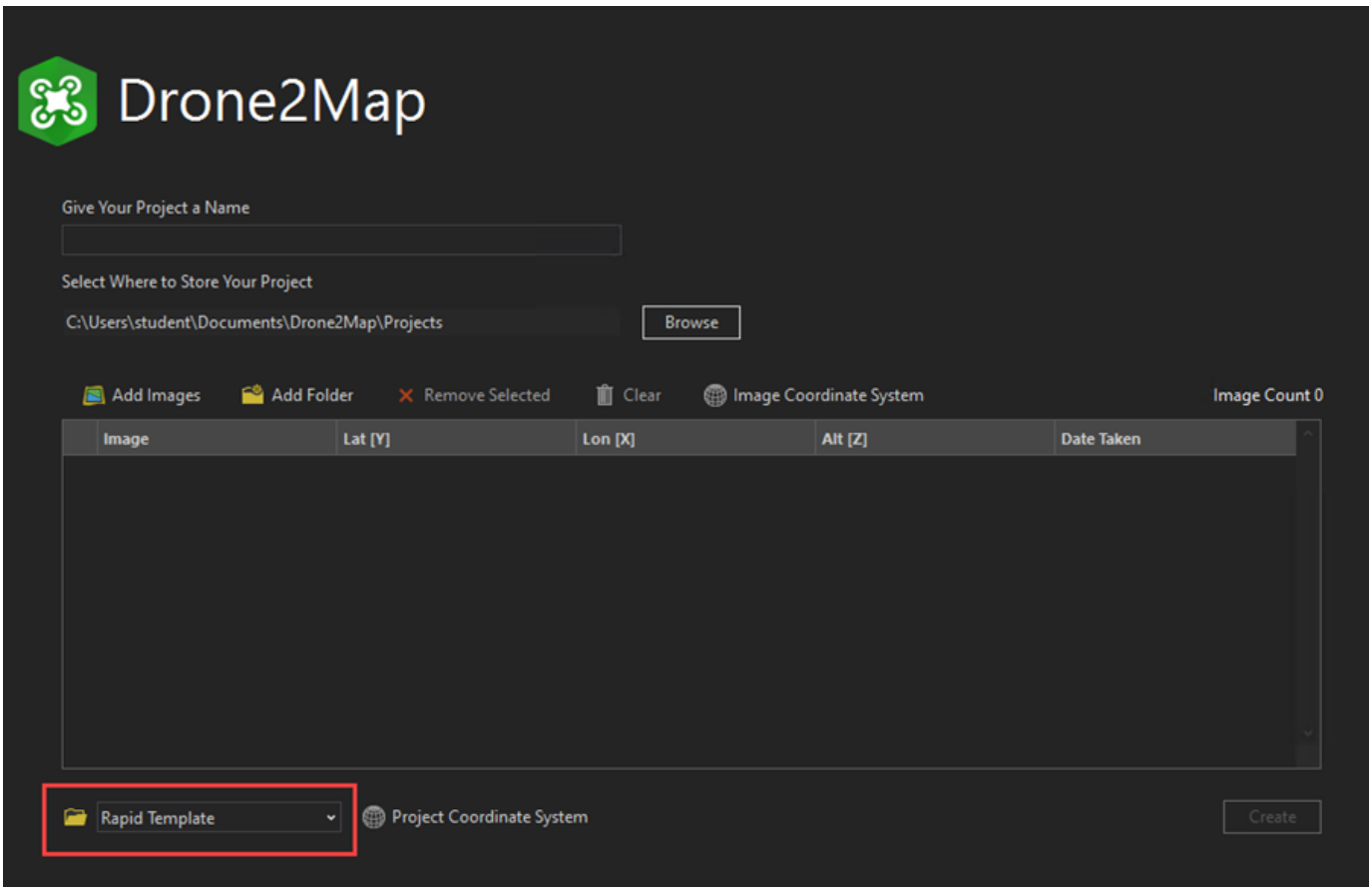
a Start ArcGIS Drone2Map.

b When prompted, sign in to Drone2Map with your MOOC credentials.

Next, you will set the template to use as the default output product template for your project. Drone2Map includes several templates that you can use, allowing you to quickly create output products based on the needs or requirements of your project. However, if you choose to, you can modify the output products required for your individual needs. In other words, if you select the 2D Products template but decide while working in your project that you want to create 3D products, you have the ability to modify the processing options to reflect your requirements. For this project, you will be creating both 2D and 3D products to show project progress. You will start with the Rapid template to quickly verify that importing your drone collection was successful.

c Click the 2D Products Template to expose the template drop-down list.

d Choose Rapid Template, as indicated in the following graphic.

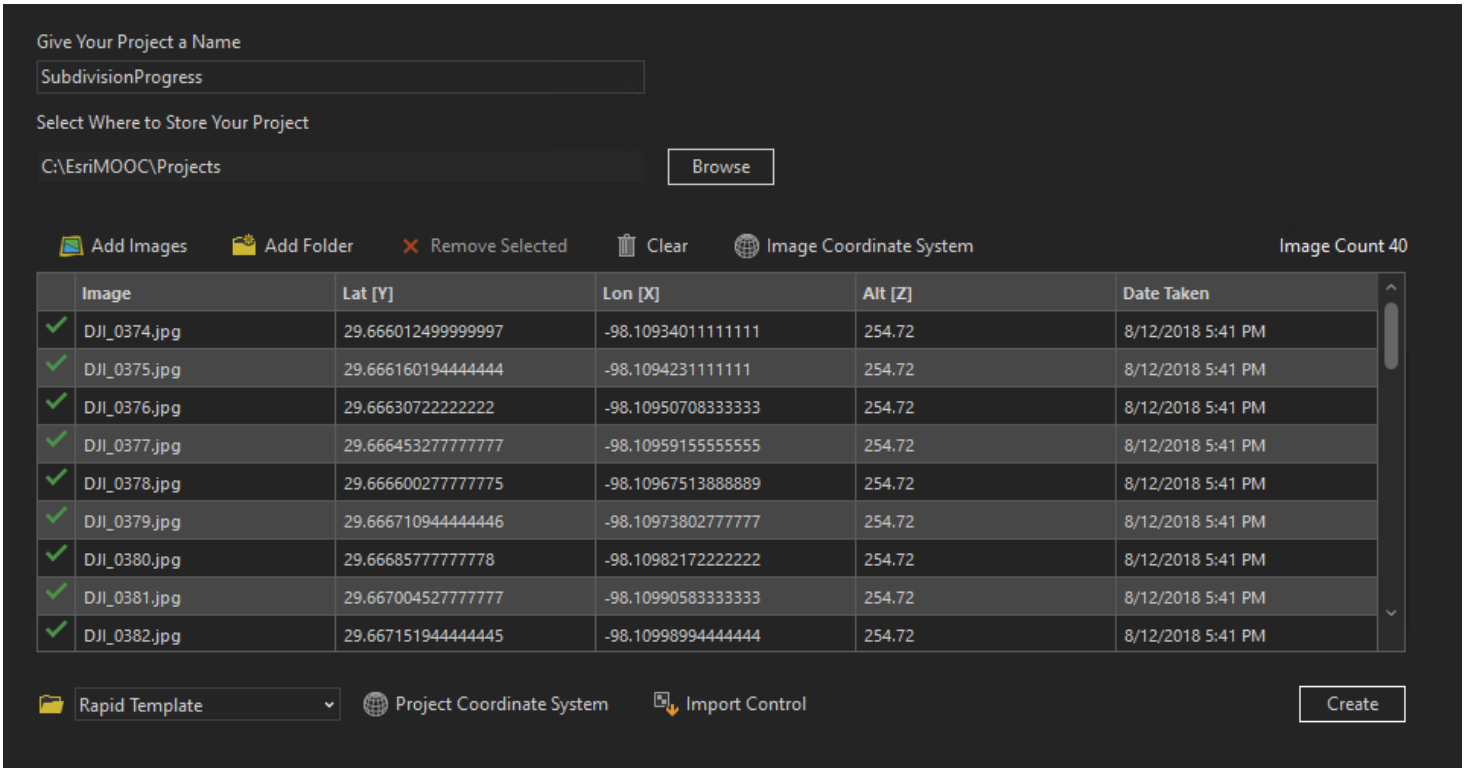


The Rapid template is designed to quickly create lower-resolution image products, which is sufficient for this project. For more information on the default project templates available in Drone2Map, including the output product type and example uses, go to ArcGIS Drone2Map Help: Work with project templates.

e For Give Your Project A Name, type **SubdivisionProgress**.

f For Select Where To Store Your Project, click Browse and browse to **C:\EsriMOOC**, and then click the Projects folder to select it and click OK.

g Click Add Folder and browse to **..\EsriMOOC\Data\SubdivisionDroneData**, and then select the SubdivisionImages folder and click OK.



*Step 3g***: Input drone data.*

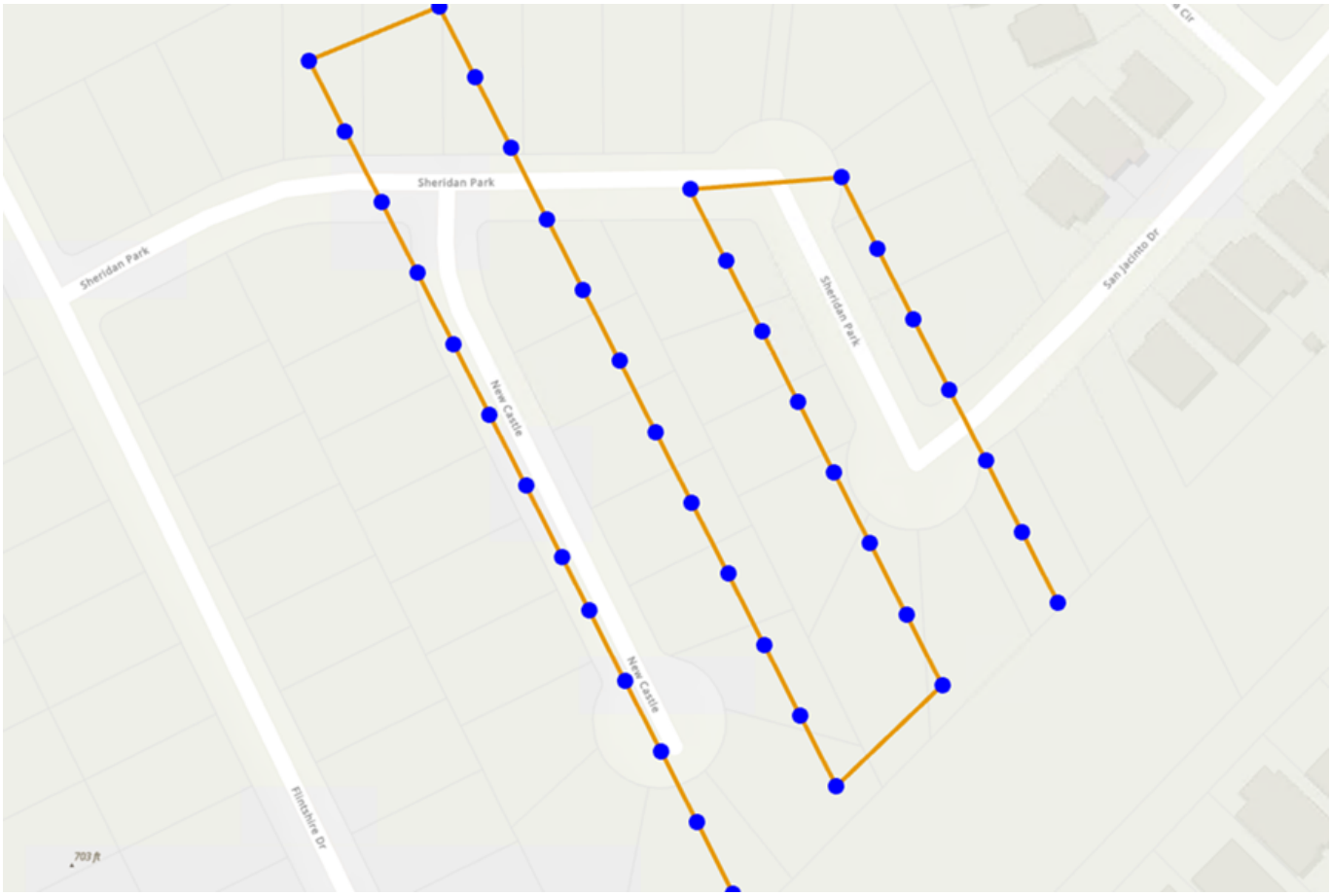
The Image Count should show 40 images to be added to the project.

h Click Create.

*Step 3h***: Input drone data.*

In Drone2Map, you will see 2D and 3D maps added to the display. The flight line pattern in the 2D map will be visible based on the arrangement of the input data.

i From the Home tab, in the Layers group, click Basemap and select the Topographic basemap.



*Step 3i***: Input drone data.*

In Drone2Map, you will see 2D and 3D maps added to the display. The flight line pattern in the 2D map will be visible based on the arrangement of the input data.

j Review the Contents pane on the left, which shows the layers that have been added to the map.

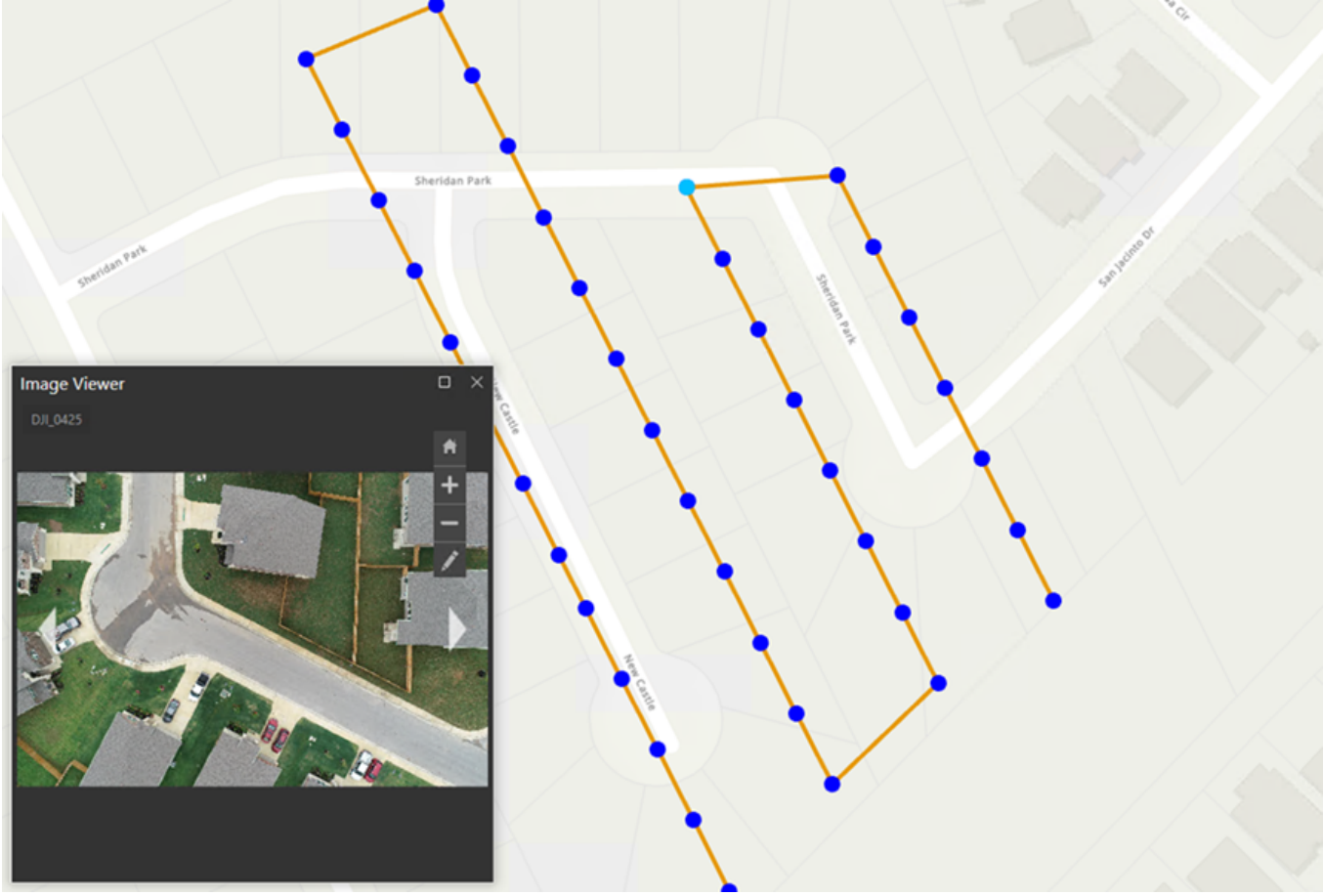
? What does the orange line represent?

- Answer
The orange line represents the flight line, or flight track, of the drone during collection.

? What do the blue dots represent?

- Answer
The blue dots are the enabled images in the project.

k In the map, in the third column from the left, click the top blue dot for image DJI_0425, as shown in the following graphic.



The Image Viewer appears in a new window, showing the image that you just selected from the map. You can scroll through the images added to the project. The purpose of the Image Viewer is to review input images before imagery products are created. You can add notes to images or even remove them if they are not needed for your project.

1. Close the Image Viewer.

You added images to a new project and are now ready to configure processing options.

- Step 4: Select processing options

In this step, you will choose options for the imagery products necessary to monitor the progress of the construction.

ArcGIS Drone2Map is capable of producing many different imagery outputs. For this exercise, your specific study requirements indicate that you must create a True Ortho, various digital elevation models (DEMs), including both a digital surface model (DSM) and a digital terrain model (DTM), a 3D point cloud, and two meshes.

2D Imagery Products	
Digital Surface Model (DSM)	Representation of elevation values over a surface, including features such as vegetation and non-natural structures.
Digital Terrain Model (DTM)	Representation of elevation values over a surface, often referred to as bare earth, it does not include features such as vegetation and non-natural structures.
True Ortho	An orthorectified image corrected using a digital surface model, which removes perspective distortion. There is no displacement caused by relief, vegetation, or non-natural structures.

3D Imagery Products	
3D Point Cloud	A large collection of high density x,y,z points represented in 3D space.
DSM Mesh	2.5D textured model in which the adjusted images are draped on a triangular irregular network (TIN) version of the DSM.
3D Mesh	3D textured model in which the ground and above-ground features such as vegetation and non-natural structures, are densely and accurately reconstructed. A 3D mesh can be viewed from any angle to get a realistic and accurate depiction of a project area.

From the Home tab, in the Processing group, click Options.

In the Options dialog box, you can choose the products that you want to create and the parameters to use during the processing.

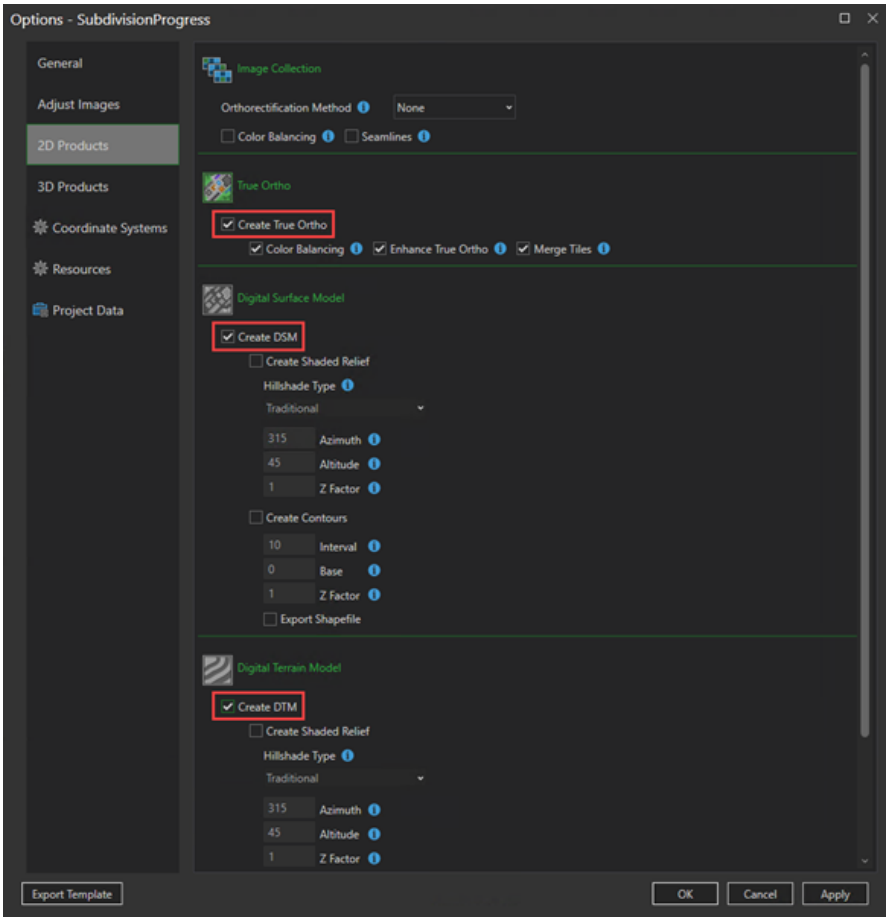
a Click the 2D Products tab, and then confirm that the box for Create True Ortho is checked.

b Additionally, check the boxes for Create DSM (Digital Surface Model) and Create DTM (Digital Terrain Model).

Your 2D Products tab should look like the following graphic.

- Hint

  You may have to scroll and expand the Options dialog box.



For more information about the 2D Products options, go to ArcGIS Drone2Map Help: Processing options – 2D products.

Now you will set the processing options for the 3D products that you want to create. You will select options to create scene layer packages (SLPK) for the DSM and 3D textured meshes. Additionally, you will create a LAS point cloud. The LAS point cloud is a set of points that represents coincident locations in the project area where several pixels from various input rasters are the same. These keypoints are then used to create a point cloud that can be used to model different elevation imagery products.

For more information about Scene layer packages, LAS datasets, and point clouds, go to ArcGIS Pro Help: Point cloud scene layer.

c In the Options dialog box, click the 3D Products tab.

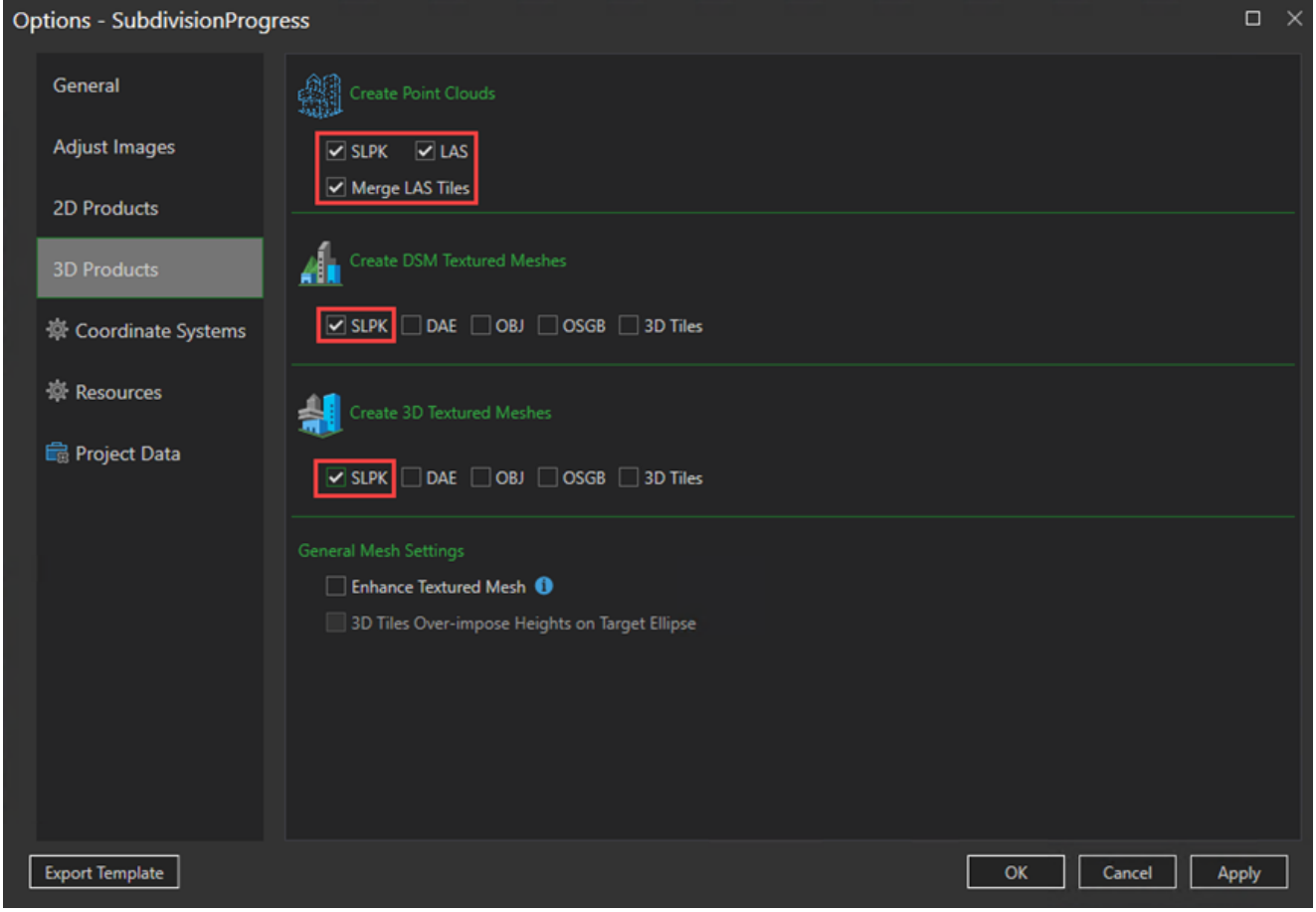
d In the Create Point Clouds section, check the boxes for SLPK, LAS, and Merge LAS Tiles.

e In the Create DSM Textured Meshes section, check the box for SLPK.

f In the Create 3D Textured Meshes section, check the box for SLPK.

The textured mesh options will create an object that can be viewed in three dimensions. The meshes can be used to model what the project area looks like as if you were on the ground looking around at the features.

Your 3D Products tab should look like the following graphic.



For more information about the 3D Product options, go to ArcGIS Drone2Map Help: Processing options – 3D products.

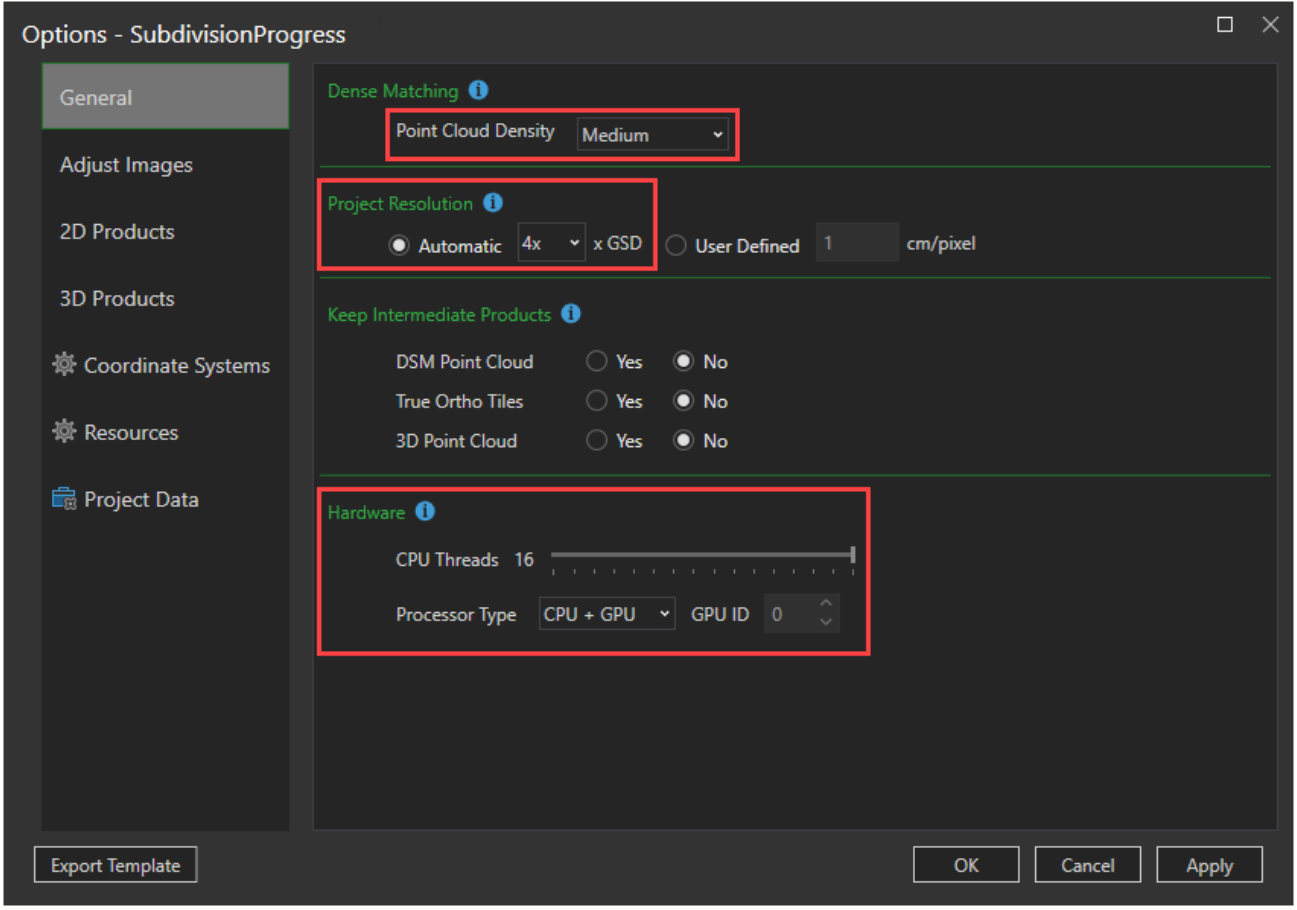
g Click the General tab, and then ensure that Point Cloud Density is set to Medium and Project Resolution is set to Automatic with 4x.

If you are working on a computer that is GPU-enabled, Processor Type is set automatically to use both CPU and GPU processors to maximize processing speeds. For more information on different factors that can influence processing speed of your drone collections, go to ArcGIS Drone2Map Help: Hardware resources and performance.

h If possible, in the Hardware section, for CPU Threads, set the slider bar to the maximum number available for your machine.

i If possible, and if necessary, in the Hardware section, set the Processor Type to CPU + GPU.

Your General tab should look similar to the following graphic.

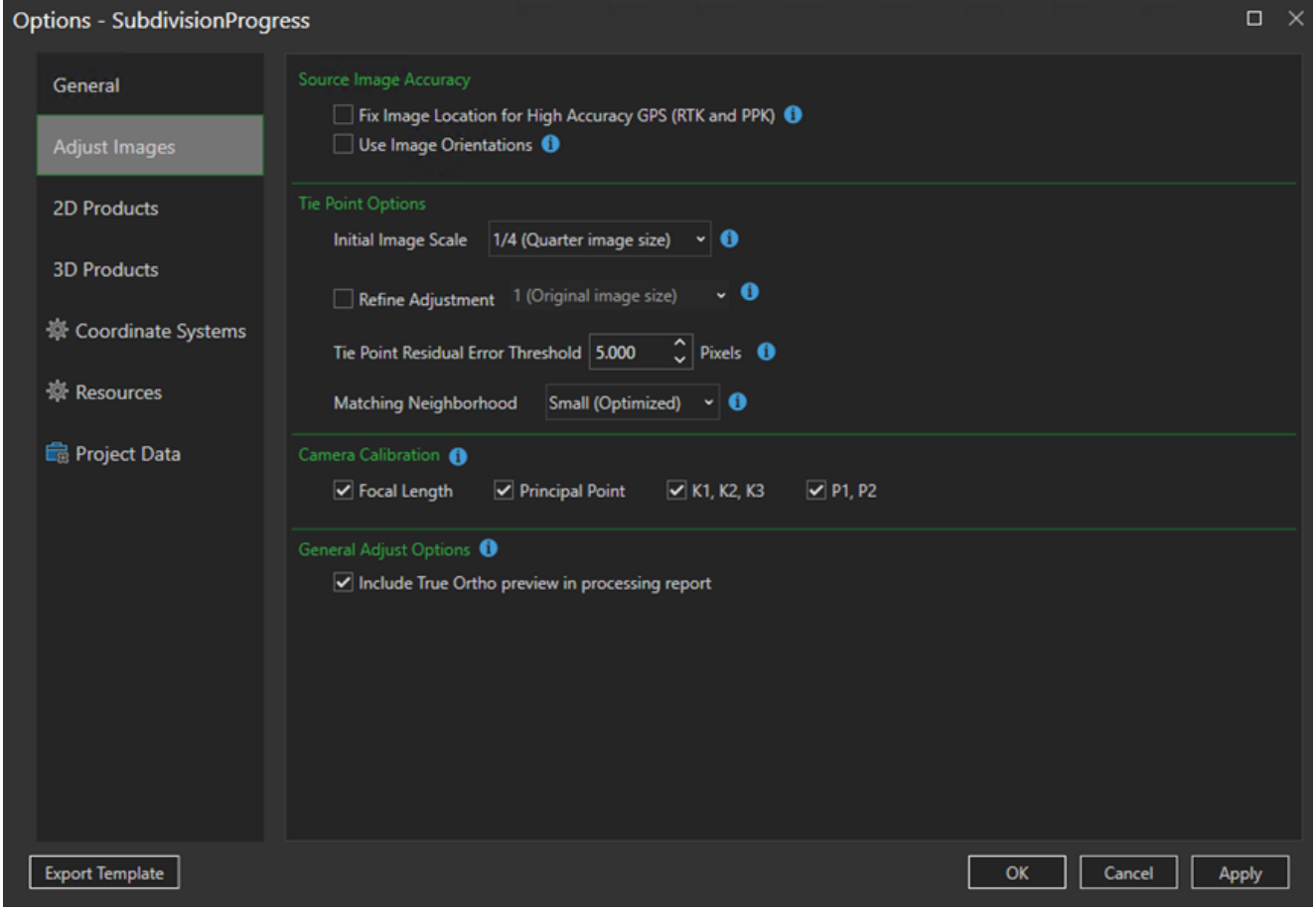


Note: In the preceding graphic, the hardware used has 16 CPU Threads available and an NVIDIA GPU enabled, so the CPU+GPU is the option shown. Set your Hardware options to maximize your processing speed based on your available resources.

j Click the Adjust Images tab and review the various options that are available.

The options on the Adjust Images tab allow for finer control of certain image parameters, if necessary. You can define key adjustments to be used in the block adjustment process, tie point matching, and point cloud generation options. These parameters, and their settings, are dependent on the type of drone that you use for collection, the type of internal accuracy of the drone collection, different orientation variables, and calibration types. Refer to your drone manuals and documentation to see which of these that you may need to adjust when necessary.

k Verify that the Adjust Images tab looks like the following graphic.



For this exercise, and for these images, there is no need to adjust any properties or options on this tab. For more information on these options, go to ArcGIS Drone2Map Help: Processing options – Adjust Images.

l On your own, examine the final two options tabs: Coordinate Systems and Resources.

In most cases, your coordinate system will be set based on the input parameter of your drone imagery, but you have the option to modify these, if desired. If you want to have a different output coordinate system, for instance, if your final project files are in a different spatial reference system than the drone imagery, the Coordinate Systems tab is where you can modify those parameters.

The Resources tab provides you with the flexibility of setting how you want to allocate various image resources, project settings, files, and image locations when necessary.

m Click OK.

For more information about these remaining options available on the Coordinate Systems and Resources tabs, go to ArcGIS Drone2Map Help: Processing options.

In this step, you selected the 2D and 3D products that you want to create and set their processing parameters. To further refine your output, you will provide ground control points.

- Step 5: Add ground control points

Ground control points (GCPs) are marked points on the ground used in aerial photography to identify known coordinate locations. These points are used to improve the spatial registration and accuracy of your images by linking them to precisely measured ground locations.

When applied, GCPs include two parts:

- Known (x,y) coordinates for a photo-identifiable feature in a defined coordinate system (ideally including values that represent the uncertainty of the measurements as these coordinates cannot ever be absolutely accurate)
- The "photo-identifiable feature" refers to either a temporary object, such as a black/white marker or white cross, or a permanent feature, such as the corner of a concrete block, that you can locate in your drone images.

Next, you will add GCPs to your project to improve the quality of the 2D and 3D products derived from your drone imagery. Upon being imported as part of your project, these points appear on your map—based on the known (x,y) coordinates—and will provide more accurate results by controlling the spatial registration for your images.

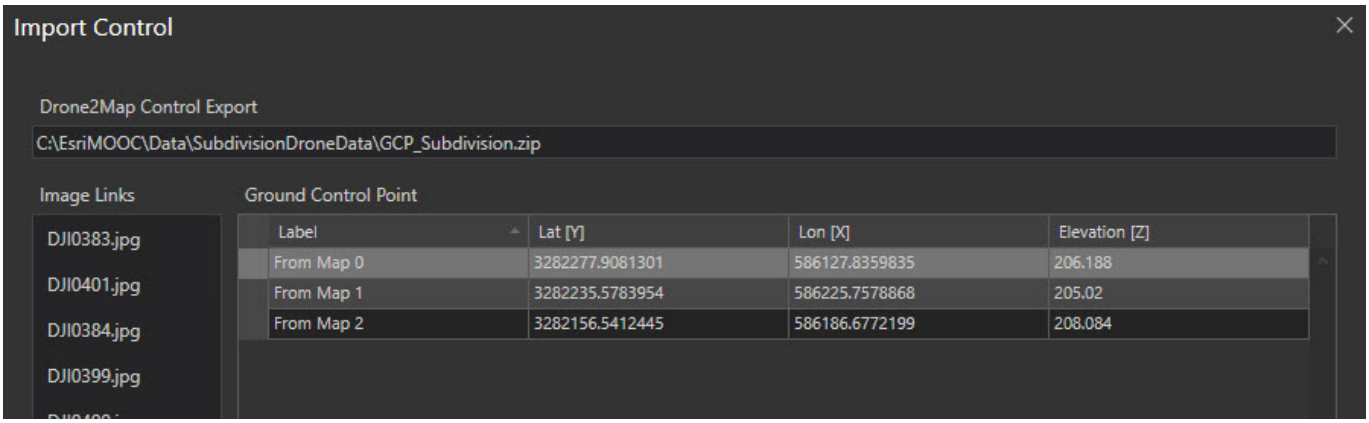
While there are several methods to add control points to a project (see *More information* below), you will import three GCPs from the subdivision site, which were previously linked to this set of example images within a Drone2Map project and then exported as a zip file. In

this case, the exported GCPs also include the image links, but in a normal project, you will have to complete the process of linking control points to the images.

More information

a From the Home tab, in the Control group, click the Control down arrow and choose Import Control.

b In the Import Control dialog box, browse to **..\EsriMOOC\Data\SubdivisionDroneData**, select the GCP_Subdivision.zip file, and click OK.



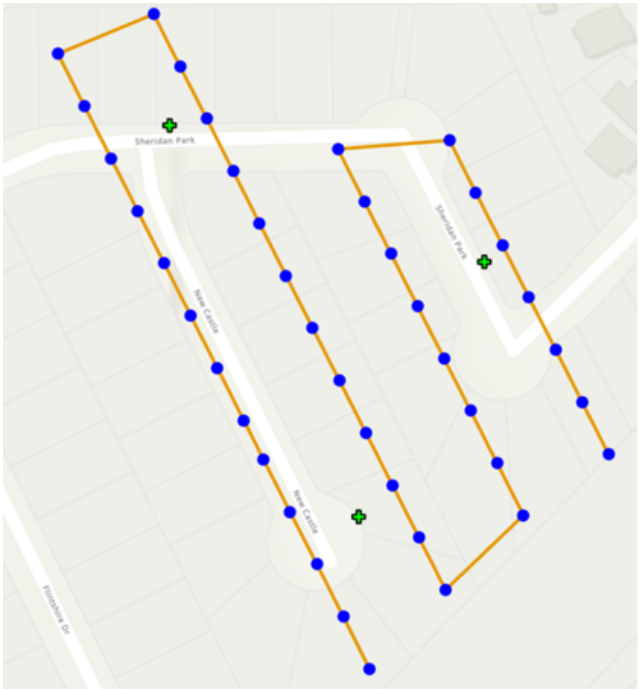
*Step 5b***: Add ground control points.*

The Import Control dialog box shows the three GCPs that will be imported. If you select one of the GCPs, the dialog box will display the names of the image files, which are linked to the selected GCP. You will notice that the GCP labeled From Map 0 has five image links.

A GCP must be linked to a minimum of two images to be used during processing; however, Drone2Map recommends linking GCPs to three to eight images for best processing results.

c Confirm that each GCP has 3 to 8 image links associated with it.

d Click OK to add the GCPs.

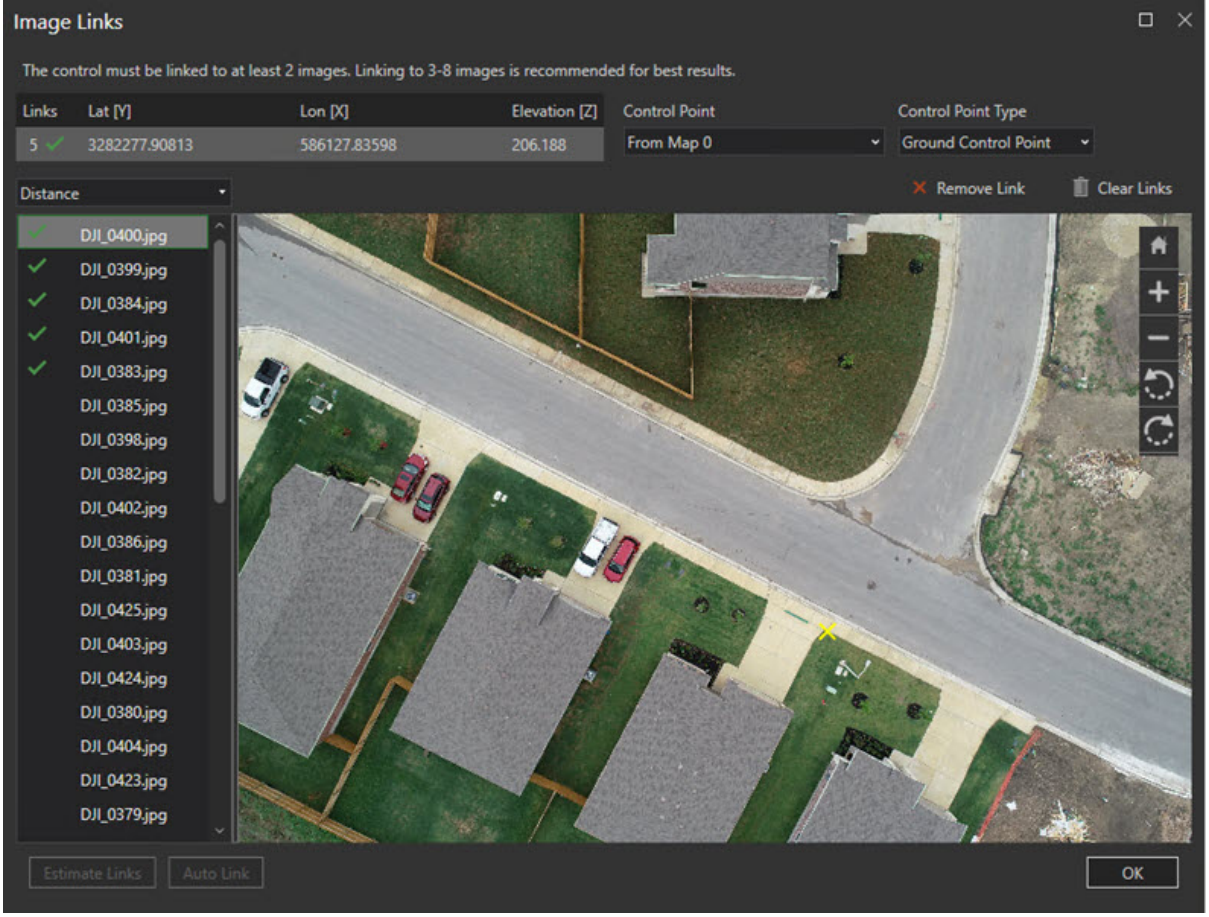


*Step 5d***: Add ground control points.*

The three ground control points are represented by green plus symbols.

The Control Manager pane also appears, showing information about the imported ground control points. You will notice that the GCPs have a green check mark in the first column. These GCPs have the minimum number of image links and can be used for processing. If a GCP had a yellow warning icon in the first column, it would indicate a problem with the number of image links associated with that ground control point. Without additional image links, the GCP would be ignored during processing.

e From the Home tab, in the Control group, click Image Links Editor.



*Step 5e***: Add ground control points.*

f In the Image Links window, for Control Point, confirm that From Map 0 is displayed.

The left column displays the images linked to the three GCPs that you imported. The images with a green check mark are the images specifically linked to the Map 0 GCP.

g Click through the images that have a green check mark.

The images linked to the Map 0 GCP overlap each other, and the yellow x represents where the From Map 0 GCP is located in the image.

h Explore the images for the other two GCPs, and when you are finished, close the Image Links window.

In this step, you added GCPs that will be used during processing to improve the accuracy of your drone data, which in turn improves the quality of your imagery products.

- Step 6: Produce imagery products

Processing drone images in ArcGIS Drone2Map can take a long amount of time, depending on multiple factors. The results shown in this exercise were generated on a system using an AMD EPYC 7v12 64-Core Processor, 2.44 GHz (4 Cores), no NVIDIA GPU, and with 14 GB of RAM. Based on the options set in the *Select processing options* step, creating all the 2D and 3D products took approximately 50 minutes. A zipped ArcGIS Pro project package of the finished 2D and 3D products can be downloaded from ArcGIS Online, Subdivision Progress (https://links.esri.com/Products), and extracted to the **..\EsriMOOC\Data** folder. This zipped file is approximately 220 MB in size. You can use ArcGIS Pro to examine these products; however, the remainder of this exercise examines and reviews these output products directly in ArcGIS Drone2Map, so some of the steps may vary.

In this step, you will create the 2D and 3D imagery products that you specified in the processing options. These imagery products are what you will use to share the progress of the residential development.

a From the Home tab, in the Processing group, click Start to create the imagery products.

As the different products are created, they will automatically be added to your map.

Note: The progress for the project will be indicated at the bottom of the Manage pane on the right. Depending on your computer system, processing times may be lengthy.

When the processing is complete, the 2D map still shows the original project data, such as the images and flight lines, but now it also includes the 2D products.

b In the Contents pane, turn off the visibility of the Project Data layer.

*Step 6b***: Produce imagery products.*

- Hint

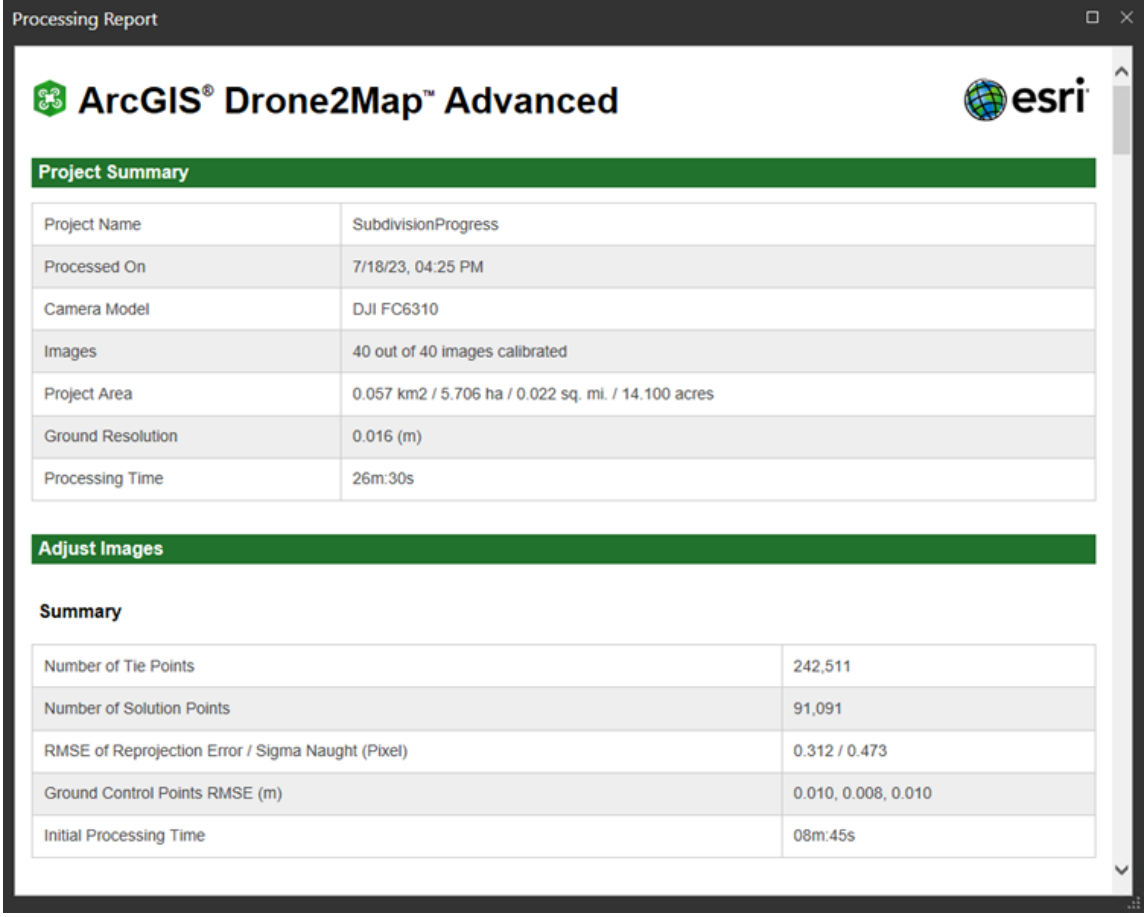
  In the Contents pane, uncheck the box for the Project Data layer to turn off its visibility.

The 2D imagery products are displayed in two group layers: the Imagery Products group layer, which contains the True Ortho layer, and the DEM Products group layer, which contains the Digital Surface Model and Digital Terrain Model layers.

- Step 7: Review the Processing Report

Following product creation, either 2D, 3D, or both, it is a good idea to review the products themselves either visually or by evaluating the various accuracy statistics generated during their creation. This assessment will ensure that they meet any quality standards for analysis that your project team may have predefined. For this project, you will review various elements of the Processing Report to assess whether the products will meet the quality standards necessary for your project. There are several ways to evaluate imagery products, including visual review, coverage area review, and output statistics.

a From the Home tab, in the Processing group, click Report to open the Processing Report.



*Step 7a***: Review the Processing Report.*

The Processing Report includes information about the process and the resulting products.

Ground Resolution represents the ground sampling distance (GSD) of the original sensor.

? In the Project Summary section, what is the ground resolution?

- Answer
The ground resolution is 0.016 (m).

Knowing the ground resolution of your sensor is important when conveying information to engineers, architects, and other construction team members, including survey teams. This value determines the size of the smallest feature that you can resolve, or see, in your images. This information becomes very important, not only for project site status and updates but also as inputs for survey information.

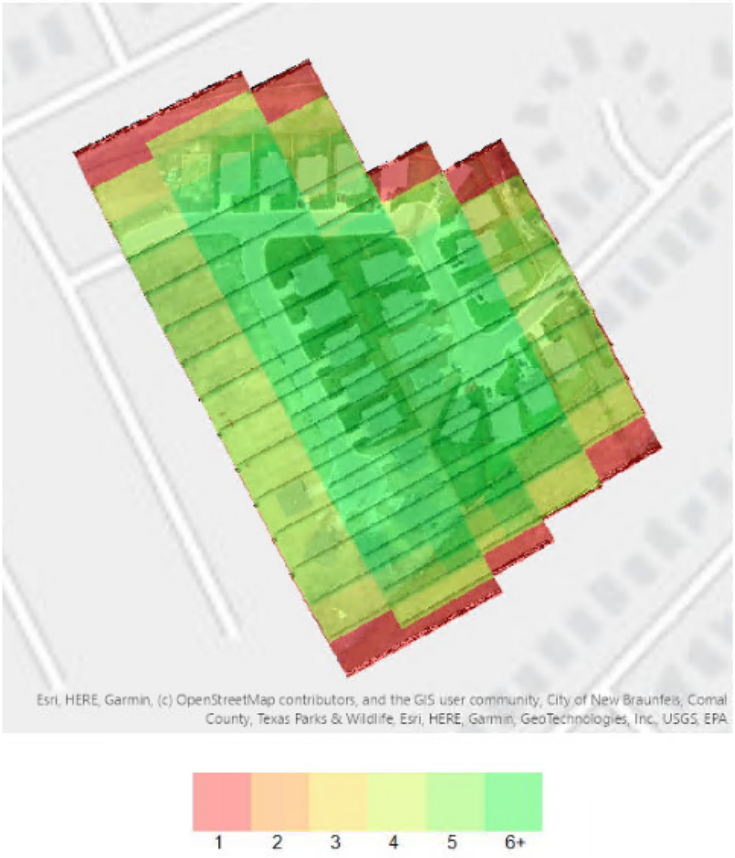
One measure of successful processing performance is if all input images were used to create the imagery products.

? In the Project Summary section, how many images were calibrated in the project?

- Answer
There were 40 images that were calibrated, which are all the images in the folder.

After confirming the number of images that were calibrated in the project, you should confirm the coverage, including overlapping coverage, of those images.

b Scroll down to the Image Overlap section of the Processing Report.



*Step 7b***: Review the Processing Report.*

The graphic indicates the coverage relative to the number of overlapping images. Areas in green indicate more coverage. Due to the number of overlapping images in the green areas, the quality of the product is greater in those areas.

c On your own, explore the other sections of the Processing Report.

d When you are finished, close the Processing Report.

You reviewed the Processing Report and are now ready to review the imagery products.

- Step 8: Review the 2D imagery product

Now you will review the recently created 2D imagery product to verify its spatial resolution. Then, you will try out mensuration tools.

a In the Contents pane, in the Imagery Products group layer, double-click the True Ortho layer to open its properties.

b In the Layer Properties dialog box, click the Source tab, and then expand Raster Information.

One of the advantages of drone data is that the sensors are capable of extremely high-resolution data. With such a fine spatial resolution, you are capable of recognizing small features within the True Ortho.

? What is the cell size reported?

- Answer

The cell size is 0.06 meters.

- Hint

To determine the linear unit of the cell size, scroll down and expand Spatial Reference.

When you configured the processing options for your 2D products, the automatic resolution was set at 4 x GSD, which is reflected in the cell size, or spatial resolution, of the new orthomosaic.

c Close the layer properties.

d In the Contents pane, in the Imagery Products group layer, right-click True Ortho and choose Zoom To Source Resolution.

Drone imagery data is collected at low altitudes and is capable of creating high-resolution imagery.

? In the bottom-left corner of the map, what is the reported scale?

- Answer
The reported scale is approximately 1:240.

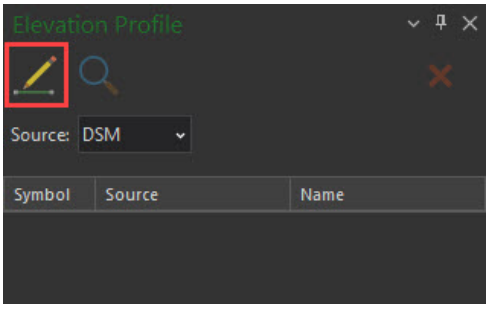
At this scale, you can clearly see many features. This true ortho will allow the project team to visually inspect the subdivision construction site.

e From the Analysis tab, in the Tools group, click Profiles and choose Elevation Profiles.

An elevation profile will display a graph of height values along a linear path that you will create in the imagery.

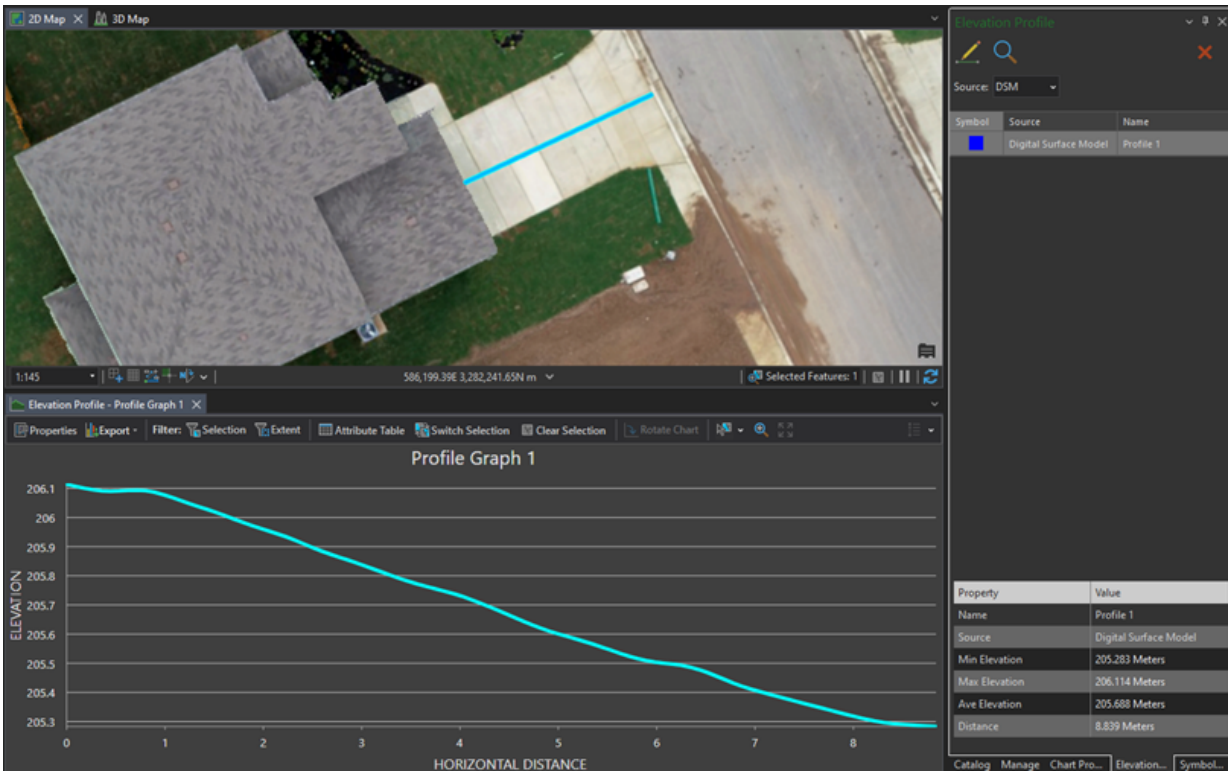
f In the map, pan to a house of your choice.

g In the Elevation Profile pane, click the Draw A New Elevation Profile button, as indicated in the following graphic.



h In the map, draw a line from the house to the driveway.

i Finish the measurement by double-clicking the last point.



*Step 8i***: Review the 2D imagery product.*
Your map and elevation profile chart may vary from this graphic.

Note: If the elevation profile graph does not populate, close the Elevation Profile - Profile Graph 1 tab and the Elevation Profile pane, and then in the Contents pane, under Charts, right-click Profile Graph 1 and choose Open.

? Using the information provided in the Elevation Profile pane and Profile Graph, what is the slope of the driveway?

- Answer
Answers may vary, but the slope of the driveway will be between 9% and 11%. (The formula to derive the slope or grade of the driveway is 100 * rise/run = slope.)

j Create additional elevation profiles to acquire more information about the development site.

k When you have completed creating your elevation profiles, in the Elevation Profile pane, select all the profiles that are listed.

l Click the Remove Selected button, and then click Yes to remove the profiles.

m Close the Elevation Profile pane and the elevation profile graph tab.

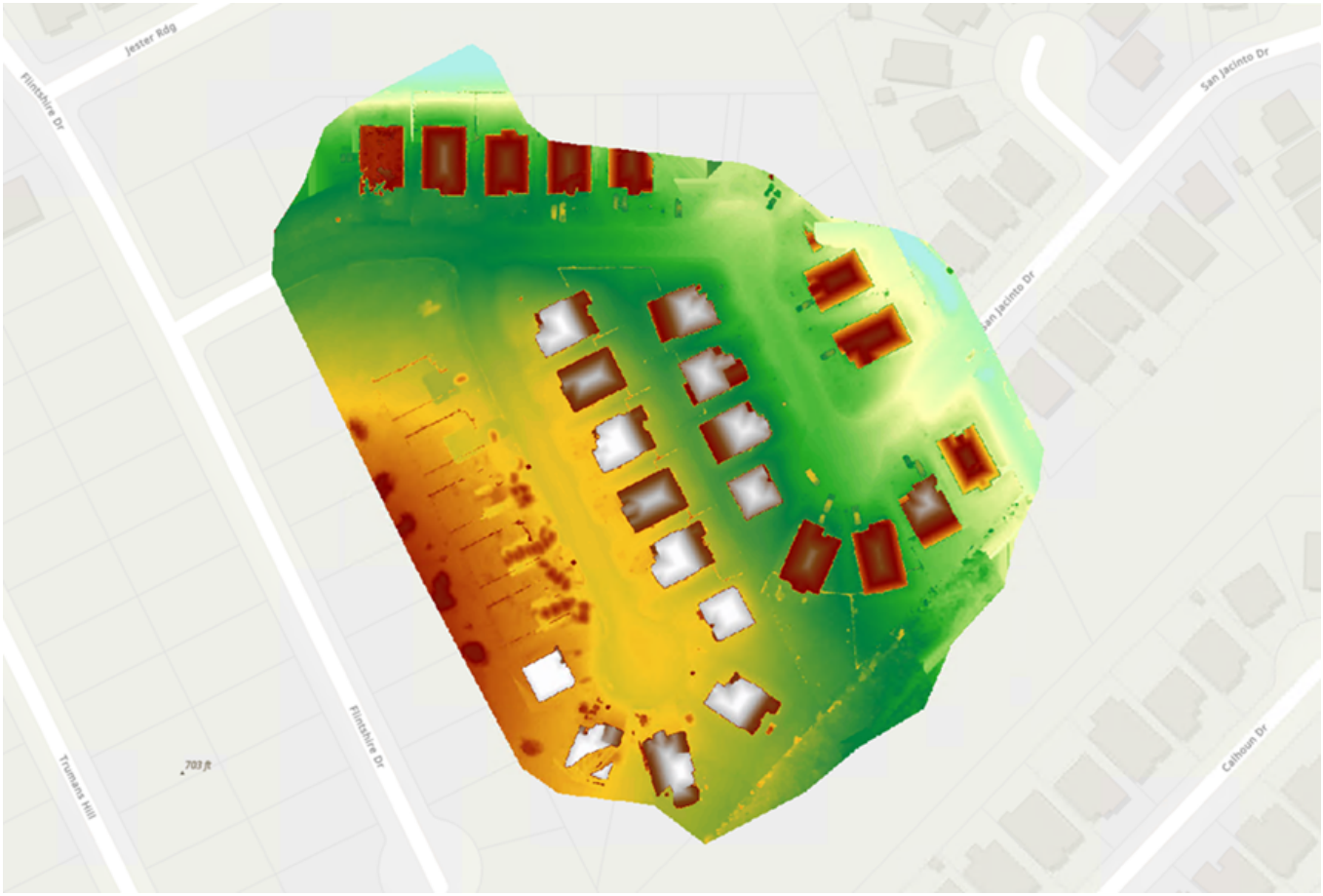
You reviewed the 2D imagery product. You will be able to use this orthomosaic image to visually assess the progress of the development and to take accurate measurements of property features.

- Step 9: Review the digital elevation model (DEM) products

In this step, you will review the DEM products that were created for the project. The two elevation products specified and created earlier in the 2D processing options are the digital terrain model (DTM) and the digital surface model (DSM).

a If necessary, in the Contents pane, right-click True Ortho and choose Zoom To Layer.

b In the Contents pane, in the Imagery Products group layer, turn off the visibility of the True Ortho layer.

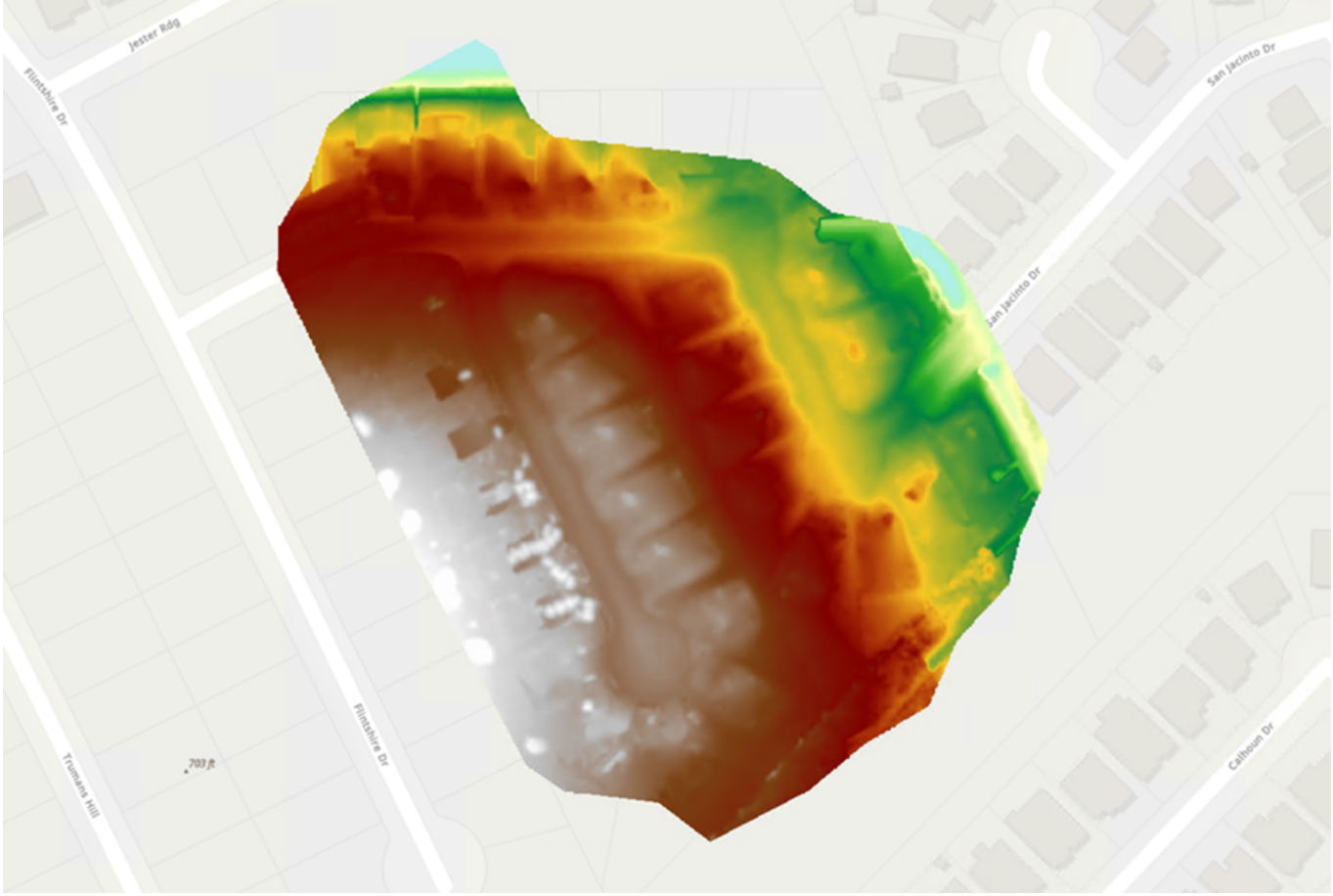


*Step 9b***: Review the digital elevation model (DEM) products.*

The digital surface model (DSM) is created from the LAS point cloud and indicates the surface elevation throughout the raster. The houses in the subdivision are clearly visible, and other features around the construction sites are also easily discernible. The values in this raster can be used for measuring the height of features.

LAS points were also used to create the Digital Terrain Model layer, which represents a bare earth surface.

c In the Contents pane, in the DEM Products group layer, turn off the visibility of the Digital Surface Model layer.



*Step 9c***: Review the digital elevation model (DEM) products.*

Note: The colors in your map may differ from the preceding graphic.

The digital terrain model (DTM) shows what the area would look like if surface features such as buildings and trees were removed; it is sometimes referred to as a base earth model or a bare earth surface.

Note: This visualization is a representation of a bare earth surface and should not be considered more than an estimation.

You reviewed the DSM and DTM, and you determined that they can provide additional context for communicating progress at the construction site to your stakeholders.

- Step 10: Review imagery products in a scene

Now you will view the 3D Mesh layer and the drone flight lines in a local scene, allowing you to visualize the data in three dimensions and providing a unique perspective of the area.

a At the top of the map view, click the 3D Map tab to view the data in three dimensions.

Note: It may take a moment for the data to load.

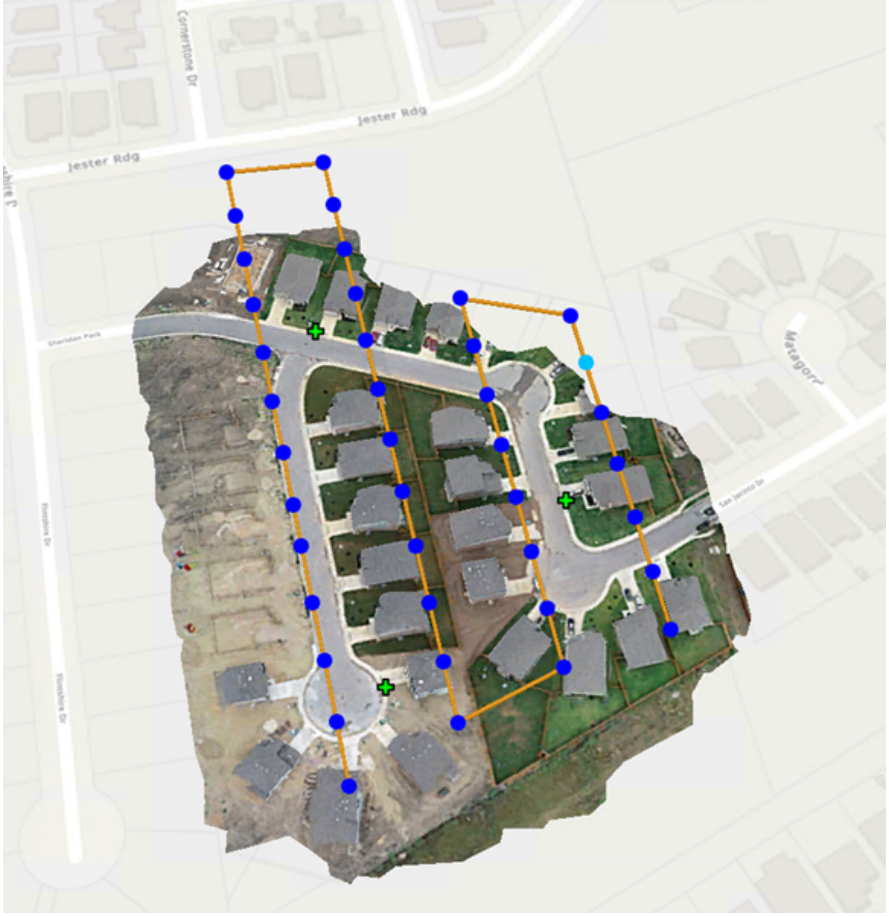
b From the Home tab, in the Layers group, click Basemap and select the Topographic basemap.

? What is the advantage when changing the basemap to topographic?

- Answer

Because the basemap appears beneath the 3D mesh, the main advantage is that it allows you to easily see the end or edge of the drone imagery collection.

c In the Contents pane, in the 3D Products group layer, right-click the 3D Mesh layer and choose Zoom To Layer.



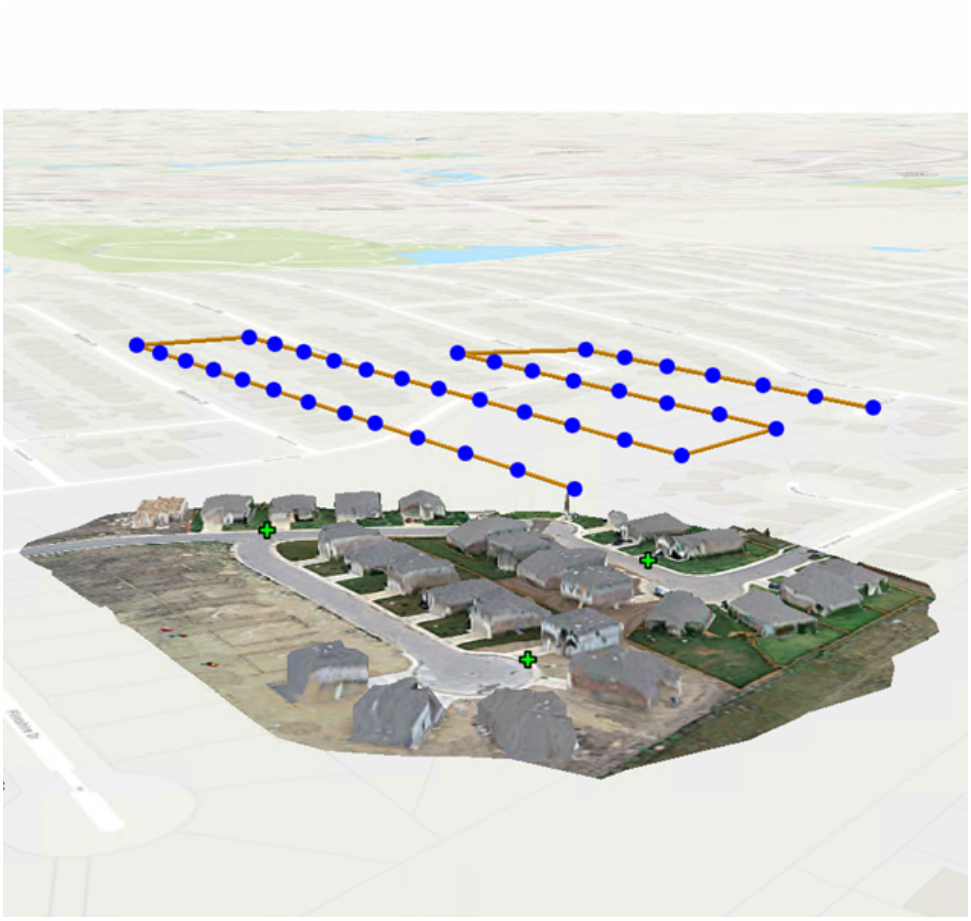
*Step 10c***: Review imagery products in a scene.*

The flight lines should be visible above the 3D mesh.

d Zoom in closer and tilt the scene.

To tilt the scene, click the scroll wheel on the mouse or use the on-screen navigator located in the lower-left corner of the scene view. For more information about how to use 3D navigation, go to ArcGIS Pro Help: Navigation in 3D.

e Rotate the scene until the flight lines are aligned, as shown in the following graphic.



Note: The 3D mesh results look a bit distorted. There are methods in ArcGIS Drone2Map and ArcGIS Pro to improve the level of detail and quality of the 3D objects.

With the flight lines visible, you can see the position of the drone during the collection of the imagery.

These 3D products can now be used to represent the progress on the development, with a realistic view for city officials and the project design and construction teams. Additionally, this view, along with others collected during the life cycle of the construction project, can be examined in its historic context to aid in lessons learned, safety checks, or to understand and track various project milestones.

f In the top-left corner, click the Save Project button  to save your project, and then exit ArcGIS Drone2Map.

You learned how to create 2D and 3D imagery products with Drone2Map based on your drone data. Many possibilities are available within ArcGIS to continue your analysis or visualization projects.

If you would like to continue exploring your data, you can work through the optional stretch goal.

- Step 11: Stretch goal (optional)

Throughout this course, you will have the opportunity to complete stretch goals. These goals allow you to continue or enhance the work that you completed during the exercise.

Stretch goals are community-supported (meaning that your fellow MOOC participants can assist you with the steps to complete the stretch goal using the Lesson Forum), and they are a great opportunity to work together to learn.

a In a web browser, go to the Subdivision Progress 3D Mesh scene layer.

Note: The complete URL for this layer is https://www.arcgis.com/home/item.html?id=f4089c2d183542c0bb4f96d278043dcb.

b Click Open In Scene Viewer.

c Use the tools provided on the toolbar, in the upper-right corner of the scene, to answer all or some of the following questions:

- What is the average height of the tallest home in the scene?
- Which house has the largest fenced-in yard?
- When the shadows are enabled, which houses have shaded backyards on August 25, 2023, at 4:00 PM, Central Time (UTC-6 CST - US and Canada)?
- Which house has the driveway with the most area, and what is the measurement?

For more information about Scene Viewer, go to ArcGIS Online Help: Get started with Scene Viewer and Scene navigation.

d When you are finished, close the web browser.

e Use the Lesson Forum to post your questions, observations, and screen capture examples to identify which homes best represent the answers.

Note: Be sure to include the **#stretch** hashtag in the posting title.