



32nd Annual Florida Chapter IAAO Conference
May 1-3, 2019
St. Petersburg

DRONES FOR MASS APPRAISAL

Presented by



USES & BENEFITS FOR MASS APPRAISAL

- Provides a way to view areas that are typically inaccessible or unsafe to appraisers.
- Ability to review agricultural properties related to applications.

Inaccessible or Unsafe



Agriculture



USES & BENEFITS FOR MASS APPRAISAL

- Obtain necessary information to defend value at V.A.B.
- Identify parcels affected by storm damage after an event.

V.A.B.



Storm Damage



USES & BENEFITS FOR MASS APPRAISAL

SJCPA Drone Operations – Coastal Highway Storm Assessment

<https://youtu.be/PO2-GXd4Vtk>

WHAT YOU NEED TO GET STARTED

- Personnel, Requirements, & Good Practices
 - 107 Commercial Licensed Pilot
 - Visual observer(s)
 - Drone registration
 - Waiver
 - Flight log book
- Equipment
 - Drone(s)
 - Tablet/Mobile device
 - Aircraft radio
 - Walkie-talkies
 - Extra flight batteries
 - Chargers
 - High powered PC
- Software
 - DJI G04 app & the Pix4Dcapture app or Sense Fly
 - Air map
 - Pix4D desktop application

WHAT YOU NEED TO GET STARTED

107 COMMERCIAL Licensed Pilot

- Steps to take in order to obtain & maintain license:
 - Remote Pilot 101 Course.
 - A study guide is available online.
 - The test is available at some local airports. Call your local airport to inquire.
 - Required retest every two years.

WHAT YOU NEED TO GET STARTED

Waiver

- In order to fly in a Class D air space you are required by law to have a waiver.
- Utilize **FAADZONE.FAA.gov** to obtain a waiver.
 - There is a 107 Dashboard under the account login with a “create Part 107 Waiver/Authorization” tab.
 - This application process can take up to 90 days from start to finish and is good for 6 months from date of application.

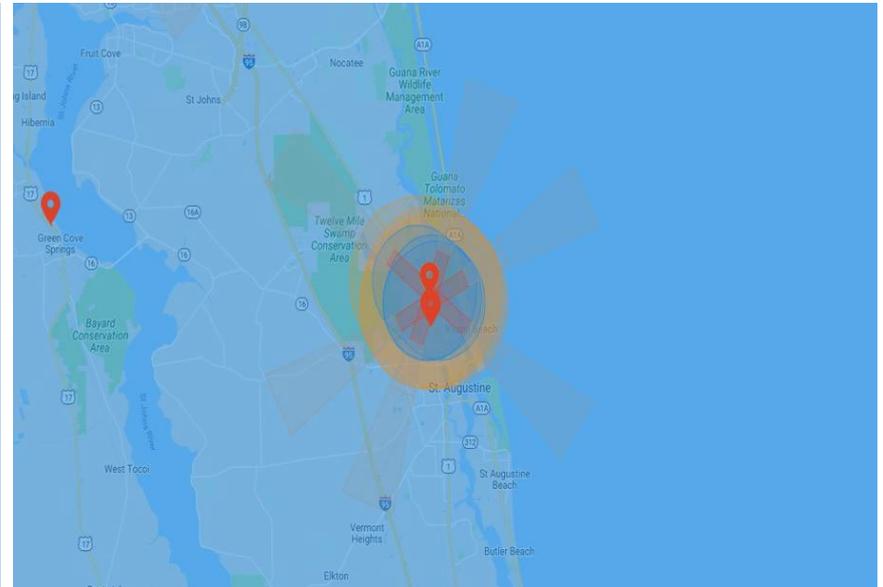
WHAT YOU NEED TO GET STARTED

Waiver

FAA Restricted Area Map



DJI Restricted Area Map



- Max altitude for flying a drone is indicated within each area's quadrant.
- 400 foot altitude limitation in Class G airspace. Exception allows 400 foot limitation above structures within a 100 foot radius.
- **Orange** – Warning zone.
- **Darker Blue** – Class D airspace.
- **Red** – Off limits airspace.
- **Light Red** – Lower altitude limitation than other Class D airspaces.

COST

Fixed Wing – eBee Plus RTK

- **Drone:**
 - \$26,990
- **DELL Precision 5510 *laptop*:**
 - \$1,300-\$1,900
- **Sense Fly *computer program*:**
 - Free

Quad Copter – Mavic Pro

- **Drone:**
 - \$1,319
- **iPad Pro 9.7 inch *tablet*:**
 - \$459-\$559
- **DJI G04 & Pix4Dcapture *apps*:**
 - Free

Quad Copter – Mavic Pro & Fixed Wing – eBee Plus RTK

- **Pix4D *computer program*:**
 - Initial Fee: \$4,990
 - Annual Maintenance Fee: \$749
- **107 Commercial Pilot's License:**
 - Course: \$150
 - Test (*required every 2 years*): \$150
- **Miscellaneous: \$1,000-\$1,500**
 - e.g. lenses, batteries, portable chargers, case(s) for equipment, radios, etc.
- **Initial Legal Fees associated with FAA Waiver: \$2,500**

STEPS FOR A DRONE FLIGHT

- **STEP 1** – *Pre-Flight Routine*
- **STEP 2** – *Flight*
- **STEP 3** – *Post-Flight Checks*

STEP 1

Pre-Flight Routine

- This step has 3 stages.
 1. *Select a Drone*
 2. *Plan & Prepare Flight*
 3. *Onsite Setup*

STEP 1 – *Pre-Flight Routine*

1. *Select a Drone*

Fixed Wing – eBee Plus RTK



- Ideal for flying large areas when you need high resolution imagery and/or in-depth information on the land being flown with time to plan flight.
- Drone details:
 - Max fly time approx. 45 minutes
 - Fewer flights to grid for larger areas
 - Requires large areas for takeoffs & landings
 - Only flies based of gridded flight plan in a forward moving direction
 - Extensive visibility of drone
 - Lidar capability
 - Map scanning
 - Will require adequate space in vehicle for transporting equipment
 - Requires laptop & tripod with a GPS antenna to be setup
 - Physical assistance required to launch drone

Quad Copter – Mavic Pro



- Ideal for flying small areas when you need the versatility of imagery capturing, video, and still pictures at a moment's notice.
- Drone details:
 - Max fly time approx. 25 minutes
 - Grids for flights are easy to create
 - Can take off & land anywhere
 - Ability to move in multiple directions
 - Limited visibility of drone
 - Video capability as well as live video feed option
 - Still picture capability
 - Requires iPad
 - Requires little space in vehicle for transporting equipment
 - Quick setup

STEP 1 – *Pre-Flight Routine*

1. *Select a Drone*

Fixed Wing – eBee Plus RTK

Quad Copter – Mavic Pro



Quad Copter – Mavic Pro & Fixed Wing – eBee Plus RTK



STEP 1 – *Pre-Flight Routine*

2. Plan & Prepare Flight

- Pre-plan the flight details & parameters in the drone specific programs before leaving the office.
- Weather permitting, drive to location to do the onsite setup.

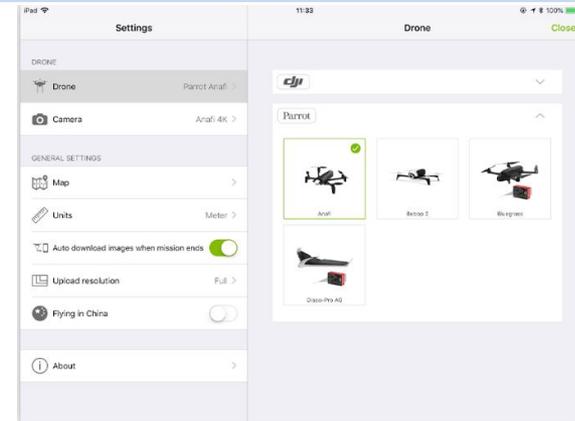
STEP 1 – Pre-Flight Routine

2. Plan & Prepare Flight

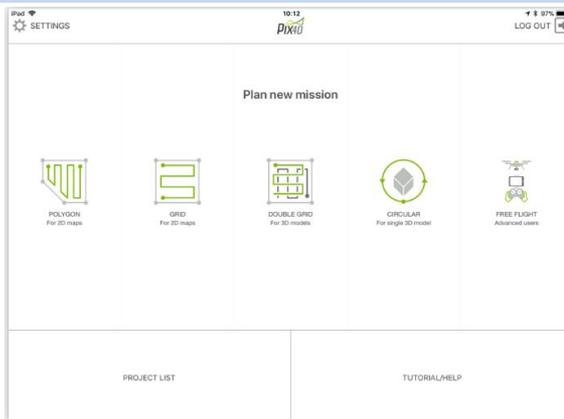
Pix4Dcapture app



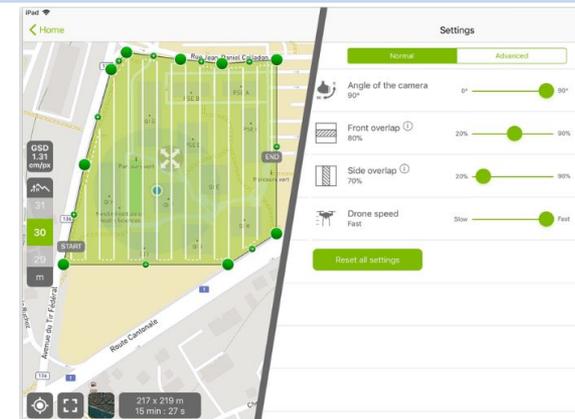
Select a Drone



Select a Mission



Adjust Flight Plan & Parameters



STEP 1 – *Pre-Flight Routine*

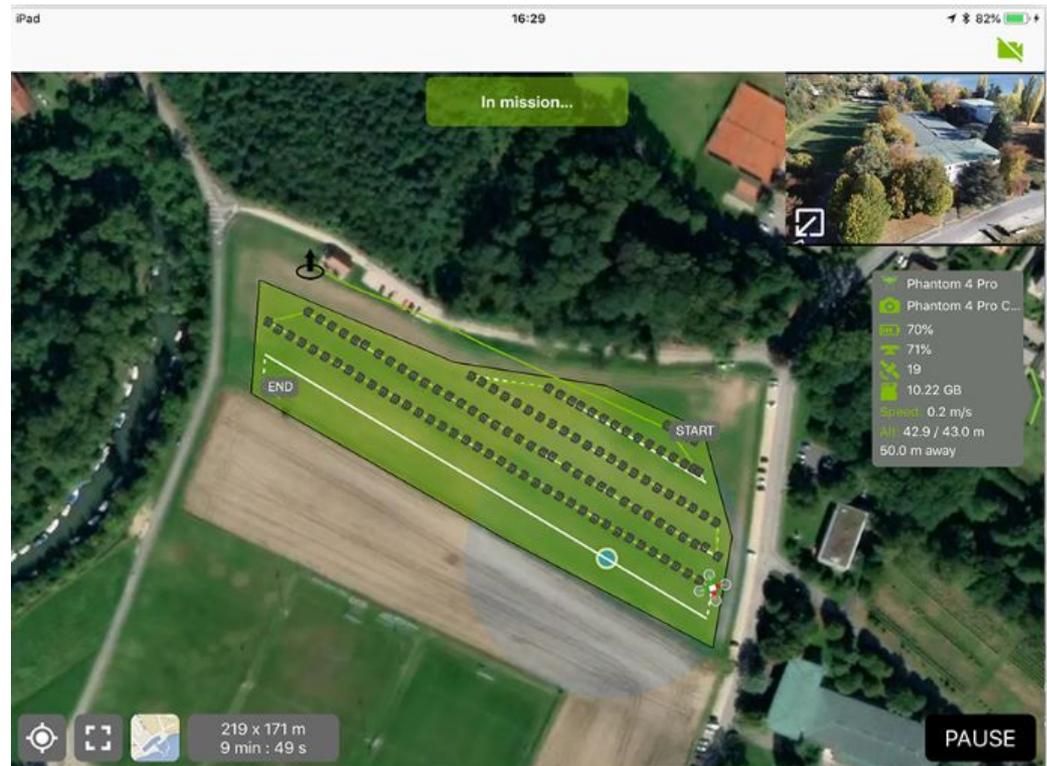
3. Onsite Setup

- Use mobile device to determine the ideal spot to setup a take-off & landing location, as well as to determine where to place observers along the flight path.
- Setup & prep drone for flight.
- Verify camera lens is clean before takeoff.

STEP 2

Flight

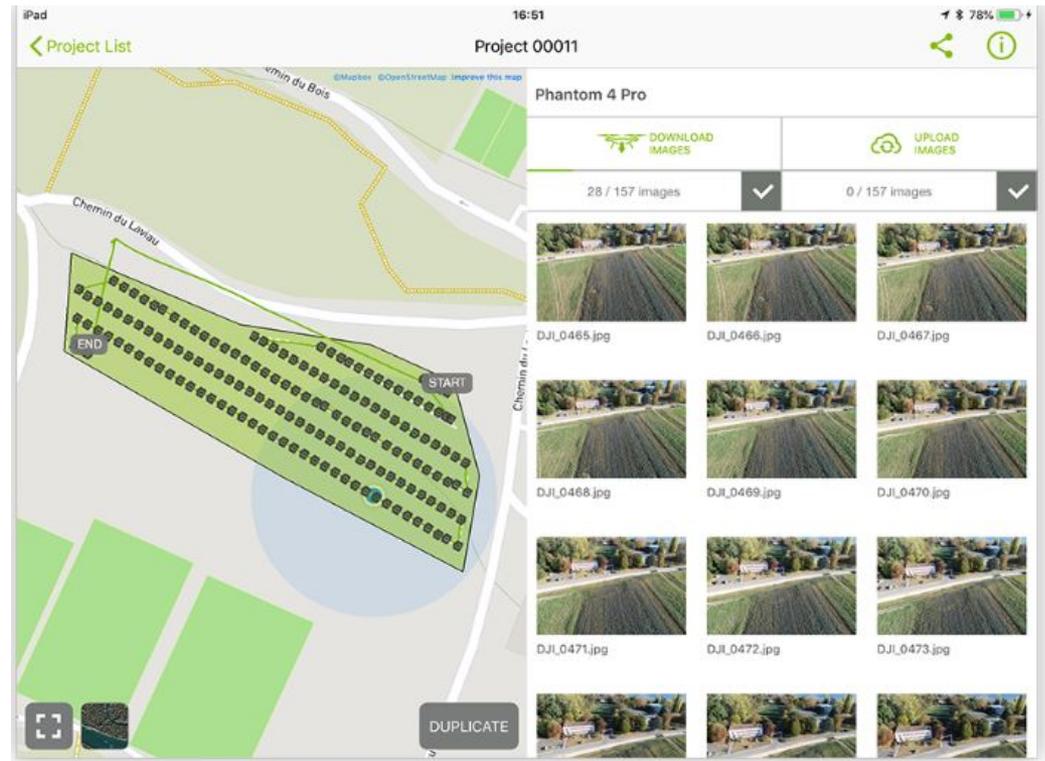
- This step has 3 stages.
 1. *Start Mission – Takeoff*
 2. *Monitor – Utilize mobile device, and keep observer(s) within 1400 feet of drone for line of site at all times.*
 3. *End Mission – Landing*



STEP 3

Post-Flight Checks

- It is important that you do not turn the drone off until the program or application tells you the images have finished uploading.
- Review mission while onsite to avoid having to return to re-fly an area.
- Check images for quality & coverage.
- Pack up gear properly, and proceed back to office to either upload images directly into CAMA system, or provide imagery to GIS staff for further processing.



STEPS FOR DRONE IMAGERY PROCESSING

- **STEP 1** – *Import Flight Data*
- **STEP 2** – *Pre-Processing*
- **STEP 3** – *Processing*
- **STEP 4** – *GIS Integration & Deployment of Processed Imagery*

STEP 1

Import Flight Data

- Drone Field Team provides flight imagery to GIS staff. The manner in which data is provided is dependent on the type of drone used.
 - Quad Copter/Mavic Pro
 - Either uses a direct connection from drone to USB port on PC (*SJCPA preferred method*).
 - Or uses a project file saved on Pix4D iPad app (*requires iTunes on PC*).
 - Fixed Wing/eBee Plus RTK
 - Insert drone camera memory card into PC memory card reader.
- SJCPA Drone Field Team also maintains a flight log book which contains project areas, flight times, and number of images collected which is utilized by our GIS staff.

STEP 2

Pre-Processing

- GIS staff organizes flight imagery into project specific folders.
- GIS staff does QC on flight imagery.
 - If any issues are noted (e.g. blurry images, corrupted files, etc.), re-upload data, or send back to Field Drone Team to re-fly area.
 - If no issues arise in the QC, import imagery into Pix4D Mapper for processing.

STEP 2

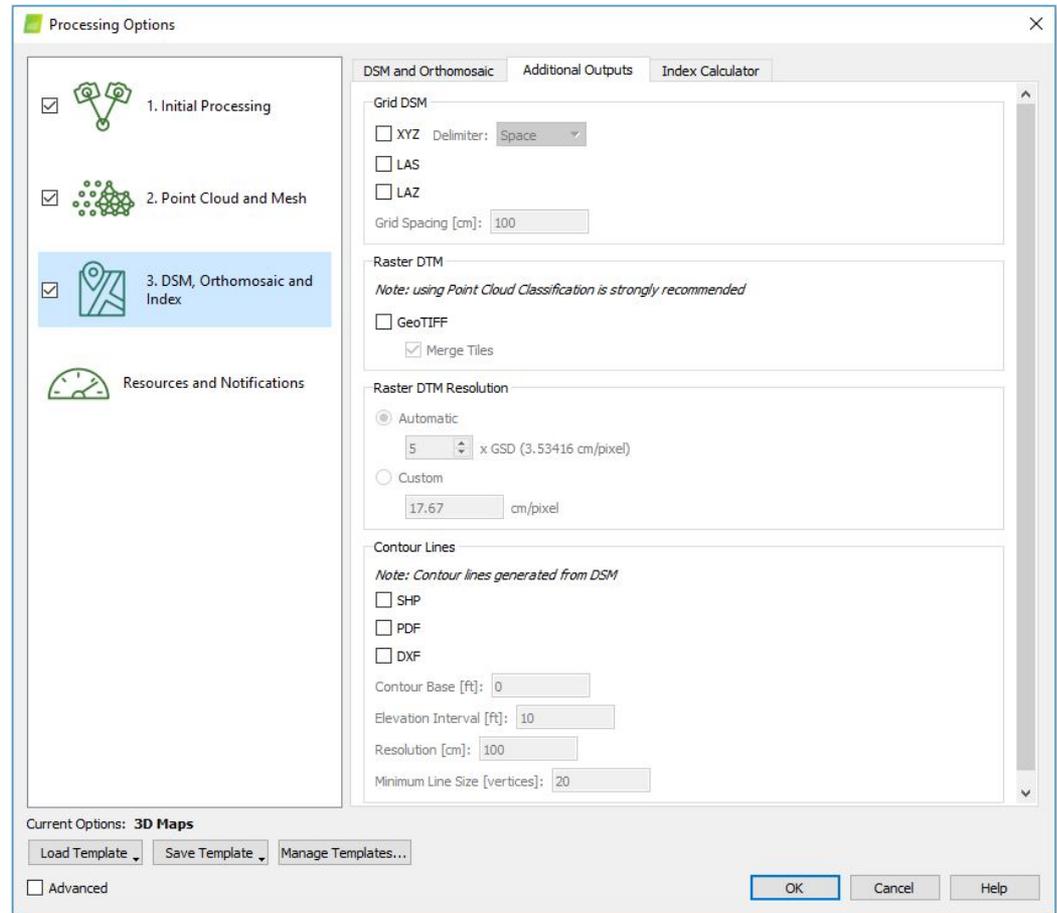
Pre-Processing

- Create a new project in Pix4D Mapper for each project area.
- Load in all imagery relevant to project area.
- The program verifies imagery geolocation, and will notify of any errors.
 - Review errors on a case by case basis.
- Select output coordinate/GCP system (e.g. NAD 1983 State Plane Florida East).

STEP 2

Pre-Processing

- Review & select additional data outputs as needed (e.g. digital elevation model, digital surface model, contour line shapefile, etc.).



STEP 2

Pre-Processing

- Once completed, image points will show above existing aerial imagery of the project area for review before beginning processing.



STEP 3

Processing

- This step has 3 stages that can take anywhere from 20 minutes to several hours.
 1. *Initial Processing*
 2. *Point Cloud & Mesh generation*
 3. *DSM, Orthomosaic, & Index*

STEP 3 – *Processing*

1. Initial Processing

- In this step, the Pix4D program calculates an image quality report which generates statistics on image calibration, image overlap, & key point matches as well as a preview of the output mosaic & digital surface model.

STEP 3 – Processing

1. Initial Processing

Quality Report

Image Calibration

2 Preview



Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

3 Computed Image/GCPs/Manual Tie Points Positions

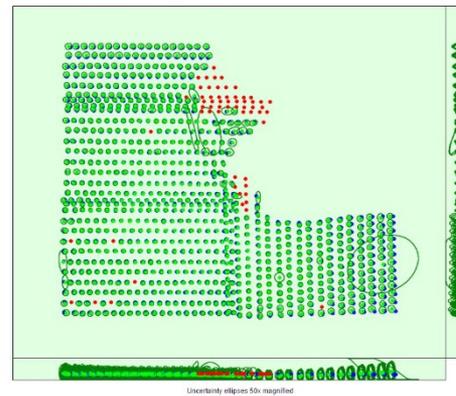


Image Overlap

4 Overlap

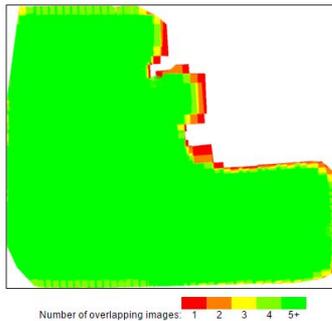


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Key Point Matches

5 2D Keypoint Matches

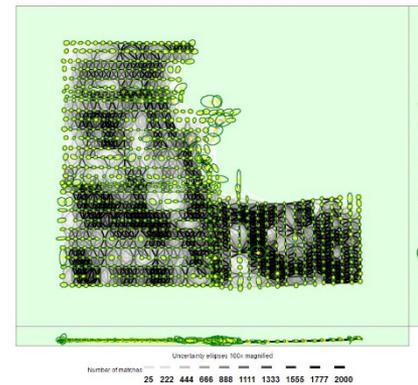


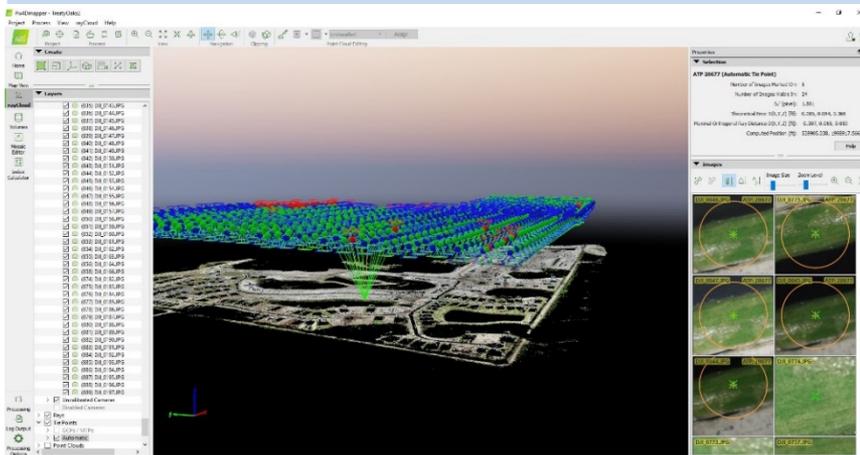
Figure 5: Computed image positions with GCPs between captured images. The distance of the lines indicates the number of matched 2D keypoint between the images. Single lines indicate weak links and reports marked by multiple lines indicate strong links. Green ellipses indicate the relative camera position uncertainty of the image from registration phase.

STEP 3 – Processing

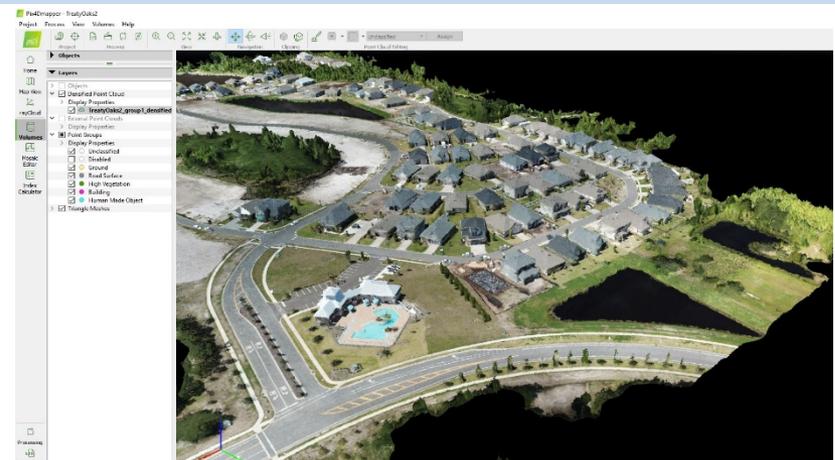
2. Point Cloud & Mesh generation

- In this step, the Pix4D program creates the point cloud & mesh which allows for the creation of 3D imagery model & digital surface models.

Ray Cloud



3D Textured Mesh



STEP 3 – Processing

3. DSM, Orthomosaic, & Index

- In this final step, the Pix4D program uses stitched images & 3D model to create the final orthomosaic image of the project area.

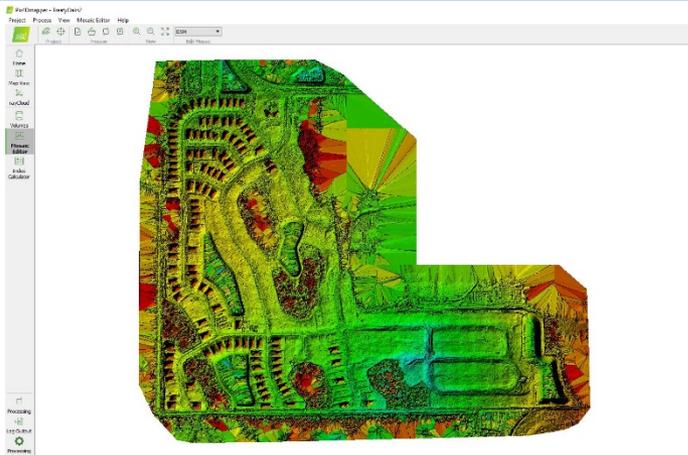


STEP 3 – Processing

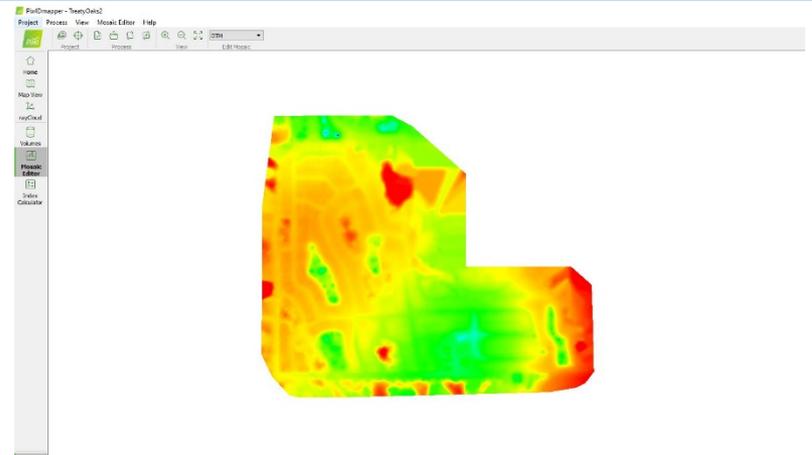
3. DSM, Orthomosaic, & Index

- It also outputs items such as Digital Surface Models (DSM), Elevation Contour shapefiles, KML files, and anything else selected for output in the pre-processing step.

Digital Surface Model (DSM)



Digital Terrain Model (DTM)



STEP 4

GIS Integration & Deployment of Processed Imagery

- Add the output orthomosaic data to a project MXD in ESRI ArcMap and proceed as follows:
 - Verify imagery output quality (e.g. resolution, location, etc.).

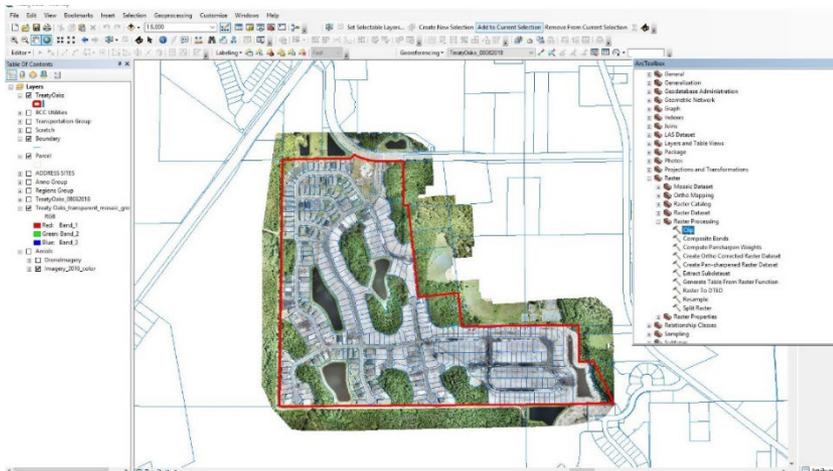


STEP 4

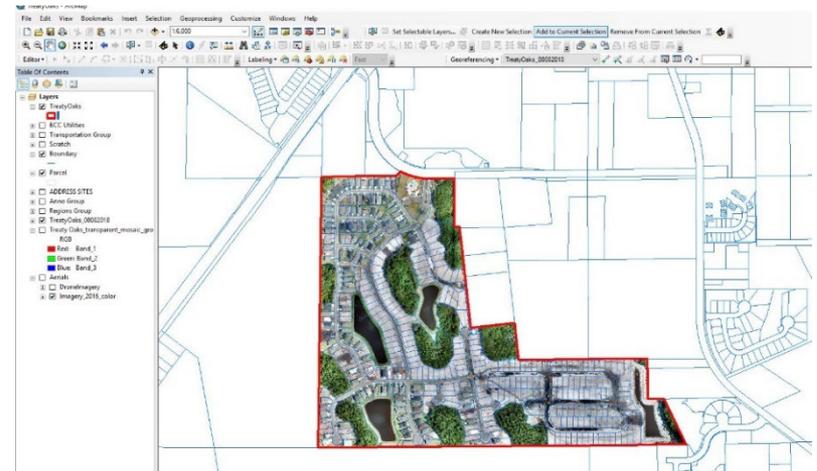
GIS Integration & Deployment of Processed Imagery

- Utilize the Raster Processing tools in ArcMap to clip the ortho to match the boundaries from the GIS Parcel layer.

Before



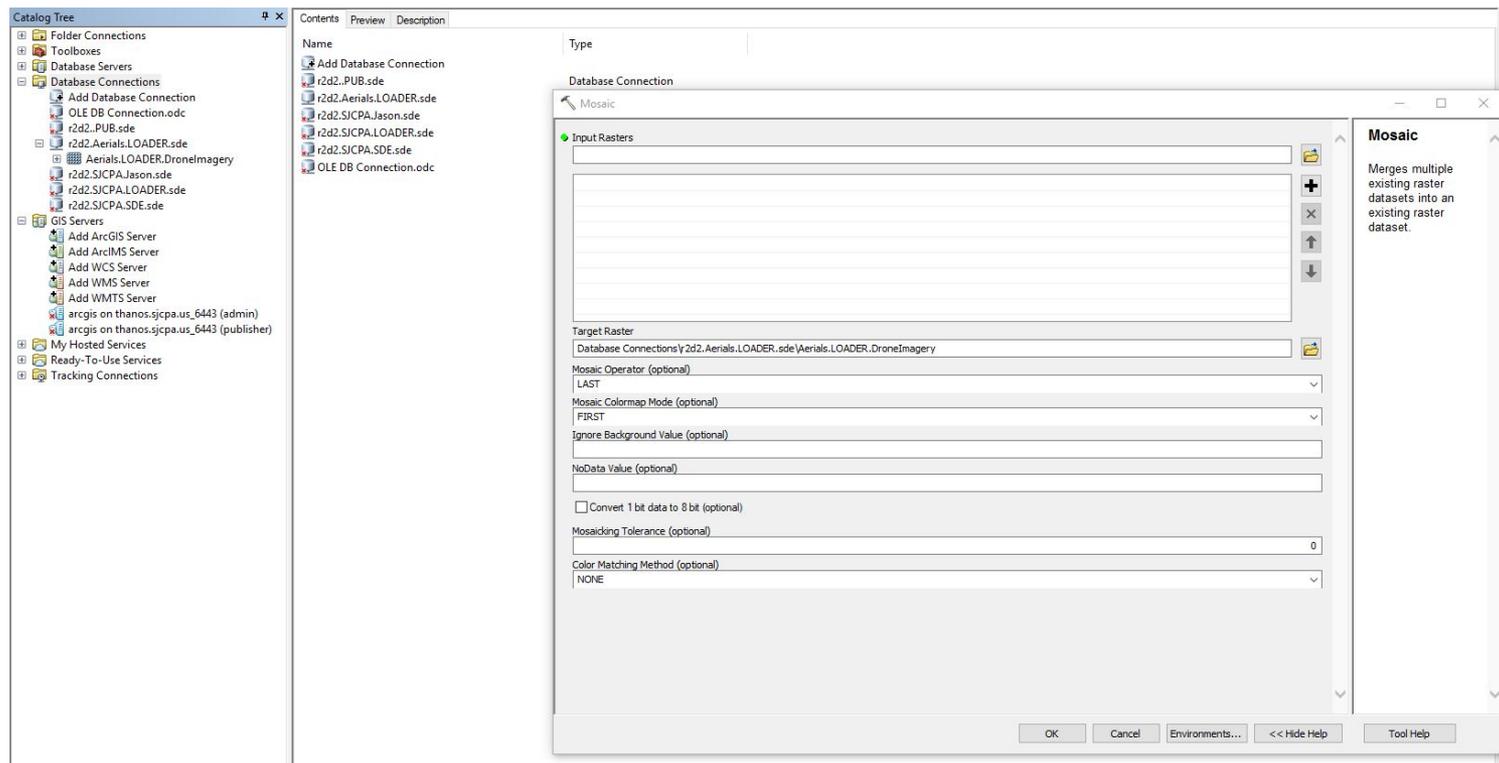
After



STEP 4

GIS Integration & Deployment of Processed Imagery

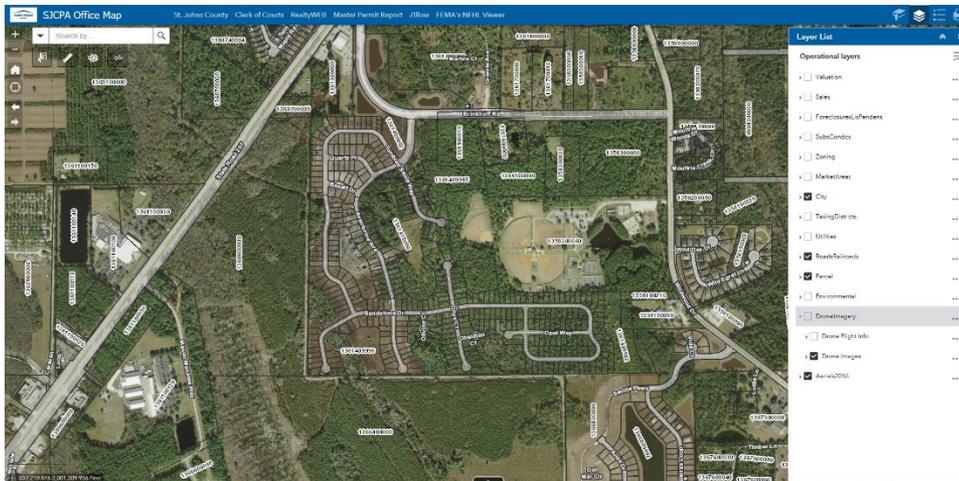
- Load output raster into the existing Drone Imagery Raster Dataset using ESRI ArcCatalog.



STEP 4

GIS Integration & Deployment of Processed Imagery

- The imagery is then immediately accessible on SJCPA's internal ArcGIS Portal mapping site via raster image service.

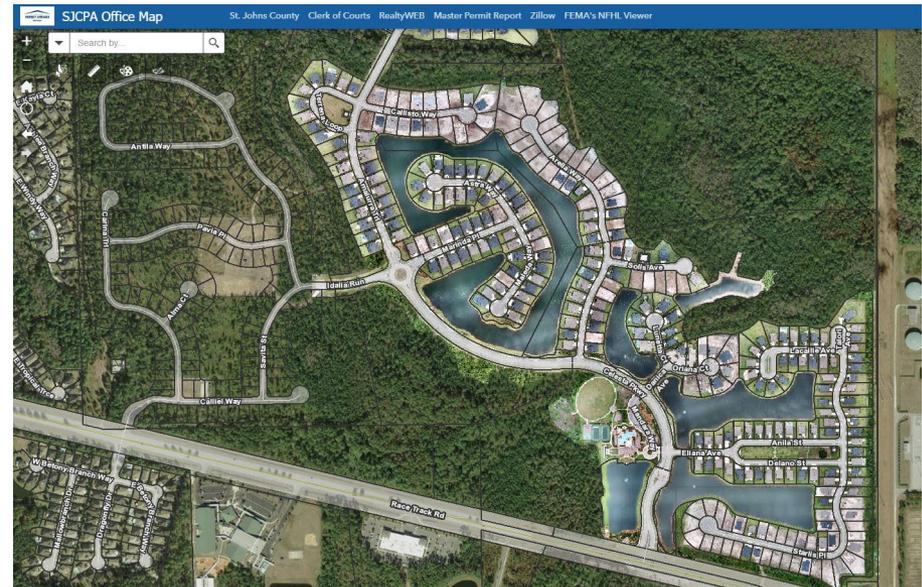
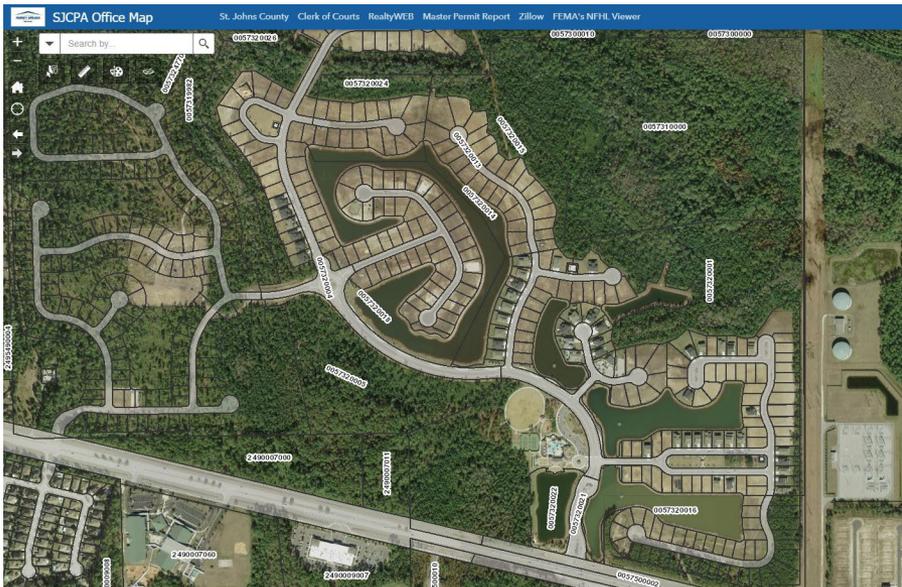


STATISTICS

- In **June 2017** SJCPA started process of building a Drone Program.
- On **June 21, 2017** SJCPA flew first flight with the Quad Copter/Mavic Pro.
- Flights to date
 - **182 gridded flights** with Quad Copter/Mavic Pro.
 - **4 flights** with Fixed Wing/eBee Plus RTK
 - Approx. **45 hours** of flying over a week's time in St. Johns County after Hurricane Matthew with Quad Copter/Mavic Pro.
 - Approx. **18 hours** of flying over 3 days in Gulf County after Hurricane Michael with Quad Copter/Mavic Pro.
- Flights processed for imagery service
 - **54 flights** were flown with Quad Copter/Mavic Pro
 - **4 flights** were flown with the Fixed Wing/eBee Plus

CONCLUSION

- Our drone program has allowed our office to obtain the latest aerial imagery on demand to facilitate appraisal in a rapidly developing county.



CONTACT INFORMATION

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