

Our Experiences with UAVs in Coastal Monitoring at Gator Lake

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**FSBPA 2018 National Conference
on Beach Preservation Technology
February 9, 2018**

Disclaimer:

MRD Associates, Inc. does not provide commercial drone services and was not paid for these services under the Gator Lake Breakwaters Monitoring contract. All work presented was for research and development only.

OVERVIEW

- Purpose
- Equipment
- Use Cases
- Acquisition and Data
- Limitations
- Value Added for Your Client

PURPOSE & GOALS

- What Can Using a Consumer Level Off-The-Shelf Drone Add to Coastal Monitoring Applications?
 - Qualitative Assessment of Project Performance?
 - Volume Changes?
 - Shoreline Response?
 - Construction Observations?
 - Georeferenced Aerials?

PHANTOM 3 PROFESSIONAL



SPECIFICATIONS

- Cost: **\$1,200** (2015/2016)
 - \$750 (2018)
- Flight Time: ~15-17 Minutes
- Camera: 12.0MP 4K UHD Sensor
- GPS+GLONASS Positioning Sensor
- Barometer
- Ultrasonic Height Sensor
- Accelerometers/Gyroscopes/etc...



ACQUISITION AND PROCESSING

- Pix4dmapper (\$\$\$\$)
 - Free App + Paid Subscription (\$350/m)
- DroneDeploy (\$\$\$\$)
 - Free APP + Paid Subscription (\$99/m) -> (\$350/m with GCPs)
- MapsMadeEasy (\$)
 - \$5 - \$30 APP + Pay as You Go/Per Job (\$350 -> ~21,000 Pts.)
 - Enough to cover ~11,000 Acres
- DJI Go (Free)
 - Manual Capture
- OpenDroneMap (Free)

*Costs taken from company websites on January 29, 2018

OUR PROCESS

- Pre-flight Planning
 - DroneDeploy Mobile or Desktop APP
 - Research TFR's, Weather, No Fly Zone's
 - Equipment and Surrounding Check Prior To Take off
- Acquisition
 - DJI Go & DroneDeploy Mobile APPs
- Post Processing
 - Uploaded Images to MapsMadeEasy for Georeferenced Stitched Aerial
 - Utilized AutoCAD for Final Georeferencing of Aerial

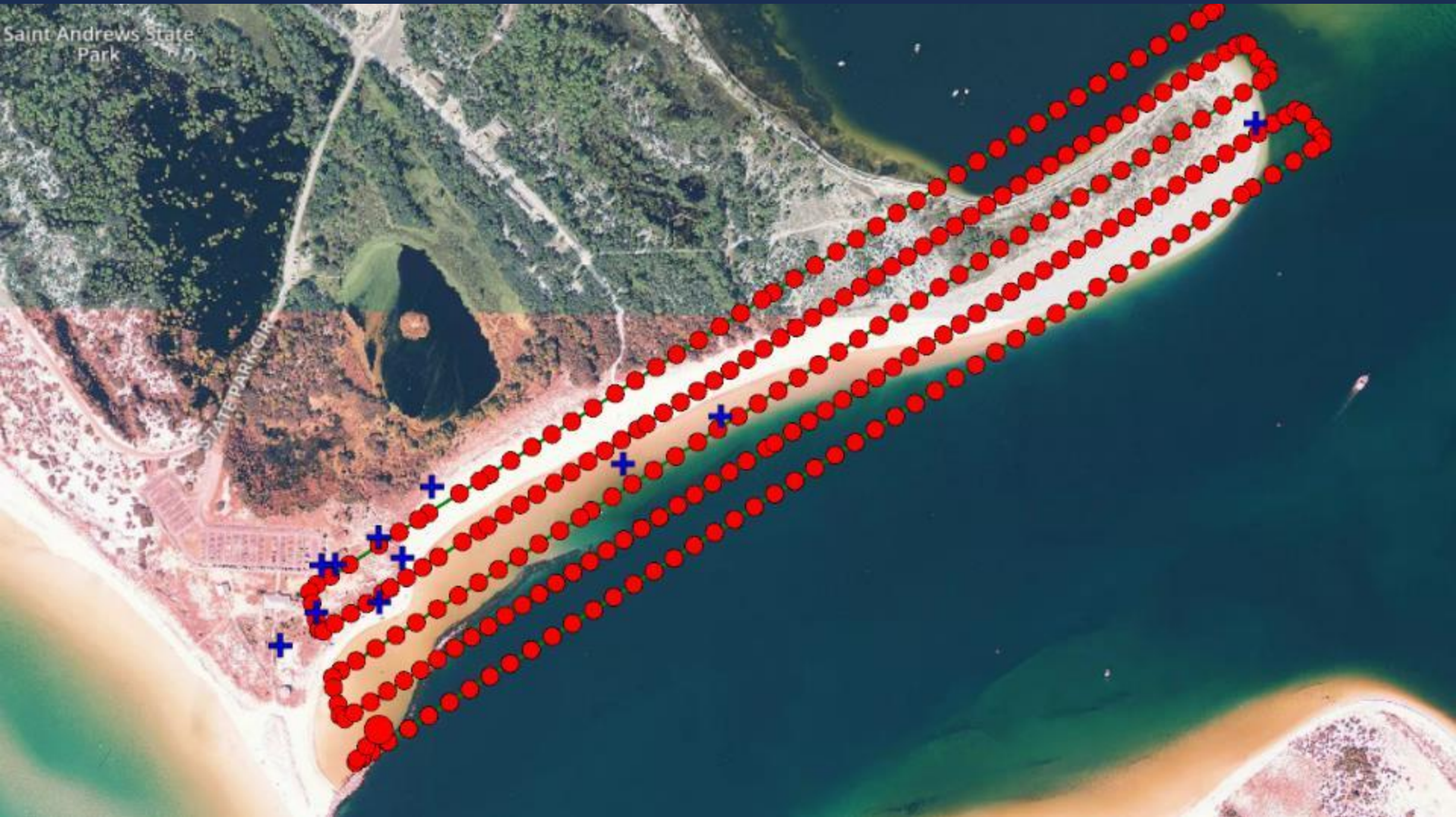
MISSION PLANNING (DRONEDEPLOY)

- 389' AGL
- 1.4" per pixel
- ~120 Acres
- 60% sidelap
- 70% frontlap
- 34 mph (max)

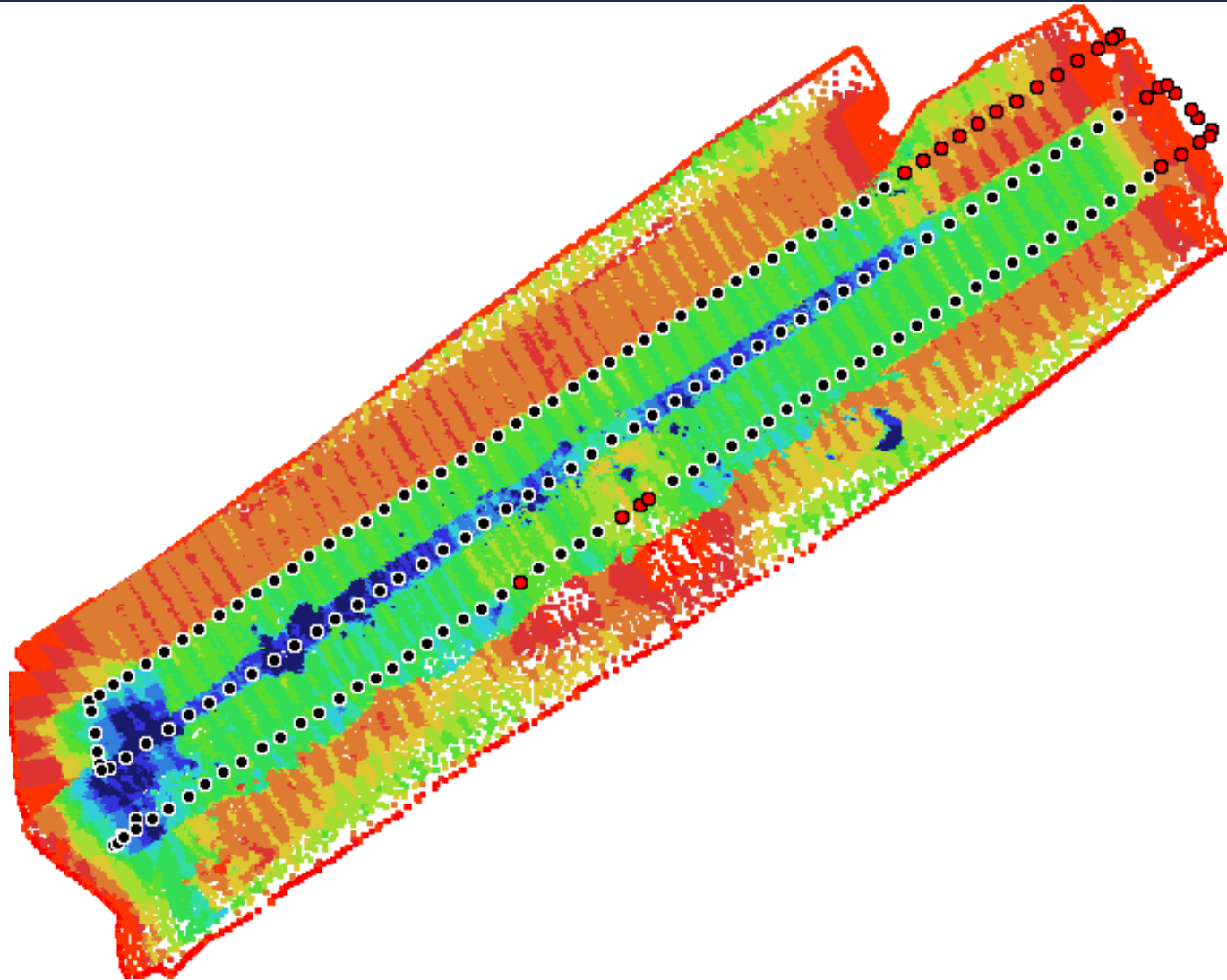


*Note: Flight Path did not encroach into any known restricted airspace.

ACQUISITION WITH GCP'S



OVERLAP REPORT



156
Images

FLIGHT LOG

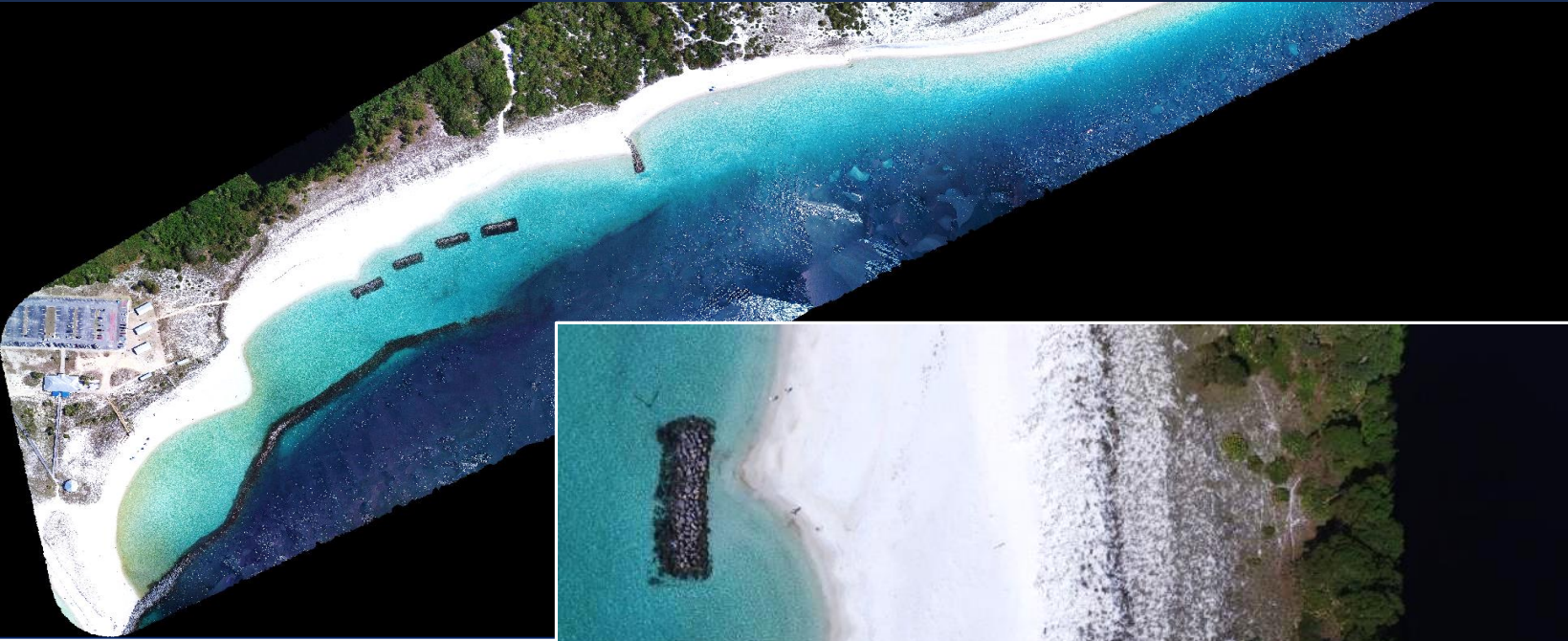
- Aerial Cartographics of America, Inc. (ACA)
 - March 15, 2017
- MRD Associates, Inc. (MRD)
 - February 2, 2017
 - May 16, 2017
 - August 2, 2017
 - September 18, 2017
 - November 20, 2017
 - Ongoing....

USE CASES

- Marketing Images and Video
- Construction Observation
- Site Conditions
- Shoreline Changes
- DEM, DTM, DSM...
- Volumes ??? (mehhh)



MARKETING IMAGES



CONSTRUCTION OBSERVATION

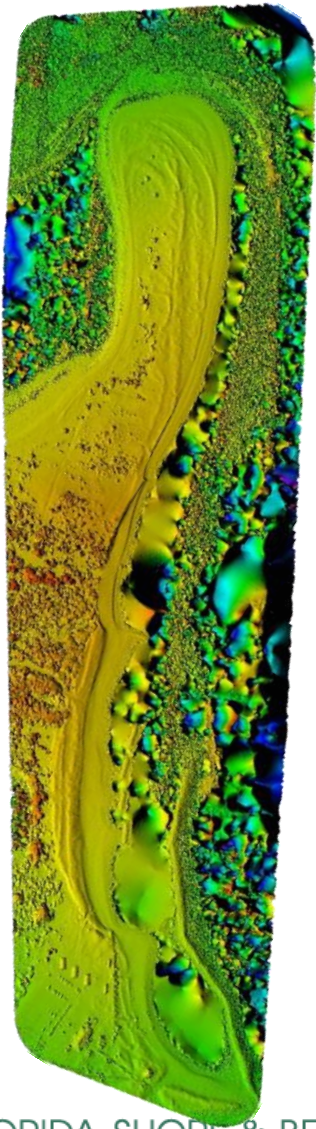


SHORELINE CHANGES

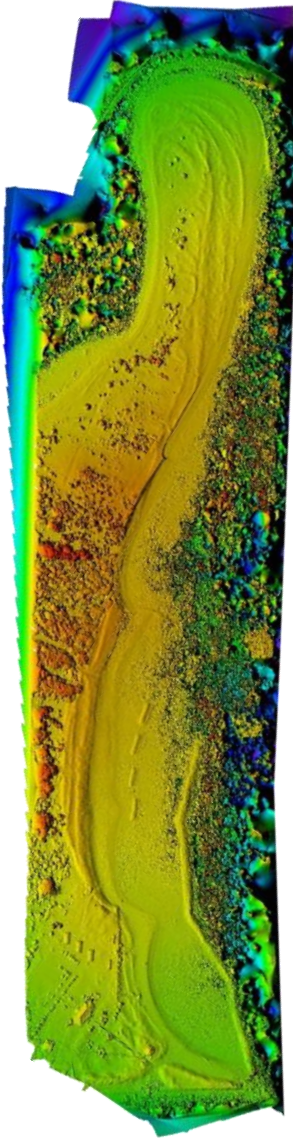


DEM'S

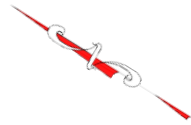
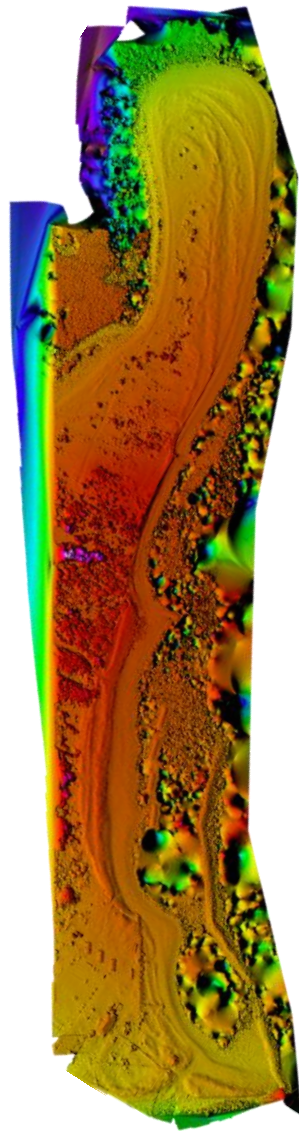
May 2017



September 2017



November 2017



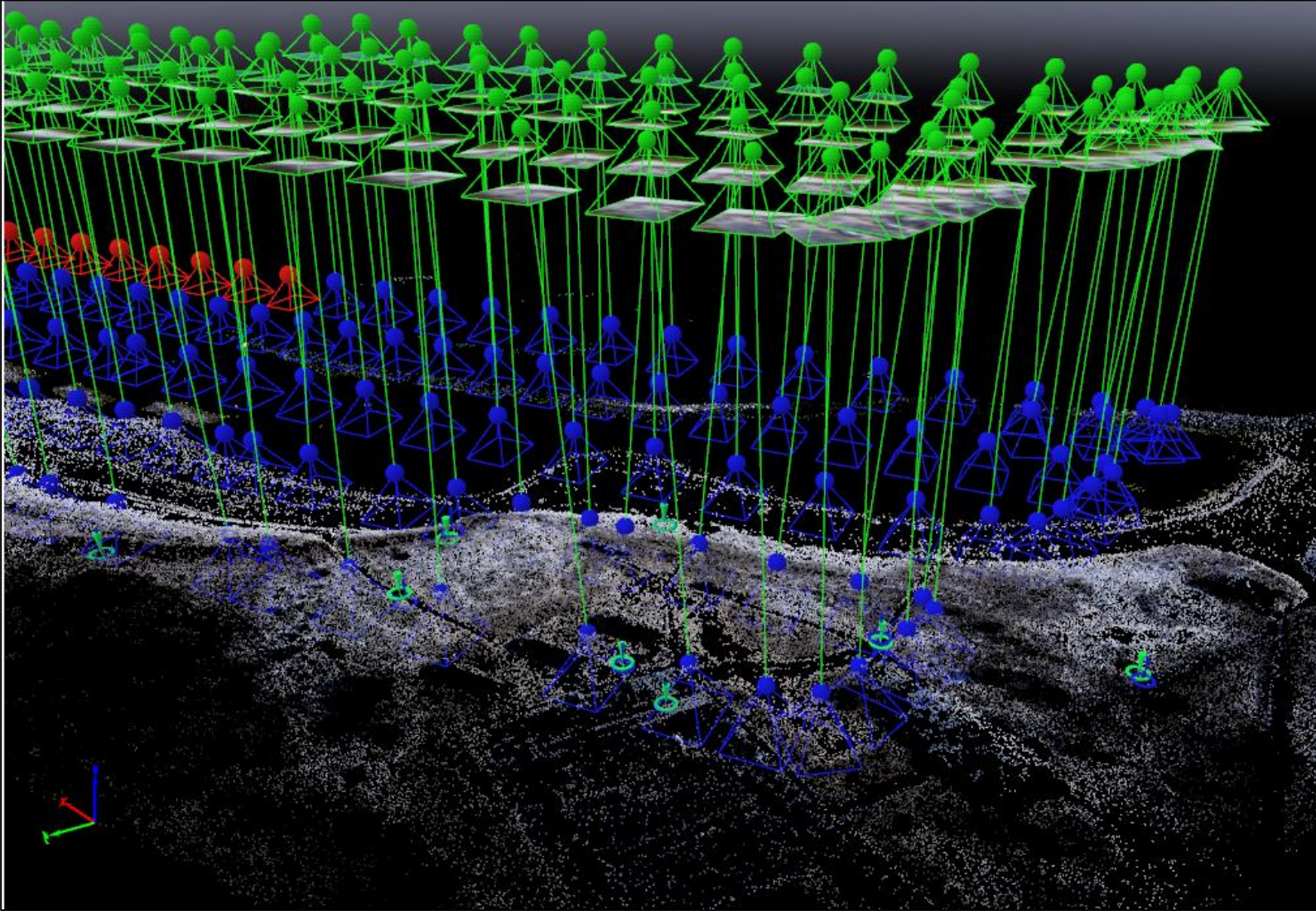
VOLUME CHANGE ANALYSIS

- Options Exist...
 - MapsMadeEasy Online tool
 - ACAD Civil 3D
 - DEM & LAS Data Sets
 - Pick your favorite surface generating program...
- Would I trust the results?
 - mehhhh

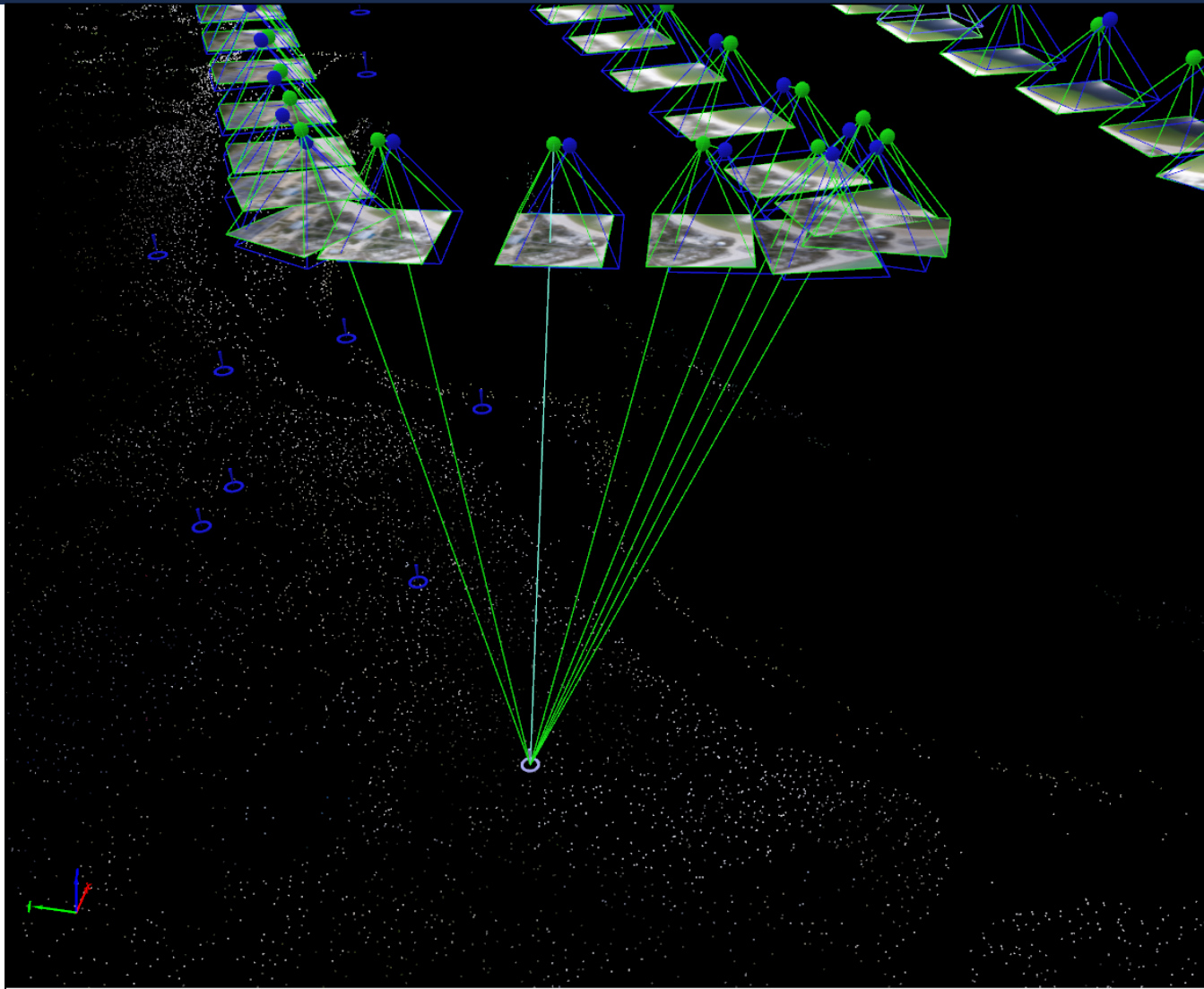
POST-PROCESSING OPTIONS

- Pix4Dmapper
- Maps Made Easy Online Editing
- AutoCAD
- Hypack
- DroneDeploy (not evaluated)
- Others...

PIX4D PROCESSING



PIX4D PROCESSING (GCP'S)



Properties

▼ Selection

85 (3D GCP)

Label: 85

Type: 3D GCP

X [ft]: 1578501.960

Y [ft]: 411019.390

Z [ft]: 9.780

Horizontal Accuracy [ft]: 0.020

Vertical Accuracy [ft]: 0.020

Number of Marked Images: 10

S² [pixel]: 0.8357

Theoretical Error S(X,Y,Z) [ft]: 0.059, 0.048, 0.170

Maximal Orthogonal Ray Distance D(X,Y,Z) [ft]: -0.277, -0.119, 0.088

Error to GCP Initial Position [ft]: 10.017, 7.811, 83.630

Initial Position [ft]: 1578501.960, 411019.390, 9.

Computed Position [ft]: 1578491.943, 411011.579, -7

Automatic Marking Apply Cancel Help

▼ Images

Image Size Zoom Level

DJI_0121.JPG GCP: 85

DJI_0122.JPG GCP: 85

PIX4D AND MAPS MADE EASY OUTPUTS

- 2D Outputs:
 - Orthomosaics in GeoTIFF Format
 - Google KML Format
 - Others...
- 2.5D Output:
 - DSM and DTM's in GeoTIFF Format
- 3D Output:
 - Point Cloud in .las, .xyz and .ply formats
 - Contour Lines in .shp, .dxf, and .pdf formats
 - Others...

PROCESSING RESULTS

- How accurate is accurate?
 - 30 feet
 - 5 foot
 - 1 foot
 - 1 inch
- What are your goal(s)?
- What is an acceptable RMS Error?
 - Typical DEP Upland Survey Criteria requires RMS no greater than 0.1' for Horizontal and Vertical Control



LOCATION ACCURACY

- MapsMadeEasy (with and without GCP's)
 - Horizontal RMS Error (ft): **>25'**
 - Z RMS Error (ft): **Varied Greatly >10'**
 - No Method to Tweak Results



LOCATION ACCURACY

- Pix4D Processing (w/o GCP's)

- X RMS Error (ft): 9.8*
- Y RMS Error (ft): 6.8*
- **Z RMS Error (ft): 3.6***

*Accuracies
Relative to
Input Images

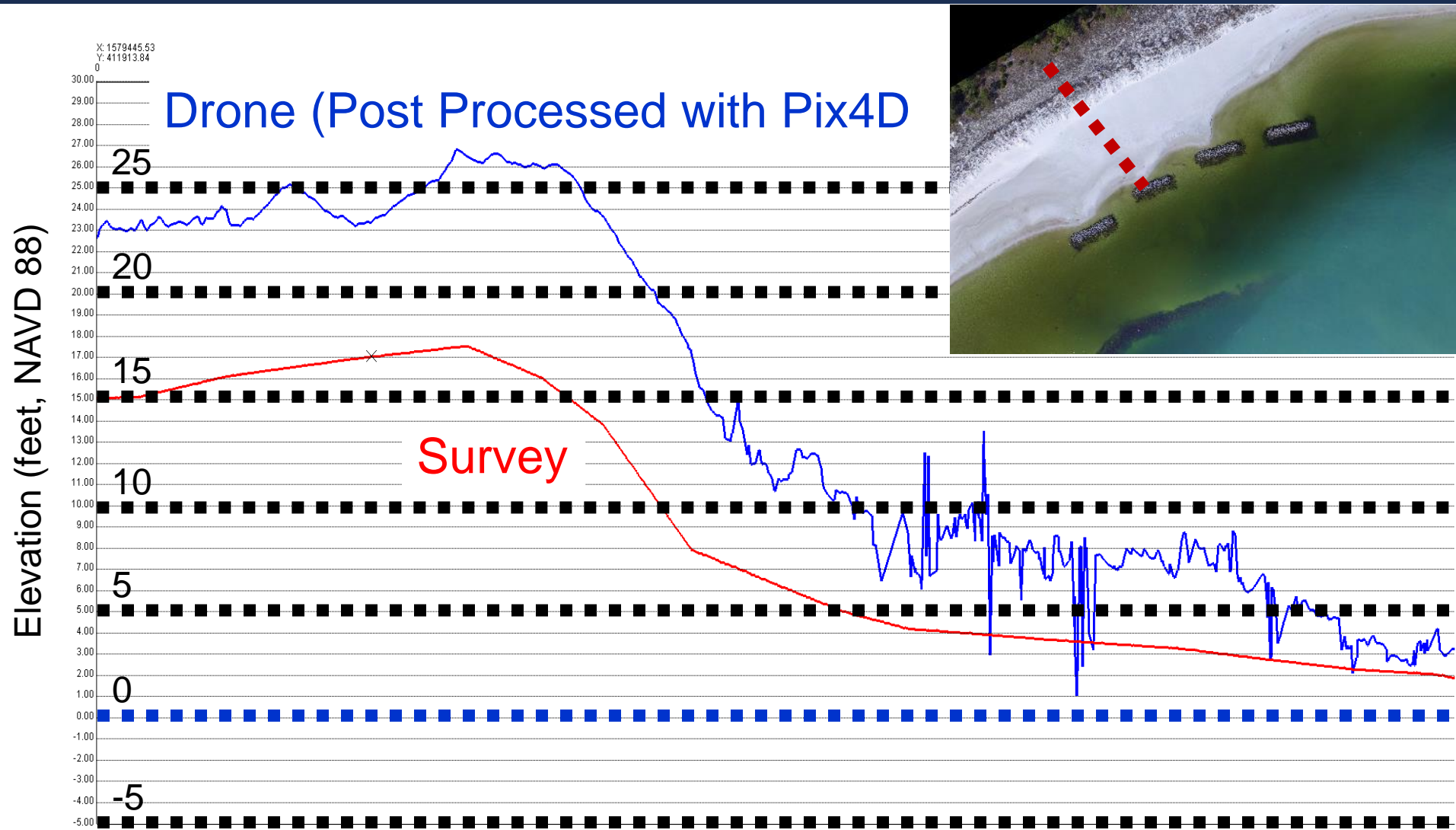


- Pix4D Processing (with 11 GCP's)

- X RMS Error (ft): 3.79
- Y RMS Error (ft): 3.03
- **Z RMS Error (ft): 1.55**

- ACA Aerial (03/2017) Horizontal RMS Error (with 4 GCP's): 0.07'

VOLUME CHANGE ANALYSIS



IMPROVING ACCURACY

- Survey Markers & GCP'S
 - More may or may not be better
 - Location of the GCP's
- Add more overlap (forward and side)
- Lower Altitudes
- RTK GPS
- Another UAV

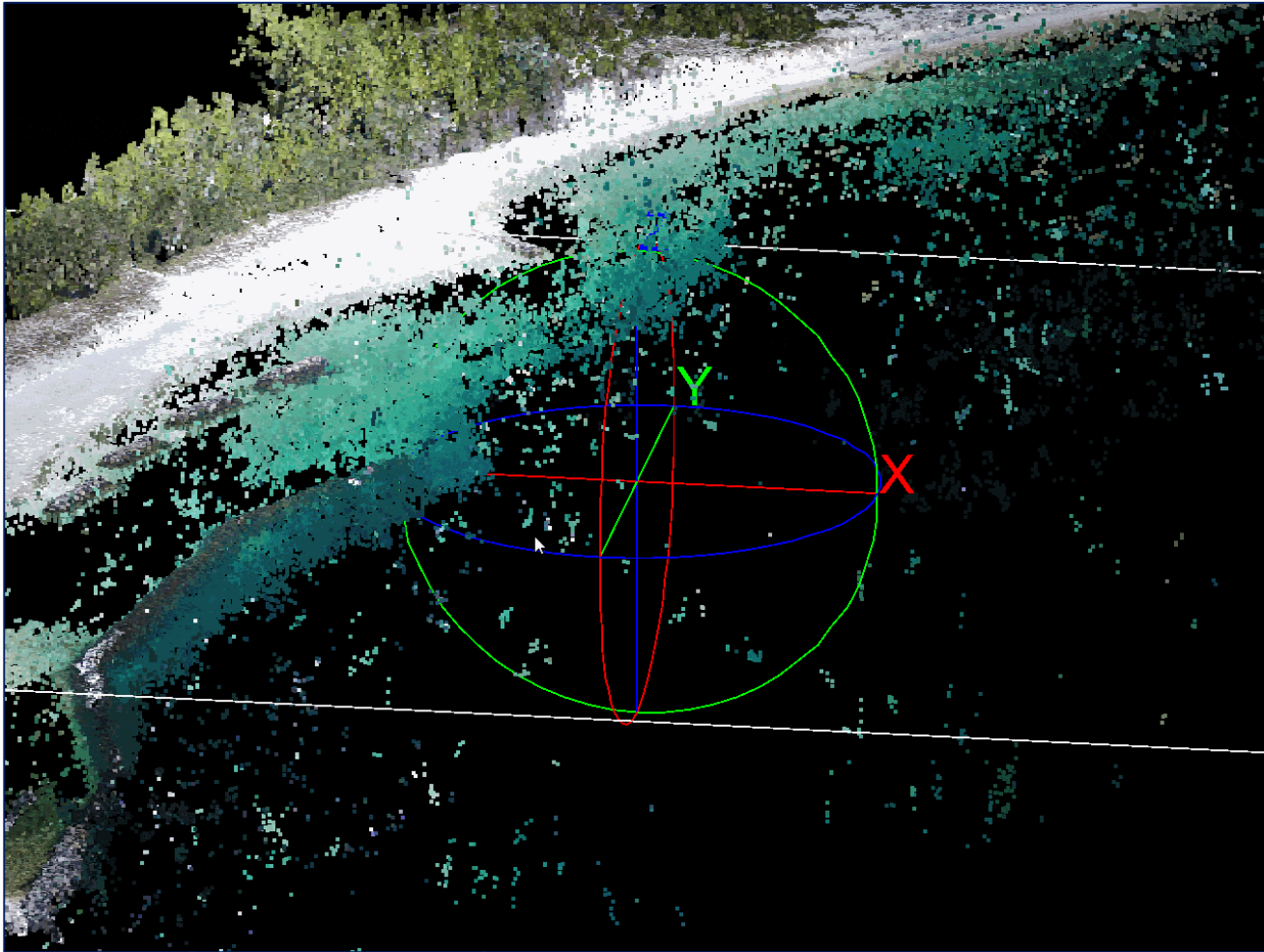


LIMITATIONS

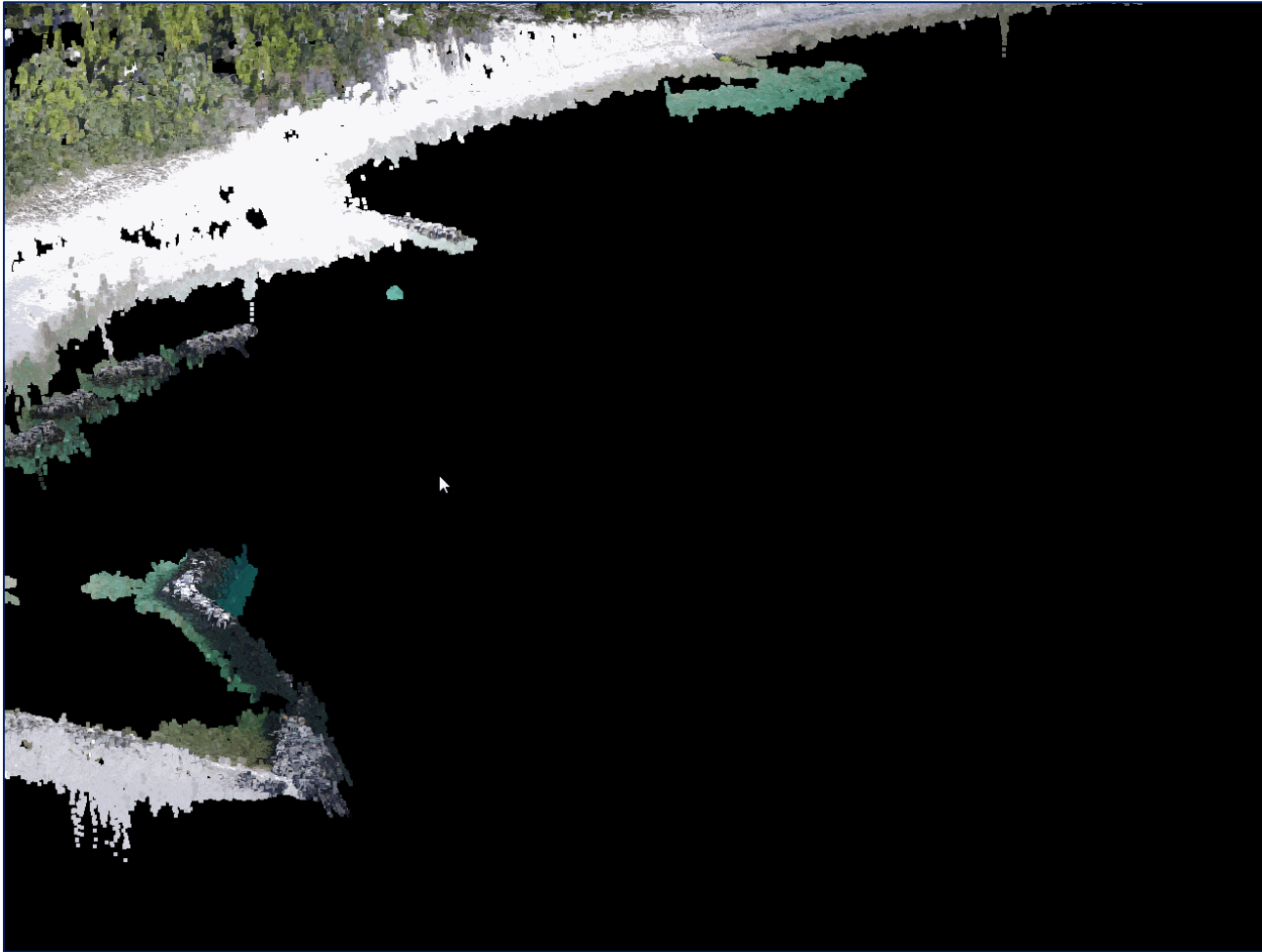
- Flight Time
 - %30 Rule
- Camera Sensor
- Flight Restrictions (TFR's, Military Bases, Airports, etc...)
- Pure Water Shots
- Software Options
 - Garbage In...Garbage Out



LIMITATIONS (POST-PROCESSING)



LIMITATIONS (POST-PROCESSING)



CONCLUSIONS

- Qualitative Assessment of Gator Lake Breakwater Performance?
 - YES!
- Shoreline Response?
 - YES!
- Georeferenced Aerials
 - YES! (with some work)
- Volume Change Analysis
 - Possible, but significant planning and post-processing efforts required

CONCLUSIONS

- Will This Equipment Replace Your Surveyor?
 - Absolutely Not
- Could The Phantom 3 Professional be used as a substitute to LIDAR?
 - Absolutely Not
- Is it Great for a Qualitative Assessment of the Project Performance and its Surroundings?
 - Absolutely 😊

CONCLUSIONS

- **The Good**
 - Shoreline Changes and Project Performance
 - Construction Observation
- **The Bad**
 - Utilized ACA Aerial for Ultimate Geo-referencing of Aerials
 - Volume Calculations not realistic
- **Value added to your Products**
 - Marketing Images and Video
 - Project Promotion Material
 - Another Perspective for your Client to see the Final Project as well as Interim and Post Project Updates

THANK YOU!

