



# **INTRODUCTION TO SMALL UNMANNED AIRCRAFT SYSTEMS (sUAS)**

# Presentation Outline

- Introduction
- sUAS Hardware and Software
- Operation Policies and Procedures
- The ELM Drone Program
- Short and Long Term Goals



# INTRODUCTION

# What is a drone?

“An unmanned aircraft system (UAS), sometimes called a **drone**, is an aircraft without a human pilot onboard – instead, the UAS is controlled from an operator on the ground.”

- *Federal Aviation Administration (FAA)*

# Why use a drone in our business?

- *Drone technology has made rapid advances in the past few years. The FAA certifies pilots for commercial use and consulting firms like ELM are quickly taking advantage of this technology.*
- *Drones allow us to get a different perspective at project sites. They give us the ability to investigate difficult access areas quickly. They can collect highly accurate data that is used to characterize/model site conditions and they can do all of this at a small fraction of the cost of traditional methods (e.g. maned flights).*
- *Drones will be as common as a GPS in the consulting realm in a few short years. It is a tool that allows us to provide a much better product to our clients.*



# What data are we collecting?

- **High Resolution Photography**
  - High resolution basemap creation (e.g. key features, surrounding landscape)
  - High resolution photography for marketing and development
- **Videography**
  - Recording videos of sites for observing remediation and construction work, planning and marketing purposes
  - Site inspection of areas not easily inspected
- **Elevation Data**
  - Acquire elevation data to be used for analysis and planning
- **3D Modeling**
  - Three dimensional building and infrastructure capture
- **Geographic Mapping**
  - Mapping inaccessible terrain and locations
- **Thermal Photography**
  - Acquire temperature data to be used for analysis of vegetation and other land uses
- **Near-infrared (NIR), Red-Edge (RED) and Multispectral Photography**
  - Estimating biomass
  - Determining plant health to be used for analysis

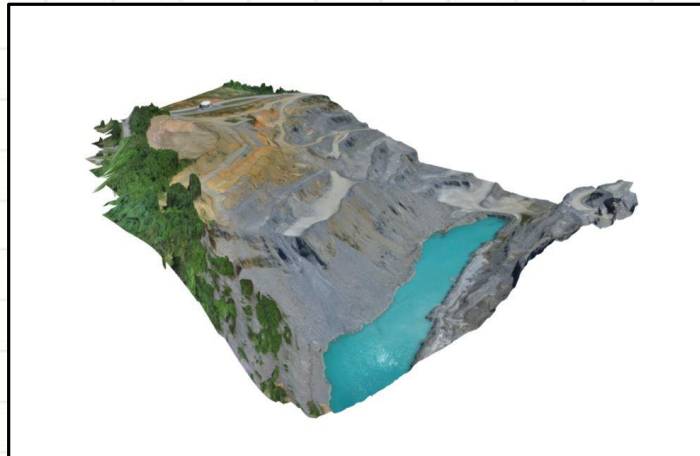
# Examples:



High resolution aerial photography  
Provided by FTI Consulting



High resolution Orthoimagery  
Provided by Drone Deploy



3D Model  
Provided by Drone Deploy



Elevation Contours  
Provided by ELM

# What type of deliverables are we generating?

- High resolution basemaps
- Georeferenced Orthomosaic Imagery
- High Resolution Elevation Data (cm accuracy)
- Site Flight Videos
- 3D Models
- Volumetric Data
- Site Inspection Information
- Construction Oversight
- Wetland Delineation



# DRONE Project Budgeting

- Drone will be billed at \$500 per day
- Additional costs will be billed at the hourly rate of the pilot and the data analyst.

Billable activities to consider:

- Preflight Prep - Airspace restrictions check and flight plan setup.
- Flight Labor Time – This includes travel to and from the site.
- Data Post-Processing – Conversion of raw data into a usable product.

# Approximate cost of generating orthomosaic imagery.

## *Task 1 - Drone Flight Plan Setup*

Technical Staff – 1 hours x \$80 / hour = \$80

## *Task 2 - Drone Flight Time (Includes travel to the site.)*

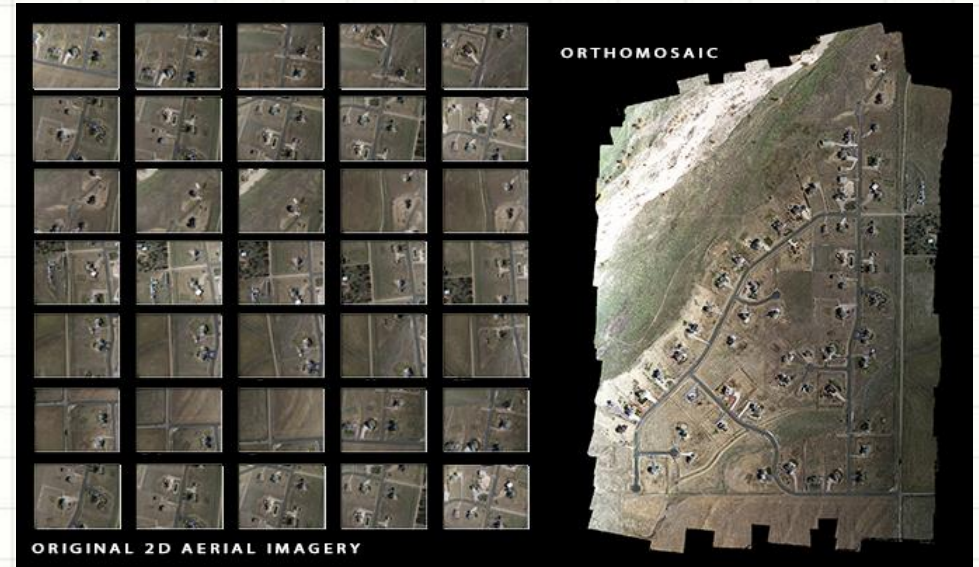
Drone Pilot – 6 hours x \$80 / hour = \$480

Use of the drone for a full day - \$500

## *Task 3 – Data Post Processing*

Technical Staff – 1 hour x \$80 / hour = \$80

Total Cost = \$1140



## Approximate cost of generating elevation contours.

### *Task 1 - Drone Flight Plan Setup*

Technical Staff – 1 hours x \$80 / hour = \$80

### *Task 2 - Drone Flight Time (Includes travel to the site.)*

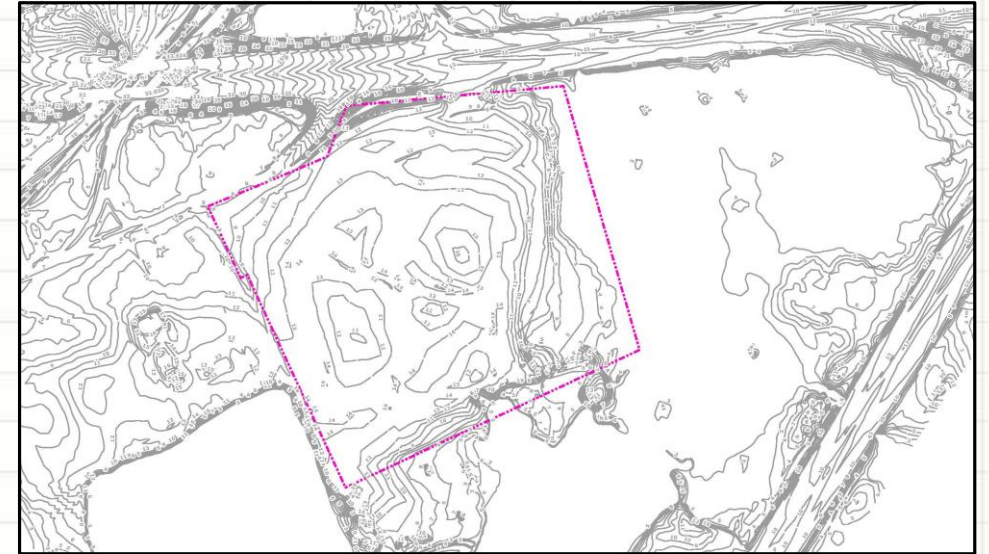
Drone Pilot – 8 hours x \$80 / hour = \$640

Use of the drone for a full day - \$500

### *Task 3 – Data Post Processing*

Technical Staff – 2 hour x \$80 / hour = \$160

Total Cost = \$1380





# **DRONE HARDWARE AND SOFTWARE**



# The ELM DRONE

- **DJI Phantom 4 PRO**
- 30 minute maximum flight time
- 4.3 mile Control Range
- 100 Feet Sensor Range
- Avoid obstacles automatically (4 directions and downward sensors)
- Smart return home



# DRONE Software

## DroneDeploy PRO

- Map and 3D Model Processing
- Pre-determine flight path
- Mobile app
- Export data
- Measure area, distance, and volume
- Generate contours from elevation data

## DJI GO App

- Mobile app
- Intelligent flight modes
  - Point of interest
  - Follow me
  - Waypoints
- Measures aircraft height and distance from controller
- Measures GPS signal and interference

## DroneLogBook

- Manage Flight Data
- Automatic Flight Data Logging
- Data Export
- Flight Log upload and import
- Pre-flight Forms
- Recordkeeping

# **OPERATIONAL POLICES AND PROCEDURES**

# Pilots in Command (PIC)

## What is a Pilot in Command?

- FAA certified UAS Pilot
- The PIC is directly responsible for the small unmanned aircraft system
- The PIC must ensure that the small unmanned aircraft will pose no undue hazard to other people, other aircraft, or other property in the event of a loss of control of the aircraft for any reason
- A pilot in command **MUST** be present before and during the flight of the drone

## Who is a PIC?

Cathrine Rinnier – Pilot in Command

Dave Towsey – Backup Pilot in Command

Justin Beslity – Princeton Drone Coordination – Answer basic questions and facilitate work opportunities out of the Princeton Office.



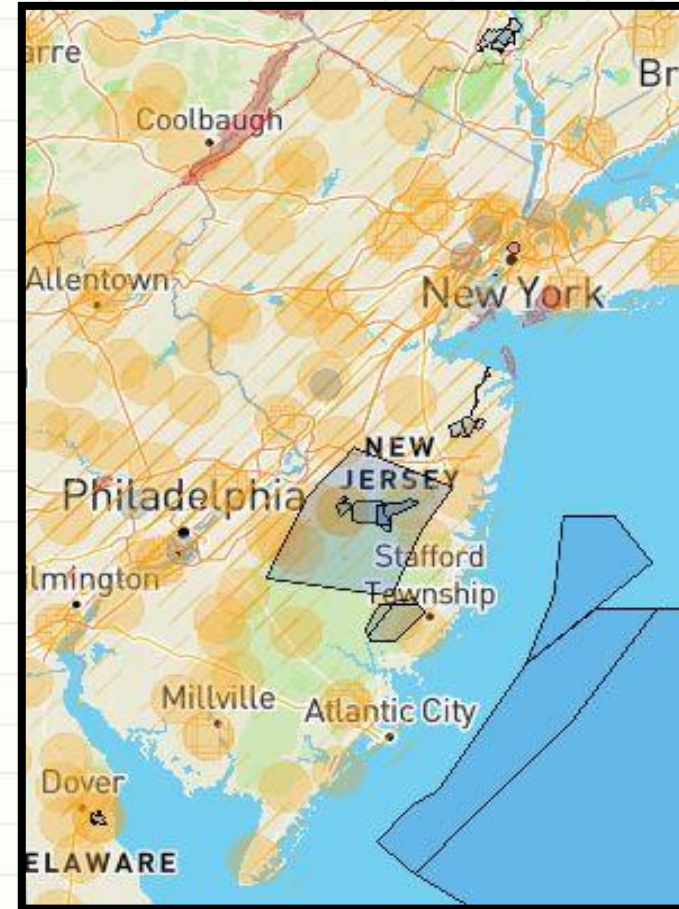
# DRONE Restrictions

The following are FAA regulations regarding drone flights

- Remote Pilot in Command must be present
- Must fly under 400 feet \*
- Air space restrictions
  - Must fly in Class G airspace \*
  - Cannot fly within five miles of an airport\*
  - Cannot fly in temporary flight restricted areas (Stadiums)
- Must keep the aircraft in sight \*
- Must yield right of way to manned aircraft \*
- Must not fly directly over non participating people or vehicles without written consent\* (can be accomplished at the health and safety tailgate.)

The NJDEP and EPA have no specific regulations regarding the use of drones on hazardous waste sites.

**\*These rules are subject to waiver**



(Source: New Jersey Flight Restrictions, KnowBeforeYouFly, <http://knowbeforeyoufly.org/air-space-map/>)

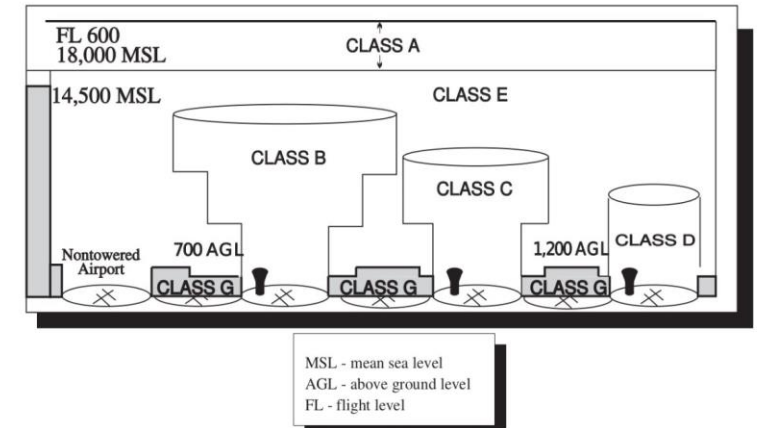
# Air Space Authorizations and Waivers

- **Authorization**

- Valid for less than six months
- Intended for centralized locations

- **Waiver**

- Intended for recurring operations over six months to two years
- Intended for broad areas



- Each application only waives or authorizes access into a single class of airspace
- The application must include certification of waiver or authorization that is associated with a specific location
- Must include certification of waiver or authorization that are currently valid or being processed by the FAA
- Once submitted the application may take up to 90 days to be evaluated by the FAA and the waiver or authorization to be valid
- Must provide description of proposed operation and justification that the operation is safe under the terms of a certificate of waiver or authorization

# Hazards to Flight

- **Collision**
  - The aircraft collides with another object or person
- **Fly Away**
  - The pilot is unable to effect control of the aircraft, as a result, the UAS is not operating in a predictable or planned matter
- **Possible Loss of GPS service**
  - Sources of interference:
    - Electromagnetic transmission
    - Wi-fi transmitters
- **Battery Fire**
  - The highly flammable batteries can self ignite when the battery short circuits or is overcharged

# Weather Conditions

- Drones cannot be flown at night
- Drones must fly 500 feet below clouds and 2000 feet horizontally of clouds
- Minimum visibility is 3 statute miles
- Cannot be flown in rain, sleet, or snow
- Cannot be flown in fog or mist
- If lightning is forecasted in the area Drones cannot be flown
- High winds drain the battery faster and lead to a greater accident potential
- Higher altitudes negatively affects aircraft performance
- Extreme temperatures can reduce drone performance
  - DJI manufacture recommends not flying below 32 degrees or above 104 degrees due to decrease drone performance



# THE ELM DRONE PROGRAM

# DRONE Request Form



Prior to submitting a drone request form, you requested to call a PIC and discuss the use of the Drone on your project.

Consider what short term, long term or monitoring over time needs may be of interest before scope the work for a particular project.

A form will be available on the Treehouse or can be submitted via email (Drone@elminc.com)

Please submit as soon as need is identified. If there is an airspace restriction for the area a waiver can take at a minimum 90 days to obtain.

Once the request is receive research will occur to see if there are any airspace restriction associated with the requested location and if a waiver is required.

Non-billable tasks (e.g. support of proposals or business development) can be approved by a Managing Partner.

- Project Name: \_\_\_\_\_
- Project Number: \_\_\_\_\_
- Project Task: \_\_\_\_\_
- Sub Task: \_\_\_\_\_
- Description of non-billable tasks: \_\_\_\_\_
- Site Address: \_\_\_\_\_
- Submitted By: \_\_\_\_\_
- Request Date: \_\_\_\_\_
- Flight Date: \_\_\_\_\_
- Flight Description: \_\_\_\_\_
- Deliverable Type and Description: \_\_\_\_\_
- Comments: \_\_\_\_\_

# Sequence of Events

## Before Flight

1. **Discuss the scope of the request with a PIC.**
2. **Submit Request**
3. Pre-flight airspace restrictions check
4. File for waivers *(if required)*
5. Receive approval *(if required)*

## Day of Flight

1. Pre-flight weather check *(if weather conditions are not optimal flight cannot take place)*
2. Pre-flight temporary flight restrictions check *(if TFR is located over site flight cannot take place)*
3. Drone Flight

## After Flight

1. Post-processing of data
2. Generating deliverables

# How can you get involved?

- **Who can Fly?**

- Technically anyone can fly the drone under direct supervision of the pilot in command

- **Training**

- How-to-fly hands on training session with Mini Drone along with operating rules and tips
- How-to-fly hands on training session with the Phantom 4 Pro Drone flight simulation
- How-to-fly hands on training session with the Phantom 4 Pro Drone with operating rules and tips



**REALACC H36 Mini Quadcopter**





# **SHORT AND LONG TERM GOALS**

# Initial DRONE Services

## First 3 to 6 Months

- High Resolution Aerial Photography
- Videography
- Elevation Data Collection
- Full list of services (see next slide) available now; however, learning curve for more advanced services will require more time.

# Long Term DRONE Services

## After 6 Months

- High Resolution Photography
- Georeferenced Orthomosaics
- Generating 3D Point Cloud
- Elevation Contouring
- 3D Mapping
- Integrated CSM
- Field oversight and Inspections
- Videos
- Support of Proposals and Marketing
- Volumetric Data & Analysis
- Thermal Data & Analysis



**QUESTIONS?**