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CalRecycle

# Drones in the Solid Waste Industry

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# Presented By:

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- Bachelor of Science in Civil Engineering from Cal Poly, San Luis Obispo
- Assists in improving efficiency of solid waste operations through:
  - Drone Mapping
  - Airspace Utilization Analysis
  - Time-Motion/Efficiency Studies
  - Thermal Imaging

# Today's Discussion: Drones in the Solid Waste Industry

- Types of Drones
- Applications of Drones
- Challenges Facing the Drone Industry

# Unmanned Aircraft Systems (UAS)

- Includes all elements involved in drone operations:
  - Unmanned Aerial Vehicle (UAV) (a.k.a. drone)
  - Ground-based controller
  - System of communications between the two

# Commercial Drones

- A remote controlled (or pre-programmed) fixed-wing aircraft or copter equipped with:
  - GPS Tracking/Controls
  - Advanced Software
  - Radio Link
  - High-Resolution Camera
- While they are fun, commercial drones are NOT toys!

# Types of Drones

## Multi-Rotor Drone

## Fixed Wing Drone

# Multi-Rotor Drones

- Common Models: 3DR Solo, DJI Phantom, DJI Mavic
- Usually collect data at lower elevations (< 200 ft AGL)
- Usually fly slower than fixed wing drones (< 30 mph)
- Reduced battery life (< 30 mins)
- More control and maneuverability
- Best applications:
  - Small-scale (< 100 acres)
    - Photography and videography
    - Time-motion studies
    - 3D mapping
    - Surveying/mapping
    - Thermal imaging

# Multi-Rotor Drones

# Fixed Wing Drones

- Common Model: SenseFly eBee
- Usually collect data at higher elevations (250 - 400 ft AGL)
- Usually fly faster than multi-rotor drones (30 - 50 mph)
- Increased battery life (30 - 60 mins)
- Usually autonomous, less control (unable to hover)
- Best applications:
  - Large-scale (100 - 1,500 acres)
    - Surveying/mapping
    - Multispectral imaging
    - Photography
    - Thermal imaging

# Fixed Wing Drones


# Drones in the Solid Waste Industry

Drone applications in the solid waste industry can be broad, but mainly include the following areas:

- Surveying / Photogrammetry
- Volume Calculations / Airspace Utilization Analysis
- Productivity Analysis
- Traffic Flow Analysis
- Thermal Imaging

# Surveying / Photogrammetry

The ultimate goal of surveying a solid waste facility is to produce a topographic map.

<u>Traditional Manned Aircraft Surveying</u>

- Can cost $10k - $30k
- Can take 1 - 3 months
- Expected accuracy is +/- ½ of the contour interval
  - For a topo map with 5 ft contours, the expected accuracy is +/- 2.5 ft

<u>Drone-based Surveying</u>

- Can cost $3k - $6k
- Can take 1 - 3 weeks
- For standard mapping, expected accuracy is +/- 4 in
- For increased accuracy mapping, expected accuracy is +/- 2 in

# Surveying / Photogrammetry

What you need:

- Multi-rotor or fixed wing drone
- Drone compatible phone/tablet/computer
- Drone compatible camera
- Drone data processing software (e.g., Pix4D)
- AutoCAD Civil 3D (or other compatible program)
- Fast/powerful computer to process drone data
- Engineering technician to analyze captured data

Basically, it's a big investment!

# Volume Calculations / Airspace Utilization Analysis

- Airspace is a landfill's primary commodity. The landfill has paid to develop the airspace, and it generates revenue from the waste that fills the airspace.
- Using drones to survey landfills on an annual basis, we can calculate the volume that the landfill's waste consumed over the last year. Comparing this to the annual inbound waste tonnage (and soil usage), we can calculate the effective density and waste density for the landfill.
- These metrics can be used to assess the landfill's performance and analyze their airspace utilization.

# Volume Calculations / Airspace Utilization Analysis

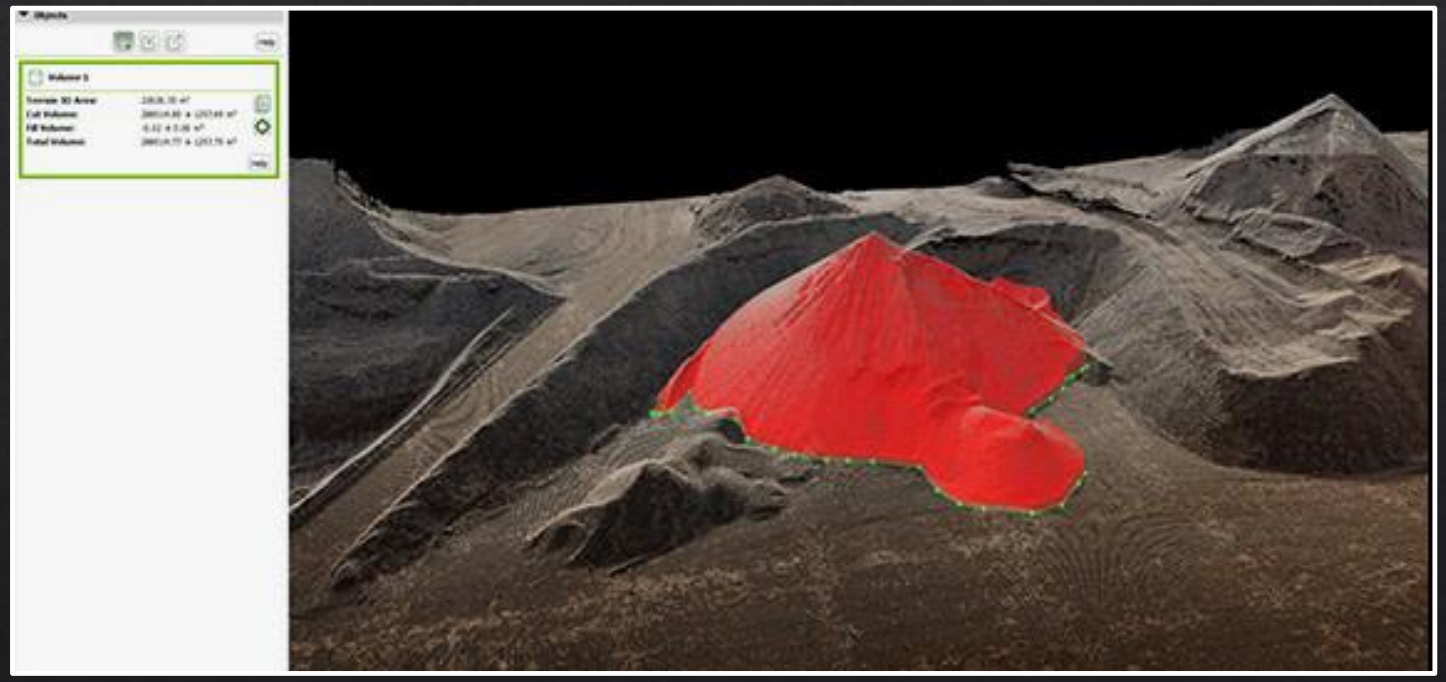
- On a smaller scale, we can use drones to conduct density tests and determine a landfill's optimum compactor production rate (and optimum waste density).
- The optimum waste density is where the overall (combined) cost of compactor usage and airspace are minimized. Optimum waste density is achieved by managing the compactor's production rate.

# Volume Calculations / Airspace Utilization Analysis

- By building waste cells with controlled waste tonnage and compactor usage, we can use drones to quickly survey the cell on a daily basis…and calculate volume and waste density.
- The results of these tests can save landfills big money on compactor costs and airspace costs.

# Volume Calculations / Airspace Utilization Analysis

- Drones can also be used for quick volume calculations:
  - Mass excavations
  - Stockpiles
  - Compost piles



# Productivity Analysis

- Time motion studies, video analysis, and activity sampling can be used to evaluate equipment productivity.
- Traditionally, we were only able to use stationary cameras and/or machine-mounted cameras…but now drones provide a birds-eye view for improved analysis.


# Traffic Flow Analysis

- Optimizing traffic flow improves efficiency, safety, and facility function.
- Drones provide the best perspective for evaluating traffic flow patterns and space utilization for:
  - Landfills
  - Transfer Stations
  - Organics Processing Facilities
  - Collection Routes
  - MRFs

# Traffic Flow Analysis

- Clear view of entire operations
- Easily track and observe routes
- Easily track number of vehicles/machines

# Thermal Imaging

Ever had a fire at your site?  It usually starts underneath the surface!

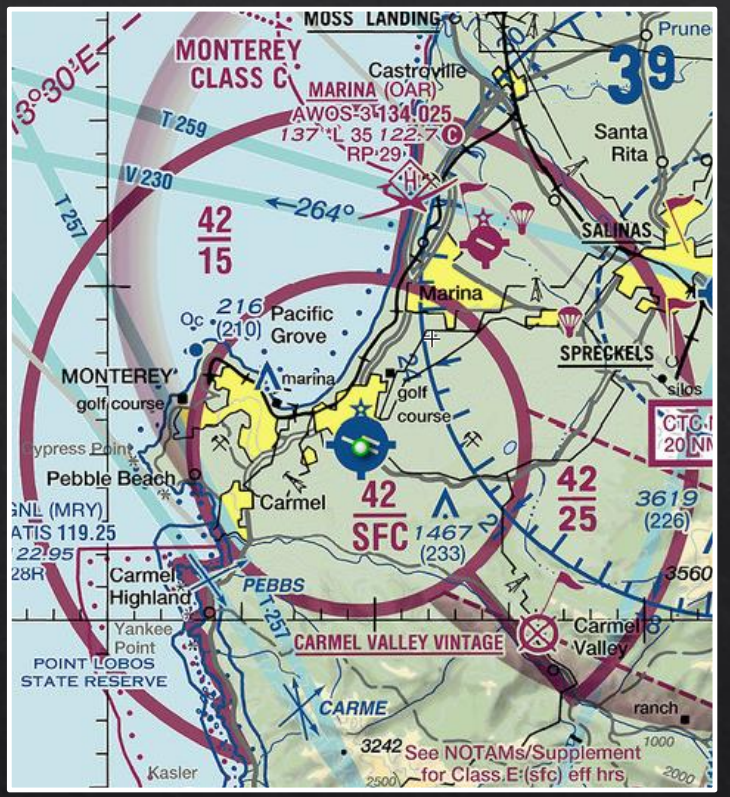
- Subsurface hotspots are more common than you think.
- Drone-based thermal mapping can provide a quick, inexpensive means of finding thermal activity.

# Challenges Facing the Drone Industry

- FAA Regulation
- Unlicensed/Unexperienced Drone Operators
- Unpredictable Environmental Conditions

# Challenges Facing the Drone Industry: FAA Regulation

- The FAA has done a great job of ensuring safe air travel.
- This is partially due to restricting use of drones near airports and sensitive infrastructure.
- However, the process for licensed pilots to receive authorization to fly in these areas does not work well, and it eliminates potential business for a lot of drone companies.
- **Airspace authorization and traffic management processes will continue to improve.**



# Challenges Facing the Drone Industry: Unlicensed/Unexperienced Drone Operators

- Unfortunately, there are a lot of drone operators that are not licensed, not insured, and not aware of potential risks.
- These operators are the reason for strict regulation and poor public perception of drones.

# Challenges Facing the Drone Industry: Unlicensed/Unexperienced Drone Operators

- As part of the drone community, we all need to work together to make sure we are working as safely and efficiently as possible.
- We need to be lawful and helpful if we want to see the industry take off!

# Challenges Facing the Drone Industry: Unpredictable Environmental Conditions

- Most drones should not operate in wet conditions or in winds above 20 mph.
- Conditions can sometimes be unpredictable and change in a matter of minutes.
- Some birds tend to be territorial and will take action against a drone.
- Detailed operating procedures and contingency plans should be developed.

# Summary

- Types of Drones
  - Multi-Rotor
  - Fixed Wing
- Applications of Drones
  - Surveying / Photogrammetry
  - Volume Calculations / Airspace Utilization Analysis
  - Productivity Analysis
  - Traffic Flow Analysis
  - Thermal Imaging
- Challenges Facing the Drone Industry

# For More Information

For more information regarding
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# Questions or Comments?