

Washington State



County Road Administration Board

UAV (AKA DRONE) TECHNOLOGY IN TRANSPORTATION PROJECTS

CO-PRESENTER'S:

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WASHINGTON STATE COUNTY ROAD ADMINISTRATION (CRAB)

Washington State Transportation Commission
Meeting March 15th, 2016



Purpose of presentation is to:

Provide a fundamental understanding of UAV's and how they can operate **Safely** and **Effectively** in Transportation Projects.

Contents:

1. UAV Applications in the Public Arena.
2. History and types of Drones & UAV's.
3. Why should we use UAV's for Transportation Projects?
4. Examples of Fixed Winged UAV's & Rotary UAV's.
5. How to utilize the UAV data for Transportation purposes.
6. Current FAA authorization requirements to fly an UAV.

UAV Applications in the Public Works Arena

- ▶ Information Technology is one of CRAB's Core Missions.
- ▶ Investigate and research innovative, cost effective, technical strategies for counties for possible implementation.
- ▶ Drone or UAV's (Unmanned Aerial Vehicles) technology has grown rapidly over the last decade and the future growth is almost assured.
- ▶ Data obtained from UAV's is 1% to 10% of the cost of conventional aircraft.
- ▶ Owner controlled data with better quality, clarity, and safer.
- ▶ Data gathered and processed for usage more quickly.

UAV Applications in the Public Works Arena

▶ Inspections

- ▶ Existing Bridge Structures (routine, damage, replacement)
- ▶ Quarry and pit site operations and depletion surveys
- ▶ Waste site operations and cell development surveys
- ▶ Construction project progress and conflict resolution surveys

▶ Mapping and Surveying

- ▶ Aerial Photography
- ▶ LIDAR data for 3D modeling of surfaces
- ▶ Environmental assessments and evaluations

UAV Applications in the Public Works Arena

- ▶ Observation and Monitoring
 - ▶ Wildland Fire
 - ▶ Search and Rescue
 - ▶ Environmental Incidents
 - ▶ Transportation Incidents
 - ▶ Pre-emergency/disaster reconnaissance and warning systems
 - ▶ Emergency/disaster response
 - ▶ Post-emergency/disaster recovery efforts
- ▶ Legal records and documentation

Washington State



County Road Administration Board

Jim Ayres, P.E.

Washington State County Road Administration Board (CRAB)

* Design Systems Engineer CRAB

1999- present

* Grays Harbor County Public Works

Civil Engineer 1986 -1999

* BSCE St. Martin's University '86



DRONE (pre UAV) History



Early 1940's German V1 – Buzz



Military Insect
UAV (rumored)



...s Remotely Piloted Vehicle (RPV)

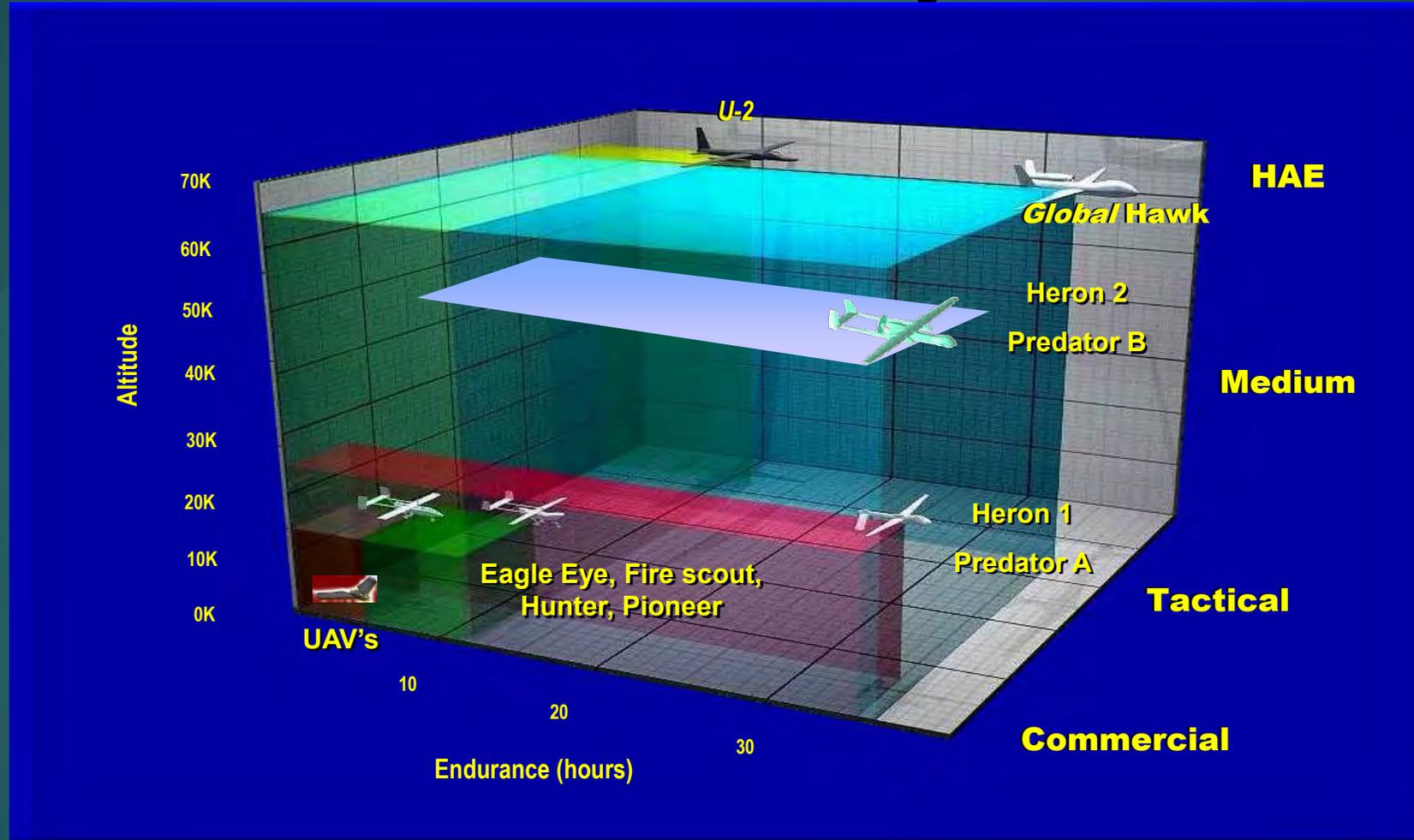


2000's M-9 Reaper

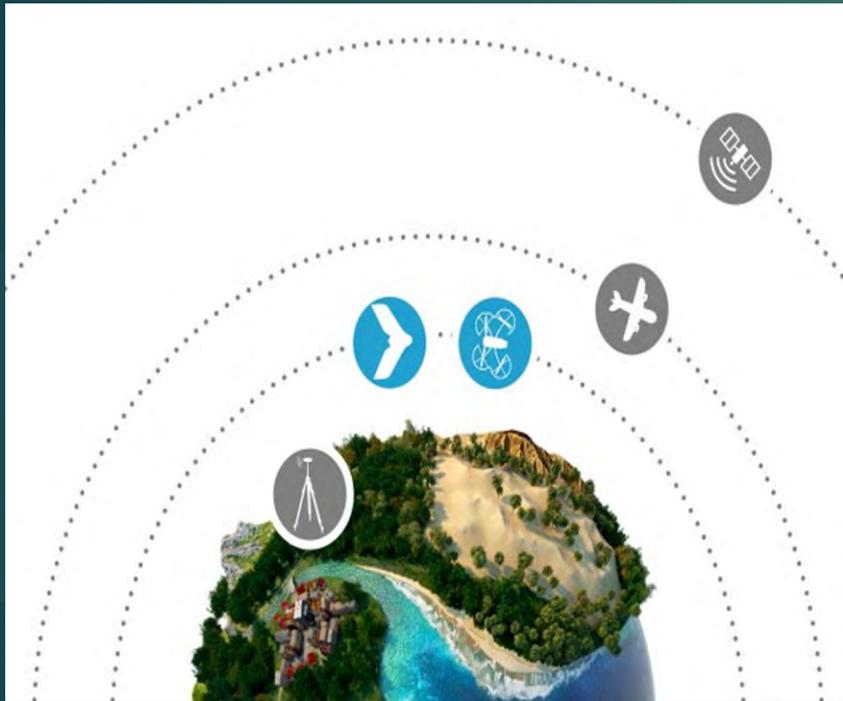


Today's Hobbyist Drones

UAV/UAS Altitude by Class



Filling The Gap (Infographic) UAV's vs Other Geospatial Data Sources



	<ul style="list-style-type: none"> + Extensive coverage + Wide spectral capabilities including LIDAR <ul style="list-style-type: none"> - Relatively low-resolution (down to 30 cm/pixel) - Image timing controlled by provider - Limited coverage in some regions - Imagery susceptible to cloud cover
	<ul style="list-style-type: none"> + Large single-flight coverage + High-resolution (down to 7 cm/pixel) + Wide spectral capabilities including LIDAR <ul style="list-style-type: none"> - Typically expensive (not suited to smaller projects) - Image timing controlled by provider (if external) - Specific flight approval can be required - Operations susceptible to weather - Aircraft availability may be limited in remote regions
	<ul style="list-style-type: none"> + Cost-effective (suits smaller projects) + Imagery can be acquired on demand + Very high-resolution (fixed-wing: 2.5 cm/pixel, rotary: sub-millimetre) + Typically unaffected by cloud cover (due to lower flight altitudes) + Excellent positional accuracy with GCPs or RTK <ul style="list-style-type: none"> - Relatively small single-flight coverage - Drone regulations or bans can restrict usage - Operations susceptible to bad weather - No canopy penetration (unless heavy LIDAR payload) - Difficult to reconstruct imagery with few tie points (for example, imagery of homogenous terrain or water)
	<ul style="list-style-type: none"> + Excellent positional accuracy + Just the data required (no data overload) + Very high resolution + On the go data classification (vector/meta data) <ul style="list-style-type: none"> - Slow, labour-intensive collection - Equipment can be expensive (e.g. laser scanner) - Line-of-sight issues - Difficult to record tops of features - Some sites inaccessible on foot - Limited graphical outputs (depending upon equipment)

© senseFly 2015



Why use UAV's for Transportation Projects?

1. High Precision UAV mapping accuracy is similar to GPS
2. Worker Safety & Labor spent mapping using a UAV is considerably lower than GPS Surveying
3. Photographic Data – Quality Assured



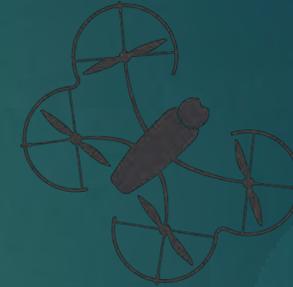
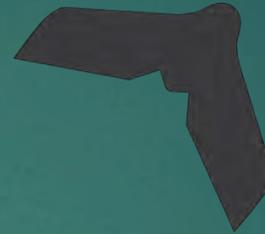
County Demonstration Project Scope

- Utilize UAV technology in case studies at various locations through Washington State.
- Investigate & Evaluate the UAV's capabilities and effectiveness in improving Mapping and Reducing Mapping/Inspection costs.
- UAV technologies were investigated to evaluate their capabilities as they relate to county road and bridge projects.

Today's Transportation Inspection & Surveying Tools....

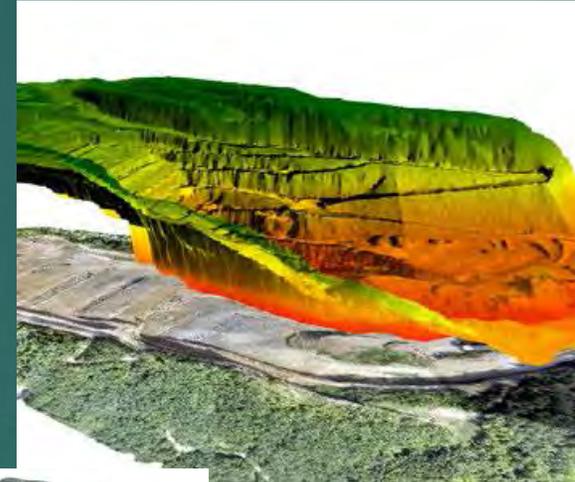
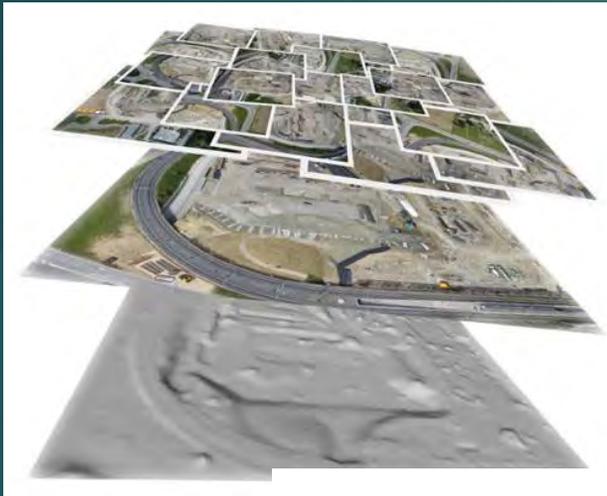


Two Types of UAV': Fixed-wing vs rotorcraft



coverage	large areas	small areas
takeoff & landing	linear	spot
object resolution	Inch/pixel	mm/pixel
oblique imagery	0° to -50°	+90° to -90°
3D mapping of infrastructure	difficult	much easier
Close-up inspection	not adapted	well adapted

Each UAV Type Produces Geo-referenced orthomosaics, Digital Surface Models, and Point Clouds



Example of Fixed Winged UAV's



The UAV is good to go for launch -



**Phyllis Kanyer,
Kitsap County Surveyor**

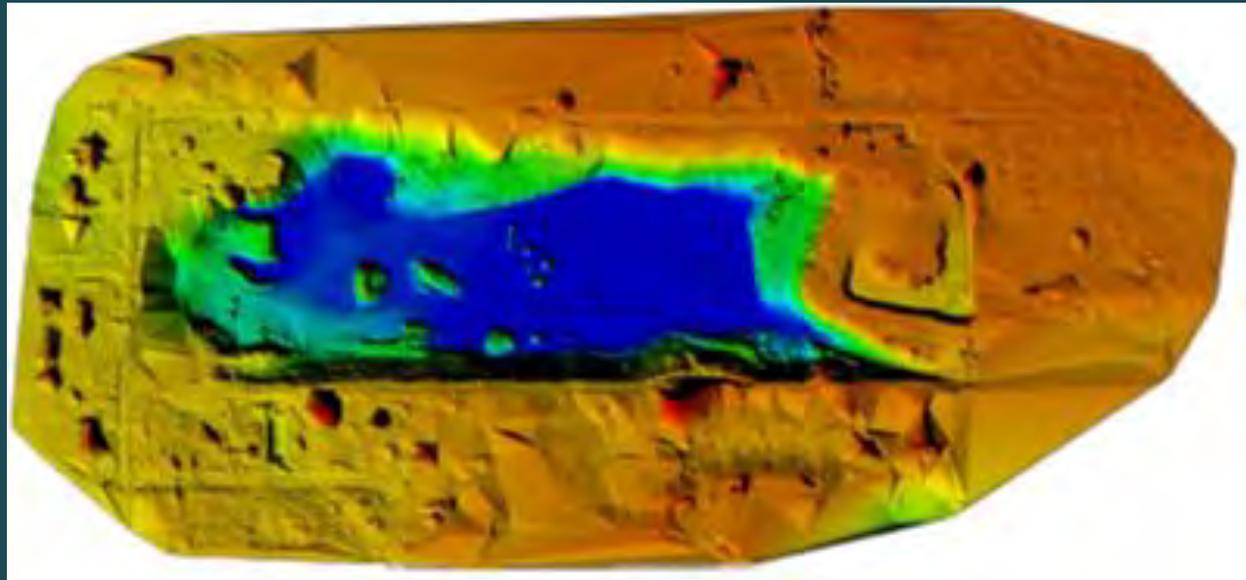
▶ Click on image to begin video

- ▶ THIS IS A COMPOSIT OF THE PHOTOS TAKEN DURING THE FLIGHT.



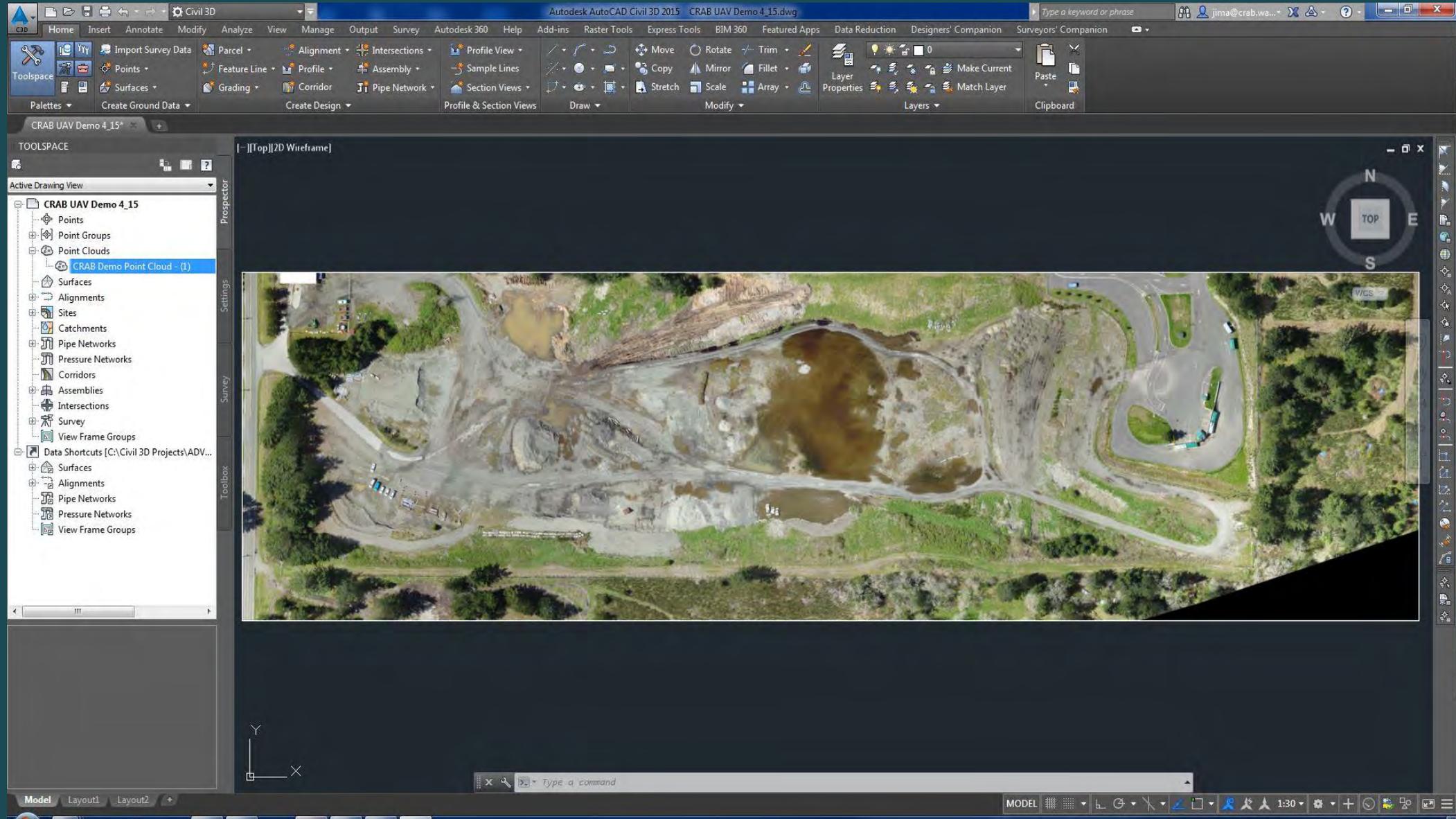
- ▶ 129 PHOTOS WERE TAKEN, ONLY 124 WERE USED DUE TO THE EAGLE.

▶ THE SOFTWARE CONVERTS THE PHOTOS INTO A DIGITAL SURFACE MODEL.



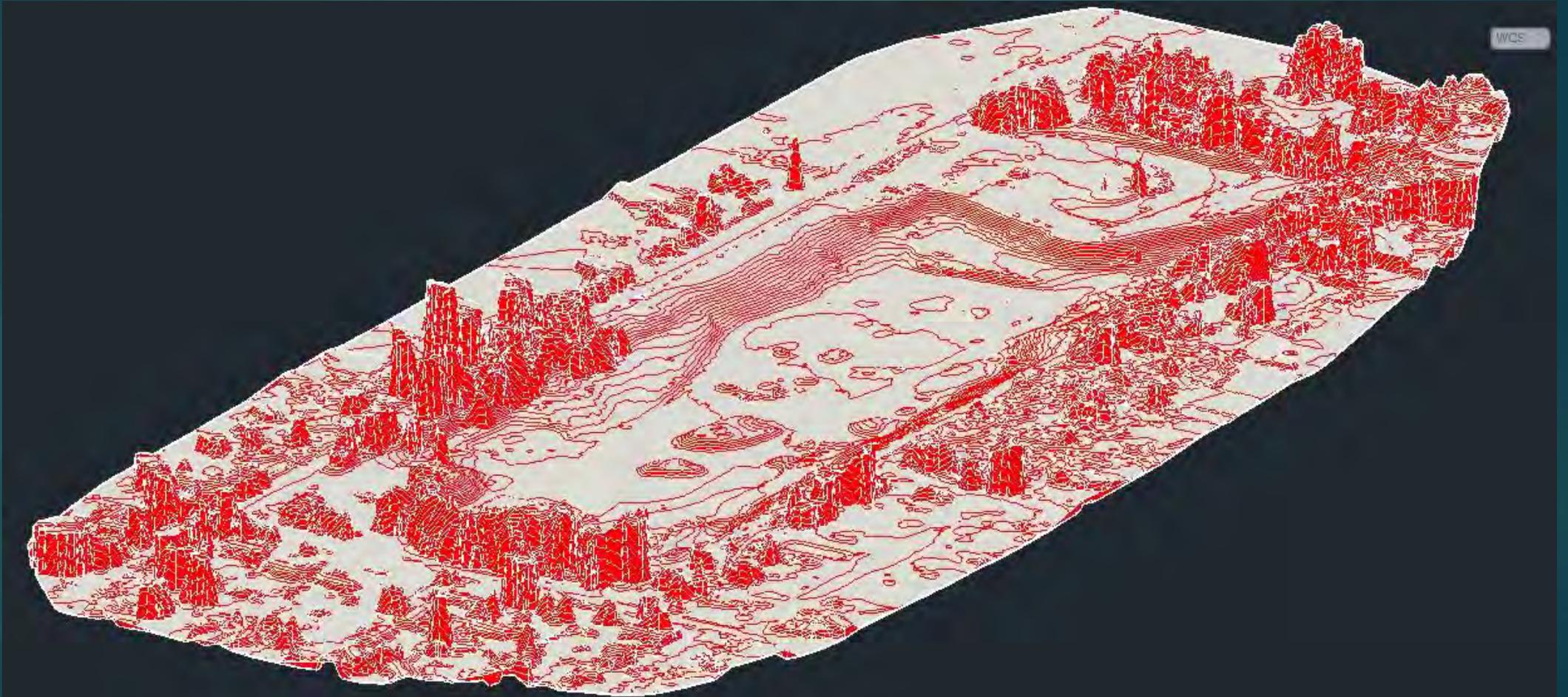
STOCK PILES CAN BE SELECTED AND
VOLUMNS CALCULATED.

Photographic rich data seamlessly imported into a design System CAD program for surface creation.



Design System Software

- Point Cloud Creation
- Surface Creation



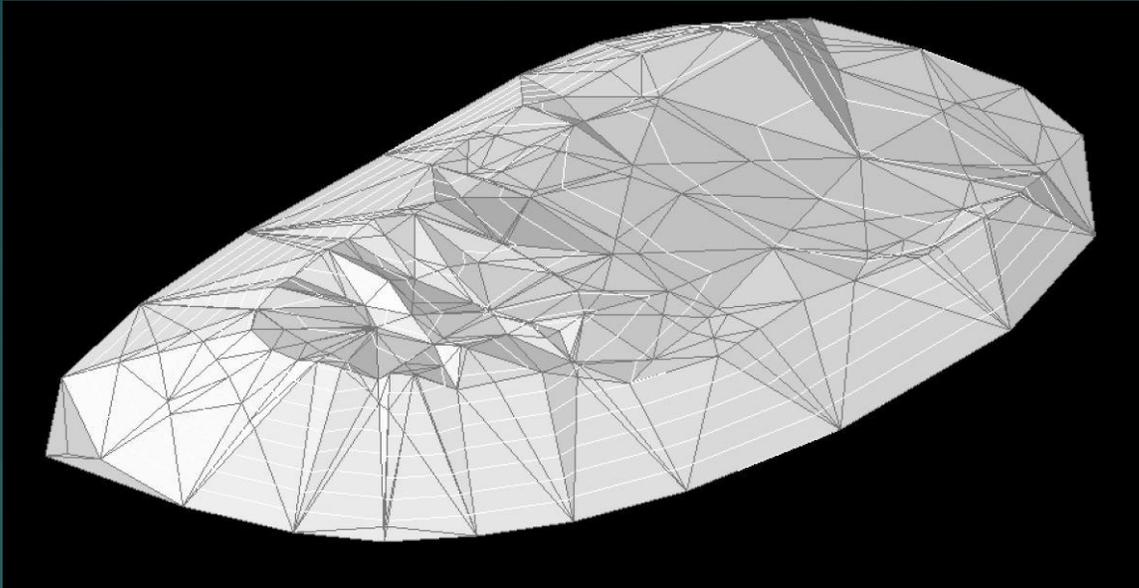
Stockpile Surface Quality Comparison and Volumes

Field Demo Results:

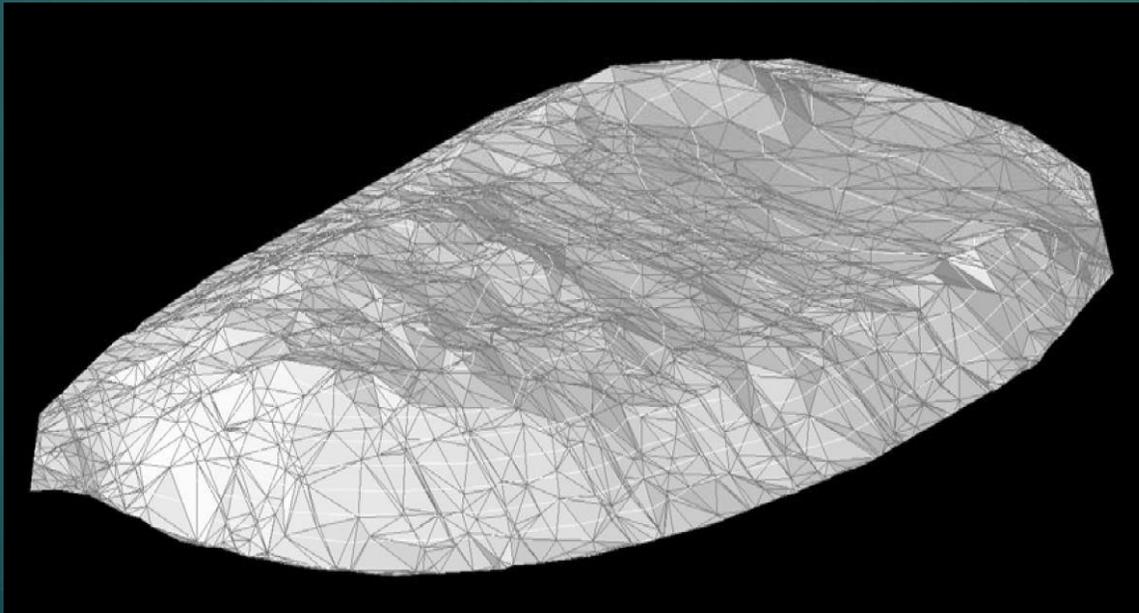
Flight distance
> **2.6 Miles**

Land area mapped
> **30 acres**

Total flight time
9 minutes



Conventional Survey
Surface:
Volume = **4,236** C.Y.



UAV Surface:
Volume = **3,838** C.Y.

Types of Rotorcraft UAV's



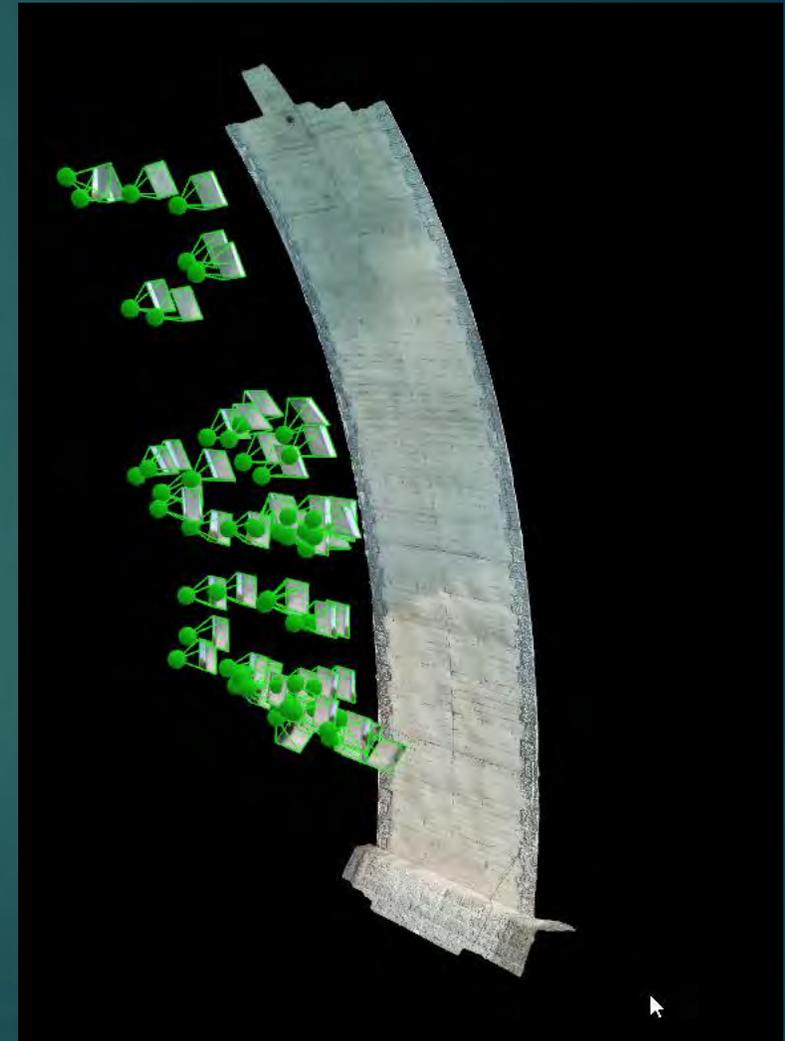
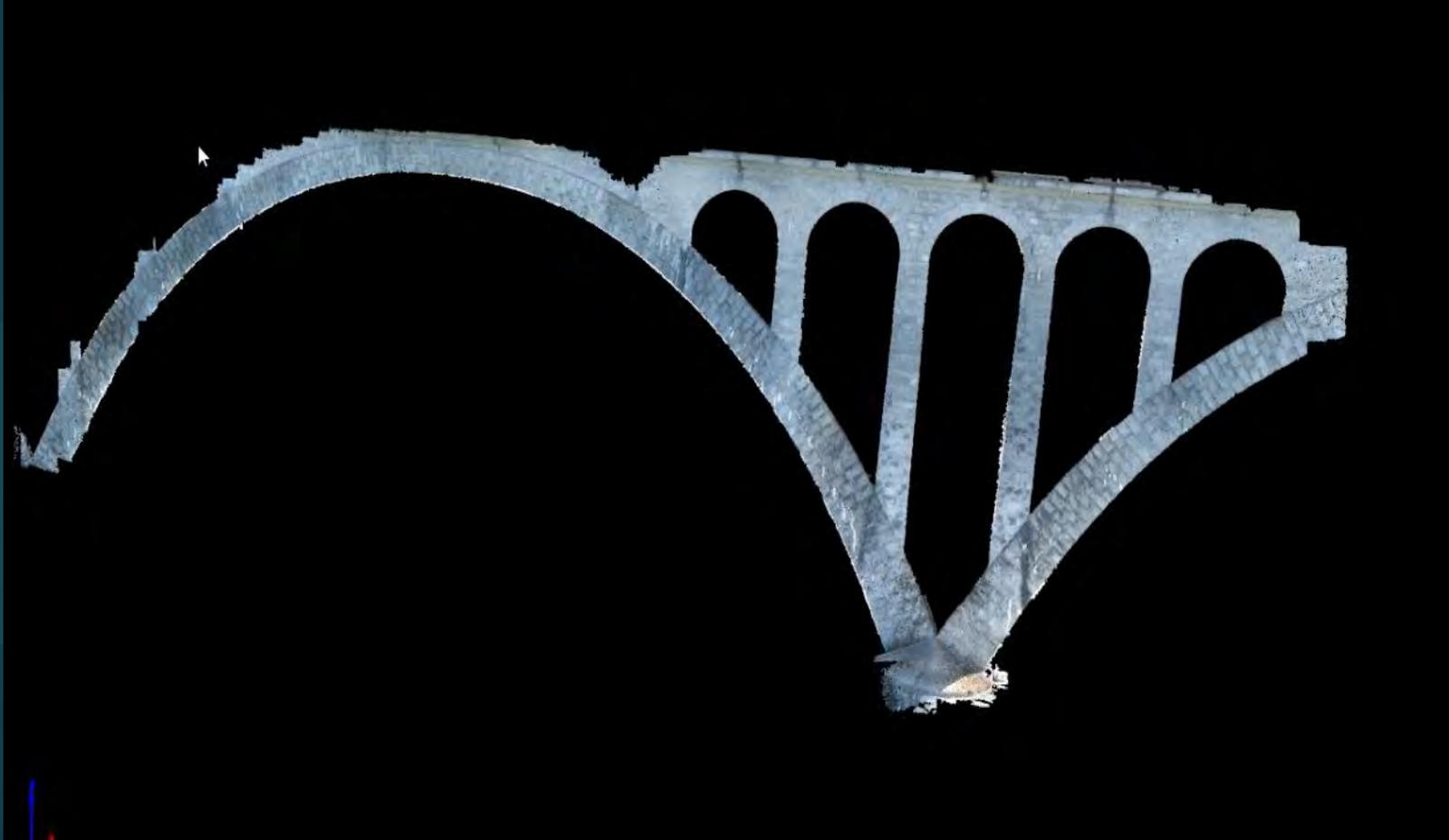
3 typical applications



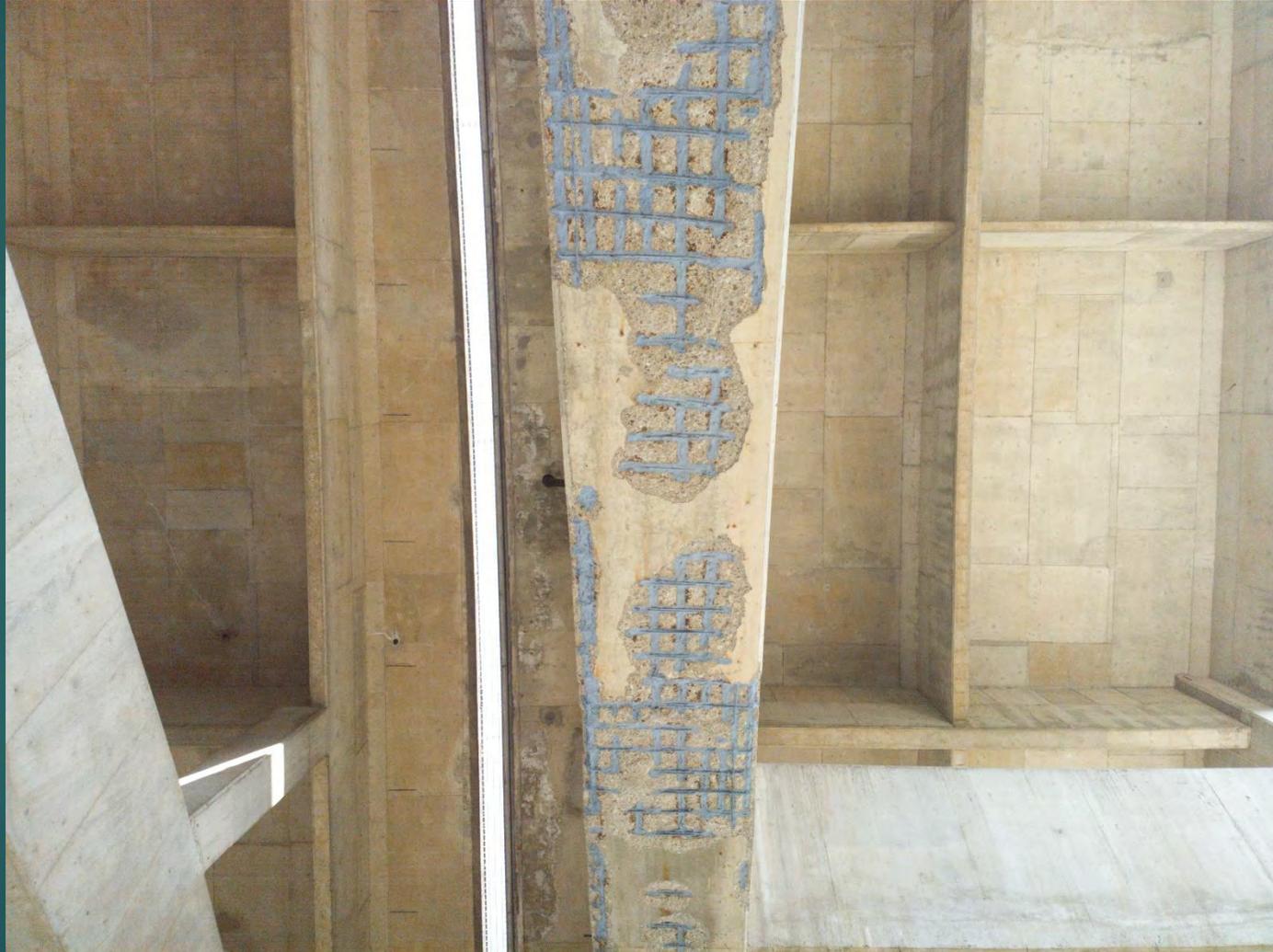
Bridge inspection



Bridge inspection: Arch Condition Rating



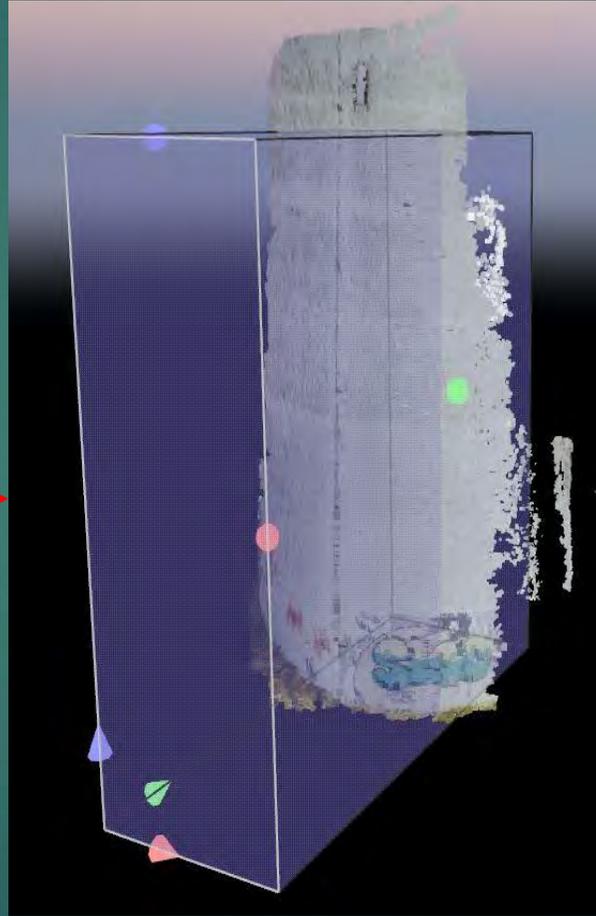
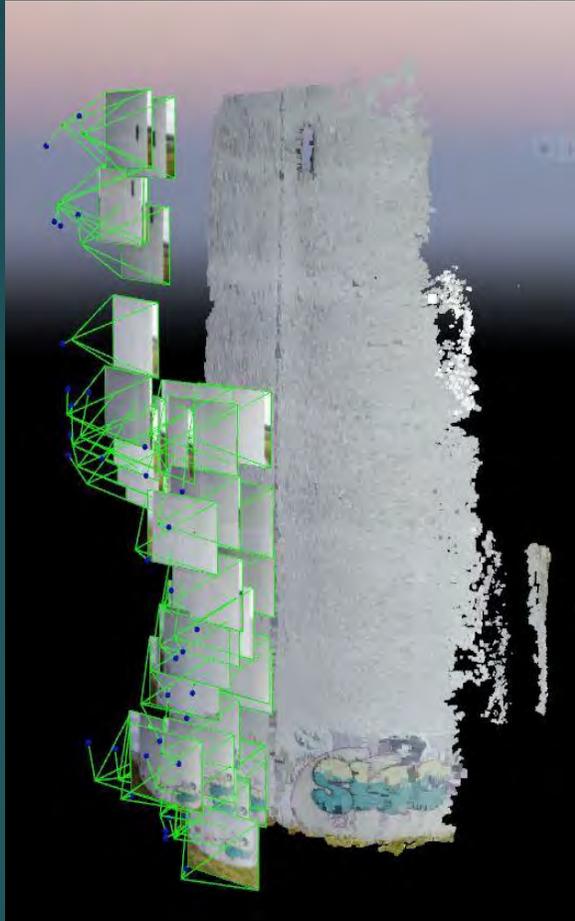
Bridge inspection: Girder rebar



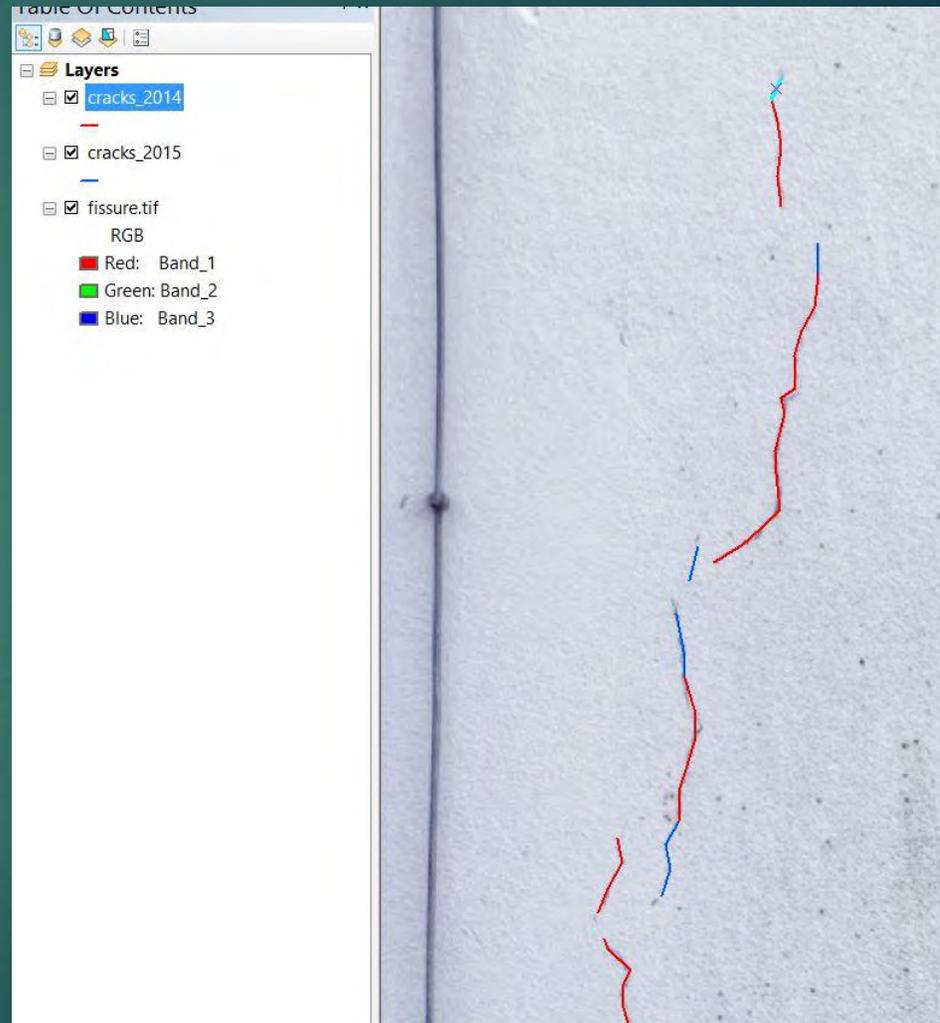
Bridge inspection: piers



Bridge Pier – Mapping Cracks



Cracks detection and monitoring



Rock Face Inspection's

- ▶ 15 minutes flight
- ▶ 36 ft distance from cliff
- ▶ 0.01 Ft. or 0.3 cm / pixel.



- ▶ Cracks & potential rockfalls clearly visible (useful for volume / mass estimation & reinforcement planning)

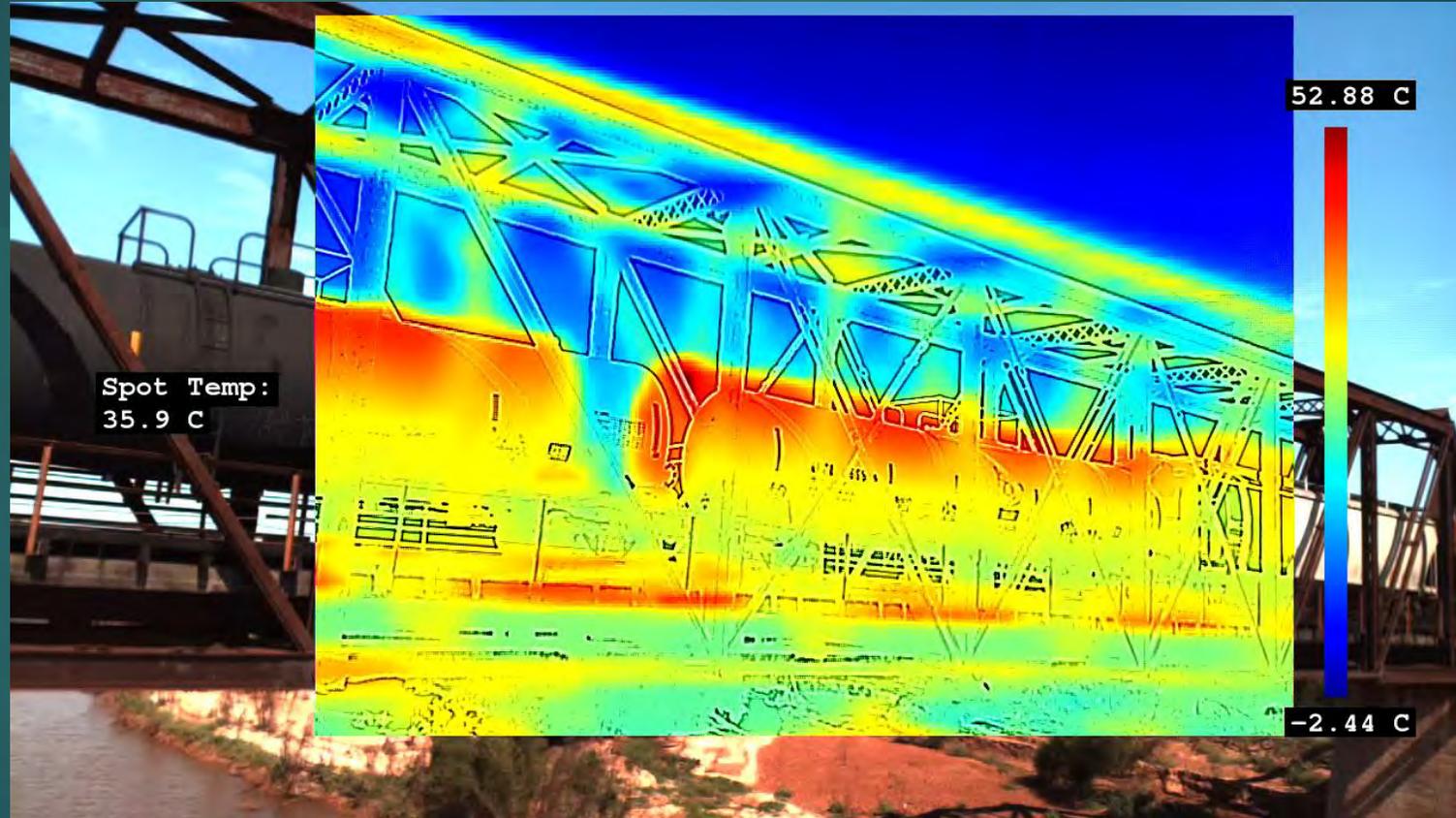
Truss Bridge inspection:



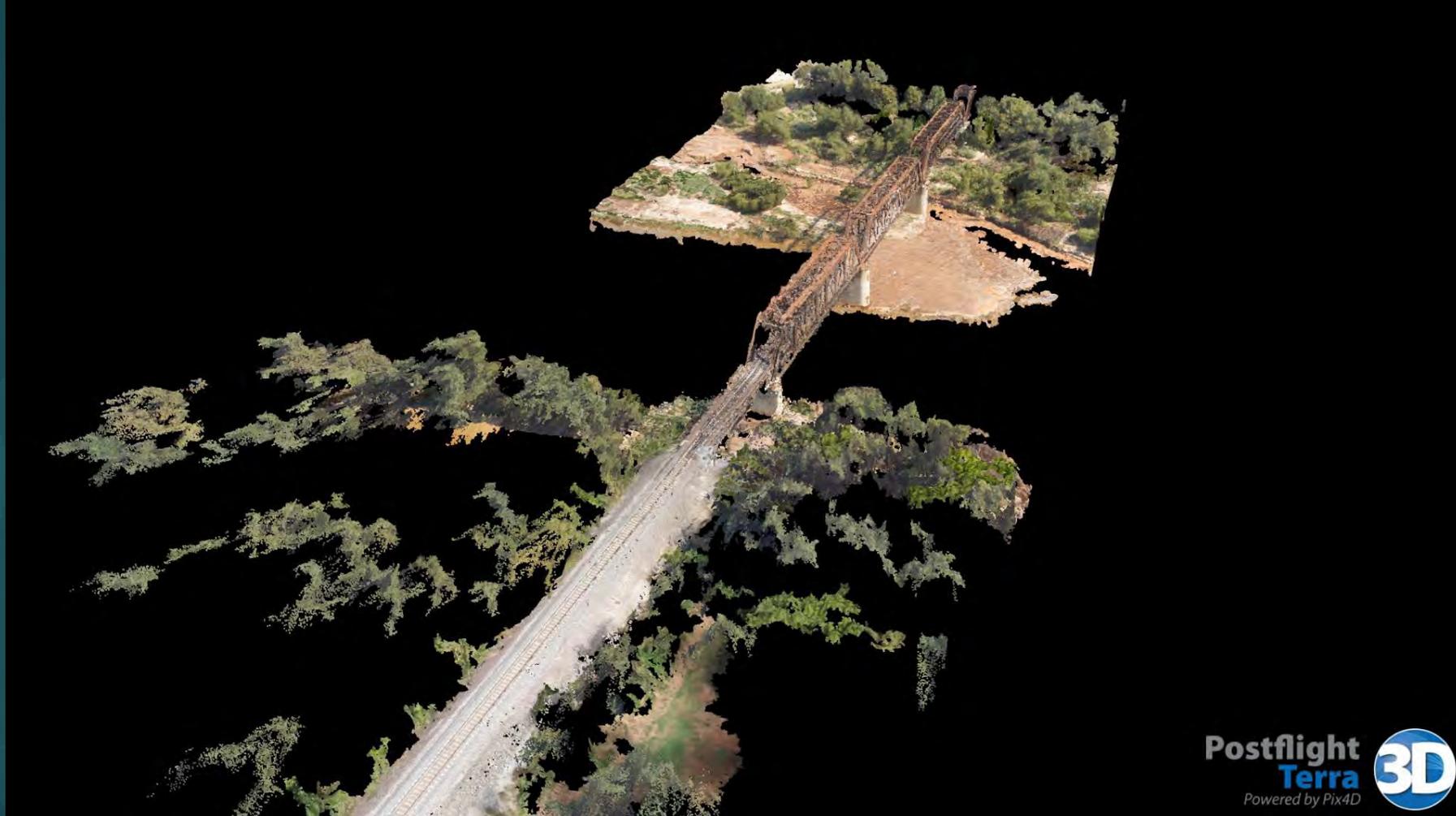
Bridge inspection: Substructure difficult to Access.



Bridge inspection: Use of InfraRed Payload



INFRASTRUCTURE ARCHIVE MODELING



Postflight
Terra
Powered by Pix4D



Congress Tells FAA to Get Busy



License Timeline

- **February 3, 2012** – Incorporate UAS ops safely into the NAS system without being a huge burden on the owners/operators, which they are obligated by congress to do so, in the [Airspace Modernization Act of 2012](#).
- **March 7, 2012** – Issued notice it was looking for 6 test sites
- **May 14, 2012** – Public Safety can fly up to 25 lbs. UAV's without license:
 - UAS must be flown within the LOS (line of sight) of the operator,
 - less than 400 feet above the ground,
 - during daylight conditions, and
 - inside Class G (uncontrolled) airspace and more than five miles from any airport or other location with aviation activities.*Current FAA regulation 333 Exemption is the only current system for commercial UAS compliance....*

Until FAA Part 107 rules proposed for 2016...



What's different about Part 107 from Section 333?

- **No need for previously licensed FAA pilot as operator.**
- **An extra VO (Visual Observer) is not required for flights.**
- **No need for Air Traffic Control clearance in class G airspace.**
This is a big deal!



***In conclusion, UAV Technology
In transportation projects;***

- 1. When compared to conventional aircraft, because a UAV is easier, safer, and more efficient.**
- 2. High Precision UAV mapping accuracy is comparable to GPS accuracy.**
- 3. Photographic rich data, quality assured, owner managed, imports seamlessly into Design Systems for Digital Surface Modeling**