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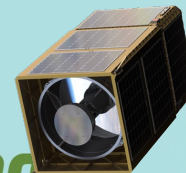




# Midwest

## DAMAGE PREVENTION TRAINING CONFERENCE

2023 • FRENCH LICK, IN



### IN ORBIT –

# Routine Infrastructure Monitoring Solutions from Space are Taking Off!!

**R. Peter Weaver**

*Vice President, Business Development*




Orbital Sidekick





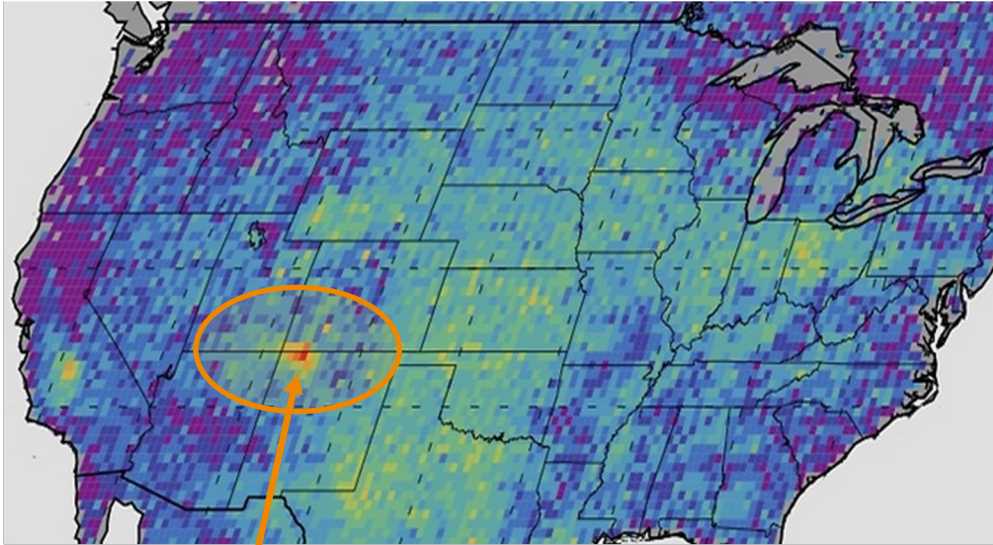
## Our Agenda:

- Satellite Detection History (ref. )
- Leak Detection State-of-the-Art
- The Commercial Space Marketplace
- Hyperspectral & Remote Sensing
- Compliance – PHMSA (also EPA)
- The Operator's Perspective





# The World's First Methane Anomaly Detected from Space



## “Four Corners,” U.S.A.

*Reported in 2012*

- ESA SCIAMACHY Sensor
- 2003 – 2009 Collections, *averaged*
- 30 km x 60 km pixel

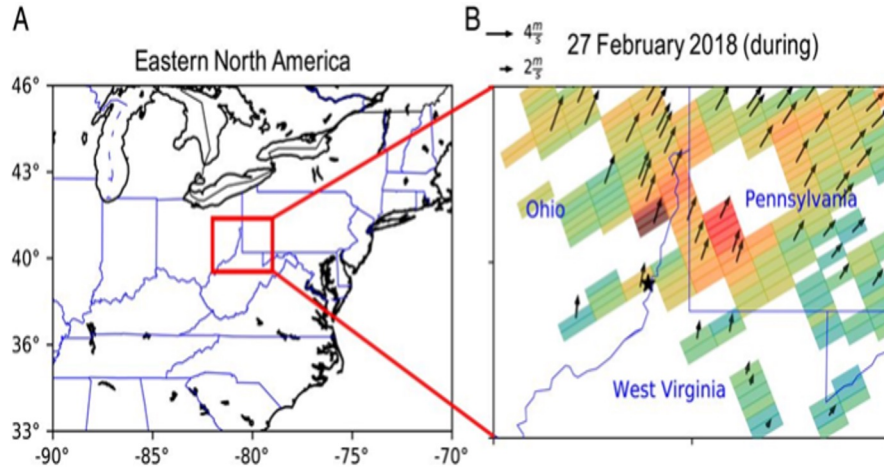


# World's First Single-Pass CH<sub>4</sub> Detection

Belmont County, OH U.S.A.

*February 2017*

- ESA Sentinel-5P Sensor
- Blowout: 120 tph for 20 days
- 7 km pixel




Map view List view

**News**

- 2023-04-20 - Power Generation - Cameroon
- 2023-04-16 - Mud Volcano - Indonesia
- 2023-04-06 - Oil & Gas - South Africa
- 2023-04-22 - Waste Management - Bolivia
- 2023-03-24 - Oil & Gas - Iran

[SEE ON MAP](#)

This observation is from an oil & gas source in Iran emitting at a rate of 1,863 kg/h.



2023-03-14 - Waste Management - Vietnam

2023-03-04 - Mining - Colombia

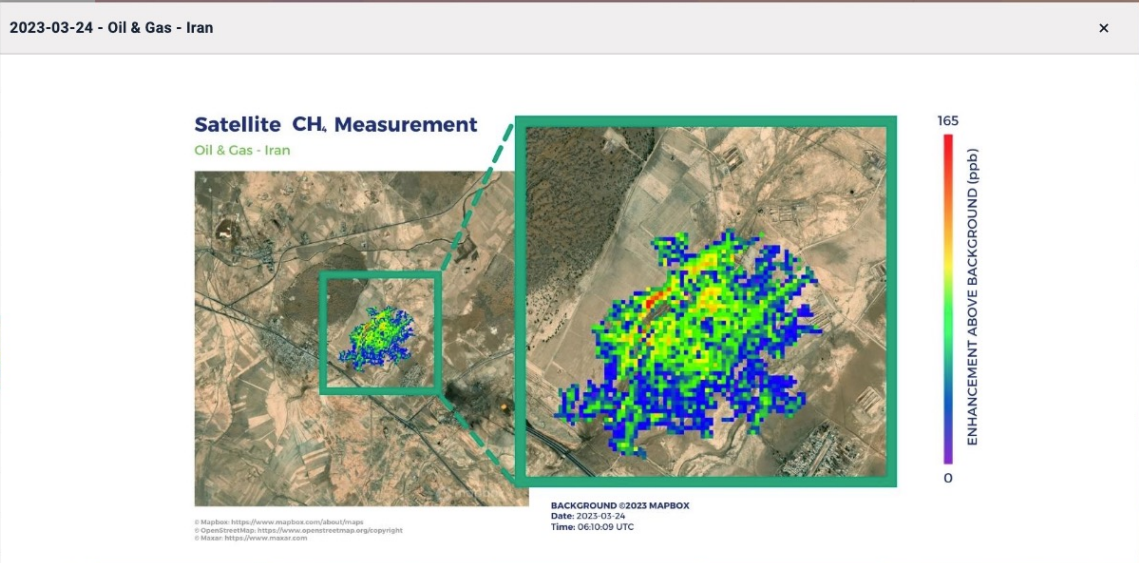
2023-03-01 - Oil & Gas - Mexico

2023-02-27 - Oil & Gas - Mexico

2023-02-14 - Mining - Russia

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V 1.0.13    [Terms of Use](#) | [Leaflet](#) | Powered By [Esri](#) | [GHGSat](#) | Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

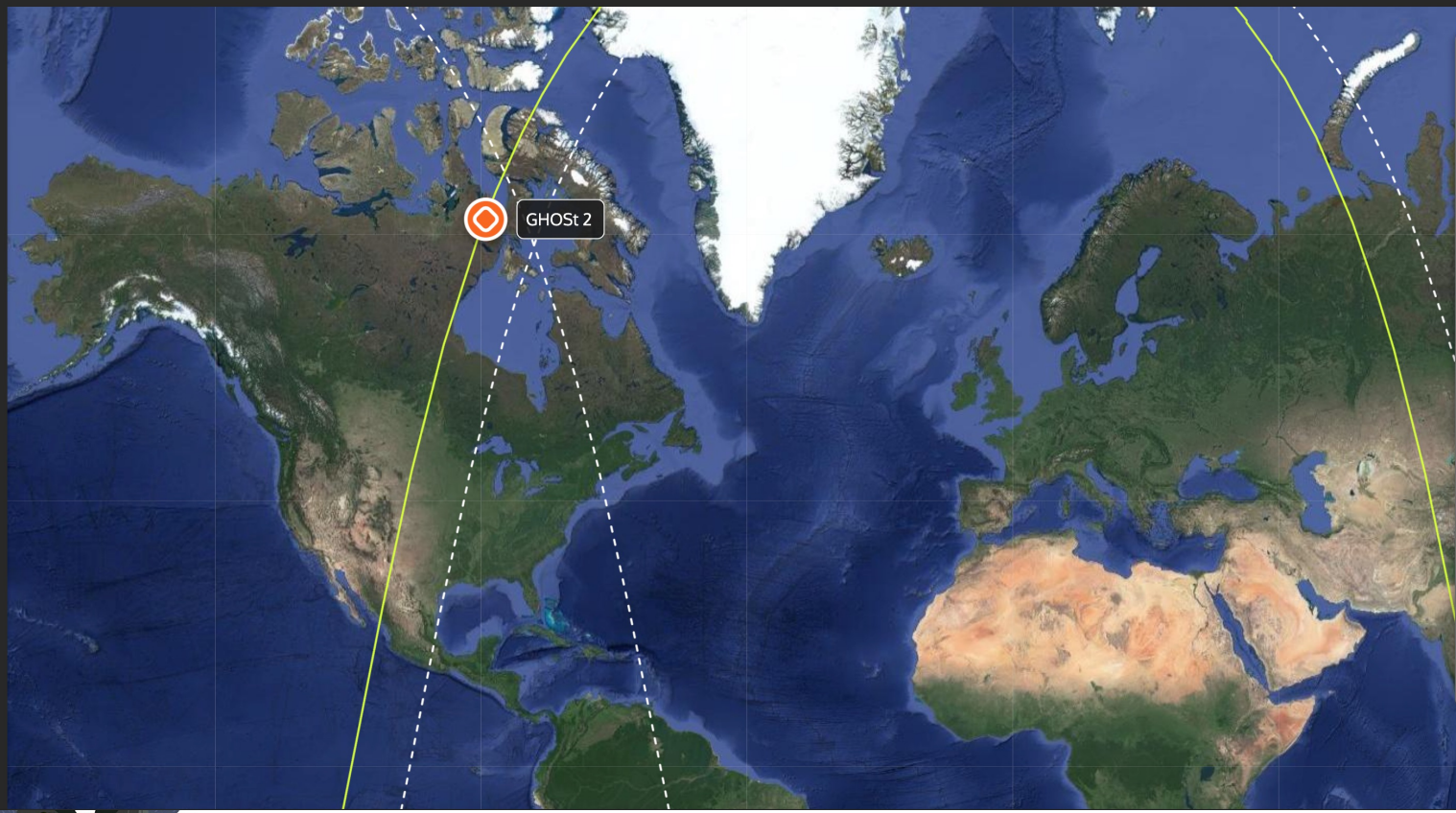
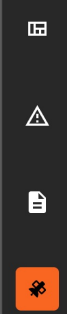


Analytics From  
Sep 30 to Oct 06, 2023

3 km  
2 mi



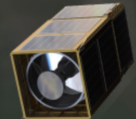




### GHOSSt 2 ✕

Location:  
67.73931395249008, -89.05500060263395

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Apr 15 2023 Vandenberg  
Launch Date Launch Site


Earth Observation Active ●  
Spacecraft Type Status

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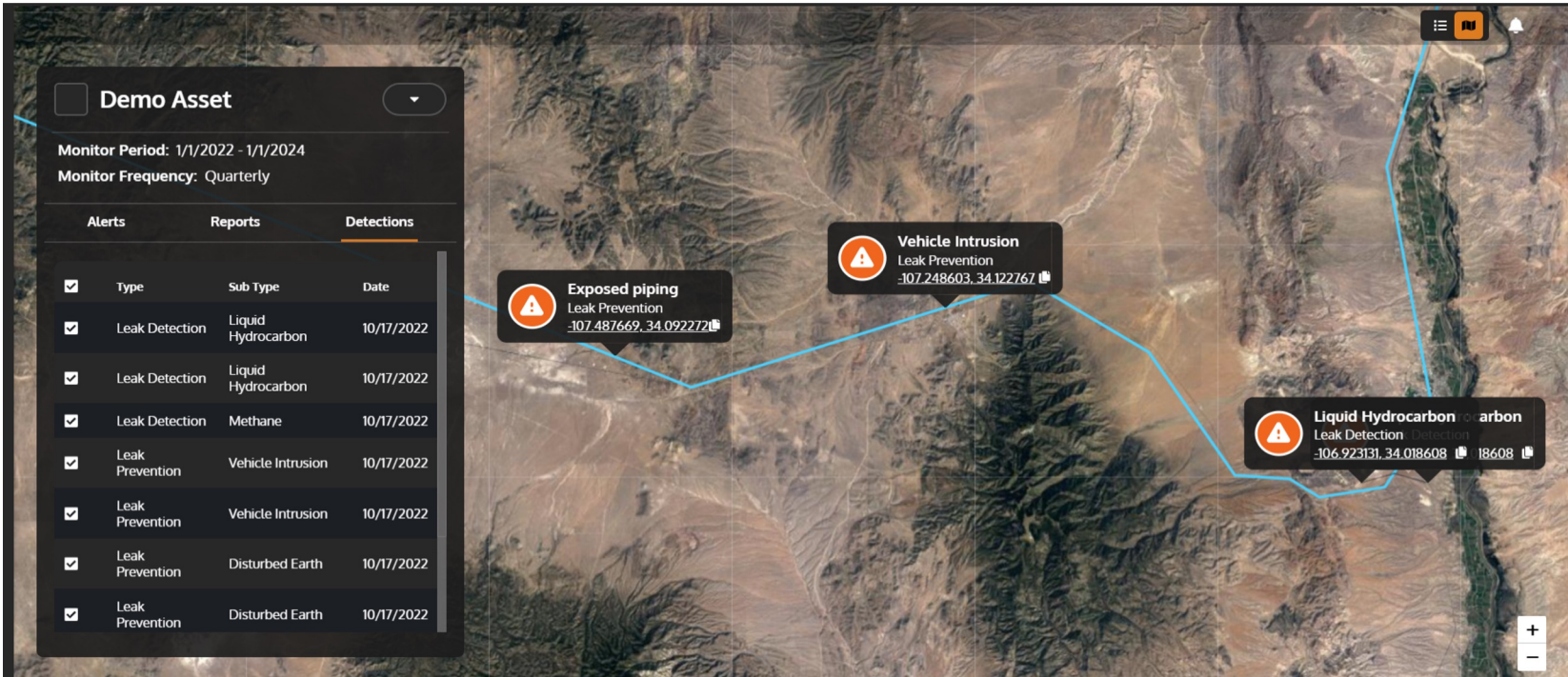
 **472 Bands**

 **400-2500 NM**

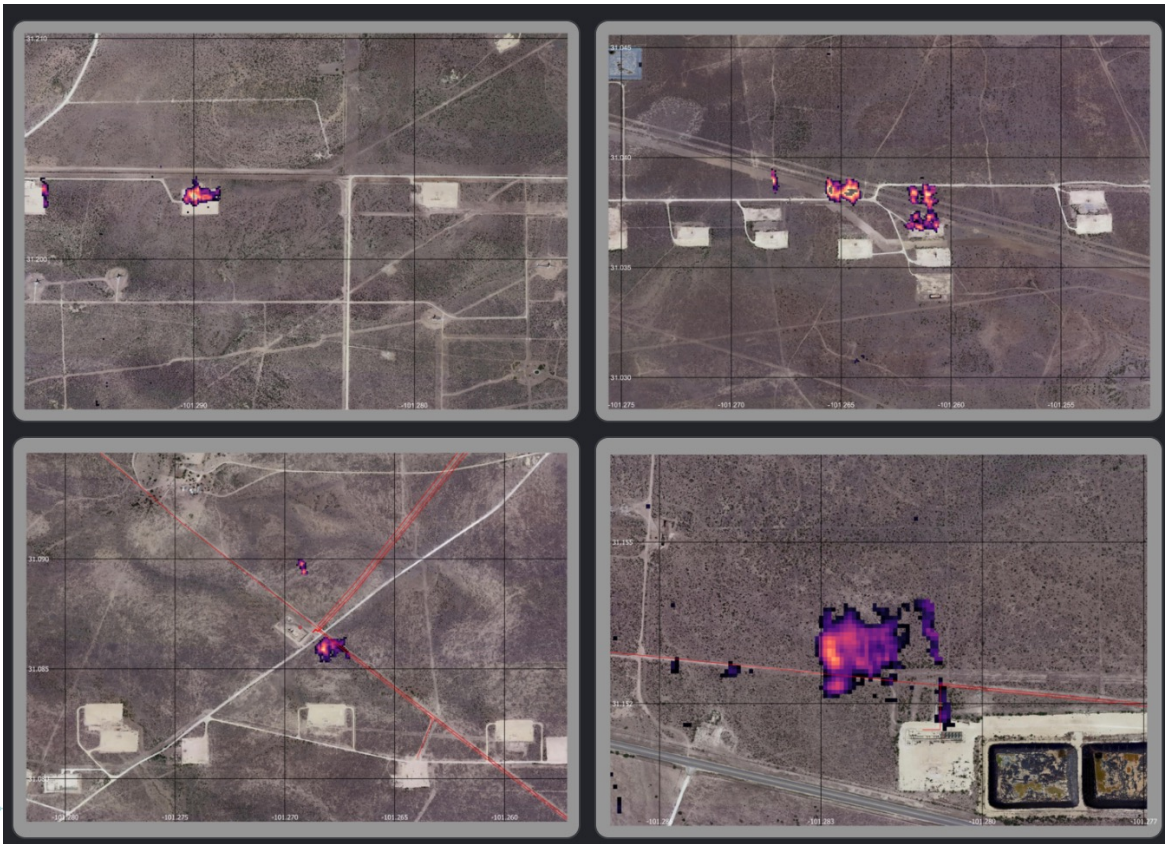
 **8M HSI**

 **3 Meter Grayscale**









## Alerts

20220727\_01\_02\_008

Leak Detection Liquid Hydrocarbon



20220727\_01\_02\_002

Leak Detection Liquid Hydrocarbon



20220727\_01\_02\_006

Leak Detection Liquid Hydrocarbon



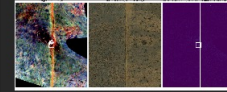
20220423\_01\_01\_21

Leak Detection Gas Plume



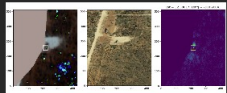
20220423\_01\_01\_22

Leak Detection Gas Plume



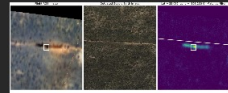
20220423\_01\_01\_24

Leak Detection Gas Plume



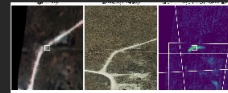
20220423\_01\_02\_03

Leak Detection Liquid Hydrocarbon



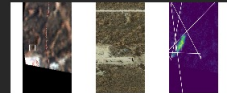
20220423\_01\_02\_09

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_14

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_23

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_36

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_57

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_58

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_60

Leak Detection Liquid Hydrocarbon



20220423\_01\_02\_64

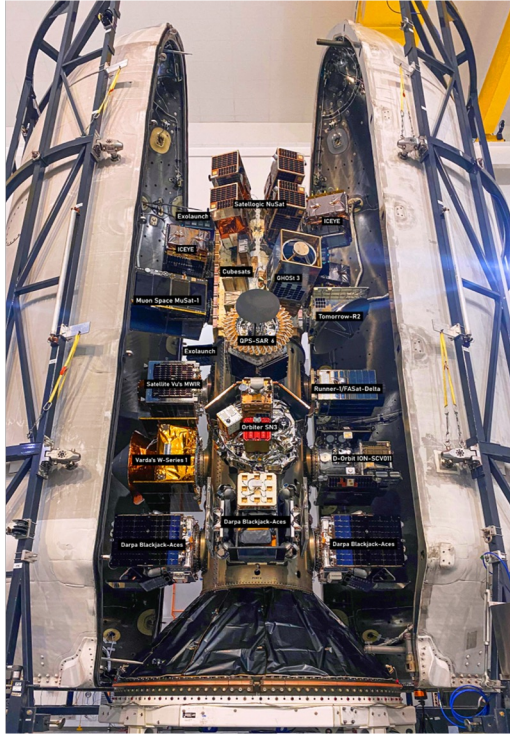
Leak Detection Liquid Hydrocarbon



# Deploying the Next Generation of Sensors into Orbit







# SPACEX

AVAILABLE FLIGHTS > PLATE SELECTION > ADD-ONS > DEPOSIT > FLIGHT REVIEW > SUBMISSION

## RIDESHARE PROGRAM

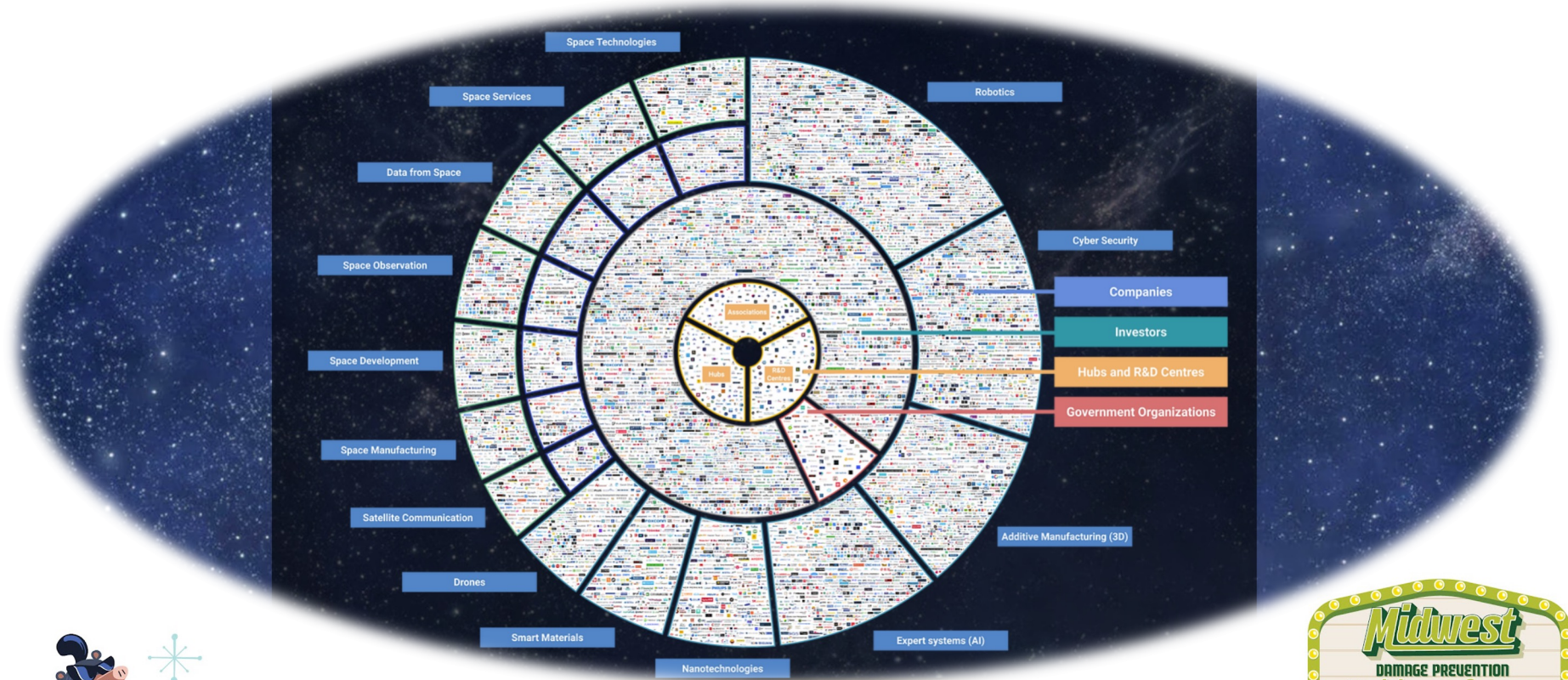
DESIRED ORBIT: LEO    
 NO EARLIER THAN: 12/2023    
 INPUT PAYLOAD MASS: 50 kg   
 ESTIMATED PRICE: \$0.28 M

### AVAILABLE FLIGHTS

SEE ALL FLIGHTS > SEE DEDICATED RIDESHARE FLIGHTS >

DATE	ORBIT	PERIGEE	APOGEE	SEMI-MAJOR AXIS ALT.	INCL.	AVAILABILITY	
04/2024	LEO	--	--	550-605km	45.4±0.1	1/4, 1/2, Full	<input type="button" value="→"/>
11/2024	LEO	--	--	550-605km	45.4±0.1	1/4, 1/2, Full, XL	<input type="button" value="→"/>
02/2025	LEO	--	--	550-605km	45.4±0.1	1/4, 1/2, Full, XL	
05/2025	LEO	--	--	550-605km	45.4±0.1	1/4, 1/2, Full	

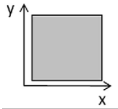




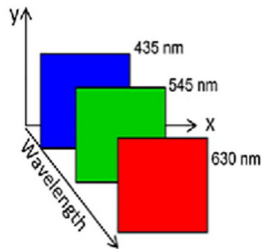


# What Is Hyperspectral Imagery?

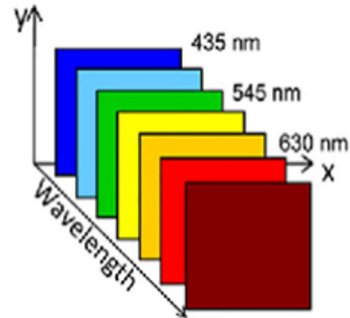
Monochrome



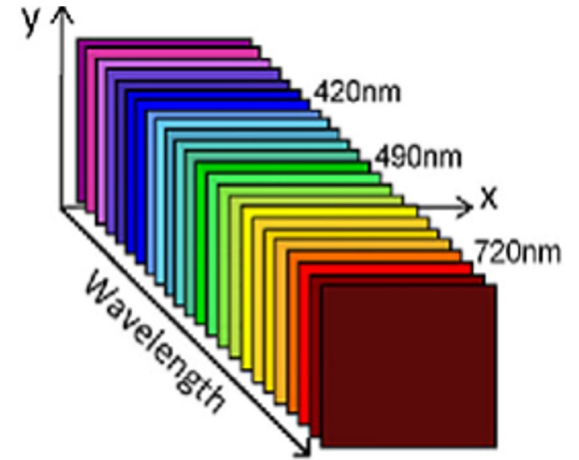
“True Color” (RGB)



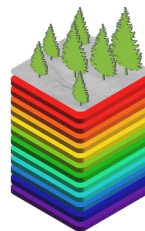
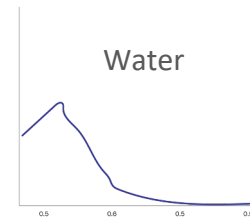
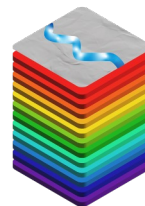
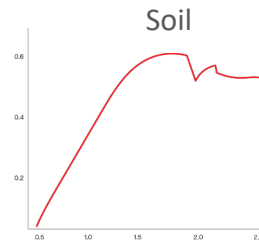
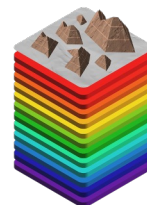
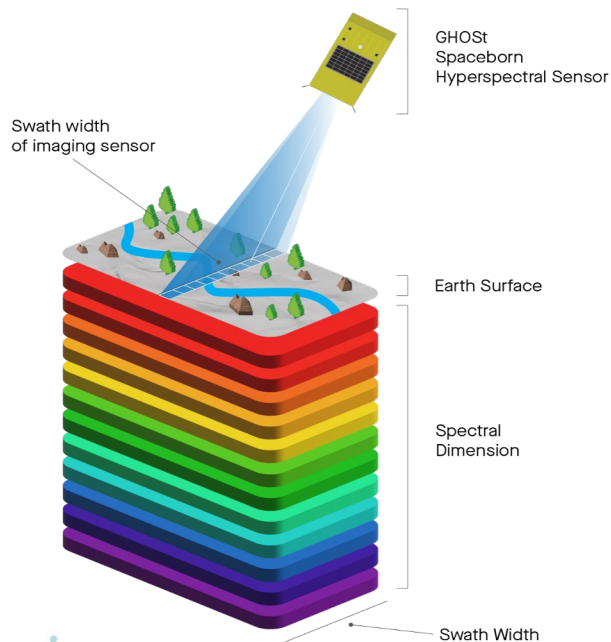
Multispectral



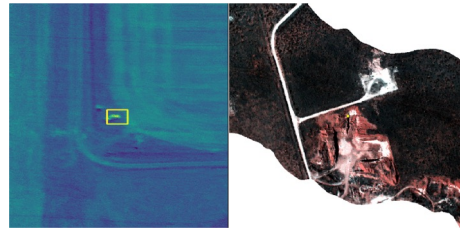
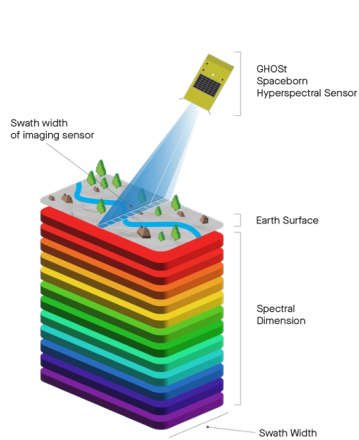
Hyperspectral



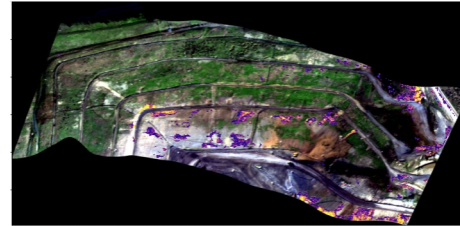
# What is Hyperspectral Monitoring?



# Using Hyperspectral Monitoring

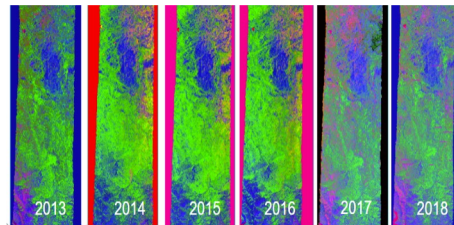
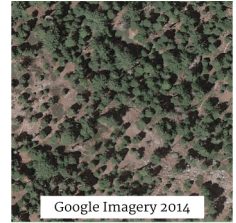


Right-of-Way Intrusion

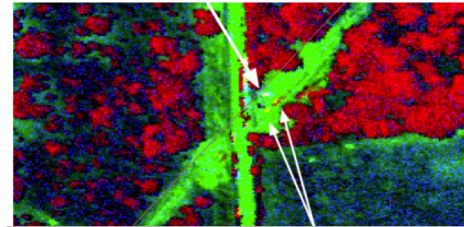


Plume Detection

Change detection



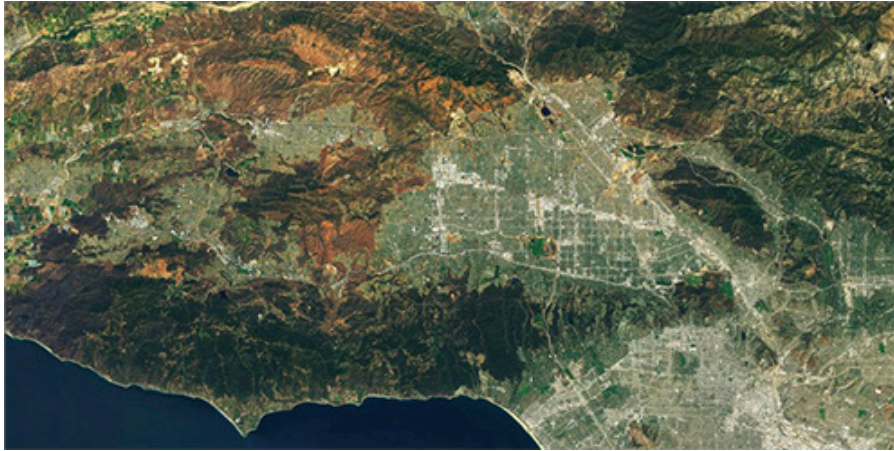
Vegetative Health



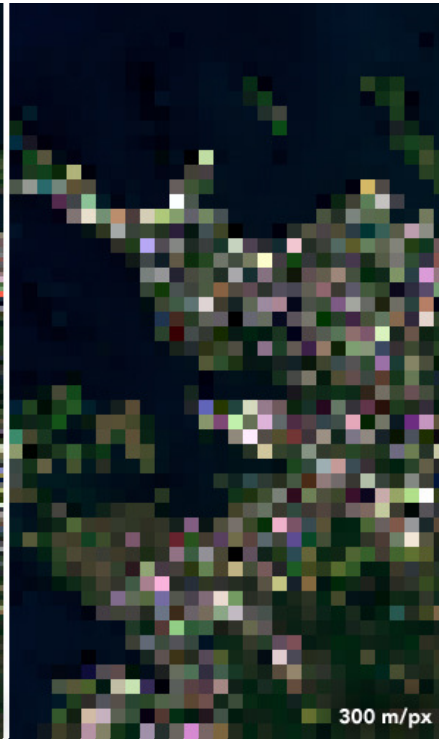
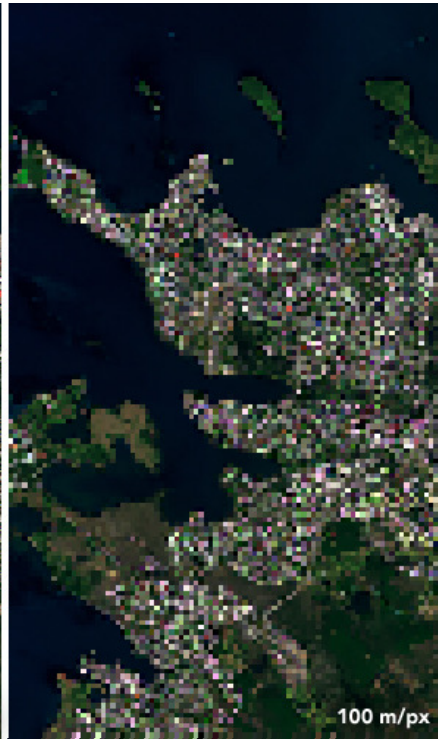
Hydrocarbon Detection



# Putting HSI Into Practice





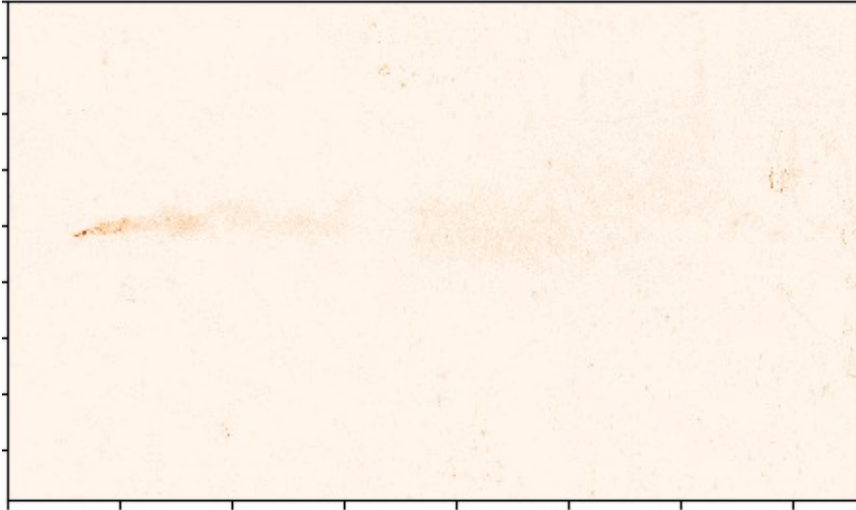


How Big is YOUR Pixel??

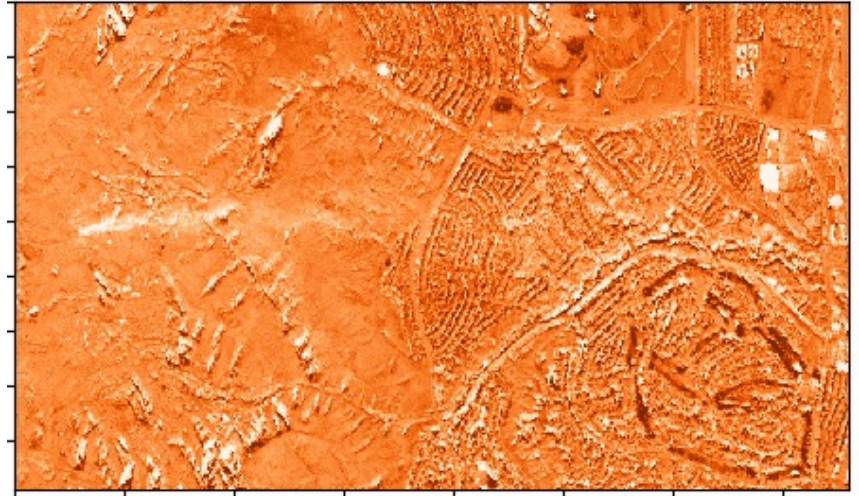




OSK Index



Methane Index



Putting it All Together



# Appeasing the Compliance Gods... PHMSA? / EPA? / States?

- Soil Disturbances
  - Construction / digging
  - Erosion
  - Landslides
- Vehicle Detection
- Building / Structure detection
- Hydrocarbon detection
- ***Methane***

*... And, generally, changes over time*





Figure 4. Example of

“Other appropriate means” *may* include satellite imagery if this method *compares* to the other specified methods.



Figure 1. Identification of Vehicles and Mechanical Threats on or near a Right of Way



Figure 2. Identification of a Liquid Hydrocarbon Spill with Geospatial Outline of the Affected Area.

Other appropriate means may include satellite imagery if this method compares to the other specified methods. However, the satellite imagery in your examples did not provide sufficient resolution to provide the necessary details of the surface conditions on or adjacent to each pipeline right-of-way. Therefore, the satellite imagery as you submitted, cannot be used as an appropriate means. If we can be of further assistance, please contact Tewabe Asebe at 202-366-5523.





Figure 4. Example of

“Other appropriate means may include satellite imagery if this method compares to the other specified methods.”

“(T)he satellite imagery as you submitted cannot be used as an appropriate means.”



Figure 1. Identification of Vehicles and Mechanical Threats on or near a Right of Way



Figure 2. Identification of a Liquid Hydrocarbon Spill with Geospatial Outline of the Affected Area.

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# Meeting the Requirements for “Other Specified Methods”:

## Regulation

- Mechanical Threats
- Land Disturbances
- Soil Washout / Movement
- Vegetative Health
- Presence of Liquid Hydrocarbon

## Hyperspectral “Filter”

- Vehicle Encroachment
- Digging and Construction
- Fresh Soil Exposures & Erosion
- NDVI Vegetative Health
- Direct Detection of Contamination & CH<sub>4</sub>

plus Change Detection





# The Operators' Perspective

## Constellation Downlink

Data is captured on demand over desired targets and transferred for immediate analysis



1

## Hyperspectral Analysis

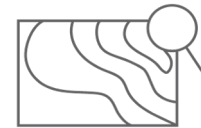
Automated algorithms rapidly and confidently identify “chemical fingerprints” of the issues we care about



2

## Insights Shared Online

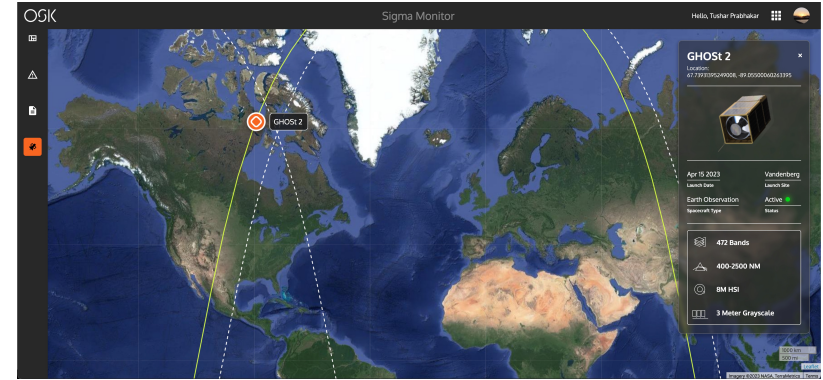
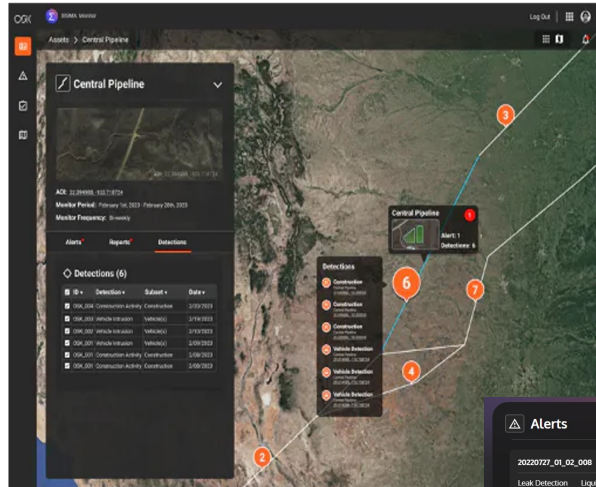
Validated insights are pushed rapidly to whomever needs them, delivering value



3



# Dude in the Truck? Management? Or the Regulator?

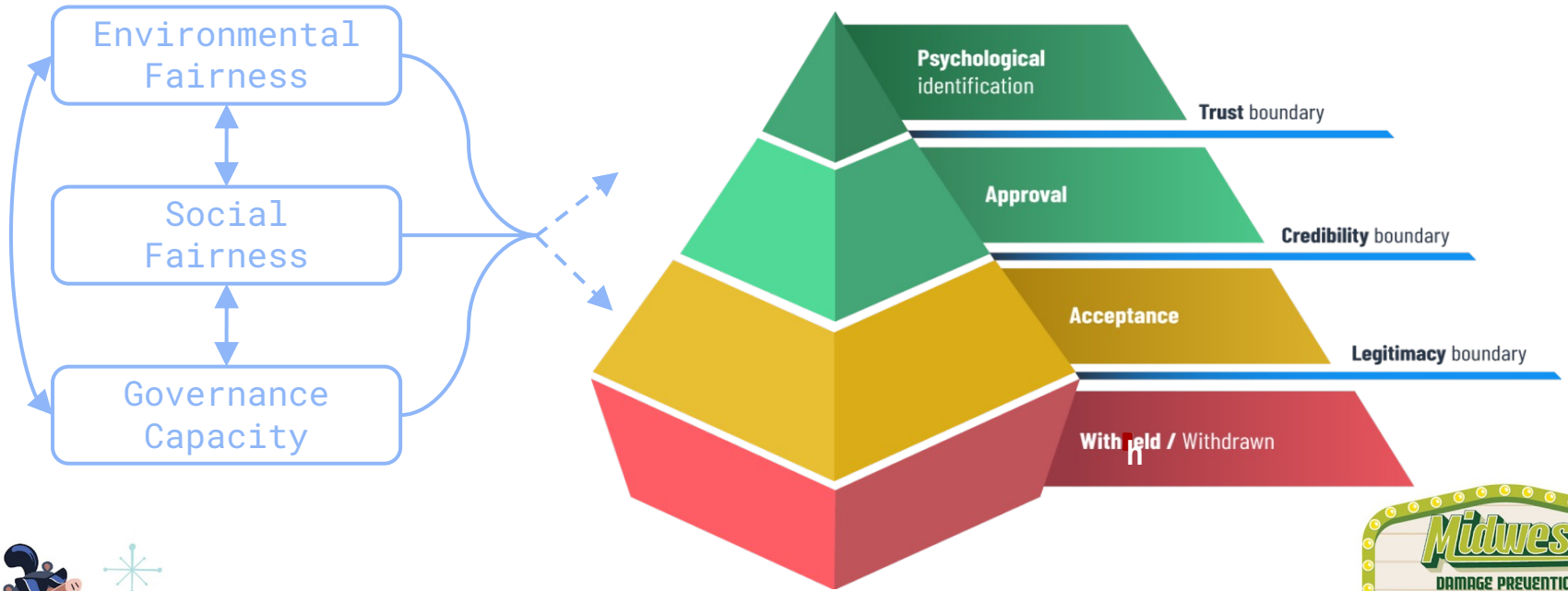


The screenshot shows the SIGK Sigma Monitor interface displaying a grid of alert notifications. Each alert includes a timestamp, a detection type, and a small image showing the detection location on the map.

Alert ID	Detection Type
20220727_01_02_008	Leak Detection / Liquid Hydrocarbon
20220727_01_02_002	Leak Detection / Liquid Hydrocarbon
20220727_01_02_006	Leak Detection / Liquid Hydrocarbon
20220423_01_01_21	Leak Detection / Gas Plume
20220423_01_01_22	Leak Detection / Gas Plume
20220423_01_01_24	Leak Detection / Gas Plume
20220423_01_02_03	Leak Detection / Liquid Hydrocarbon
20220423_01_02_09	Leak Detection / Liquid Hydrocarbon
20220423_01_02_14	Leak Detection / Liquid Hydrocarbon
20220423_01_02_23	Leak Detection / Liquid Hydrocarbon
20220423_01_02_36	Leak Detection / Liquid Hydrocarbon
20220423_01_02_57	Leak Detection / Liquid Hydrocarbon
20220423_01_02_58	Leak Detection / Liquid Hydrocarbon
20220423_01_02_60	Leak Detection / Liquid Hydrocarbon
20220423_01_02_64	Leak Detection / Liquid Hydrocarbon



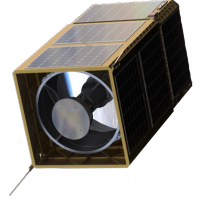
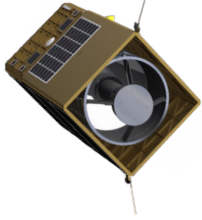
# ESG ... and “Social License,” or *TRUST*





# QUESTIONS and COMMENTS

## Earn PRIZES



**R. Peter Weaver**

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[peter@orbitalsidekick.com](mailto:peter@orbitalsidekick.com)

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