



Chesapeake Energy – Eastern Division Aerial Leak Detection in Natural Gas Gathering Pipelines



May 14, 2009

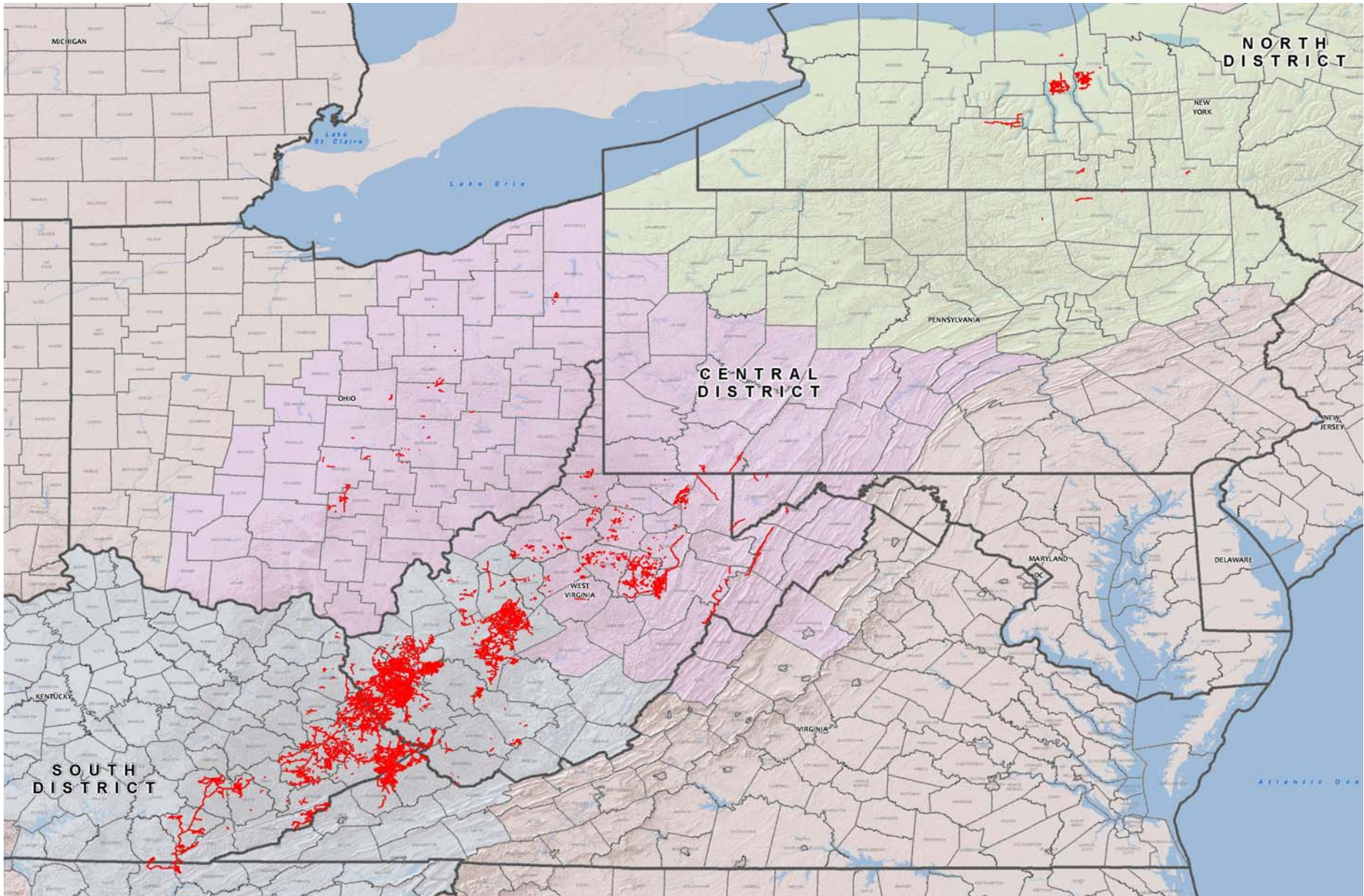


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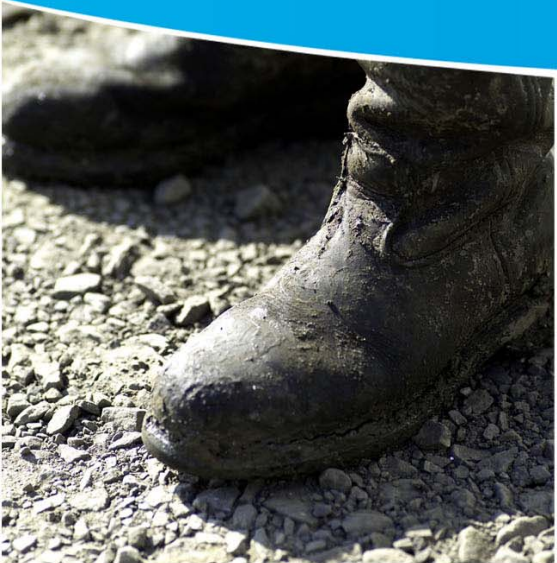
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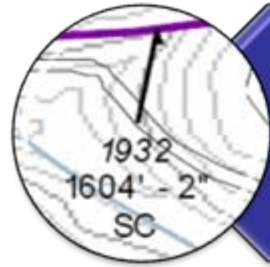
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Reasoning for Helicopter Based "Sniffer" LDS:



Approx. 6500 Miles of Active Pipeline



Vintage range from 1890's to Present



Terrain, Canopy (lack of visibility in leaf-cover), Accessibility Issues

Apogee Leak Detection System



An innovative infrared-based method for detecting leaks from hydrocarbon liquids and gas pipelines, production and storage facilities, landfills, and coal-seam seeps.



- High Speed – High Sensitivity Three Gas Detector for Mobile applications
 - Methane
 - Total Hydrocarbons
 - Carbon Dioxide
- GPS with real time mapping system
- Integrated Geographic Information System (GIS)

Truck Mounted LDS



ATV Mounted LDS



Helicopter Mounted LDS



LDS Operating Software



Apogee Scientific - Leak Detection System

Graph | Map | User Map | Directory | Peak Detection | LDS | Misc.

Methane Graph Scale: **50 PPM** Offset HC
CO2 Graph Scale: **100 PPM**
Time Scale: **1 min.** ComboBox1

Map Width: 0.8 Miles | Direction: 90 | Last mark: L-173 | Scott McLaren

Start | Delphi 7 | My Documents | **LSD ver 2.01** | 3:24 PM

CO2 graph (top right): Y-axis 0-100, X-axis 15:23:42-15:24:42. Shows a blue line with small peaks. Legend: Methane -0.6, HC -0.1, CO2 -6.2.

Methane/HC graph (bottom right): Y-axis -5 to 50, X-axis 15:23:42-15:24:42. Shows a red line with a prominent peak at 15:24:12. Legend: Methane -0.6, HC -0.1, CO2 -6.2.

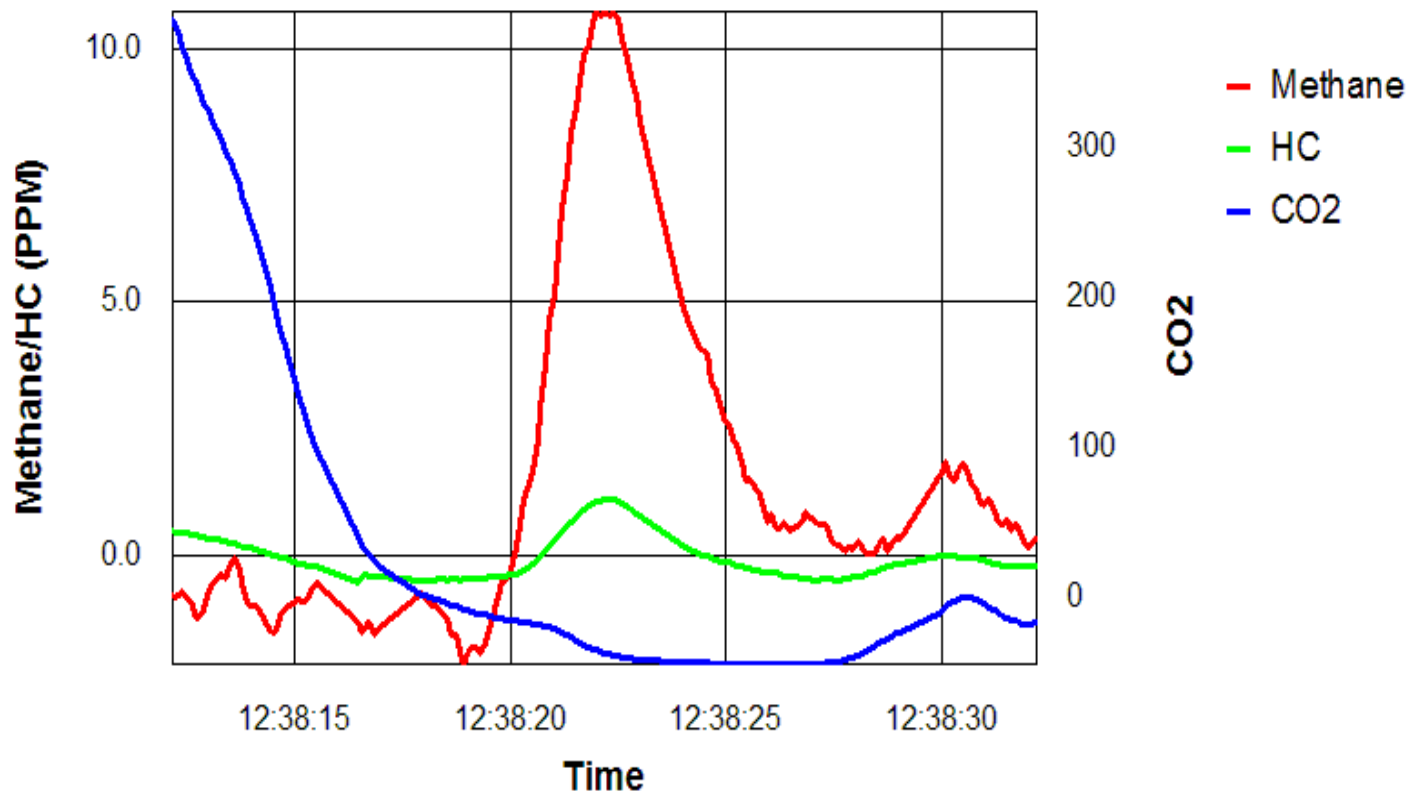
Control Panel (right): EXIT, Status, Options, Zero, Show Leaks, Mark Leak, Zoom In, Zoom out.

Dry Gas



- Mostly methane, small amount of HC, No CO2

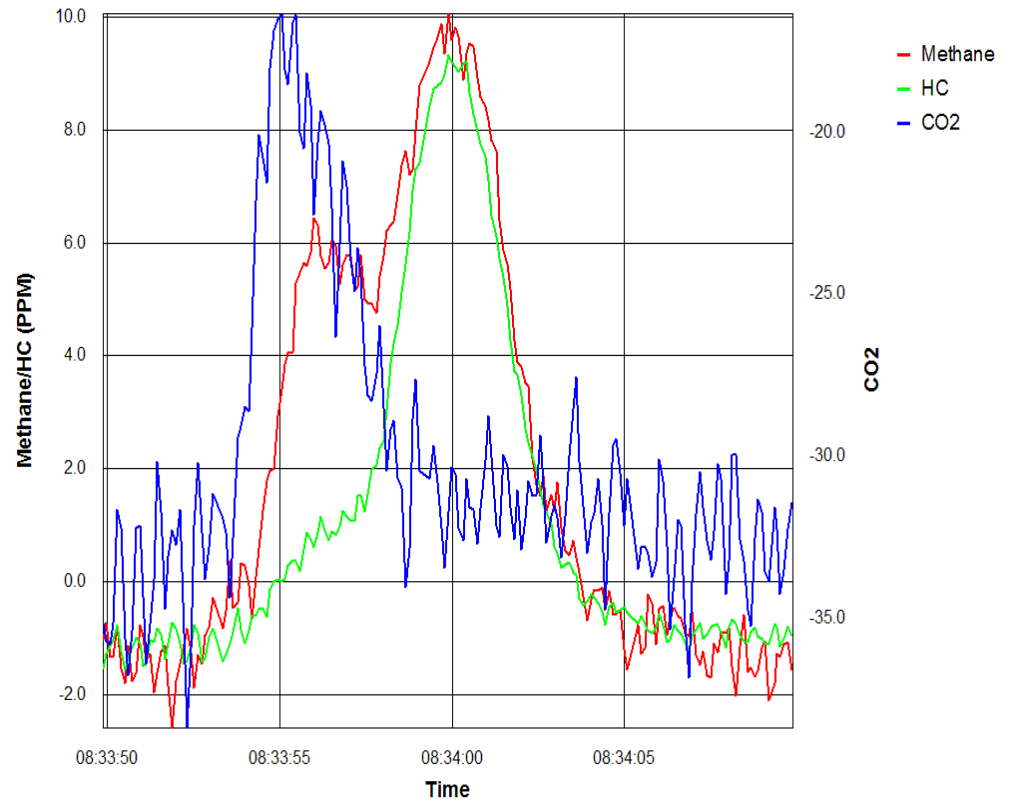
→ Dry Gas leak



Rich Gas



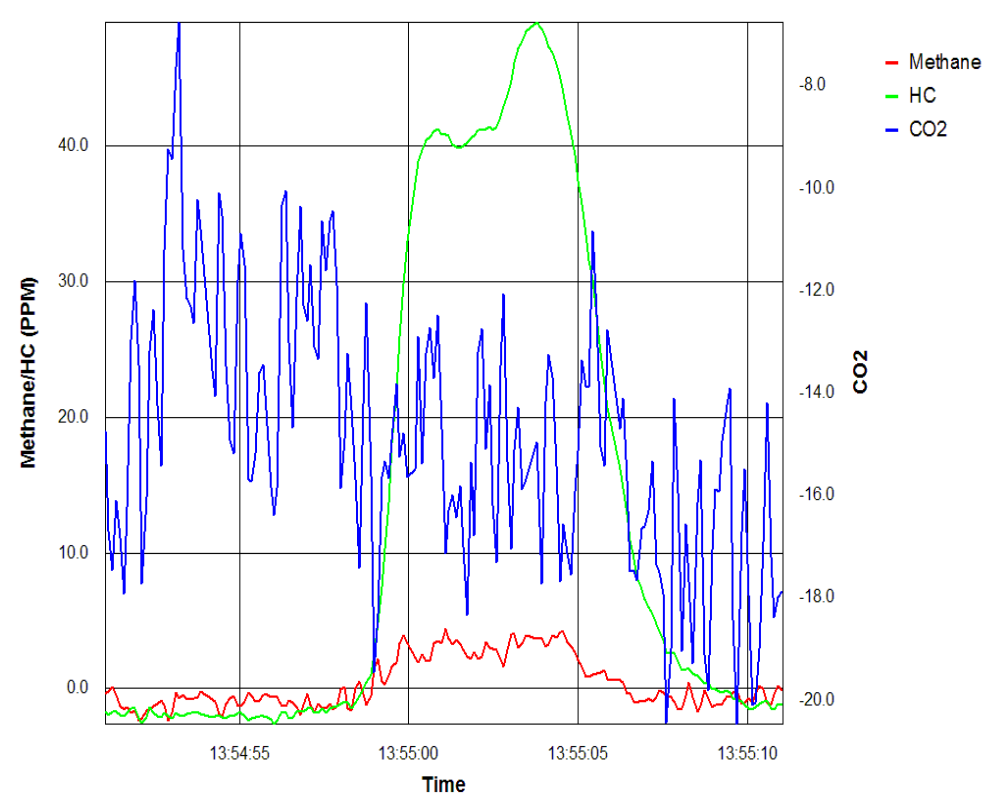
- Methane and HC, No CO2
- Rich Gas leak



Non-Methane Hydrocarbon Gas



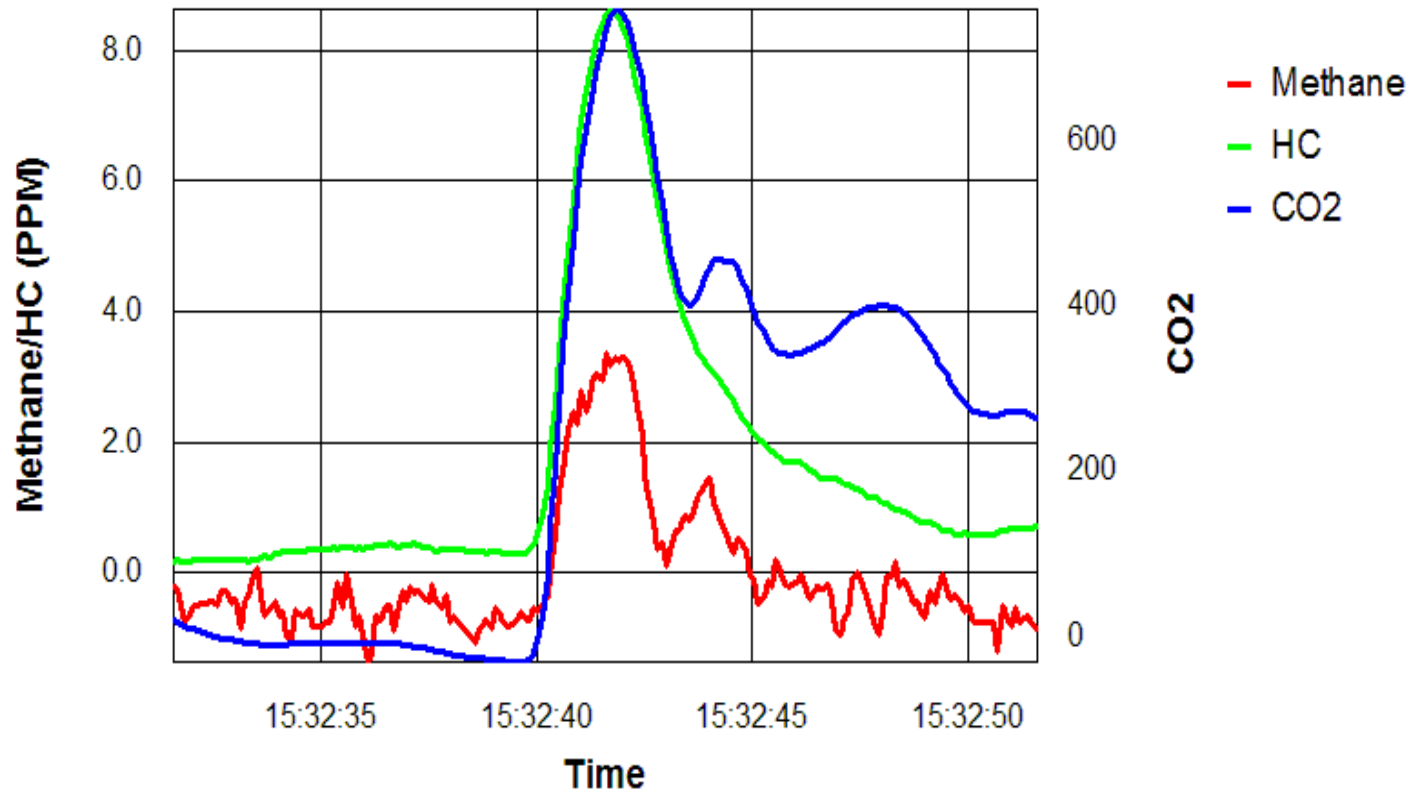
- HC, no methane or CO2
→ Propane or other HC leak



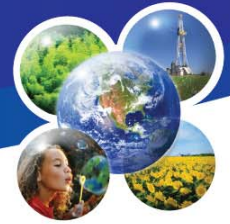
Vehicle Exhaust



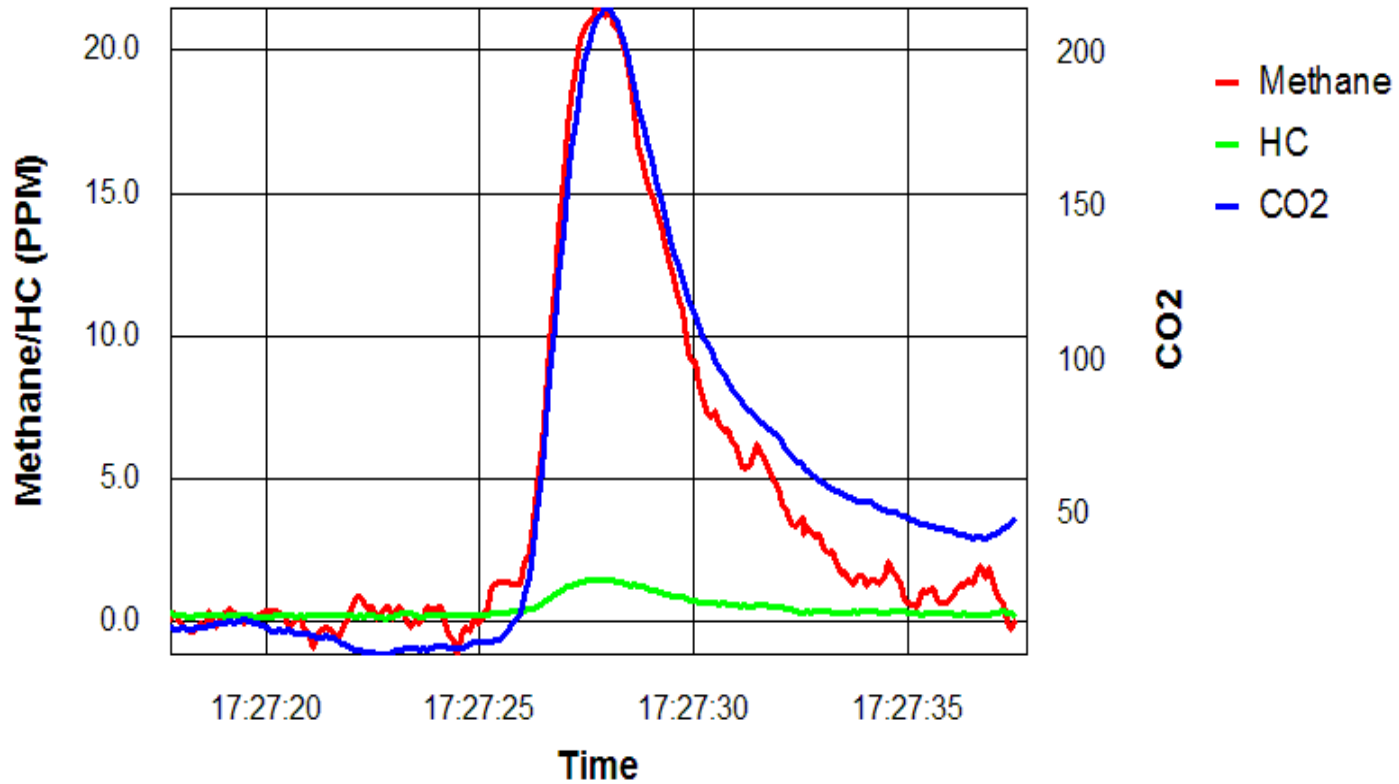
- Methane, HC, and CO2
- Exhaust Gas – Not a leak



Landfill Gas



- Methane and CO2, No HC
- Landfill or Sewer Gas



LDS Database



- All LDS data is stored in a database file
- Data can be exported into Excel or other format

Methane Responses

Leaks to Display
 All Leaks New Leaks
Also show: Deleted Leak

L-173
L-174
L-175
L-176
L-177

ID: L-173 Time: 12/02/04 15:24
Lat: 39.62698 Lon: -104.97978
Peak Conc.: 9.2 Elevation: 5427
Speed: 22 Direction: 181
Operator: Scott McLaren
CO2:CH4 Slope: 0.04 Correlation: 0.06
HC:CH4 Slope: 0.10 Correlation: 0.99
CO2:HC Slope: 0.00 Correlation: 0.02

Map Label:
L-173

Address:
4956 S Washington St
Englewood CO 80110

Memo:

Archived Display On Map

Export Data Delete Exit

Response Type
 New Response Gas Valve Leak Sewer Gas Other Source
 Gas Main Leak Compressor Leak Landfill Gas Source Not Found
 Service Line Leak Prod. Facility Leak Engine Exhaust Irreproducible
 Gas Meter Leak Tank Leak Expected Source





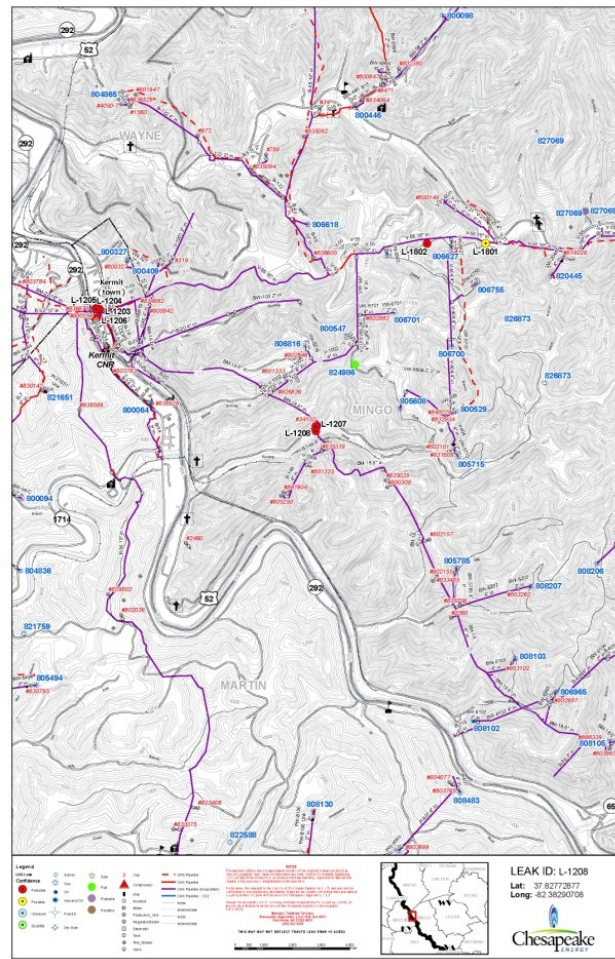
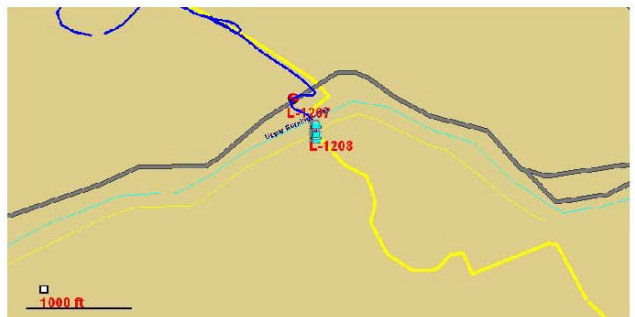
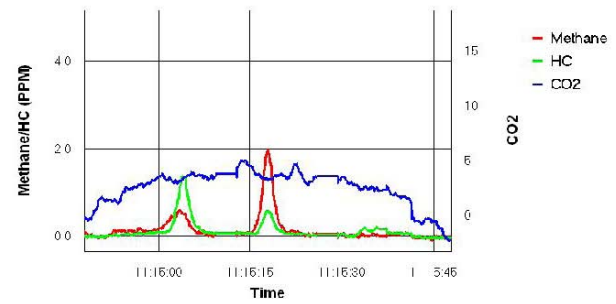
Video Sample

L-1208 (South District)



LDS Leak Report

Leak ID: L-1208
Project Name: SW
Date/Time Found: 06/25/2008 11:15
Max Methane Conc: 1.98 PPM
HC:CH4 Ratio: 0.28 R2 = 0.99
Address: Not Found
Lat: 37.827816
Lon: -82.382766
Altitude: 816 ft.
Vehicle Speed: 23 mph
Operator: Marpat
Comments:



Report generated on 7/16/2008

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Summary of Detections To-Date



- 1st Demo Flight in December 2007
- 812 Detections (Probable, Possible, Doubtful, & Unknown)
- 324 Verified Leaks So Far (Both CHK & Foreign Sources)(Note: Still awaiting feedback from North District)
- 2,229 Miles Flown on 5 Flight Groups

Example of Cost Savings



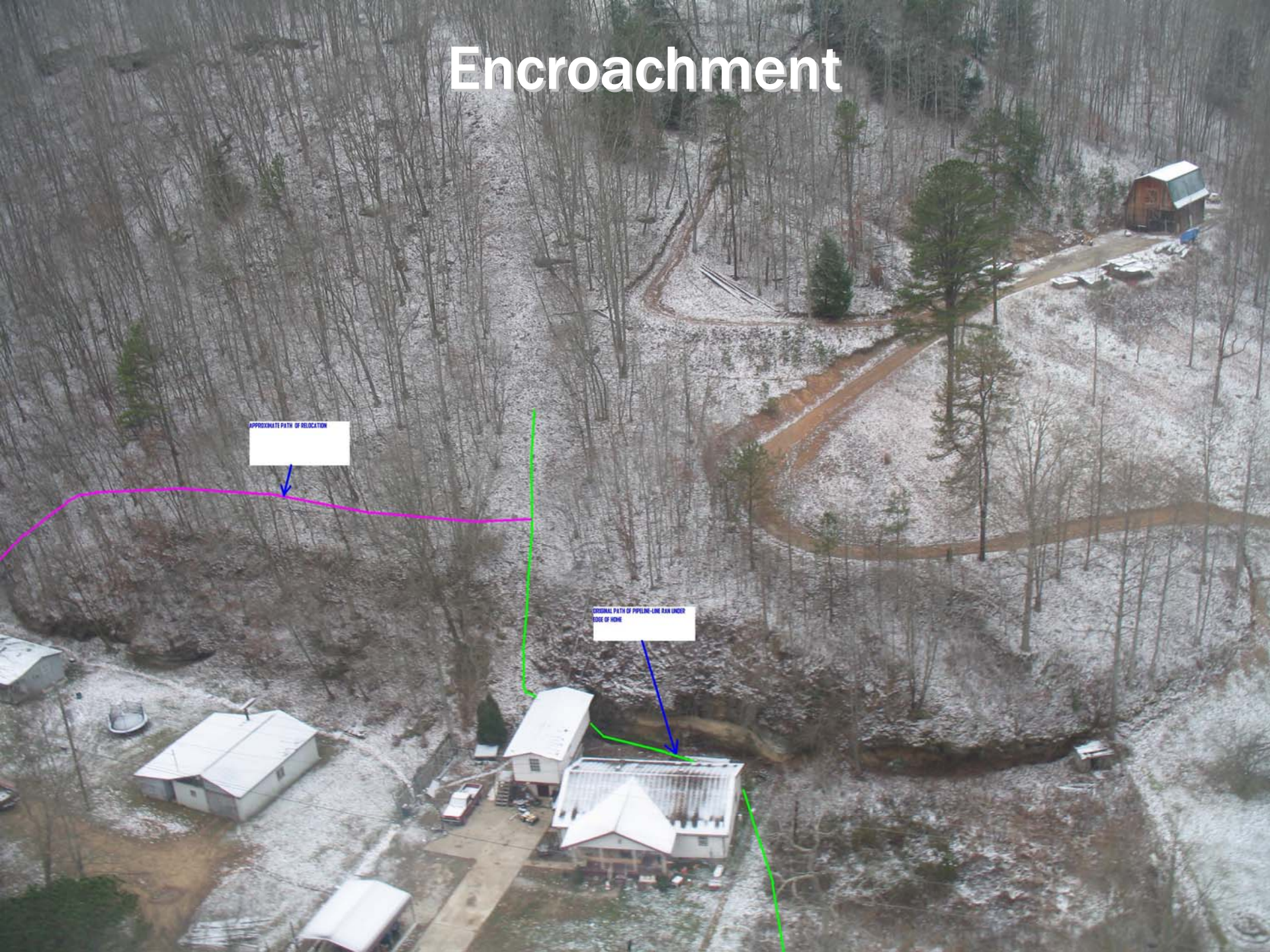
- Sept. 2008 Flight in SE District was approx. 616 Miles
- To cover the same area with ground patrol:
 - 2 Crews (4 Total men)
 - 6 Hours / Day
 - Average 6 Miles / Day Total
 - Equals 100 days, 3200 man hours, not including 2 vehicles and fuel for these 5 months
- 299 Tags (CHK, Foreign, Natural (Mine Cracks))
- Flight time was 64 hours
- Savings not only in time, but in recovered gas carried over the time frame saved by not using ground patrols.

Additional Benefits of Aerial Patrols



- **Manpower Savings**
- **Time Savings**
- **Point of Interest Collection (Customizable List)**
 - Blasting Near RoW
 - Buried Line Exposed
 - Construction Near RoW
 - Debris
 - Liquid Spill
 - Missing Line Marker
 - Power Line
 - Recent Excavation
 - RoW Needs Cleared
 - Slip
 - Stream Crossing Exposed
 - Structure on RoW (Encroachment)

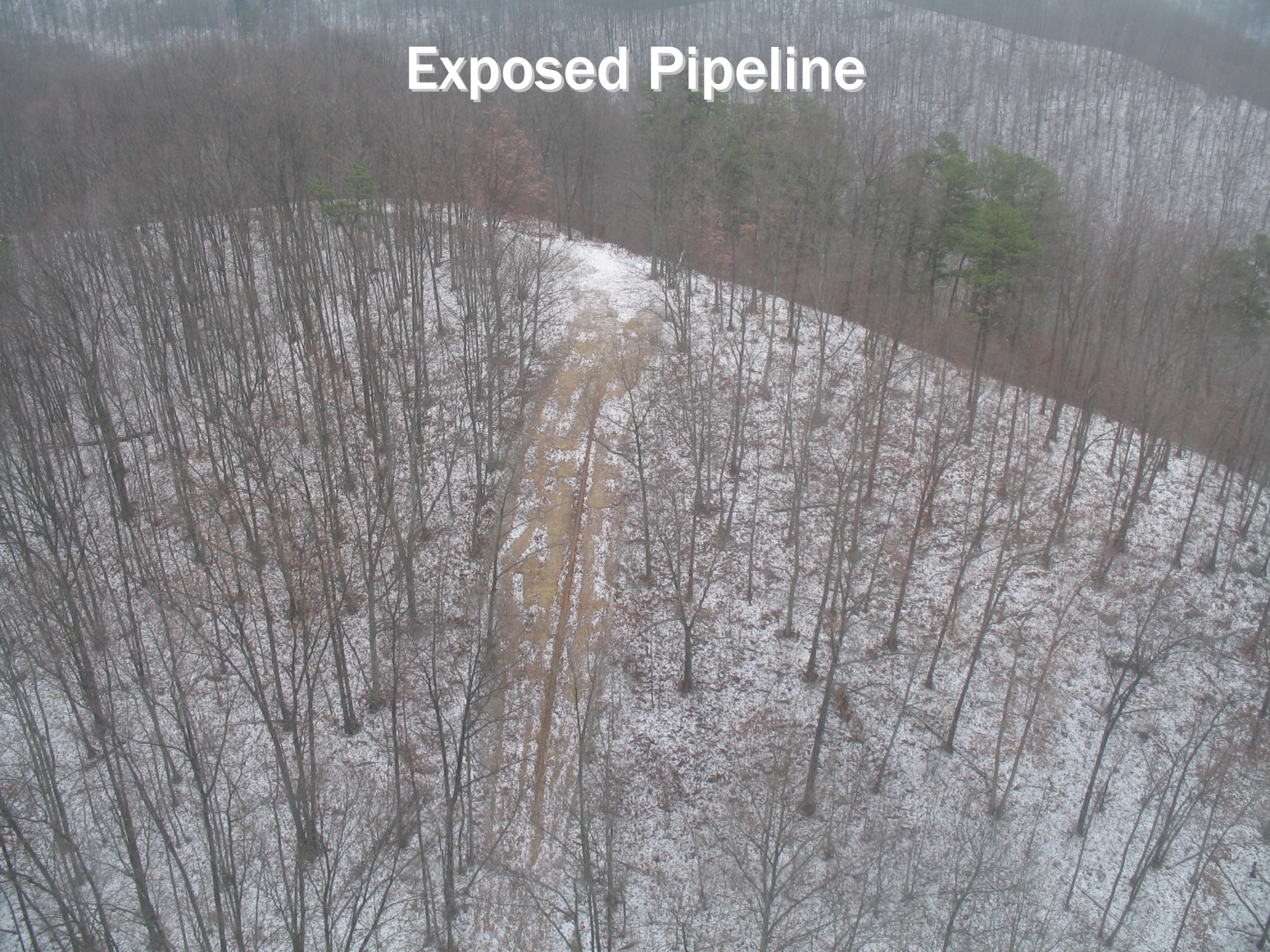
Encroachment



APPROXIMATE PATH OF RELOCATION

ORIGINAL PATH OF PIPELINE—LINE RAN UNDER
EDGE OF HOME

Exposed Pipeline





**Exposed Pipeline
In Road Crossing**

Possible Future Project Expansion



- Using gyro mounted high-def camera and external drive storage for digital record of patrols (with gps time frame stamp)
- FLIR use in conjunction around compressors and dense facility groups like meter manifolds, multiple valve settings, etc.
- Explore possibility of using this as a method of meeting DOT line patrol requirements

Apogee Scientific, Inc. Contacts



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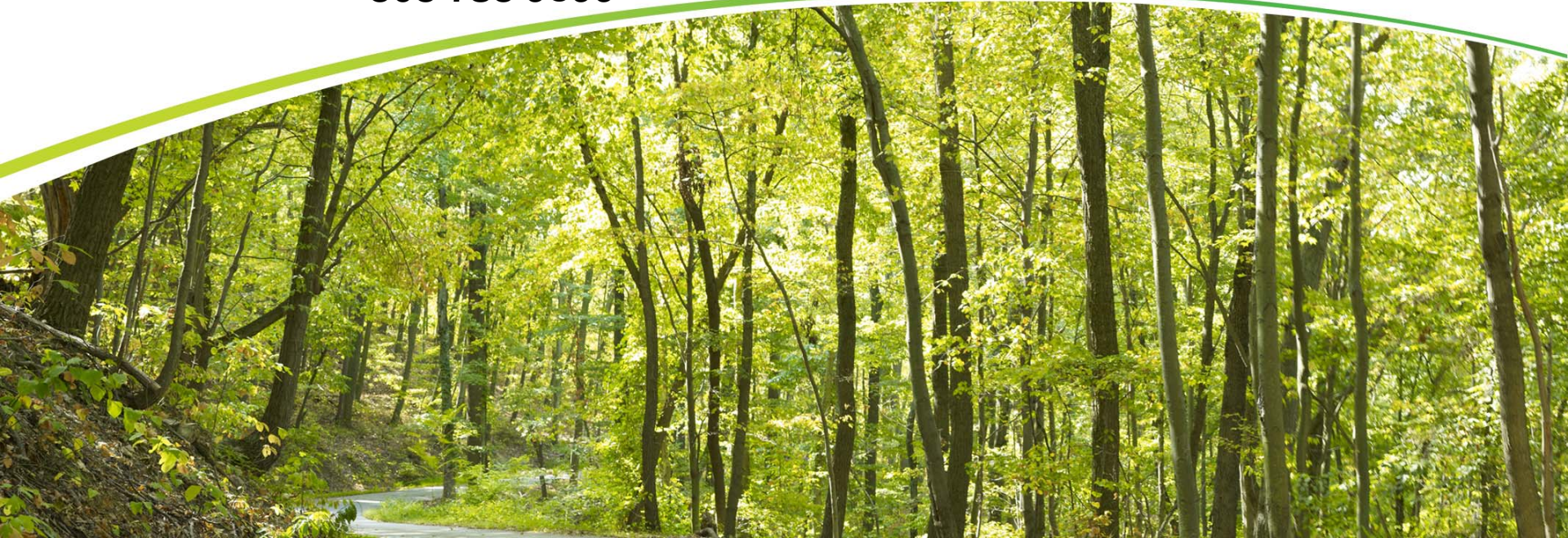
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Q & A