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Report to
Damascus Citizens for Sustainability
25 Main Street, Narrowsburg, New York 12764

Baseline Methane Emissions in Town of Hancock, Delaware County, New York

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EXECUTIVE SUMMARY

A baseline data set has been collected for the Town of Hancock, Delaware County, New York. The data have been compiled, processed, and examined and found to be of high quality. The data indicate low and consistent methane concentrations throughout the Town except within the village of Hancock and at a location near a natural gas compressor station. Since no standard criteria for such baselines currently exist, we define for present purposes baseline criteria that could be readily applied by anyone using commonly available spreadsheet software, e.g., Microsoft Excel. For the Town of Hancock this approach showed that 99% of all data in any similar future methane survey should be less than 1.99 ppm, 99.9% should be less than 2.2 ppm. Appropriate methods can be applied to the baseline data set to extract baseline methane levels for any specific location along the surveyed roadways. Other implications of the data, and related data from other locations in the Marcellus Shale region are briefly discussed.

BACKGROUND

Damascus Citizens for Sustainability (DCS), with funding from generous foundation grants including from the Heinz Foundation, sought to document an environmental baseline for methane in ground-level ambient air in the interest of the residents and property owners of the Town of Hancock (Delaware County, NY), and to increase the environmental baseline data available for the region. Such baseline methane data enable early detection of environmental contamination from gas well drilling, gas processing and transmission infrastructure or other methane sources. Ambient air contamination is most readily detected and quantified if baseline data is collected before any contamination occurs. Recently developed technology for measurement of trace gases in the environment offers a useful approach to development of baseline data, early detection of contamination from gas drilling, and verification of actual contamination. Further, this technology in combination with sufficient geological information on faults and fractures could enable pre-drilling identification of lands likely to develop methane migration problems even at considerable distances from the source gas well.

Methane is the lightest, most mobile component of natural gas, and makes up at least 85% of the volume of natural gas, and typically 95% or more of Marcellus Shale gas. Methane is lighter and less viscous than air. Consequently it will move farther and faster than any other contaminant that might be released from shale gas wells. The same properties also cause methane to disperse rapidly once it has reached the open atmosphere. Nevertheless, methane is the first and most rapidly dispersing contaminant likely to be detected from a shale gas

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well.[3]

The rapid dispersion of methane once it has been released into the open atmosphere implies the need for analytical instrumentation capable of accurately and consistently measuring trace levels of the gas. Previously the potential usefulness of methane as an indicator of environmental contamination from gas wells or other sources was limited by the difficulties involved in effective air sampling and analysis for trace levels of the gas. Measurement of low but environmentally important levels of methane in air required special sample collection work in the field followed by transport to a lab for analysis using sophisticated laboratory instruments. Recent developments in analytical technology, i.e., cavity ring-down laser spectroscopy, have made it possible to measure very low levels of methane in the field continuously with continuous logging of results. The instrumentation is rugged enough for routine field use and capable of measuring methane concentrations consistently to levels of parts per billion (compared to parts per million for most previously used methods). Depending on the instrument configuration, methane measurements are made continuously about once per second. Typically the instrument is operated in parallel with a GPS unit (internal or external) and tags each methane measurement with location data. Whenever this combination of both the methane measurement and GPS technology is active it will continuously determine and record the time, location, and methane concentration in the air, every second, wherever the instrument has been. This was the instrument combination used to collect the baseline data reported here.

Gas Safety, Inc. (GSI) offers methane measurement services based on this new technology, including environmental methane surveys. To fulfill its grant funding commitments to develop baseline data in the interests of local residents and property owners, DCS engaged GSI to measure and document methane levels in ambient ground level air in the Town of Hancock.

The contracted field data collection work was carried out on 15-16 and 18 September 2014. The data was subsequently compiled, processed and analyzed by GSI. The work, data and findings are documented in this report. The actual data, time, location and methane concentration, are too voluminous for presentation with this report, and have been separately submitted to DCS. It is our understanding that the dataset will be provided to the Town following a meeting to explain these findings.

NOTE: All figures follow the narrative section of this report. This report includes one table that is presented in the section “Basic Statistical Summaries of Data”.

FIELD WORK

In order to facilitate as much coverage of the Town in the available time as possible, and to avoid concerns or delays related to private property rights, all measurements were taken driving on public roadways. The air sample intake was positioned to ride, pointing downward, on the passenger side of the vehicle ≈24 inches (60 centimeters) above the road surface. Roads were driven at the posted speed limit or slower if necessitated by road conditions. GSI experience has shown this approach is adequate for detection of even relatively weak methane sources under most circumstances. Reasonable efforts were made to run the instrument over every public roadway in the Township twice during the methane baseline survey field work.

DATA COMPILATION AND PROCESSING

Data is logged by the instruments as data lines in a digital data file. Each line will have several data types, including time, latitude, longitude, methane, and various types of data used by the instrument to monitor and

[3] The single exception to the broad usefulness of methane as an indicator contaminant is during the drilling of the well. Free-flowing methane (natural gas) may or may not be encountered during drilling of the well, i.e., before hydraulic fracturing. When there is no free-flowing methane, other potential contaminants might appear first, e.g., drilling fluids, flowback water. Reports to date suggest free-flowing methane is frequently encountered during the drilling (before hydraulic fracturing) of shale gas wells. Hence, the cases in which methane is not the most likely first contaminant are probably few.

assure proper function. A total of 67,504 data lines were recorded during the survey. The instrument automatically records and starts a new digital data file about every hour to produce data logs as files of sizes (typically 1,000 - 4,000 lines of data) that are reasonably easy to handle and to reduce risk of data loss. It is not practical or even advisable to turn off the instrument when making necessary vehicle stops, e.g., for instrument function tests, turns, traffic, re-fueling, meals, U-turns, navigation, crossing contract area boundaries, etc. Consequently the raw data recorded in the data log may be disproportionately weighted in favor of locations where vehicle stops occurred. In order to develop a more geographically balanced data set, the data collected at such stop locations are removed by visual examination. Following removal of such data, the amount of data analyzed for the Hancock Town baseline was 62,290 lines.

The processed data were further processed and analyzed using Microsoft Excel (version 12.2.8) for spreadsheet work and Google Earth (version 6.0.3.2197) for mapping and visualization. The distribution of measured methane levels among selected ranges was determined using the FREQUENCY function in Excel (use of some other functions is precluded by the large amount of data or by the time required for calculations for such large amounts of data).

RESULTS

The methane levels in the Town of Hancock were unusually uniform with 95.3% of the methane data on 16 September and 97.7% on 15 September occurring in the range of 1.89-1.97 ppm. That is, at least 95% of the methane levels in the Town of Hancock varied by no more than 0.08 ppm. The few minor deviations from the very consistent methane levels appeared to occur near ponds, residences, barns or other areas of human activities. There were three exceptions to these very consistent methane levels. The most notable was the Village of Hancock, where elevated methane levels up to 10.6 ppm occurred at different times along Front and Main Streets between Pennsylvania Avenue and Academy Street (Figure 3). Determining the source of the methane in the Village was beyond the scope of our survey, but observations during the GSI methane survey suggested that a gas leak investigation was underway.

There was another area with elevated methane levels along Hoolihan Brook Road that had an unusual number of relatively minor increases in methane concentration (Figure 4). The highest methane level encountered on Hoolihan Brook Road was 2.24 ppm. The slightly higher methane levels in this area could have been due to methane emissions from the brook, geological methane seepage, or drift from the parallel valley to the west where minor elevations were detected on 16 September and higher levels, up to 2.88 ppm, when this limited area was surveyed again on 18 September (Figure 4). The increased methane levels were associated with the location of the natural gas pipeline compressor station on Hungry Hill Road. When this area was previously surveyed on 03 June 2013, before the compressor station was built, no unusual methane levels were encountered in the area.

Plots of Survey Data on Remote Imagery

Figures 1-4 present the methane baseline survey data superimposed using Google Earth on aerial/satellite imagery of the Town (and surrounding areas). The consistently low methane levels encountered around the Town, and the exceptional levels in the Village of Hancock are apparent, especially in Figure 2. Closer views of areas with elevated methane levels are presented in Figures 3 and 4.

Basic Statistical Summaries of Data

Another approach to examining the quality of and understanding the baseline methane data is to consider some basic statistical summary information. Table 1 shows the summary methane data for each of the two days of the Town of Hancock survey. Each day is processed separately because there are daily variations in wind, and other conditions that affect methane levels in the air.

	15 September	16 September	18 September*
Total Measurements	26,251	36,039	308
	Methane (ppm)		
Maximum	10.65	3.304	2.888
99.9% less than	2.32	2.19	2.84
99% less than	1.99	2.03	2.49
95% less than	1.93	1.97	2.03
90% less than	1.92	1.96	2.02
Median	1.904	1.936	1.929
Average	1.925	1.937	1.961
Minimum	1.831	1.811	1.905
* Hungry Hill Road area only			

Table 1. Basic statistical summaries of the Town of Hancock methane baseline survey daily data.

The descriptive statistical summary data in Table 1 indicate the methane measurements collected during the survey were consistently low, 99% being less than 2.03 ppm. Only one data point in a thousand exceeded 2.10 ppm on 15 September and 2.16 ppm on 16 September and all of those occurred in a small area in the Village of Hancock. The data also provide a means by which to define and select appropriate baselines for methane in ground level air in the Town of Hancock.

RECOMMENDED BASELINES

GSI suggests two broad types of baselines, a general broad area baseline and location specific baselines

The General Area Baseline

The general Town broad area baseline is to be regarded as the normal methane condition in ground level air in the Town. It is based on conditions that can be considered normal or typical in the Town generally regardless of location. A general baseline value is important for assessing future changes in broad area methane levels, e.g., for evaluating whether or not the results of a future methane survey indicate new or unusual sources of methane have developed in the Town. The baseline should be conservative, i.e., favor high values in order to avoid false alarms regarding possible future methane contamination sources. Consequently, we base the recommended general area baseline on the statistical summary data for the higher of the two days for which methane levels were measured over the Town generally (excluding the 18 September follow up survey in the Hungry Hill Road area). The recommended baseline should be based on statistical criteria that are readily obtainable for large methane data sets. The percentiles based on frequency distributions provide such readily obtainable statistical summary. For the present, GSI recommends the following values (listed in the table above for 16 September) be defined as the broad area baseline measures. The recommended general area Town methane baseline measures for similarly run surveys are then as follows:

95% of all methane data should be less than 1.97 ppm
99% of all methane data should be less than 2.03 ppm
99.9% of all methane data should be less than 2.19 ppm
Any area with a methane level above 5 ppm outside the Village of Hancock should be considered a matter of concern meriting further investigation, especially if not clearly associated with an agricultural operation.

Specific Location Baselines

Baseline criteria for specific locations within the Town survey area can be extracted from the full baseline data set. As a result of this methane baseline survey, there are now methane data covering to our knowledge all of the public roadways in the Town. It is, however, important to recognize that the survey vehicle is moving constantly over the road near most specific locations. A short time is required for the sampled air to travel from the sample intake through the sample tube into the laser chamber. That sample tube transit time causes the methane data for a given location to be offset in data plots from the actual location, in proportion to the speed of the vehicle. This offset is not important for general area baseline studies, but it is for evaluation of methane concentrations at specific locations. Further, the baseline data for a given location should not be regarded as the value of the single methane measurement nearest the location of interest, even if the vehicle speed offset has been accounted for. An array of data points surrounding the location of interest should be selected from each survey run, and appropriate statistical tests applied to establish a confidence level regarding whether a given methane result is consistent with previous methane baseline data for the location. It should be noted that methane levels at almost all locations in the Town of Hancock were at local baseline levels, i.e., less than 1.97 ppm for 95% of the surveyed locations.

CONCLUSIONS

A baseline data set has been collected for the Town of Hancock, Delaware County, New York. The data have been compiled, processed, and examined and found to be of high quality. Three areas with elevated methane levels were encountered. Minor elevated methane levels occurred along Hoolihan Brook Road suggesting emissions from the brook or geological seepage or perhaps drift from the adjacent valley where methane levels appeared to be elevated by a natural gas pipeline compressor station. Elevated methane levels in the vicinity of that compressor station were confirmed in a special survey on 18 September. All of the highest methane levels occurred in a small area within the Village of Hancock where observations indicated efforts were underway to address natural gas distribution system leaks. The data indicate low and consistent methane concentrations throughout the Town away from the Village and the compressor station, leading to a set of baseline recommendations including that 95% of all data in any similar future methane survey should be less than 1.97 ppm, 99.9% should be less than 2.2 ppm, and maxima should not exceed 5 ppm outside the Village of Hancock. Appropriate methods can be applied to the baseline data set to extract baseline methane levels for any specific location along the surveyed roadways. The general Town broad area baseline can be regarded as the normal methane concentration in ground level air in the Town.

Four fIgures follow on pages 7, 8, 9, and 10.

Figure 1. Ground Level Ambient Air Methane Survey of the Town of Hancock, Delaware County, New York. 15-16 September 2014. Yellow lines indicate roadways travelled and tracks of methane measurements during the survey.

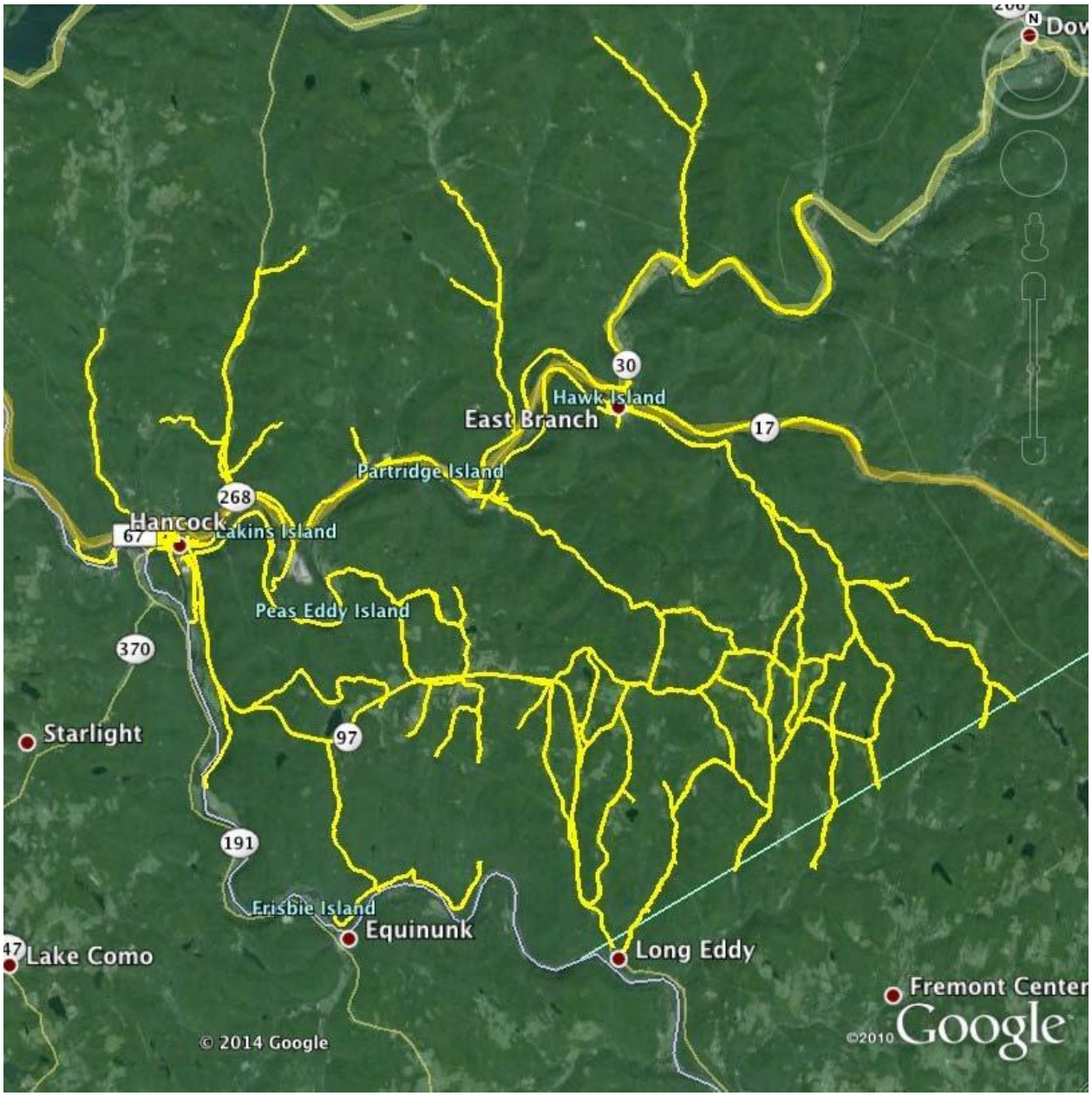

Figure 2.

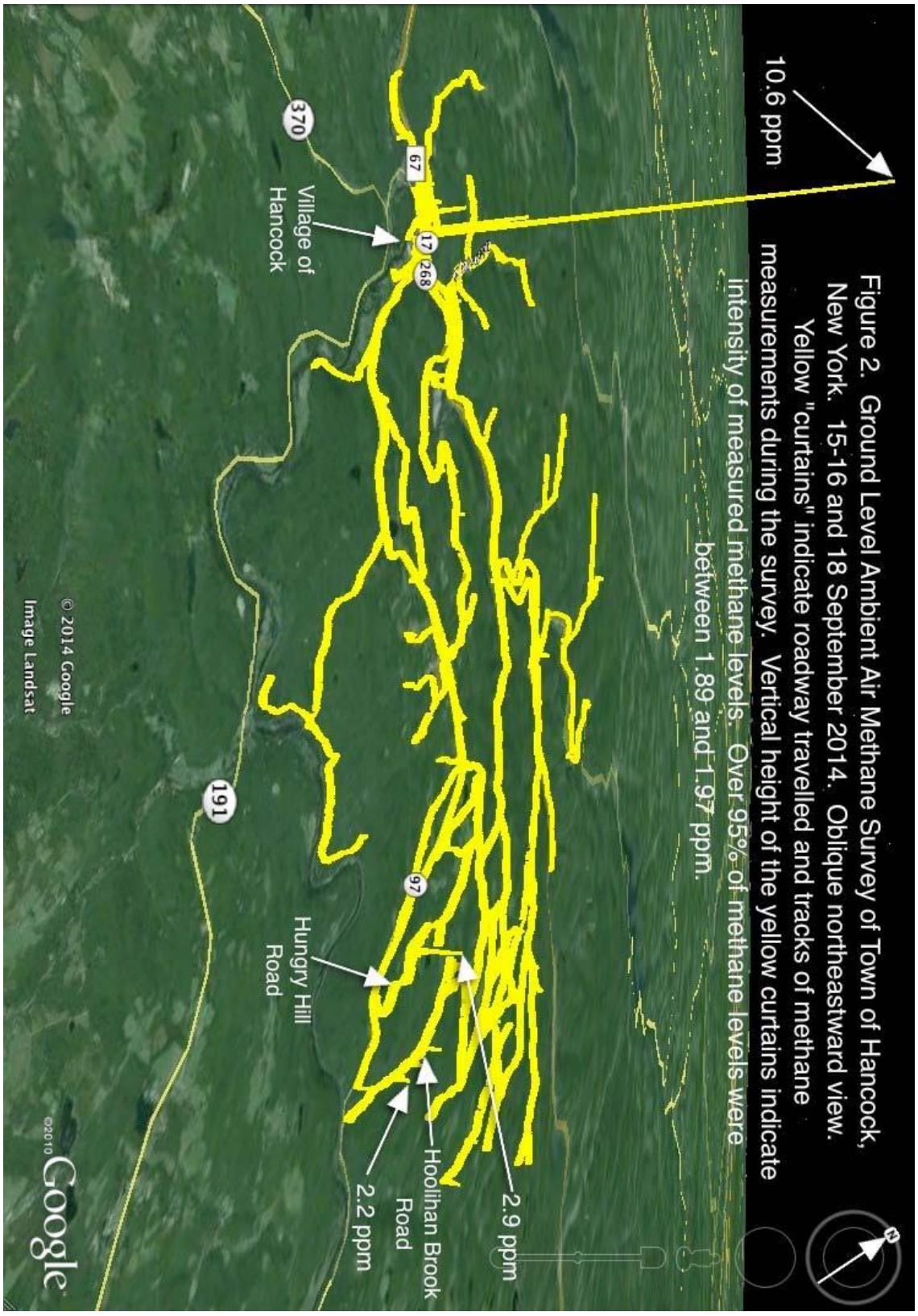
10.6 ppm
Figure 2. Ground Level Ambient Air Methane Survey of Town of Hancock, New York. 15-16 and 18 September 2014. Oblique northeastward view. Yellow "curtains" indicate roadway travelled and tracks of methane measurements during the survey. Vertical height of the yellow curtains indicate intensity of measured methane levels. Over 95% of methane levels were between 1.89 and 1.97 ppm.
370
Village of Hancock
67
17
268
97
191
Hungry Hill Road
Hoolihan Brook Road
2.9 ppm
2.2 ppm
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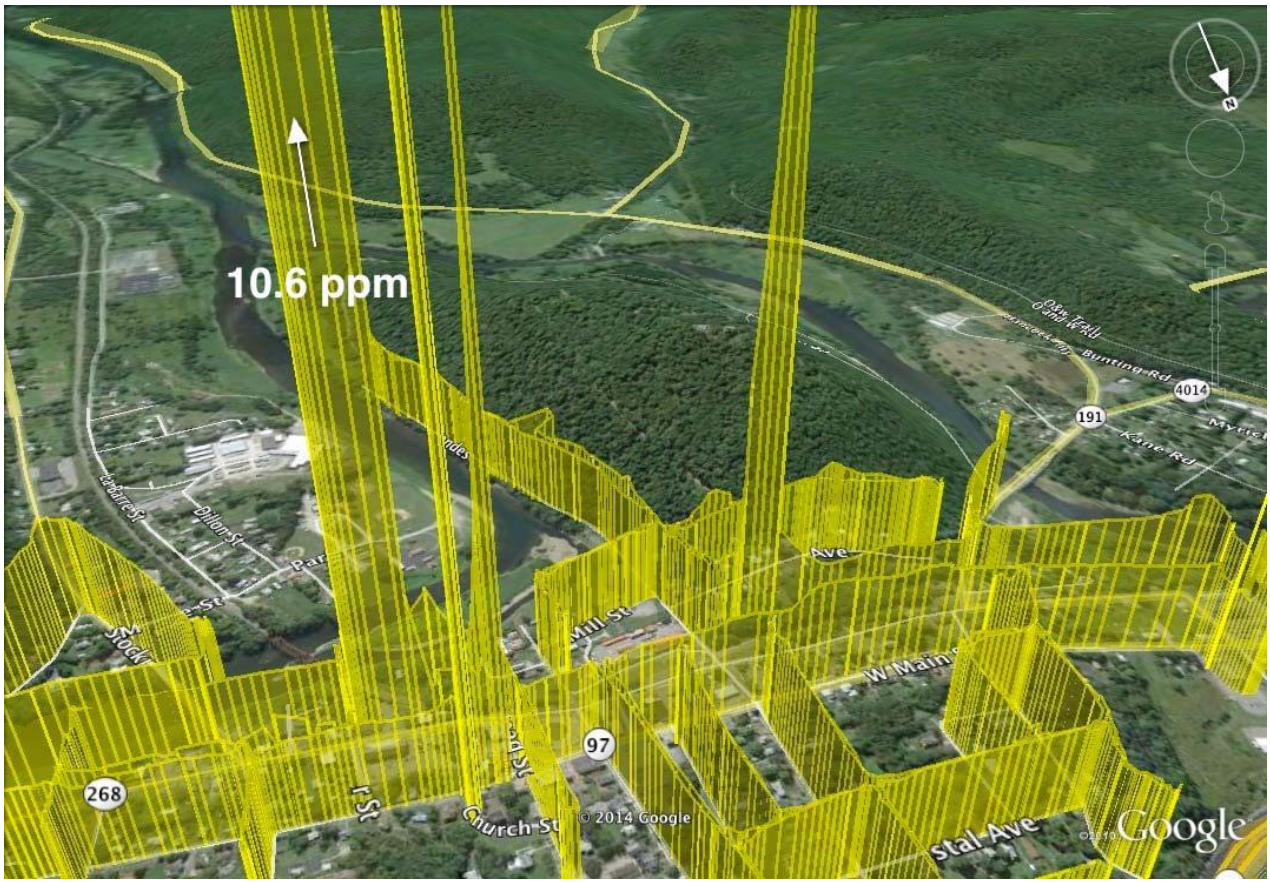
Image Landsat
Google

Figure 3. Village of Hancock Ground Level Methane Survey. Southwestward close up view. Yellow "curtains" indicate track of methane survey. Height of yellow "curtains" indicate measured methane levels. Visible bottom of curtain indicates 1.79 ppm methane. Most methane levels are around 1.9 ppm. Markedly elevated methane levels apparently associated with natural gas distribution system leaks are visible as sharp rises in the curtain, the highest of which rose to 10.6 ppm. The highest methane levels completely visible in this image are around 3 ppm (the higher level points extend out of the frame of the image).



Figure

4. Ground Level Methane Survey in the Hungry Hill Road Area.
Eastward view. Yellow "curtains" indicate track of methane survey. Height of yellow "curtains" indicate measured methane levels. Most methane levels are around 1.9 ppm. Markedly elevated methane levels (up 2.9 ppm) occurred near a natural gas pipeline compressor station. The path of the pipeline is visible as a lighter green line running from the lower left corner toward the center of this image.