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Report to

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Baseline Methane Emissions in a Minisink Area, Orange County, New York

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EXECUTIVE SUMMARY

A baseline data set has been collected for Parts of the Town of Minisink, Orange County, New York. The Minisink survey area has very slightly elevated methane levels, with 6 locations above the area background. It should be noted that methane levels at almost all locations in Minisink were at local baseline levels. The data have been compiled, processed, and examined and found to be of high quality. The data indicate relatively low and reasonably consistent methane concentrations throughout the surveyed area. 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.

Field observations and interviews with residents confirmed gas transmission and distribution lines in the survey area. No effort was expended to confirm

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actual locations of gas lines or whether or where gas lines extended beyond the survey area. It is presumed the slightly elevated gas levels in the survey area may be related to the presence of the gas lines. Identification and measurement of potential gas leaks was beyond the scope of this work project.

Since no standard criteria for ambient air methane baselines currently exist, we elected to define for present purposes baseline criteria that could be readily applied by anyone using commonly available spreadsheet software, e.g., Microsoft Excel. For the surveyed area of Minisink this approach showed that 99% of all data in any similar future methane survey should be less than 2.34 ppm, 99.9% should be less than 3.5 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 are briefly discussed.

BACKGROUND

Out of concern for the residents and property owners of Minisink (Orange County, NY), the planned site for a natural gas line compressor station, Damascus Citizens for Sustainability (DCS) sought a means by which an environmental baseline for methane in ground-level air could be economically acquired. This area is home to a number of 911 first responders with existing respiratory and other health problems who moved to this location for the cleaner environment. Though methane itself is not known to be toxic, it is the most mobile and largest (>90%) component of natural gas. It is, therefore, among the most likely to escape from a pipeline compressor station. Consequently, a methane baseline could aid early detection of environmental contamination from a natural gas line compressor station. 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, leaks from gas lines and compressor station and other natural gas infrastructure.

Methane is the lightest, most mobile component of natural gas, and makes up at least 85% of the volume of natural gas at the source well, and typically >93% after processing into commercial gas. At mixture of 5% to 15% methane in air methane is explosive. At concentrations higher than the explosive level methane is an asphyxiant, causing suffocation by diluting oxygen levels in air. Such high levels of methane only occur in very close proximity to most methane sources or leaks. In fact, most biological sources methane cannot exceed concentrations of 50% methane. In most situations where methane is of concern as a pollutant or explosion hazard a concentrated source, like a septic tank, sewage digestor, landfill, or natural gas pipeline, compressor, or other infrastructure, is the source. When methane is emitted from such sources the concentrations are high, and usually associated with other malodorous gases that are also products of the biological conditions that produce methane, or are added to natural gas to assure leaks are noticed before explosion hazards can develop. Consequently, identifying and measuring such leaks close to the source is relatively easy. However, many methane sources are underground, including most gas pipelines, natural gas deposits that seep to the surface, and underground areas of biological methane production. Direct underground detection of methane leaks is impractical. So, practical reality is that underground methane leaks have to be detected by measuring methane concentrations in the air above the ground over the methane source. In the process of getting from the underground source to the surface and into the air, at least two important processes occur, biological oxidation of the methane, and dilution of the methane in the surrounding air. Biological oxidation of methane occurs when microorganisms in the soil use the methane as an energy source, converting it to carbon dioxide. Appreciable amounts of methane can be consumed as the gas travels from its source underground up through the soil. In 1996 EPA/GRI put forth an estimate that up to 40% of the methane from low level leaks can be oxidized before reaching the surface. Dilution occurs as the methane escaping from the underground source mixes with the air in the surrounding soil. The result of these processes is that methane emerging from the land surface into the above-ground air is already at a lower concentration than at the source underground.

Methane is lighter and less viscous than air. Consequently it will move farther and faster than any other contaminant that might be released from natural gas facilities. The same properties also cause methane to disperse rapidly once it has reached the open atmosphere, i.e., to be diluted rapidly to near the average global ground level air concentration of 1.7-1.9 ppm (0.00017-0.00019%). As an example of how fast dispersion (dilution) of methane occurs, in a recent GSI gas leak survey natural gas was emerging from a hole in pavement at a concentration of almost 70%, but just a few feet away, downwind, the concentration was only 23 ppm, that is, 0.0023%. Over just a few feet and a matter of a second or two the methane was diluted to 1/30,000th of the concentration at which it left the hole in the pavement. So, if instead of a source at the surface, what if the source is a leak in a natural gas pipeline 3 feet below the surface? In practice, detection of underground sources of methane is dependent on the ability to detect, and preferably actually measure, very low levels of methane in the air above ground, levels at or below 1 ppm (0.0001%).

So, 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 commercial natural gas systems 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 laboratory instruments with sufficient sensitivity. Recent developments in analytical technology, i.e., cavity ring-down laser spectrometry, 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 (ppb, 1000 times more sensitive than the ppm or parts per million capabilities of most previously used field instruments). Depending on the instrument configuration, methane measurements are made continuously every 0.25 to 5 seconds. Typically the instrument is operated in parallel with a GPS unit (internal or external) and links 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 0.25-5 seconds, wherever the instrument has been. This was the instrument combination used for baseline data collection in Minisink.

Gas Safety, Inc. (GSI) offers methane measurement services based on this new technology, including environmental methane surveys. DCS engaged GSI to measure and document methane levels in ambient ground level air in Minisink.

Like any effort to measure and document environmental conditions, this effort to had to fill three requirements. (1)The materials and methods would have to be appropriate to the purpose. Equipment had to be in good working order and functioning normally throughout the data collection work. (2)The collected data would have to be of verifiable technical quality. (3)The results would have to be consistently plausible for the area being surveyed.

Fulfilling requirement (1), the instrument used, produced by Picarro, Inc. [www.picarro.com] has an onboard monitoring and control system. The instrument was calibrated by the manufacturer to an accuracy within 2% of the actual methane level. That is, an indicated methane level of 2 ppm indicates the actual level is somewhere between 1.96 and 2.04 ppm. This inaccuracy does not reflect instrument limitations, but limitations of the accuracy of reference gas samples used during calibration. The instrument stability and function is verified periodically using reference gases. The instrument self-monitoring and control capabilities, manufacturer calibration, and periodic function ands stability verifications assure the technical quality of the data, fulfilling requirement (2).

Fulfilling requirement (3), the plausibility of the data for the conditions in Minisink would be determined by examining consistency of the data with respect to itself and to similar data previously collected in other similar areas.

The contracted field data collection work was carried out on 2 January 2013. The data was subsequently compiled, processed and analyzed by GSI. The work, data and findings are documented in this report. The digital time, location and methane concentration data are too voluminous for presentation with this report, and have been separately submitted to DCS.

NOTE: This report contains 2 Figures both of which follow the narrative section of this report. Both figures present images looking northwest as indicated by the N (North) compass indicator in the upper right corner of each image. The background were obtained and the images were prepared using Google Earth. This report includes one table that is presented in the section "Basic Statistical Summaries of Data".

FIELD WORK

The survey area in Minisink was limited to public roadways in the vicinity of the planned natural gas compressor station to be located on 73 acres along Jacobs road and south of the gas transmission line that runs NW-SE through the Town of Minisink. The survey area extended 1.88 miles from the intersection of Hortons Road and NY 284 on the northeast, to the cul-de-sac at the end of Minisink Farms Road on the southwest, and 0.9 miles from Westtown on the west to the end of Marvelle Lane on the east (see Figures 1 and 2.) The reader should keep in mind that the survey area included only a fraction (about 7%) of the area of the Town of Minisink. In this report references to the "survey area" are intended to refer to the actual survey area in Minisink, not the town of Minisink in its entirety or collectively. It is preferable to run such surveys over an area roughly centered on the area of particular concern, in the present case the location of the proposed compressor station. Unfortunately, there were no identified publicly accessible roads in reasonable proximity to the east of the site of the proposed compressor station. Consequently, the survey area covers the surrounding areas to the south, west, and north of the proposed compressor site. At least 2 survey runs were made over most of the roads in the survey area.

At the time of the survey the wind was out of the west at 12 to 18 mph. The wind was relatively strong and consistent throughout the sample period. Such wind conditions tend to increase the rapidity of dilution of methane emerging from the ground, but also tend to sweep the escaped methane into a relatively narrow plume directly downwind of the source area.

The air sample intake was positioned to ride, pointing downward, behind the vehicle ≈12 inches (30 centimeters) above the road surface. Roads were driven at the posted speed limit or slower if necessitated by road or traffic conditions. GSI experience has shown this approach is adequate for detection of even relatively weak methane sources under most circumstances.

The work effort was to provide a baseline survey of the survey area. It was not intended to identify specific sources or causes of any elevated methane levels encountered. Still, relevant observations are a matter of course during such surveys, and those observations may be important in understanding the baseline data set and its implications. Though observations suggesting a potential explanation for observed elevated methane levels are discussed in this report, these explanations should be regarded as speculative until further field investigations are carried out to confirm specific methane sources. Still, it must be recognized that some of the observed methane levels indicated possibly substantial leaks in natural gas lines that may be in the vicinity. GSI suggests and will assist DCS or others in providing gas companies serving the area with baseline survey data to help locate potential leaks.

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 assure proper function. During the Minisink baseline work each data line included individual values for 29 active data types. A total of 34,802 lines of data were processed for the survey, or a total of over a million data points.

The instrument automatically records and starts a new digital data file about every hour to produce data logs as files of sizes (usually around 13,000 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 re-fueling, meals, U-turns, navigation, crossing contract area boundaries, etc. Running the instrument during these times, however, produces a data set with geographically disproportionate amounts of data for such locations. In order to develop a more geographically representative data set, the data collected at such stop locations are manually identified and reduced or removed from the baseline data set.[3] Following removal of such data as well as data for inbound and outbound travel paths from the 34,802 methane data points collected, there were 13,688 methane data points in the baseline data set for the Minisink survey area itself.

Data subsets compiled while the survey vehicle is stopped have another effect In addition to the geographical overweighting of the full data set with data from the stop location. This effect can appear as needle-like spikes in methane concentrations. Review of the data block for such stop locations generally shows that the apparently very sharp spikes were actual variations in methane levels that occurred at the stop location over the time during which the vehicle was at that location. Since the vehicle is stopped, the main source of variation is the rate at which methane moves to the vehicle, instead of the vehicle moving through areas with differing concentrations of methane. That is, when the vehicle is stopped the data is strongly influenced by the wind, while when the vehicle is in motion the main influence is proximity to a source. The moving vehicle data necessarily incorporates wind influence into the methane measurements while the stopped vehicle measures variations only due to wind and only at the stop location. If a puff of wind is carrying a high concentration of methane when it blows by the stop location, then the methane results for that location will appear as a needle-like spike in the plot. Any such peaks within an investigation target area require selective examination of the variations of methane levels over time. In the Minisink survey area, the Marvelle Lane stop location was such a case and is discussed in more detail below.

The data was compiled, 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 and other routine statistical summary functions in Excel.

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[3] Survey vehicle stops or maneuvers that result in generation of fewer than 50 or so data lines for a single location are not modified. During the Minisink survey there were a limited number of short stops that resulted in a few, small, location-repetitive data blocks. All such blocks were left in the baseline survey data set. There was a single long stop at the east end of Marvelle Lane. That data was removed and analyzed separately. No data is permanently deleted from the original data file.

RESULTS

Observations during the survey and interviews with local residents confirmed that besides the natural gas transmission line, there is gas service to residences and businesses and there are gas lines throughout the survey area. Sewage management in the area was not discussed. Septic tanks and fields, and sewage lines and treatment facilities can be substantial sources of methane at times. No observations indicated landfills in the survey area.

Visualization is the most convenient first approach to attempting to understand data sets the size of the methane data files generated during the GSI Minisink Methane Baseline survey runs, i.e, more than 13,000 methane data points in the survey area alone. Figures 1 and 2 present the methane data for the methane survey area and travel paths superimposed on aerial/satellite imagery using Google Earth.

Plots of Survey Data on Remote Imagery

Figure 1 provides a view of the Minisink survey area as well as methane levels along the inbound travel path from the northeast on NY 284 and outbound to the northwest on Route 6 and Interstate 84. This image serves to provide general geographical orientation and a sense of scale for methane emissions in the survey area compared to other areas in the region. In the image the inbound route comes in from the right (northeast), the survey area is apparent as the "loop" and branches of survey paths in the lower left, and the outbound route goes upward (northwest) and out the upper left corner of the image. The generally low baseline for most of the region is apparent on the inbound and outbound routes and nearly all of the survey area, except for three locations with sharply elevated methane levels on NY 284 to 1-3 miles northeast (to the right) of the survey area. The southern two of these three high methane areas are in the Town of Minisink, the northernmost is in the Town of Wawayanda.

The overall survey data (shown in the image) indicate such sharply elevated methane levels are unusual for the region. The typical background methane level in the region is around 1.85 ppm. The three sharp methane concentrations reached (from left to right in the image) 6.38, 11.8, and 15.7 ppm. The 11.8-ppm methane concentration may have been associated with an apparent animal farm about 400 feet to the west on Lime Kiln Road. This is an unusually high methane elevation for a farm operation. However, wind, weather, and operational aspects specific to this farm may have had a role in causing such an elevation of methane concentrations in the air downwind of the farm. No attempt was made to confirm the farm as the source of the methane.

No readily apparent methane sources were observed for the other two unusually high methane concentrations, except that both appeared to be downwind of business facilities involving junked cars. No observations were made regarding whether these facilities had natural gas services, or whether there may have been gas lines in the area. Subsequent examination of a Minisink Town zoning map indicated there is a utility easement labeled “Home Gas” running along the west side of NY 284 from Unionville to the northeast boundary of the Town of Minisink.

Visual consideration of the survey area in Figure 1 serves to clarify that, though there are some elevated methane levels in the survey area, they are limited in number and not nearly as high as the three to the northeast on NY 284.

Figure 2 provides a closer view of the Minisink methane survey area. In this closer view 6 areas with elevated methane readings are apparent. One area involves two “needle” elevations of methane just left of bottom center of the image on Jacobs Road (not labeled in the image). These “needle” elevations were associated with vehicle stops (discussed in DATA COMPILATION AND PROCESSING above) at about 100 and 1000 feet from the gas transmission line, effectively on the east side of the proposed compressor station site. The highest concentration reached in this area was 2.39 ppm, which would be regarded as a slightly elevated methane level.

There is a prominent elevation in methane concentrations apparent in the image rising up through the label for County Road 1. The leak was actually observed on Oak Hill Road just off County Road 1. Methane levels were consistently elevated, the highest reading being 4.69 ppm. This is a moderately elevated methane level, the location and strength of which would suggest need to consider a gas main leak upwind (west) of Oak Hill Road in this area.

There was a similar, but much smaller elevation of methane at the intersection of County Road 1 and Bender Road (directly up Country Road 1 in the image) from the Oak Hill Road methane elevation. The Bender Road elevation maximum was 2.31 ppm.

On NY 284 in Westtown there was a series of three progressively larger methane concentration elevations. The maxima of these three were 2.02, 2.26, and 3.30 ppm.

Continuing to the northeast (to the right in Figure 2) on NY 284 another area of elevated methane concentration is apparent near the center of the image. This elevated methane reading occurred where NY 284 crosses over the gas transmission line. The maximum was 2.60 ppm. This is a slight to low elevation. The occurrence at the gas transmission line may be coincidence as the Town zoning map indicates another gas line runs along NY 284 and there may also be other gas distribution lines (mains) or small natural sources in the area as well, any of which might be leaking small amounts of methane.

Continuing further northeast along NY 284 a broader area with elevated methane levels is encountered just before the junction with Whitford Road (just above and to the left of the “284” label in Figure 2). The methane maximum in this area was 2.50 ppm. It is likely the large horizontal spread (approaching 1000 feet) of this elevated methane area was due to wind. The wind direction was roughly coincident with the run of this section of NY 284, causing the methane emission plume to move along the roadway, extending the area over which it was measurable. This methane plume may have extended laterally to the southeast as slight methane elevations were also encountered on Whitford Road for up to 500 feet from NY 284.

The Marvelle Lane stop location is just outside the view area at the bottom (east) side of Figure 2. It is discernible as the extreme eastern (downward) extent of the survey path shown in Figure 1 (lower left)

Basic Statistical Summaries of Data

Elevated methane levels in the survey area were few and small, but well defined and easily distinguished. In the broader areas (inbound and outbound travel paths) peaks were also few, well defined, and, when present, typically larger than in the survey area. Consequently, statistical summaries were prepared for several different data sets. The most informative of these are presented in Table 1.

The available date were separated into five sets. Two were from the inbound route methane concentrations data set and were intended for comparison as regional references. Two were from the Minisink survey data set, one included all the data, the other with the data for the areas with conspicuously elevated (4 of the 6) methane levels removed. The last was the block of data collected while the survey vehicle was stopped on Marvelle Lane. As previously mentioned, large blocks of data accumulated during stops are removed to prevent excessive weighting of the data set with data only from stop locations. Because of the large amounts of data collected each of these sets or subsets was still robustly large, the smallest set, the early inbound reference data, containing 7799 methane data points.

The early inbound route data was removed as a separate data set to investigate conditions prior to encountering the three areas of exceptionally elevated methane levels on NY 284 northeast of the Minisink survey area. The influence of the high methane concentrations in those three areas was large enough to mask the regional baseline within summary statistics for the full inbound route data set. The early and full data sets were run separately and results are shown in the first two columns of Table 1.

The Minisink survey area data were similarly separated into two sets, the full data set, and another from which data for areas with prominent elevated methane levels had been removed. This was done to get a better handle on what conditions in the area might be if all gas line leaks and other manageable methane sources were corrected. For convenience, the data set from which the areas with elevated methane levels were removed is referred to as the “if-no-leaks” data set. This is not intended, and should not be construed to imply that elevated methane levels were due to gas line leaks, leaks from septic or sewer systems, natural leaks, or leaks from other sources. Identification of specific sources of elevated methane levels, i.e., “leaks”, was beyond the scope of this methane survey effort.

The data collected while stopped on Marvelle Lane appeared interesting because it is the easternmost (farthest downwind on the day of the survey) in the sampling area and because it appeared to be somewhat unusual in the methane context of the survey area. In particular it gives some indication of the role winds can play in the movement of gaseous contaminants.

The Inbound Reference Data-----
Comparison of the early and full inbound route reference data sets quickly reveals the impact of the 3 areas of high methane on 284 northeast of the Minisink survey area. If the elevated levels in those three areas were prominent but occurred as relatively short duration deviations from normal baseline conditions, then one would expect to find similar summary statistics, which was the case. The minimum, median and mode are the same for both the early and full data sets, while the mean differs by only 0.03ppm. The maximum for each set is distinctly different, however, 2.26 ppm for the early inbound and 15.73 for the full inbound data sets. The relative standard deviation of the two sets differ substantially, 1.26% for the early and 21.48% for the full inbound sets, indicating the three sharply elevated methane levels are the source of most of the variability in the full data sets. In the early inbound data the separation between the 95th and 99th percentiles is 0.06 ppm, between the 99th and 99.9th

0.25 ppm. For the full inbound data set, the 95th-99th percentile difference is five times greater, and the 99th-99.9th nearly 5 times greater.

Table 1. Basic statistical summaries of Minisink methane baseline survey data.

	Inbound Route Reference		Minisink Survey Area		Marvelle Lane
	Before 3 hi CH4 peaks	Full data set (w/3 hi peaks)	Full data set	CH4 peaks removed	stopped
Number of Data Points	7799	13235	13688	13009	9450
	Methane (ppm)				
Minimum	1.82	1.82	1.80	1.80	1.82
Mode	1.86	1.86	1.86	1.86	1.84
Median	1.86	1.86	1.86	1.85	1.90
Mean	1.86	1.89	1.87	1.86	2.00
Maximum	2.26	15.73	4.69	2.39	3.08
Relative Standard Deviation	1.26 %	21.48 %	6.20 %	2.03 %	10.85 %
	Methane (ppm)				
99.9th %-ile	2.19	9.00	3.50	2.37	3.00
99th %-ile	1.94	2.25	2.34	2.07	2.75
95th %-ile	1.88	1.95	1.97	1.91	2.50

The Minisink Survey Area Data-----
Similar comparisons of the Minisink area data lead to similar conclusions, except that the elevated methane levels and their overall effects are much smaller. The minimum and mode are the same, and the median and mean are only 0.01 ppm higher for the full data set compared to the if-no-leaks data set. The maxima are different, 4.69 for the full data set and 2.39 ppm for the if-no-leaks data set.

The difference between the 95th-99th percentiles for the if-no-leaks data set was 0.16 compared to 0.37 for the full Minisink data set. For the 99th-99.9th percentiles the differences were 0.3 ppm for the if-no-leaks and 1.16 ppm for the full set. That is, the highest 95-99.9% of all the data in the full data set are roughly 2 to 4 times greater than in the if-no-leaks data set. Showing that the differences between the two data sets involved not just the maximum for each data set, but at least the top 5% of the data in both sets.

The Marvelle Lane Stop Data-----
Because the Marvelle Lane stop data was collected at a single, extreme downwind location in the survey area, it provides an indication of the variability of methane levels coming solely from the wind bringing methane to a given location. The maximum of 3.08 is somewhat higher than the early inbound reference baseline or the if-no-leaks survey area baseline, but for a maximum value it is a relatively minor difference. The minimum is effectively the same as the other data sets, indicating when a burst of "fresh air" blows by the the survey area baseline may still be in effect on Marvelle Lane. It is interesting to note that among the five data sets, the mean Marvelle Lane methane level of 2.00 ppm was higher than the means for all the other data sets, which ranged narrowly from 1.86-1.89 ppm. This suggests the Marvelle Lane location is influenced by a nearby methane source capable of pushing methane levels above baseline conditions, or may be receiving the collective effects of multiple methane sources upwind. The relative standard deviation is higher than the full survey area data set. The differences are the same for both the 95th-99th and the 99th-99.9th percentiles, suggesting that variability reaches more consistently up to the top of the range of measured methane levels. These statistics would seem to indicate much of the above-baseline methane arriving at the Marvelle Lane stop location was being wind-carried from an unidentified source upwind. Further, the data indicates the source is not likely too distant because mixing would be more thorough, and methane concentrations more consistent and less elevated. With the limited information, it appears likely there is another low level methane source relatively near the Marvelle Lane stop location, rather than a larger source a greater distance away.

RECOMMENDED BASELINES

GSI suggests two broad types of baselines. One is a general survey area baseline. The other is a location specific baseline.

The General Area Baseline
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 survey area. The general baseline is to be regarded as the normal methane condition in ground level air in the survey area. It is based on conditions that can be considered normal or typical in the survey area generally, regardless of location. The baseline should be conservative, i.e., favor high values in order to avoid false alarms regarding possible future methane contamination sources. 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 highest value for each percentile listed in Table 1 be defined as the broad area baseline measures. The recommended general survey area 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 2.34 ppm
99.9% of all methane data should be less than 3.50 ppm

If any of these measures are not met, further investigation to determine the cause of increased methane levels should be undertaken.

Further, though at the time of this report gas line leaks have not been confirmed, it seems plausible they are the sources of most or all of the elevated methane levels in the Minisink survey area. If that is the case and all such leaks were repaired, and no new ones developed, the baseline values indicated above would need to be checked and could be reasonably expected to fall to 1.91, 2.07, 2.37 ppm, respectively. Additionally, the situation and sources of the three unusually high methane levels on NY 284 1-4 miles north of the survey area should be determined and corrective measures taken. It is conceivable that, if wind conditions were appropriate, methane collectively from those stronger sources in that area could raise methane in the Minisink survey area above baseline. This is a point of concern because any future confirmational or investigative methane surveys must include measures to take into account the potential influence of the apparently substantial sources of methane in that area on NY 284, unless the causes of those high methane levels are identified and corrected. Because of the presence of multiple gas lines of unknown pressures and sizes in the area, future surveys should be more comprehensive in order to assure that no other such high methane areas in the vicinity are impacting baseline surveys within the current or any other nearby methane survey area.

Specific Location Baselines

Baseline criteria for specific locations within the survey area should be extracted from the full baseline data set. As a result of this methane baseline survey, in most cases there is now methane data covering the area around any given location. 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 off-set 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 off-set 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 Minisink were at local baseline levels. For such locations, the location specific baseline will be the measured local baseline, which can be directly extracted from the original data.

CONCLUSIONS

A baseline data set has been collected for a selected area in Minisink, Orange County, New York. The data have been compiled, processed, and examined and found to be of high quality. The data indicate relatively low and reasonably consistent methane concentrations throughout the survey area, leading to a set of baseline recommendations including that 99% of all data in any similar future methane survey should be less than 2.34 ppm, 99.9% should be less than 3.50 ppm. Appropriate methods can be applied to the baseline data set to extract baseline methane levels for any specific location along the surveyed roadways.

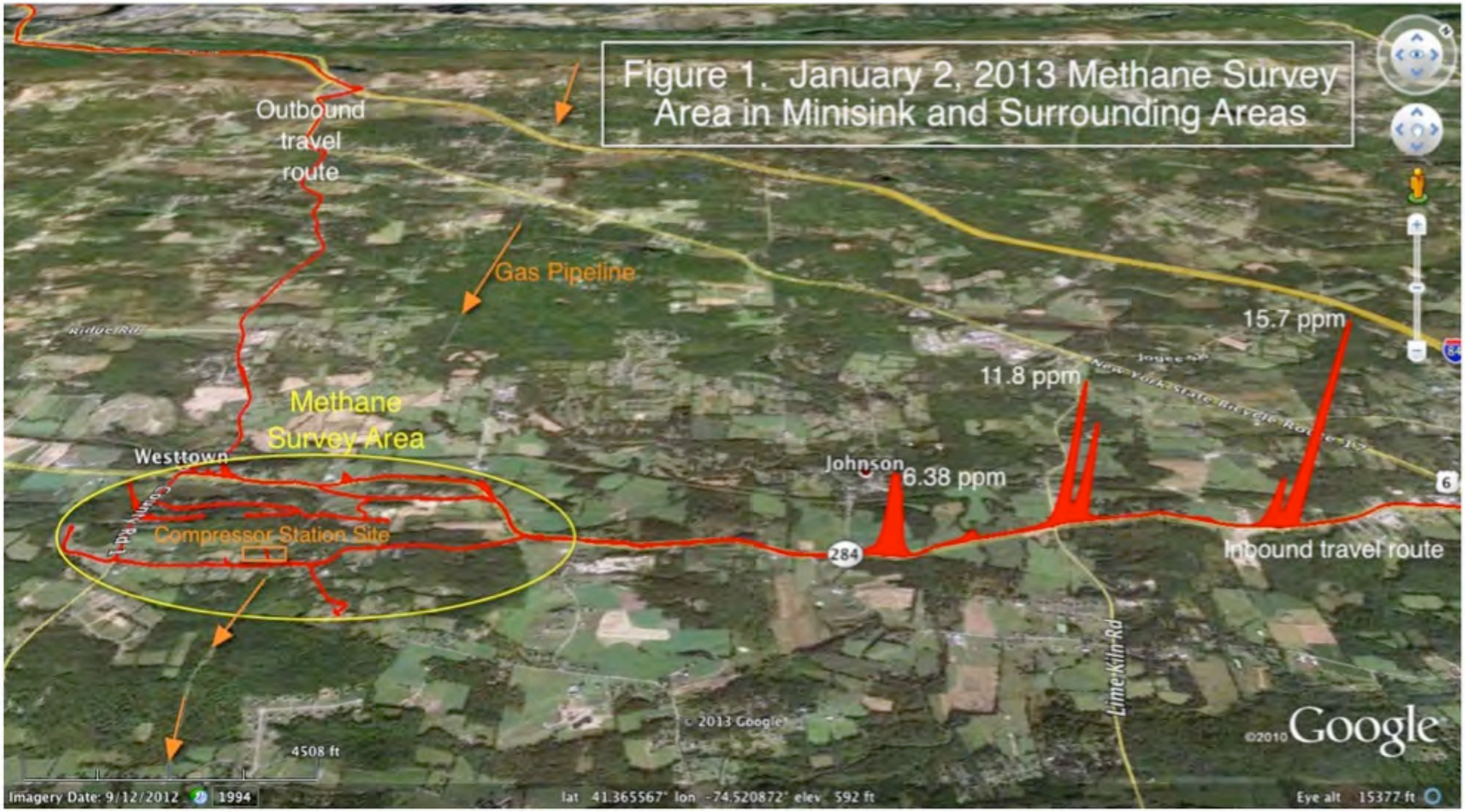
Figure 1. January 2, 2013 Methane Survey Area in Minisink and Surrounding Areas
Outbound travel route
Gas Pipeline
Methane Survey Area
Westtown
Compressor Station Site
Johnson
6.38 ppm
11.8 ppm
15.7 ppm
Inbound travel route
Lime Kiln Rd
284
4508 ft
© 2013 Google
©2010 Google
Imagery Date: 9/12/2012
1994
lat 41.365567° lon -74.520872° elev 592 ft
Eye alt 15377 ft

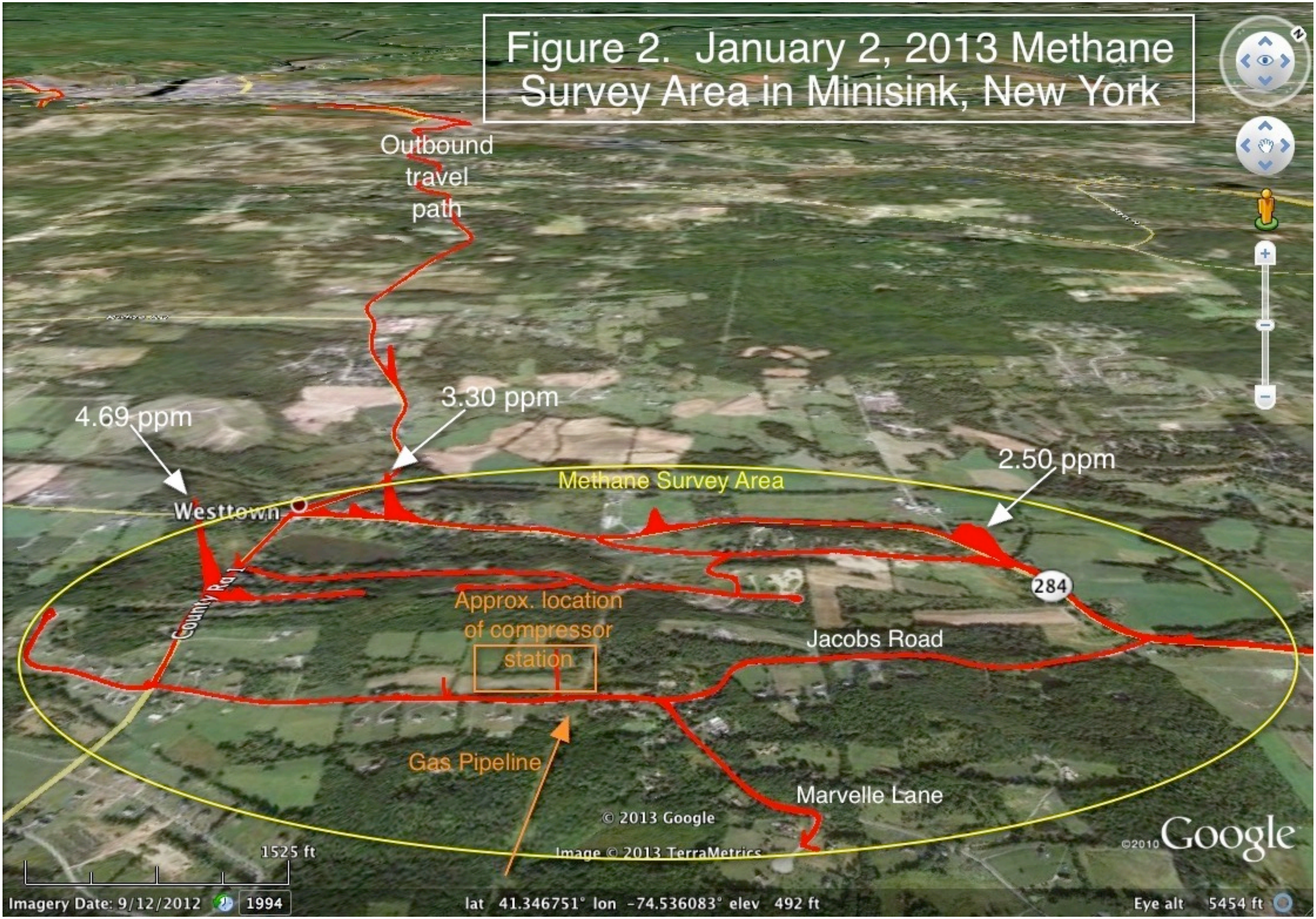

Figure 2. January 2, 2013 Methane
Survey Area in Minisink, New York
Outbound
travel
path
4.69 ppm
3.30 ppm
2.50 ppm
Methane Survey Area
Westtown
County Rd 1
284
Approx. location
of compressor
station
Jacobs Road
Gas Pipeline
Marvelle Lane
© 2013 Google
Image © 2013 TerraMetrics
1525 ft
©2010 Google
Imagery Date: 9/12/2012
1994
lat 41.346751° lon -74.536083° elev 492 ft
Eye alt 5454 ft