ENERGY-FORENSICS

Strategic Oil & Gas Ltd.

Work Order-Ref #: 19133

Vapor Intrusion Assessment (VIA) Soils Outside Casing (AGM)

Strategic et al Cameron K-74

September 10 & 11, 2019

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FORENSIC SOLUTIONS FOR ENERGY CHALLENGES

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1.0 Executive Summary

On September 10-11, 2019, Strategic et al Cameron Hills K-74 was investigated for the presence of leaking natural gases in soils outside of casing. Total combustible gas (%LEL) and H_2S field instruments were used to measure gas levels and types at soil test sites. Gas samples were collected, contained and preserved from soils outside casing (AGM) and for baseline comparison, background locations, ~30m away from the wellbore were also assessed.

Soils outside of casing immediately adjacent to and south of the wellbore were water saturated however, no gas bubbling was observed in standing water. A 108 site non-intrusive surface CH_4 scan was conducted in soils outside casing and at 3-background locations (NE30m, E25m, and W30m). Six sites (N2m-E3m, E2m-S1m, S5m-W1m, S4m-W1m, S3m-W2m and S3m-W3m) contained elevated methane levels (1185, 701, 2088, 22, 24 and 45 ppm v/v, respectively) when compared to levels measured at background locations (2 ppm v/v). All other sites tested near the wellbore contained CH_4 levels of 2 ppm v/v and were similar to the BKG sites.

A Closed Chamber Soil Vapor Flux Chamber Assessment (SV-FC) was conducted in soils outside casing at site N2m-E3m (1185 ppm v/v surface PMD) and for comparison, background site BKG NE30m. CH_4 gas at test site N2m-E3m outside casing contained a positive gas flux where CH_4 gas levels increased to 76 ppm v/v over a 24-minute test period. A CH_4 venting gas flow rate of 0.000193 $m^3/m^2/d$ (volumetric) or 0.12610241 $g/m^2/d$ (gravimetric) was calculated CH_4 gas levels in the background flux test site (NE30m) was variable, ranged from 1 to 5 ppm v/v and did not consistently increase with test time and suggests that CH_4 gas was present however, venting soil methane to atmosphere was very low (typical of baseline CH_4 - soil respiration processes - background flux measurements).

A total of 10 soil sites outside casing were assessed for gas leakage using an intrusive methodology where 5cm soil vapor test holes were augered into soils and Soil Vapor Probes (SVPs) were inserted into each test hole. Of the 10 soil vapor test sites outside casing, 4 sites (N3m 3774 ppm v/v, NE1.5m 1213 ppm v/v, W1m 539 ppm v/v and W2m 418 ppm v/v) contained elevated, above background (NE30m 230 ppm v/v) methane contents. SOG selected 2 soil sites (N2m-E3m and W1m) to measure chemical and $\delta^{13}C$ isotopic compositions to aid in classifying combustible gas contents. Test site N2m-E3m and W1m contained low levels of CH_4 gas and low, similar to background levels of associated ΣC_2+ gas. Sufficient levels of CH_4 to n-C_4H_{10} were not available to measure $\delta^{13}C$ CH_4 to C_4H_{10} for any samples however, $\delta^{13}C$ CO_2 was detected and AGM SVP site W1 was -19.73 ‰ PDB and BKG NE30 was -17.74 ‰ PDB. Elevated CH_4 gas in soils with low associated ΣC_2+ gases suggest biogenic origins for methane gas (soil respiration processes - low temperature degradation of organic matter generating biogenic CH_4 gas or 'swamp gas'). ΣC_2+ gases in soils outside casing at N2m-E3m and W1m are the result of natural movement of light hydrocarbon gases from reservoirs at depth, upward through subsurface fractures and micro-fractures to surface. This is a naturally occurring process in all hydrocarbon sedimentary basins in the world.

With information available to date, soil vapor test sites N2m-E3m and W1m would be classified as 'Biogenic-Naturally Occurring CH_4-Non-Impacted'.

2.0 Vapor Intrusion Assessment Summary

Operating Company: Strategic Oil & Gas Ltd.
Well Name: Strategic et al Cameron K-74
UWI: 300K746010117150

License Number: 001172
Test Date September 10-11, 2019
GCHEM Project Number 19133

2.1 Production Casing Test Summary

Combustible Gas (CH_4) ([%LEL])	nm		
Hydrogen Sulphide (H_2S) Gas (ppm v/v)	nm		
PC Flow Rate (m^3/day)	nm		
P-T Date Logger Installed	nm		
P-T Data Logger Removed	nm		
P-T Data Logger Test Duration	nm		
MAX Pressure (kPa)	nm		
Gas Spls. Collection-Measurement	**Total Collected**	**Analysis Requested***	**Classification****
PC Samples (Total)	0		
PC Combustible Gas Class. Level-1 (Chemical)		NA	NA
PC Combustible Gas Class. Level-2 ($\delta^{13}C$)		NA	NA
PC Combustible Gas Class. Level-3 (δD)		NA	NA
PC Combustible Gas Class. Level-4 (^{14}C)		NA	NA

2.2 Surface Casing Vent Flow (SCVF) Test Summary

SCV Ten-Minute Bubble Test Result	nm		
SCV Flow Rate (m^3/day)	nm		
SCVF Pressure-Temp Logger Installed	nm		
SCV Pressure-Temp Data Logger Removed	nm		
SCV Shut-In Time (hrs)	nm		
SCV MAX-Recorded Build Up Pressure (kPa)	nm		
SCV Stabilized Build-up Pressure (kPa):	nm		
SCV Stabilized Build-up Time (hours)	nm		
SCV Standpipe Max CH_4 Content (% LEL):	nm		
SCV Standpipe Max H_2S Content	nm		
SCV Gas Spls. Collection-Measurement	**Total Collected**	**Analysis Requested***	**Classification****
SCV Samples (Total)	0		
SCV Combustible Gas Class. Level-1 (Chemical)		NA	NA
SCV Combustible Gas Class. Level-2 ($\delta^{13}C$)		NA	NA
SCV Combustible Gas Class. Level-3 (δD)		NA	NA
SCV Combustible Gas Class. Level-4 (^{14}C)		NA	NA

2.3 Soil Gas Migration-Vapor Intrusion Assessment: Soils Outside Casing (AGM) Summary

A) Non-Intrusive CH_4 Surface Soil Scan (PMD) (Figure-1 and Table-1)

Well Casing Surface CH_4 Test Sites	108
MAX Surface CH_4 Reading	2088
MAX H_2S Well Soil Reading (ppm v/v)	0
Number of Background Sites	3
MAX Background CH_4 (ppm v/v)	2
Max H_2S BKG Soil Reading (ppm v/v)	0
Surface CH_4-PMD Gas Classification	

B) Non-Intrusive Surface Enclosed Soil Vapor FLUX Chamber Test

Surface SV-FC CH_4 Test Sites	2 (N2m-E3m & BKG W30m)		
MAX SV-FC CH_4 Reading (ppm v/v)	76		
SV-FC Gas Spls. Collection-Measurement	**Total Collected**	**Analysis Requested***	**Test Site**
SV-FC Samples (Total)	2		
SV-FCs Requested for Level-1 Analysis		1	N2m-E3m
Combustible Gas Classification Level-1 (Chem.)		Biogenic, Non-Impacted	
SV-FCs Requested for Level-2 Analysis		1	N2m-E3m
Combustible Gas Classification Level-2 ($\delta^{13}C$)		Biogenic, Non-Impacted	
SV-FCs Requested for Level-3 Analysis		0	NA
Combustible Gas Classification Level-3 (δD)		NA	
SV-FCs Requested for Level-4 Analysis		0	NA
Combustible Gas Classification Level-4 (^{14}C)		NA	

C) Intrusive Auger Test Holes with Soil Vapor Probes (Figure 2 and Table 2)

Number Soil Vapor Probe (SVP) Test Sites	10		
MAX SVP CH_4 Reading (%LEL)	7.5		
Max H_2S SVP Field Reading (ppm v/v)	0		
Number SVP BKG Test Sites	3		
MAX SVP CH_4 BKG Test Sites (ppm v/v)	230		
SVPs Gas Spl. Collection & Measurement	**Total Collected**	**Analysis Requested***	**Test-Site**
Soil Vapor Probes (SVPs) AGM (Total)	4		
SV-FCs Requested for Level-1 Analysis		1	W1m
Combustible Gas Classification Level-1 (Chem.)		Biogenic, Non-Impacted	
SV-FCs Requested for Level-2 Analysis		1	W1m
Combustible Gas Classification Level-2 ($\delta^{13}C$)		Biogenic, Non-Impacted	
SV-FCs Requested for Level-3 Analysis		0	NA
Combustible Gas Classification Level-3 (δD)		NA	
SV-FCs Requested for Level-4 Analysis		0	NA
Combustible Gas Classification Level-4 (^{14}C)		NA	

BKG Gas Spl. Collection-Measurement	Total Collected	Analysis Requested*	Test Site
BKG Soil Vapor Probe (SVPs) (Total)	3		
SV-FCs Requested for Level-1 Analysis		1	BKG NE30m
Combustible Gas Classification Level-1 (Chem.)		Biogenic, Naturally Occurring, Baseline	
SV-FCs Requested for Level-2 Analysis		0	
Combustible Gas Classification Level-2 ($\delta^{13}C$)			
SV-FCs Requested for Level-3 Analysis		0	
Combustible Gas Classification Level-3 (δD)		NA	
SV-FCs Requested for Level-4 Analysis		0	
Combustible Gas Classification Level-4 (^{14}C)		NA	

**** Sample selection for chemical and isotopic analysis (geochemical analytical suite) selected by client/operator.***

2.4 Interpreted Source of Migrating Gases (measured depth from KB of the well)

Sample Point	Geologic Formation	Depth Range	Source Depth
SV-FC N2m-E3m & SVP W1m	Near Surface Soil Respiration	Biogenic CH_4, NON-Impacted, Baseline	

3.0 Background of Vapor Intrusion Assessments (VIA) at Resource Wells & Tracing Gas Contents in the Environment using Energy Forensics

Undesired natural gas leakage from depth to surface at resource wells is becoming increasingly recognized and is a significant financial burden to the resource industry. When high levels of natural gas are found in the surface casing vent it is termed surface casing vent flow (SCVF) and when found in soils outside casing it is termed active gas migration (AGM). Identifying the source of leaking gas, maintaining zonal isolation and eliminating gas leakage to surface has proven to be a challenging task. Industry success rates using conventional gas leakage identification tools (e.g. noise, temperature, cement bond-integrity, ultra-sonic imaging logs, etc.) to eliminate surface gas migration in the first attempt is approximately 15% to 20%. Since 1997, through collaboration with industry, government regulators and academic institutions, GCHEM Ltd. has developed 'Energy-Forensics' and has obtained extensive expertise in field testing, gas sampling and preservation, analytical and interpretational techniques to pinpoint the geologic source of natural gases at resource wells.

It is important to note that detection of elevated combustible gases at surface does not always mean the well is impacted with deep sourced natural gas (thermogenic). Accurate gas characterization at well sites is critical as elevated CH_4 (%LEL) contents measured at or near surface may not indicate it is leaking or impacted (false-positive) but rather the combustible gases present are the result of biogenic activity or hydrocarbon contamination (or a combination of).

Thermogenic hydrocarbon gases have unique chemical and isotopic signatures based on many variables including the starting organic material they are produced from, the chemical processes from organic origin to current form, interaction with surrounding formation rock and fluids, and effects from migrating from origin to current trap. For example, molecular and isotopic composition ($\delta^{13}C$ and $\delta^{2}H$) of a low temperature, shallow sourced natural gas is significantly different with respect to those of a high temperature deep sourced natural gas. This principle allows the geologic source of leaking natural gas at a wellbore to be determined.

3.1 Biogenically Derived Methane Gas

As a normal part of soil respiration, methane may be generated via two biotic pathways (depending on substrate availability):

CO_2 reduction reaction	$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$
Fermentation Process	$CH_3COOH \rightarrow CH_4 + CO_2$

Biogenic methane gas may be further oxidized by bacteria. Oxidizing bacteria in soils preferentially consume ^{12}C over ^{13}C resulting the residual gas enriched in ^{13}C (i.e. $\delta^{13}C$ values become less negative) with respect to the biogenic gas (isotope enriching effect). Therefore, biogenic oxidization may provide the false signature of a 'mixture of biogenic and thermogenic methane' or 'thermogenic' gas (GCHEM in prep). Biogenic CH_4 is generally prevalent in landfill or swamp gas.

3.2 Thermogenic Methane Gas

Methane gas can be generated by abiotic processes such as the thermo-degradation of organic matter at high pressure and temperature (thermogenesis). During thermogenic CH_4 generation, pending organic matter content, pressure and temperature, associated C_2+ gases may also be formed. Thermogenic CH_4 and C_2+ gases contain enriched $\delta^{13}C$ and δD values pending gas maturity, mixing and alteration and torturous pathway from source to trap.

3.3 Classification, Characterization and Geological Origins of Combustible Gases in the Environment.

Combustible gases in soils outside casing maybe classified and characterized (biogenic, thermogenic or mixed) using chemical, carbon and hydrogen and isotopic measurements and ^{14}C concentrations. Leaking thermogenic natural gas in soils outside casing is easier to scientifically prove than biogenic methane sources. Elevated %LEL measured in AGM (on location) maybe the result of naturally occurring biogenic processes, anthropogenic leaking thermogenic natural gases and mixtures of both. A systematic 4-level approach can be used to determine the origins (biogenic-thermogenic or mixed) combustible gas contents and include:

1)	**Level-1 Characterization**	**High Resolution Compositional-Chemical Measurements.** Permanent, inert and CH_4 to n-C_5H_{12} & C_6+. See NGGC-1 CH_4 vs ΣC_2+ (Szatkowski et al 2000 & 2001). See NGGC-2 C_2H_6 vs. c_6+ (Szatkowski et al 2000 & 2001).
2)	**Level-2 Characterization**	**Stable Carbon Isotope Measurements ($\delta^{13}C$).** $\delta^{13}C$ CH_4 to n-C_5H_{12} & CO_2 (pending concentrations-gas levels). See NGGC-3 $CH_4/\Sigma C_2$+ vs. $\delta^{13}C$ CH_4 (Bernard 1978). See NGGC-4 $\delta^{13}C$ CO_2 vs. $\delta^{13}C$ CH_4 (Whiticar 1993).
3)	**Level-3 Characterization**	**Hydrogen in Methane (δD).** δD CH_4 to dD C_4H_{12} (pending concentrations-gas levels). See NGGC-5 $\delta^{13}C$ CH_4 vs δD CH_4 (Coleman 1993).
4)	**Level-4 Characterization**	**^{14}C pMC concentrations (radioactive ½ life of 5750 yr).** Pending concentrations-gas levels. ^{14}C reveals the age of the organic matter source from which CH_4 was generated but not the time of methanogenesis.

To determine the geological origins of leaking thermogenic natural gas contents, a series of plots developed by GCHEM Ltd are used and include.

1)	**Chemical & Isotopic Gas Field Diagram**	$C_2H_6/\Sigma C_3$+ vs $\delta^{13}C$ C_2H_6 (Szatkowski et al 2000, 2001).
2)	**Isotopic Gas Field Diagram**	$\delta^{13}C$ C_2H_6 vs. $\delta^{13}C$ C_3H_8 (Szatkowski et al 2000, 2001).
3)	**Modified Chung Plot**	$\delta^{13}C$ vs 1/n (carbon & hydrogen number) (Chung 1988, and GCHEM Ltd. Unpublished).

Additional chemical and stable carbon and hydrogen isotopic plots have been developed to aid in determining the geological origins of natural gas found in the environment however, GCHEM has not published these novel and new correlations and relationships and they will not be shown or discussed in detail at this time (GCHEM Unpublished Internal Research).

4.0 Methods and Results

4.1 Field Assessment Methods and Results

4.1.1 Non-Intrusive Vapour Intrusion Assessment

On September 10, 2019, GCHEM conducted a surface soil methane scan using a Sensit PMD (Figure 3). CH_4 readings were measured at 108 locations on a grid pattern (1m x 1m) covering approximately an 10m x 10m square area around the marked wellbore. Soils immediately outside the casing were wet (standing water in some areas) however, no gas bubbling in standing water was observed while conducting the VIA in soils outside of casing.

To establish background surface CH_4 gas levels a distance away from the well bore, three locations (30m northeast, 25m east, and 30m west of the wellbore) were also assessed. To enhance results of the surface methane scan and reduce potential effects from industrial contamination, at each test site, an atmospheric CH_4 gas level was recorded, the PMD gas sampling wand was coupled to surface soils and the CH_4 level was recorded for that specific test site. Atmospheric CH_4 level was subtracted from the CH_4 level measured after ground coupling to derive a surface soil CH_4 level at that point of the grid.

Six sites (N2m-E3m, E2m-S1m, S5m-W1m, S4m-W1m, S3m-W2m and S3m-W3m) contained elevated (1185, 701, 2088, 22, 24 and 45 ppm v/v, respectively) above background methane readings (2 ppm v/v). All other sites tested near the wellbore contained low levels of CH_4 gas (2 ppm v/v) that were similar to 3-BKG sites.

Figure 1. AGM Non-Intrusive Surface PMD

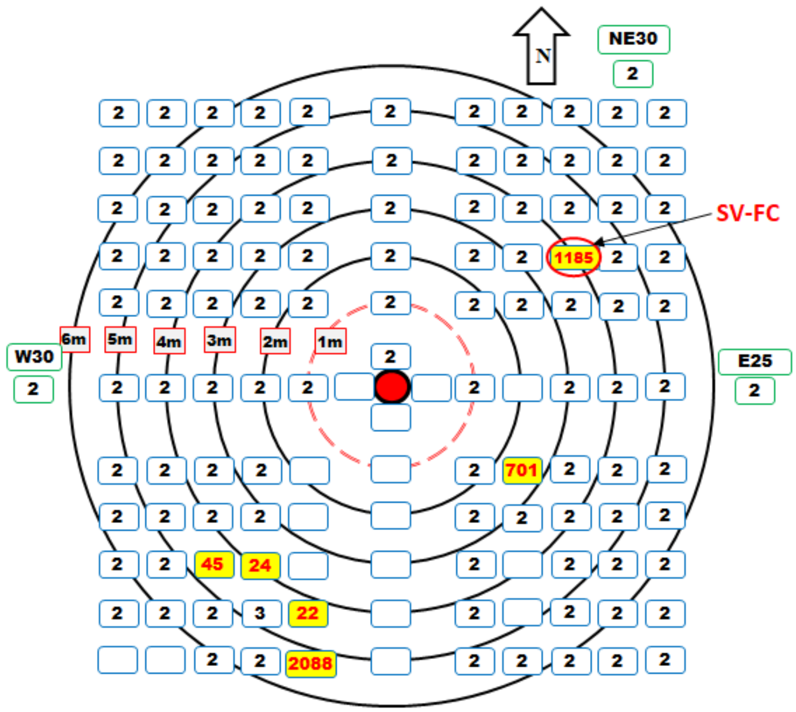
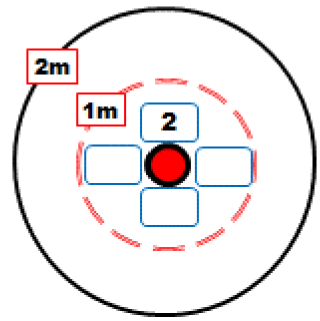


Figure-1A. NON-Intrusive CH_4 Surface Scan Well Casing Detail VIEW



Seeded grass surrounding the well casing is of similar stand-growth to surrounding lease vegetation. No stressed dead spots or discoloration was observed.

Table 1. AGM Non-Intrusive Surface PMD

WELL CASING (AGM) Non-Intrusive Surface PMD (CH_4) Soil Scan

Test Site (m)	PMD CH_4 (ppm v/v)	(% Vol)	Test Site (m)	PMD CH_4 (ppm v/v)	(% Vol)	Test Site (m)	PMD CH_4 (ppm v/v)	(% Vol)	Test Site (m)	PMD CH_4 (ppm v/v)	(% Vol)
N.5	2		E.5			S.5			W.5		
N1	2		E1	2		S1			W1	2	
N2	2		E2			S2			W2	2	
N3	2		E3	2		S3			W3	2	
N4	2		E4	2		S4			W4	2	
N5	2		E5	2		S5			W5	2	
N5-E1	2		E5-S1	2		S5-W1	2088		W5-N1	2	
N4-E1	2		E5-S2	2		S4-W1	22		W5-N2	2	
N3-E1	2		E5-S3	2		S3-W1			W5-N3	2	
N2-E1	2		E5-S4	2		S2-W1			W5-N4	2	
N1-E1	2		E5-S5	2		S1-W1			W5-N5	2	
N1-E2	2		E4-S5	2		S1-W2	2		W4-N5	2	
N2-E2	2		E4-S4	2		S2-W2	2		W4-N4	2	
N3-E2	2		E4-S3	2		S3-W2	24		W4-N3	2	
N4-E2	2		E4-S2	2		S4-W2	3		W4-N2	2	
N5-E2	2		E4-S1	2		S5-W2	2		W4-N1	2	
N5-E3	2		E3-S1	2		S5-W3	2		W3-N1	2	
N4-E3	2		E3-S2	2		S4-W3	2		W3-N2	2	
N3-E3	2		E3-S3	2		S3-W3	45		W3-N3	2	
N2-E3	1185		E3-S4	2		S2-W3	2		W3-N4	2	
N1-E3	2		E3-S5	2		S1-W3	2		W3-N5	2	
N1-E4	2		E2-S5	2		S1-W4	2		W2-N5	2	
N2-E4	2		E2-S4			S2-W4	2		W2-N4	2	
N3-E4	2		E2-S3			S3-W4	2		W2-N3	2	
N4-E4	2		E2-S2	2		S4-W4	2		W2-N2	2	
N5-E4	2		E2-S1	701		S5-W4			W2-N1	2	
N5-E5	2		E1-S1	2		S5-W5			W1-N1	2	
N4-E5	2		E1-S2	2		S4-W5	2		W1-N2	2	
N3-E5	2		E1-S3	2		S3-W5	2		W1-N3	2	
N2-E5	2		E1-S4	2		S2-W5	2		W1-N4	2	
N1-E5	2		E1-S5	2		S1-W5	2		W1-N5	2	

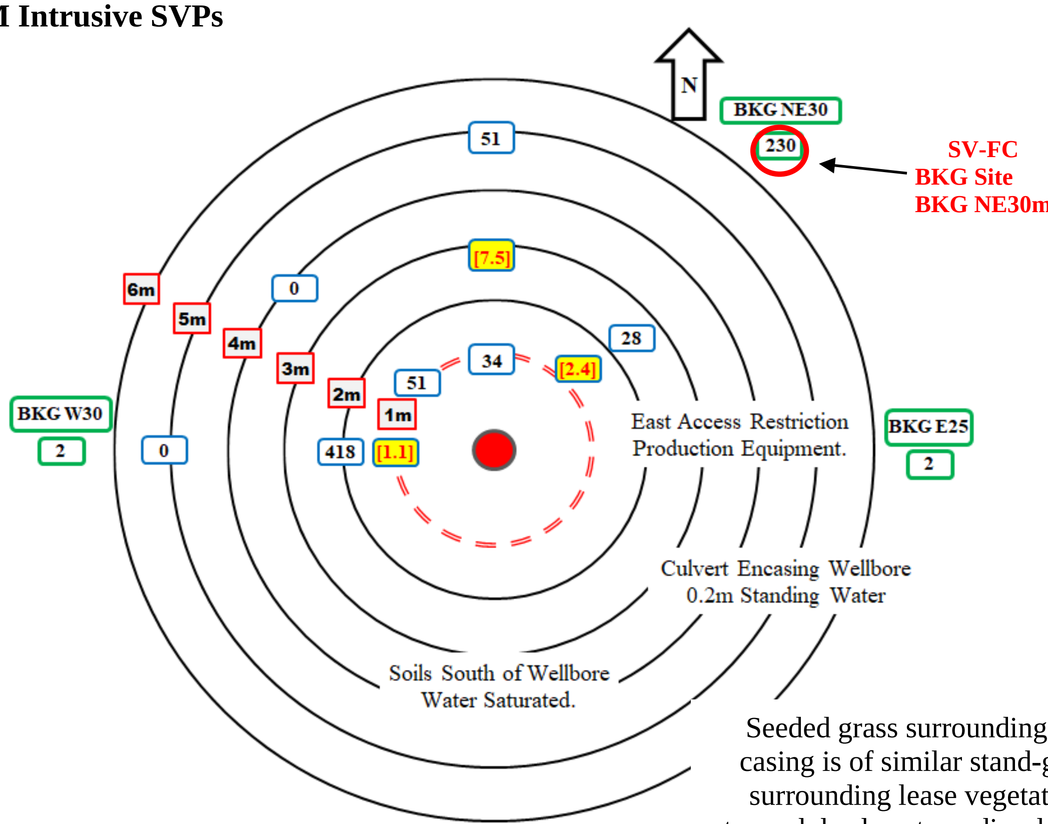
BACKGROUND Non-Intrusive Surface PMD (CH_4) Soil Scan

Test Site (m)	PMD CH_4 (ppm v/v)	(%)	Test Site (m)	PMD CH_4 (ppm v/v)	(%)	Test Site (m)	PMD CH_4 (ppm v/v)	(%)	Test Site (m)	PMD CH_4 (ppm v/v)	(%)
NE30	2		E25	2					W30	2	

4.1.2 Intrusive Vapor Intrusion Assessment

A total of 10 soil sites outside casing were assessed for gas leakage using an intrusive methodology where 5cm soil vapor test holes were augered into soils and Soil Vapor Probes (SVPs) were inserted into each test hole. The SVPs were allowed to stabilize for approximately 30-minutes prior to combustible gas content measurement with the PMD (Figure 4). Soils were water saturated at depths below 1.5m thus a full intrusive 16-auger hole test pattern could not be conducted. Of the 10 soil vapor test sites outside casing, 4 sites (N3m 3774 ppm v/v, NE1.5m 1213 ppm v/v, W1m 539 ppm v/v and W2m 418 ppm v/v) contained elevated, above background levels (NE30m 230 ppm v/v) of methane gas.

Figure 2. AGM Intrusive SVPs



Seeded grass surrounding the well casing is of similar stand-growth to surrounding lease vegetation. No stressed dead spots or discoloration was observed.

Table 2. AGM Intrusive SVPs

Intrusive AGM - Hand Auger-Test Hole-Install Soil Vapor Probes (SVPs) ATM-Isolated

Test Site (m)	Soil Vapor Probes IR-CH_4 (ppm v/v)	(% Vol)	H_2S (ppm v/v)	Soil Parameters Type	Moist. (1-5)	HC-CONT (Y-N)	Gas Sample (Y-N)	Site Assessment Comments
N1	34		<1.0	Si	5	No		
N3	3774	[7.5]	<1.0	Si	5	No	Yes	
N5	51		<1.0	Si	5	No		
NE1.5	1213	[2.4]	<1.0	Si	5	No	Yes	
NE2.5	28		<1.0	Si	5	No		
E1								
E3								
E5								
S1								Surface Water
S3								Surface Water
S5								Surface Water
W1	539	[1.1]	<1.0	Si	5	No	Yes	
W2	418		<1.0	Si	5	No	Yes	
W5	0		<1.0	Si	5	No		
NW1.5	51		<1.0	Si	5	No		
NW4	0		<1.0	Si	5	No		

Test Site (m)	Soil Vapor Probes IR-CH_4 (ppm v/v)	(% Vol)	H_2S (ppm v/v)	Soil Parameters Type	Moist. (1-5)	HC-CONT (Y-N)	Gas Sample (Y-N)	Site Assessment Comments
BKG NE30	230		<1.0	Si	5	No	Yes	
BKG E25	2		<1.0	Si	5	No	Yes	
BKG W30	2		<1.0	Si	5	No	Yes	

4.1.3 Soil Vapor Flux Measurements

Soil Vapor flux measurements can be conducted in soils to establish the rate and volume of gas leakage at surface. The soil Vapor flux methodology utilizes an enclosed chamber (known internal volume and surface soil area) with three gas ports: gas-in, gas-out and a pressure release valve. Gases are cycled from the gas-out port to a PMD and re-injected or cycled back into the flux chamber. The atmospheric pressure release valve allows leaking gas from soils to enter the chamber and displace atmospheric gas contents within the chamber.

Pristine, naturally occurring gas venting from soils as a result of natural movement of light hydrocarbons from reservoirs at depth, upward through subsurface fractures or micro-fractures to surface combined with soil respiration processes is a naturally occurring process prevalent in all sedimentary basins (i.e. hydrocarbon surface seeps). These soil gases are usually comprised of low, but variable, levels of CH_4 and CO_2 with low-to-trace levels of associated C_2+ thermogenic natural gases that cannot be generated by bacterial processes in great quantities. Soils influenced by anthropogenic process (i.e. natural gas leakage at a wellbore from natural gas reservoirs at depth, upwards through compromised cement sheaths securing production casing to formation rock to surface) usually contain highly elevated, above background levels of CH_4 (thermogenic, biogenic and/or mixtures) and associated C_2+ thermogenic gases.

CH_4 gas contents in the flux chamber were monitored and data logged using a PMD. Soil gas flux volumes and rates in soils can be calculated either volumetrically or gravimetrically considering the following relationship:

$$\text{Flux (F)} = (dC/dt)*(\text{volume}) / (\text{area})$$

Where:

C = concentration

t = time

dC/dt = change in concentration with time (the slope of a *concentration versus elapsed time* plot).

The volumetric flux is calculated from ppm v/v units (10^{-6} m^3 light alkanes/ m^3 air) and the gravimetric flux is calculated by converting ppm v/v to g/m^3 of air using the ideal gas law (PV = nRT) with P = 1 atmosphere and T = 25°C.

On September 10, 2019 the highest methane reading observed during the non-intrusive surface scans was at N2m-E3m (1185 ppm v/v methane). A GCHEM soil vapour-flux chamber (SV-FC) was installed at N2m-E3m and a 25-minute flux was conducted (Figure-3, Table-3). At the start of the flux the combustible gas reading was 14 ppm v/v methane and increased to 76 ppm v/v methane after a 24-minute test. Gas samples were collected from the flux chamber at the conclusion of the test (25-minutes).

A second flux test was performed at BKG-NE30m (Figure-3, Table-4). At the start of the flux combustible gas levels were 1 ppm v/v methane and did not increase throughout the 31-minute test. Gas samples were collected from the flux chamber at the conclusion of the 31-minute flux test.

Strategic et al Cameron K-74 Soil Vapor Flux Field CH_4 Test Time & Levels AGM Site-N2m-E3m

Test-Time	PPM	%LEL	%V/V	Test-Time	PPM	%LEL	%V/V	Test-Time	PPM	%LEL	%V/V
13:19:30	14	0	0	13:28:30	61	0.1	0	13:37:30	69	0.1	0
13:20:00	53	0.1	0	13:29:00	61	0.1	0	13:38:00	71	0.1	0
13:20:30	54	0.1	0	13:29:30	62	0.1	0	13:38:30	71	0.1	0
13:21:00	54	0.1	0	13:30:00	63	0.1	0	13:39:00	69	0.1	0
13:21:30	53	0.1	0	13:30:30	62	0.1	0	13:39:30	70	0.1	0
13:22:00	55	0.1	0	13:31:00	64	0.1	0	13:40:00	73	0.1	0
13:22:30	55	0.1	0	13:31:30	63	0.1	0	13:40:30	72	0.1	0
13:23:00	57	0.1	0	13:32:00	64	0.1	0	13:41:00	72	0.1	0
13:23:30	56	0.1	0	13:32:30	65	0.1	0	13:41:30	73	0.1	0
13:24:00	58	0.1	0	13:33:00	66	0.1	0	13:42:00	74	0.1	0
13:24:30	56	0.1	0	13:33:30	66	0.1	0	13:42:30	73	0.1	0
13:25:00	56	0.1	0	13:34:00	66	0.1	0	13:43:00	74	0.1	0
13:25:30	60	0.1	0	13:34:30	68	0.1	0	13:43:30	74	0.1	0
13:26:00	59	0.1	0	13:35:00	67	0.1	0	13:44:00	75	0.1	0
13:26:30	58	0.1	0	13:35:30	67	0.1	0	13:44:30	76	0.1	0
13:27:00	59	0.1	0	13:36:00	70	0.1	0	13:45:00	76	0.1	0
13:27:30	59	0.1	0	13:36:30	68	0.1	0	13:45:30	76	0.1	0
13:28:00	61	0.1	0	13:37:00	69	0.1	0	13:46:00	76	0.1	0

Table-3. Non-Intrusive Soil CH_4 Levels Enclosed Soil Vapour Flux Chamber (SV-FC). CH_4 levels vs. Test recorded in the Soil Vapor-Flux Chamber (SV-FC) located at AGM Site N2m-E3m at Strategic et al Cameron K-74.

Strategic et al Cameron K-74 Soil Vapor Flux Field CH_4 Test Time & Levels BKG Site-NE30m

Test-Time	PPM	%LEL	%V/V	Test-Time	PPM	%LEL	%V/V	Test-Time	PPM	%LEL	%V/V
13:19:20	1	0	0	13:30:20	5	0	0	13:41:20	4	0	0
13:19:50	0	0	0	13:30:50	3	0	0	13:41:50	5	0	0
13:20:20	1	0	0	13:31:20	4	0	0	13:42:20	4	0	0
13:20:50	1	0	0	13:31:50	3	0	0	13:42:50	4	0	0
13:21:20	2	0	0	13:32:20	4	0	0	13:43:20	4	0	0
13:21:50	1	0	0	13:32:50	4	0	0	13:43:50	5	0	0
13:22:20	1	0	0	13:33:20	3	0	0	13:44:20	4	0	0
13:22:50	1	0	0	13:33:50	3	0	0	13:44:50	4	0	0
13:23:20	2	0	0	13:34:20	3	0	0	13:45:20	4	0	0
13:23:50	1	0	0	13:34:50	2	0	0	13:45:50	5	0	0
13:24:20	1	0	0	13:35:20	4	0	0	13:46:20	5	0	0
13:24:50	2	0	0	13:35:50	3	0	0	13:46:50	4	0	0
13:25:20	3	0	0	13:36:20	3	0	0	13:47:20	4	0	0
13:25:50	2	0	0	13:36:50	3	0	0	13:47:50	4	0	0
13:26:20	4	0	0	13:37:20	3	0	0	13:48:20	4	0	0
13:26:50	4	0	0	13:37:50	3	0	0	13:48:50	4	0	0
13:27:20	5	0	0	13:38:20	3	0	0	13:49:20	5	0	0
13:27:50	5	0	0	13:38:50	3	0	0	13:49:50	5	0	0
13:28:20	4	0	0	13:39:20	2	0	0	13:50:20	5	0	0
13:28:50	4	0	0	13:39:50	3	0	0	13:50:50	5	0	0
13:29:20	5	0	0	13:40:20	4	0	0				
13:29:50	4	0	0	13:40:50	4	0	0				

Table-4. Non-Intrusive Soil CH_4 Levels Enclosed Soil Vapour Flux Chamber (SV-FC). CH_4 levels vs. time recorded in the Soil Vapor-Flux Chamber (SV-FC) located at AGM Site BKG NE30m at Strategic et al Cameron K-74.

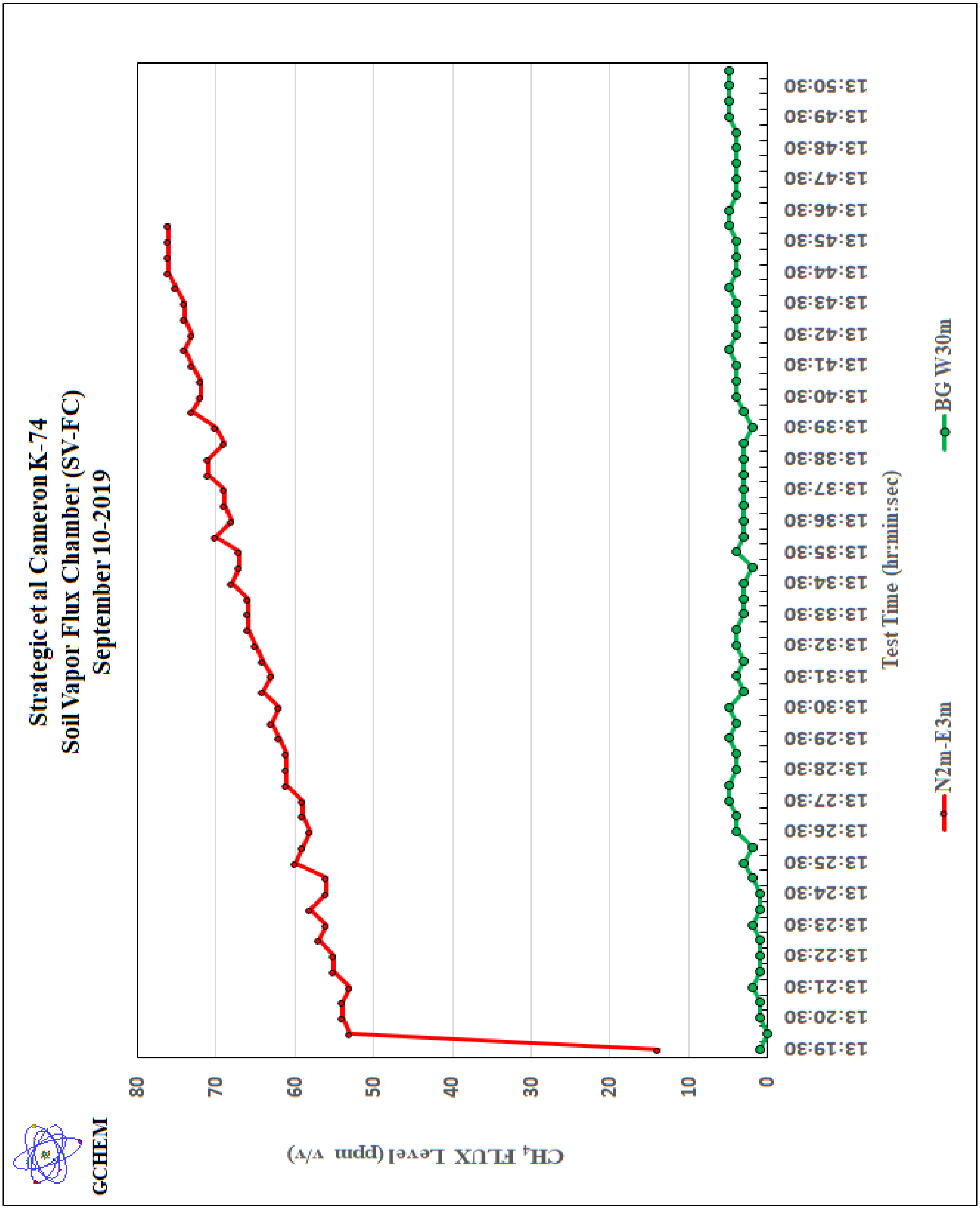


Figure-3. CH_4 Gas Levels vs. Test Time measured by the PMD in the FLUX Chamber at AGM Sites N2m-E3m and BKG NE30m from the well head at Strategic et al Cameron K-74.

Venting Gas Volume Calculation Type	Gas Component	Volumetric FLUX ($m^3/m^2/day$)	Gravimetric FLUX ($g/m^2/day$)
CH_4 Gas FLUX Volume	Methane (CH_4)	0.000193	0.12610241
Laboratory Chemical Compositions			
	Gas Component	Volumetric FLUX ($m^3/m^2/day$)	Gravimetric FLUX ($g/m^2/day$)
Speciated LHG & CO_2 Gas FLUX Volume	Methane (CH_4) Ethane (C_2H_6) Propane (C_3H_8) n-Butane (n-C_4H_{10}) Carbon Dioxide (CO_2)		

Table-5. Calculated venting CH_4 (methane) gas FLUX & Speciated FLUX Rate-Volume measured at anomalous AGM Site N2m-E3m from the well head at Strategic et al Cameron K-74. A speciated light hydrocarbon venting gas flux rate-volume (methane, ethane, propane, butane) and carbon dioxide was not calculated.

4.2 Analytical Methods

a. High Resolution Compositional Analysis (HRCA).

   i. He, H_2, O_2, N_2, CO_2, CH_4 to n-C_5H_{12} & C_6+

b. Stable Carbon ($\delta^{13}C$) and Hydrogen (δD) Isotopic Analysis.

   i. $\delta^{13}C$ CH_4 to n-C_5H_{12} and CO_2, and δD CH_4 to n-C_5H_{12}

Compositional (molecular) analyses were conducted at GCHEM's Analytical Laboratory using Hewlett Packard 5890 and Agilent 7890 Gas Chromatographs (GCs) configured for low (ppb v/v to ppm v/v) too high (vol. %) level detection of light alkane/alkene gases and atmospheric gas components. Chemical analysis of gases measured, and analytical error are shown in Table-6.

Stable carbon ($\delta^{13}C$) isotope ratios of light hydrocarbon gases (LHG) and carbon dioxide and hydrogen isotope ratios (δD) of LHG were also measured at GCHEM's Analytical Laboratory on a Thermo-Scientific MAT-253 Gas Chromatograph-Combustion-Continuous Flow-Isotope Ratio Mass Spectrometer (GC-C-CF-IRMS). Carbon isotope ratios are reported in delta (δ) notation and per mil (‰, parts per thousand) with respect to VPDB (Vienna Pee Dee Belemnite). Hydrogen isotope ratios are reported in delta (δ) notation and per mil (‰) with respect to VSMOW (Vienna Standard Mean Ocean Water).

Gas Component (ppmv)	Molecular Formula	Analytical Error (%)	Stable Carbon Isotopic Composition ($\delta^{13}C$)	Analytical Error (‰ VPDB)	Hydrogen Isotopic Composition (δD)	Analytical Error (‰ VSMOW)
Hydrogen	H_2	±7%	-	-	δD H_2	±10
Helium	He	±7%	-	-	-	-
Nitrogen	N_2	±7%	-	-	-	-
Oxygen	O_2	±7%	-	-	-	-
Carbon Dioxide	CO_2	±7%	$\delta^{13}C$ CO_2	±0.2	-	-
Hydrogen Sulphide	H_2S	±7%	-	-	-	-
Methyl Mercaptan	CH_4S	±7%	-	-	-	-
Ethyl Mercaptan	C_2H_6S	±7%	-	-	-	-
Thiophene	C_4H_4S	±7%	-	-	-	-
Dimethyl Disulfide	$C_2H_6S_2$	±7%	-	-	-	-
Methane	CH_4	±7%	$\delta^{13}C$ CH_4	±0.1	δD CH_4	±10
Ethane	C_2H_6	±7%	$\delta^{13}C$ C_2H_6	±0.2	δD C_2H_6	±10
Ethene	C_2H_4	±7%	$\delta^{13}C$ C_2H_4	±0.2	δD C_2H_4	±10
Propane	C_3H_8	±7%	$\delta^{13}C$ C_3H_8	±0.2	δD C_3H_8	±10
Propene	C_3H_6	±7%	$\delta^{13}C$ C_3H_6	±0.2	δD C_3H_6	±10
iso-Butane	i-C_4H_{10}	±7%	$\delta^{13}C$ i-C_4H_{10}	±0.2	δD i-C_4H_{10}	±10
normal-Butane	n-C_4H_{10}	±7%	$\delta^{13}C$ n-C_4H_{10}	±0.2	δD n-C_4H_{10}	±10
iso-Pentane	i-C_5H_{12}	±7%	$\delta^{13}C$ i-C_5H_{12}	±0.2	δD i-C_5H_{12}	±10
normal-Pentane	n-C_5H_{12}	±7%	$\delta^{13}C$ n-C_5H_{12}	±0.2	δD n-C_5H_{12}	±10
Hexane and higher	C_6+	±7%	-	-	-	-

Table 6. Gas components, isotopic compositions measured and the analytical error of the measurements at GCHEM's Analytical Laboratory.

5.0 Geochemical Measurements-Laboratory Results.

As part of this VIA (SCV-AGM), a total of 9 gas samples were collected, contained and preserved from the following locations or sample points: SVPs-soils outside casing (N3m, NE1.5m, N2m-E3m Flux Chamber, Wm1, and W2m) and 4-BKG locations (BKG E25m , BKG W30m, BKG NE30m, BKG NE30m Flux Chamber).

At the request of the Strategic Oil and Gas, chemical and $\delta^{13}C$ isotopic compositions were measured for gases obtained from two (N2m-E3m Flux Chamber and W1m) of the SVPs that contained elevated, above background, levels of combustible gases and one BKG SVP (NE30m). High Resolution chemical and $\delta^{13}C$ isotopic compositions were measured at GCHEM's Forensic Lab and are provided in Table 7.

5.1 Gases Obtained from Soil Vapor Probes (SVPs).

Gases measured in two SVPs in soils near the well bore (N2m-E3m Flux Chamber and W1m) contain slightly above atmospheric levels of CO_2 (487.7 and 1680 ppm v/v, respectively). Methane gas was elevated (57.48 and 93.35 ppm v/v, respectively) when compared to background level measured at BKG NE30m (1.71 ppm v/v) (Table 7 and Figure 4). C_2+ gas levels in SVPs N2m-E3m Chamber and W1m were low (0.31 and <0.01 respectively) and were similar to background levels (<0.01 ppm v/v). High methane with low, associated C_2+ thermogenic gases suggests a biogenic or biotic source via CO_2 reduction or fermentation reactions for methane gas. C_{6+} gas contents at SVPs sites N2m-E3m Flux Chamber and W1m were low (0.15 and 0.07 ppm v/v respectively) and suggest hydrocarbon contamination was not present at SVP test sites (Figure 5).

CH_4 and C_2+ gas levels at SVP sites N2m-E3m Chamber and W1m were too low to measure $\delta^{13}C$ isotopic compositions. Sufficient levels of CO_2 were available for $\delta^{13}C$ at W1m. $\delta^{13}C$ CO_2 at SVP W1m was -19.73 ‰ VPDB. (Table 7). These values are consistent with gases originating from a biogenic source (low temperature bacterial degradation of organic matter).

Table 7. High resolution molecular and stable carbon isotopic compositions of gas samples collected as part of the VIA at Strategic et al Cameron K-74. Hydrogen isotopic compositions were not measured at the request of SOG.

Sample Point / Date Collected / Gas Component	W1 Sept. 10-19 (ppm v/v)	Chamber N2-E3 Sept. 10-19 (ppm v/v)	BKG NE Sept. 10-19 (ppm v/v)
Hydrogen	3.57	161.54	3.85
Helium	2.91	2.82	2.85
Nitrogen	777466	777435	776587
Oxygen	220754	221854	219079
Carbon Dioxide	1680	487.7	4325
Methane	93.35	57.48	1.71
Ethane	<0.01	0.31	<0.01
Ethene	<0.01	<0.01	<0.01
Propane	<0.01	<0.01	<0.01
Propene	<0.01	<0.01	<0.01
iso-Butane	<0.01	<0.01	<0.01
n-Butane	<0.01	<0.01	<0.01
iso-Pentane	<0.01	0.18	<0.01
n-Pentane	<0.01	<0.01	<0.01
C_6+	0.07	0.15	0.06
C1 Index (C1/ΣC2+)	N/A	185.6	N/A
C2 Index (C2/ΣC3+)	N/A	N/A	N/A
C3 Index (C3/ΣC4+)	N/A	N/A	N/A
C4 Index (C4/C5)	N/A	N/A	N/A
ΣC2+	N/A	0.31	N/A
ATM Ratio (N2/O2)	3.52	3.50	3.54
Vol % CO2 of TG	0.17	0.05	0.43
Vol % Lt. Alk. of TG	0.01	0.01	0.00
Vol % Lt. Alk. CH4	100.0	99.16	100.0
Vol % Lt. Alk. C2+	0.00	0.84	0.00
Vol % C2+ of TG	0.00	0.00	0.00
Stable Carbon Isotope Compositions (‰ VPDB)			
δ13C CH4	nm	nm	nm
δ13C C2H6	nm	nm	nm
δ13C C2H4	nm	nm	nm
δ13C C3H8	nm	nm	nm
δ13C C3H6	nm	nm	nm
δ13C i-C4H10	nm	nm	nm
δ13C n-C4H10	nm	nm	nm
δ13C i-C5H12	nm	nm	nm
δ13C n-C5H12	nm	nm	nm
δ13C CO2	-19.73	nm	-17.74
Stable Hydrogen Isotopic Compositions (‰ VSMOW)			
δD H2	nm	nm	nm
δD CH4	nm	nm	nm
δD C2H6	nm	nm	nm
δD C3H8	nm	nm	nm
δD i-C4H10	nm	nm	nm
δD n-C4H10	nm	nm	nm
14C Concentration (pMC)	nm	nm	nm

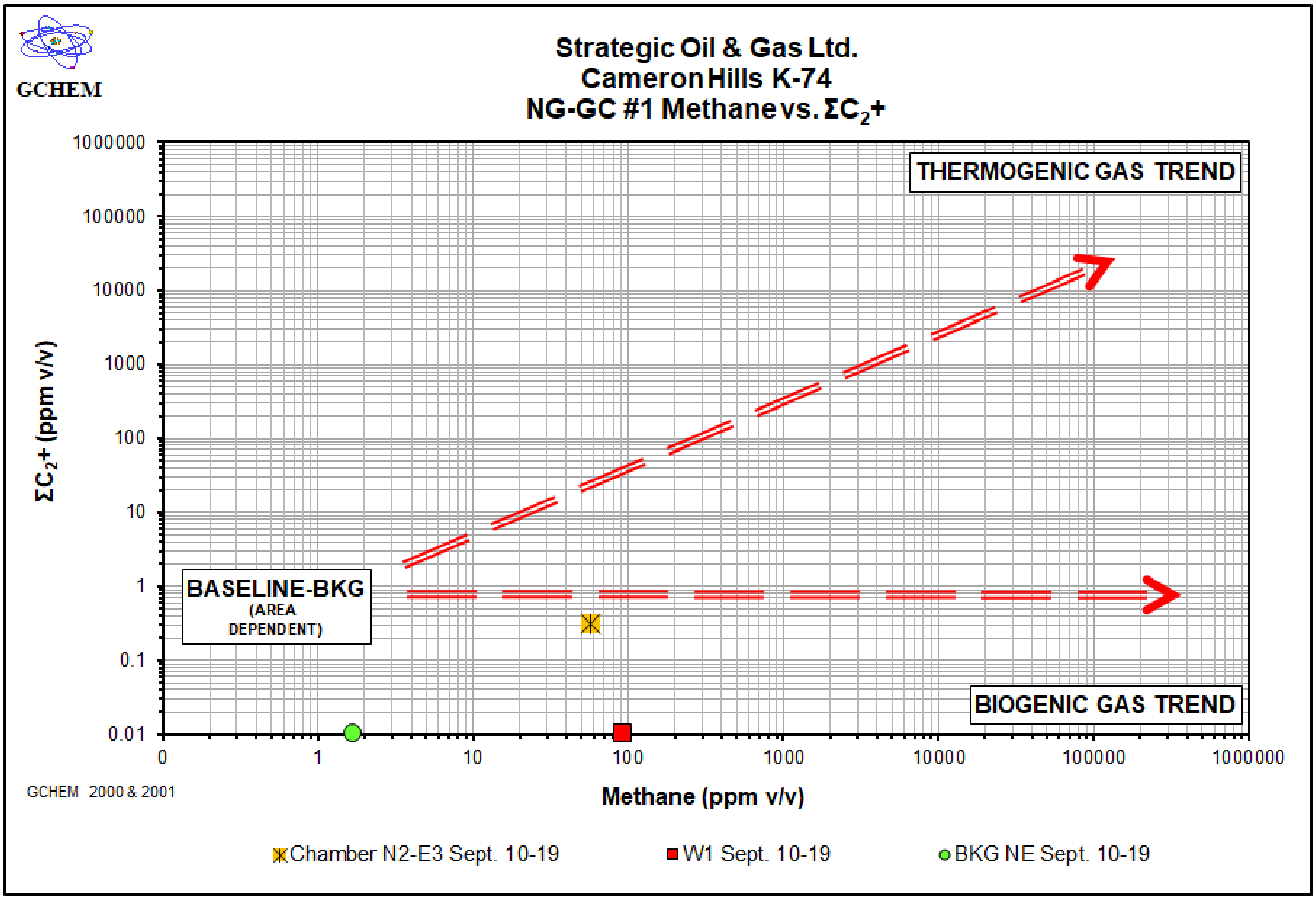


Figure-4. ΣC_2+ vs Methane. Combustible gases detected in soils and SCVs at a wellhead may result from several origins. Natural gases indicative of SCVF or AGM are thermogenic in origin (natural gas in deep reservoirs), contain high methane and C_2+ contents and plot in the Upper RH Quadrant. Low natural gas levels in background, off lease areas are naturally present in soils, vary from region to region and plot in the Lower LH Quadrant. Biogenic gases (swamp-gas) are produced by bacteria, are comprised of predominantly methane and plot in Lower RH Quadrant. Samples plotting in the Lower LH and RH do not contain SCVF or AGM and would not require down-hole remediation.

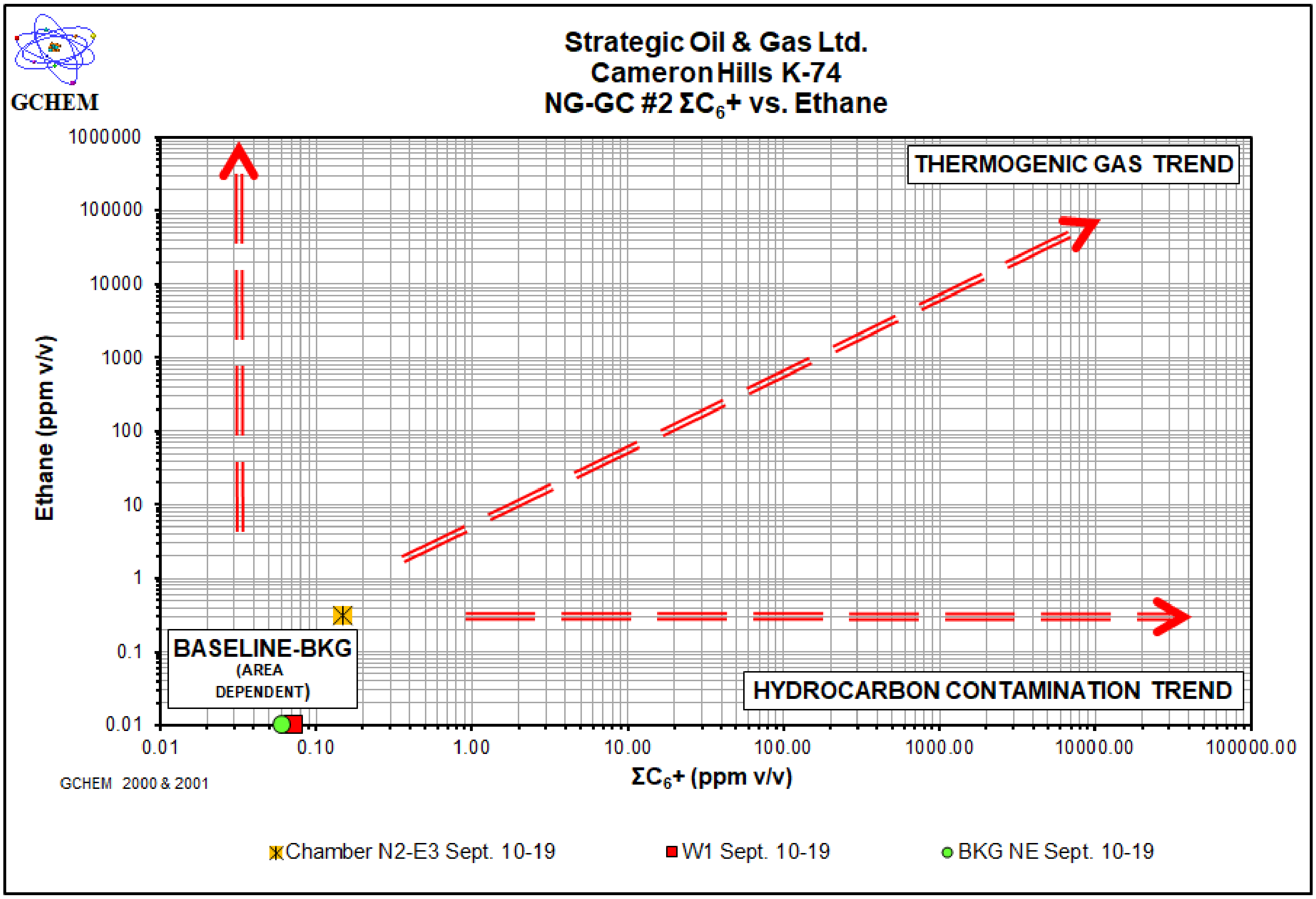


Figure 5. ΣC_6+ vs Ethane. C_6+ gases are relatively large molecules that do not readily or easily migrate in large quantities from depth upwards through subsurface fractures or micro-fractures to surface. Contamination by oil spills, fuels, and solvents is indicated by soil vapor samples that have high contents of C_6+ compounds and plot in the Lower RH Quadrant**.** Samples plotting in the Lower LH and RH Quadrants do not contain evidence of either SCVF or AGM and would not require downhole repair operations.

6.0 Conclusions

Soils outside casing are wet (water saturated in some areas) increasing the difficulty to conduct leaking natural gas assessments. 4 of the 10 intrusive soil sites outside casing tested for combustible gas contents contained elevated methane levels that ranged from 418 to 3774 ppm v/v. H_2S was not detected (< 1.0 ppm v/v) at any of the soil test hole sites. SOG selected sites N2-E3 Chamber (1185ppm v/v) and W1 (539ppm v/v) for high resolution chemical and stable carbon isotope measurements to classify combustible gas contents. Light hydrocarbon gases were dominated by methane gas while associated C_2+ gases were low and similar to background levels measured at test site BKG NE30m. Sufficient levels of light alkane gas were not available for $\delta^{13}C$ CH_4 or $\delta^{13}C$ C_2+ at test site N2m-E3m Flux Chamber or W1m.

With information available to date, SVP soil test sites N2m-E3m Flux Chamber and W1m would be classified as 'biogenic-baseline' where CH_4 gas is the result of natural soil respirations processes via CO_2 reduction or fermentation processes generating biogenic CH_4. C_2+ gases in soils near the well are low, similar to background levels and the result of natural movement of thermogenic natural gas, from reservoirs at depth, upward through fractures and micro-fractures to surface. This is a naturally occurring process prevalent in every hydrocarbon sedimentary basin in the world.

Attachment-1

Strategic Oil & Gas Ltd.

Strategic Cameron K-74

Well Site Photographs

Strategic Oil and Gas Ltd.
Cameron Hills K-74
September 10-11, 2019

Strategic Oil and Gas Ltd.
Cameron Hills K-74
September 10-11, 2019

Strategic Oil and Gas Ltd.
Cameron Hills K-74
September 10-11, 2019

Attachment-2

Strategic Oil & Gas Ltd.

Strategic Cameron K-74

Chain of Custody (COC)

GCHEM LTD.

Bay#1, 4810-62nd Ave, Lloydminster, Alberta T9V 2E9
E:info@gchem.ca
Tel:(780) 871-4668
Fax:(780) 808-8883

CHAIN OF CUSTODY

ENERGY FORENSICS

Sample Submission Form

GCHEM Ltd. Project#

Client Information

Company Strategic
Address
City,Prov.
Postal Code
Client Contact
Phone #
Fax #
E-Mail

Sampled By Walker, Brian

Billing/Report Information

Company
Address
City,Prov.
Postal Code
Client Contact
Phone #
Fax #
E-mail

AFE/PO #

Services Needed (TAT)

*Standard 5-7 Days ✓
**Rush 48hrs.
**Priority Rush 24hrs.

(*) Working Days
(**) Call for Pricing and Advance Notice

No.	Location	Sample Identifier	Sample Time	Date Sampled	Pressure Received	Actual Pressure	Container Type	Qty.	Sample Volume	Media Type	High Resolution Compositional Analysis	IRMS δ^2H (δD) Analysis	IRMS $\delta^{13}C$ Analysis	Produced Water Forensic Suite	High Resolution Compositional H_2S Analysis
1	K 74	Soil Gas - initial		Sep 10/19			glass	5							
2		Soil Gas Chamber		Sep 10/19			glass	2							
3		Background - initial		Sep 10/19			glass	3							
4		Soil Gas - final		Sep 11/19			glass	6							
5		Background - final		Sep 11/19			glass	1							
6															
7															
8															
9															
10															

Comments

Relinquished By: Walker Brian Date/Time: Sep 17, 2019 Relinquished To: Date/Time:
Relinquished By: Date/Time: Relinquished To: Date/Time:

Attachment-3

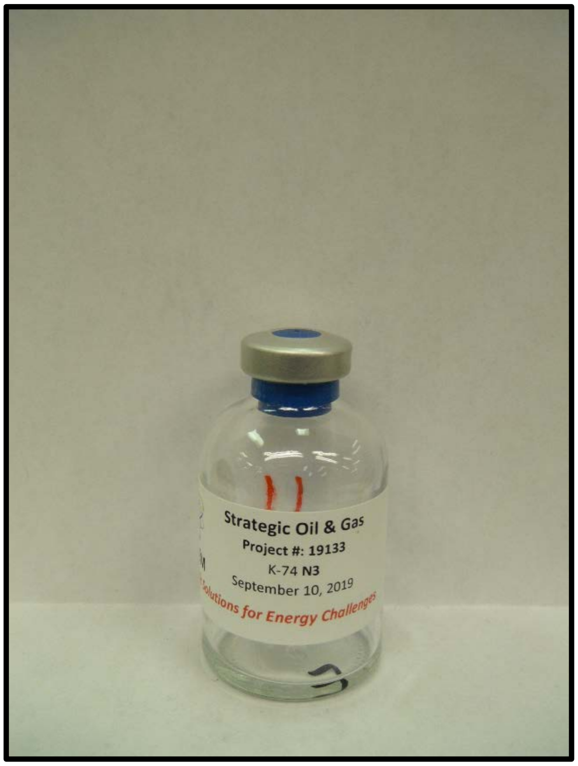
Strategic Oil & Gas Ltd.

Strategic Cameron K-74

Gas Sample Containers

Photographs

(red boxed pictures are samples measured for chemical and/or isotopic compositions)



N3m
September 10, 2019

NE1.5m
September 10, 2019

Chamber N2m-E3m
September 10, 2019

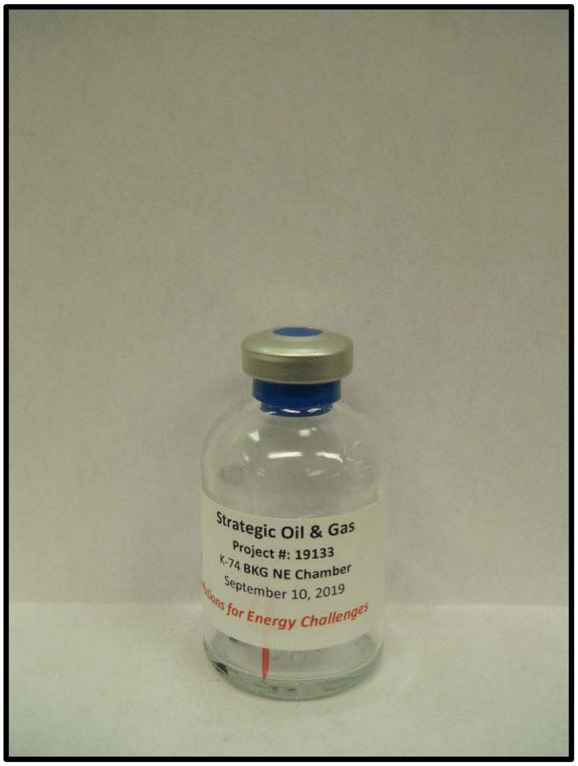
W1m
September 10, 2019

W2m
September 0, 2019

BKG E25m
September 10, 2019

BKG W30m
September 10, 2019

BKG NE30m
September 10, 2019

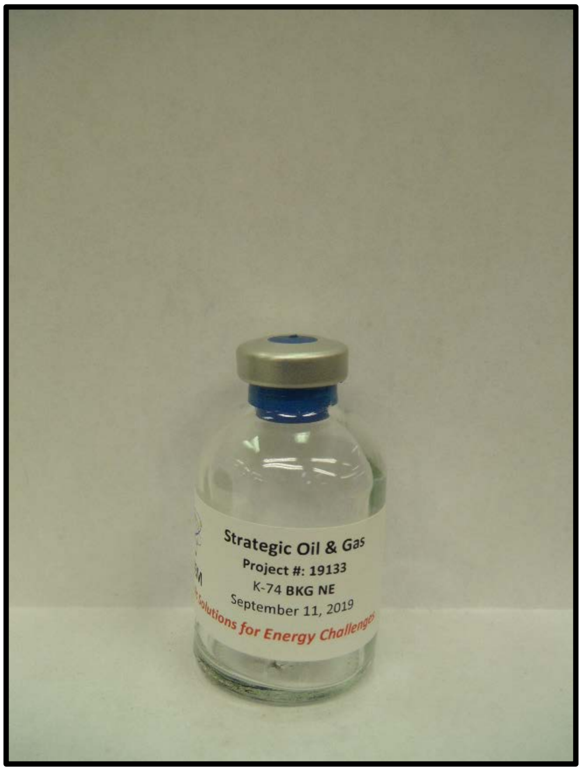


BKG NE30m Flux Chamber
September 10, 2019

N3m
September 11, 2019

NE1.5m
September 11, 2019

W1m
September 11, 2019



BKG NE 30m
September 11, 2019

Attachment-4

Strategic Oil & Gas Ltd.

Strategic Cameron K-74

Gas Analysis Data Sheets (GADS)

GCHEM LTD.

HIGH RESOLUTION GAS ANALYSIS
CARBON ISOTOPE ANALYSIS
HYDROGEN ISOTOPE ANALYSIS

Sampling Company	GCHEM Ltd.	**Lab Sample No.**	19133-06
Date Tested	September 10, 2019	**Test Type**	Soil gas
Operator Name	Strategic Oil & Gas	**Sample Container Type**	Glass Bottle
Unique Well Identifier	K-74	**Sampling Point**	W1
Well Name	not provided	**Test Intervals or Perfs mKB**	N/A
Field or Area	not provided	**Date Received**	September 17, 2019
Pool or Zone	not provided	**Date Reported**	October 9, 2019
Well License	not provided	**Entered By**	Xiaolong Wang
H2S Level (Observed at Site)	not provided	**Reviewed By**	Brad Johnston

Sample Handling Conditions

	Source/Sampled	Received
Pressure (kPa)	N/A	56
Temperature (°C)	N/A	20

Other Information:

Laboratory Analysis

Component	HRGC Analysis As Received Mol Frac.	Air Free As received Mol Frac.	Air Free / Acid Free As Received Mol Frac.	Carbon Isotope Analysis ‰ VPDB	Hydrogen Isotope Analysis ‰ VSMOW	HRGC Analysis As Received ppm v/v
Neon	0.000014	0.007969	0.007969			14.19
Hydrogen	0.000004	0.002007	0.002007			3.57
Helium	0.000003	0.001637	0.001637			2.91
Nitrogen	0.777466	0.000000	0.000000			777466
Oxygen	0.220754	0.000007	0.000007			220754
Carbon Dioxide	0.001680	0.943869	0.943869	-19.73		1680
Carbonyl Sulphide	nm	nm	nm			nm
Hydrogen Sulphide	nm	nm	nm			nm
Methyl Mercaptan	nm	nm	nm			nm
Ethyl Mercaptan	nm	nm	nm			nm
Thiophene	nm	nm	nm			nm
Dimethyl Disulphide	nm	nm	nm			nm
Methane	0.000093	0.052438	0.052438			93.35
Ethane	0.000000	0.000000	0.000000			<0.01
Ethene	0.000000	0.000000	0.000000			<0.01
Propane	0.000000	0.000000	0.000000			<0.01
Propene	0.000000	0.000000	0.000000			<0.01
iso-Butane	0.000000	0.000000	0.000000			<0.01
n-Butane	0.000000	0.000000	0.000000			<0.01
iso-Pentane	0.000000	0.000000	0.000000			<0.01
n-Pentane	0.000000	0.000000	0.000000			<0.01
C_6+	0.000000	0.000041	0.000041			0.07
TOTAL	**1.000000**	**1.000000**	**1.000000**			1000000

Properties

Compositional Indicies	
Vol % Hydrocarbons	0.01
Vol % CH_4	100.0
Vol % C_2+	0.00
$CH_4 / \sum C_2$+	N/A
$C_2 / \sum C_3$+	N/A
$C_3 / \sum n\text{-}C_{4+}$	N/A

Real Gross Heating Value (mj/m3) @15°C and 101.35 kPa	
Air Free as received	Moisture and Acid Gas Free
0.00	2.02

Relative Density	
Calc. Mol. Mass Ratio	Calc. Relative Density
0.9985	0.9985

Pseudo Critical Properties	As Received	Acid Gas Free
pPc (kPa)	3762	7212
pTc (°K)	133	297

Geological Origin of Natural Gas

Geological Formation	Depth Range (MD from KB of Well)	Probable Depth (MD from KB of Well)

Comments

Forensic Solutions for Oilfield Challenges

GCHEM Ltd. Bay #1, 4810-62 Avenue Lloydminster, AB T9V 2E9 Tel: (780) 871-4668 Fax: (780) 808-8883 e-mail: info@gchem.ca www.gchem.ca
GPA 2145-09. Revision 1.3, August 1, 2016

GCHEM LTD.

HIGH RESOLUTION GAS ANALYSIS
CARBON ISOTOPE ANALYSIS
HYDROGEN ISOTOPE ANALYSIS

Sampling Company	GCHEM Ltd.	Lab Sample No.	19133-09
Date Tested	September 10, 2019	Test Type	Flux
Operator Name	Strategic Oil & Gas	Sample Container Type	Glass Bottle
Unique Well Identifier	K-74	Sampling Point	Chamber N2-E3
Well Name	not provided	Test Intervals or Perfs mKB	N/A
Field or Area	not provided	Date Received	September 17, 2019
Pool or Zone	not provided	Date Reported	October 9, 2019
Well License	not provided	Entered By	Xiaolong Wang
H2S Level (Observed at Site)	not provided	Reviewed By	Brad Johnston

Sample Handling Conditions

	Source/Sampled	Received
Pressure (kPa)	N/A	51
Temperature (°C)	N/A	20

Other Information:

Laboratory Analysis

Component	HRGC Analysis As Received Mol Frac.	Air Free As received Mol Frac.	Air Free / Acid Free As Received Mol Frac.	Carbon Isotope Analysis ‰ VPDB	Hydrogen Isotope Analysis ‰ VSMOW	HRGC Analysis As Received ppm v/v
Neon	0.000014	0.019310	0.019310			13.71
Hydrogen	0.000162	0.227449	0.227449			161.5
Helium	0.000003	0.003976	0.003976			2.82
Nitrogen	0.777435	0.000000	0.000000			777435
Oxygen	0.221854	0.000020	0.000020			221854
Carbon Dioxide	0.000488	0.686721	0.686721			487.7
Carbonyl Sulphide	nm	nm	nm			nm
Hydrogen Sulphide	nm	nm	nm			nm
Methyl Mercaptan	nm	nm	nm			nm
Ethyl Mercaptan	nm	nm	nm			nm
Thiophene	nm	nm	nm			nm
Dimethyl Disulphide	nm	nm	nm			nm
Methane	0.000057	0.080937	0.080937			57.48
Ethane	0.000000	0.000436	0.000436			0.31
Ethene	0.000000	0.000000	0.000000			<0.01
Propane	0.000000	0.000000	0.000000			<0.01
Propene	0.000000	0.000000	0.000000			<0.01
iso-Butane	0.000000	0.000000	0.000000			<0.01
n-Butane	0.000000	0.000000	0.000000			<0.01
iso-Pentane	0.000000	0.000250	0.000250			0.18
n-Pentane	0.000000	0.000000	0.000000			<0.01
C_6+	0.000000	0.000211	0.000211			0.15
TOTAL	**1.000000**	**1.000000**	**1.000000**			1000000

Properties

Compositional Indicies	
Vol % Hydrocarbons	0.01
Vol % CH_4	99.16
Vol % C_2+	0.00
CH_4 / $\sum C_2$+	185.6
C_2 / $\sum C_3$+	N/A
C_3 / $\sum n\text{-}C_{4+}$	N/A

Real Gross Heating Value (mj/m3) @15°C and 101.35 kPa	
Air Free as received	Moisture and Acid Gas Free
0.00	5.93

Relative Density	
Calc. Mol. Mass Ratio	Calc. Relative Density
0.9979	0.9979

Pseudo Critical Properties	As Received	Acid Gas Free
pPc (kPa)	3758	5737
pTc (°K)	133	232

Geological Origin of Natural Gas

Geological Formation	Depth Range (MD from KB of Well)	Probable Depth (MD from KB of Well)

Comments

Forensic Solutions for Oilfield Challenges

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HIGH RESOLUTION GAS ANALYSIS
CARBON ISOTOPE ANALYSIS
HYDROGEN ISOTOPE ANALYSIS

Sampling Company	GCHEM Ltd.	Lab Sample No.	19133-03
Date Tested	September 10, 2019	Test Type	Soil gas
Operator Name	Strategic Oil & Gas	Sample Container Type	Glass Bottle
Unique Well Identifier	K-74	Sampling Point	BKG NE
Well Name	not provided	Test Intervals or Perfs mKB	N/A
Field or Area	not provided	Date Received	September 17, 2019
Pool or Zone	not provided	Date Reported	October 9, 2019
Well License	not provided	Entered By	Xiaolong Wang
H2S Level (Observed at Site)	not provided	Reviewed By	Brad Johnston

Sample Handling Conditions

	Source/Sampled	Received
Pressure (kPa)	N/A	63
Temperature (°C)	N/A	20

Other Information:

Laboratory Analysis

Component	HRGC Analysis As Received Mol Frac.	Air Free As received Mol Frac.	Air Free / Acid Free As Received Mol Frac.	Carbon Isotope Analysis ‰ VPDB	Hydrogen Isotope Analysis ‰ VSMOW	HRGC Analysis As Received ppm v/v
Neon	0.000013	0.003091	0.003091			13.40
Hydrogen	0.000004	0.000888	0.000888			3.85
Helium	0.000003	0.000658	0.000658			2.85
Nitrogen	0.776587	0.000000	0.000000			776587
Oxygen	0.219079	0.000003	0.000003			219079
Carbon Dioxide	0.004325	0.998042	0.998042	-17.74		4325
Carbonyl Sulphide	nm	nm	nm			nm
Hydrogen Sulphide	nm	nm	nm			nm
Methyl Mercaptan	nm	nm	nm			nm
Ethyl Mercaptan	nm	nm	nm			nm
Thiophene	nm	nm	nm			nm
Dimethyl Disulphide	nm	nm	nm			nm
Methane	0.000002	0.000395	0.000395			1.71
Ethane	0.000000	0.000000	0.000000			<0.01
Ethene	0.000000	0.000000	0.000000			<0.01
Propane	0.000000	0.000000	0.000000			<0.01
Propene	0.000000	0.000000	0.000000			<0.01
iso-Butane	0.000000	0.000000	0.000000			<0.01
n-Butane	0.000000	0.000000	0.000000			<0.01
iso-Pentane	0.000000	0.000000	0.000000			<0.01
n-Pentane	0.000000	0.000000	0.000000			<0.01
C_6+	0.000000	0.000014	0.000014			0.06
TOTAL	**1.000000**	**1.000000**	**1.000000**			1000000

Properties

Compositional Indicies	
Vol % Hydrocarbons	0.00
Vol % CH_4	100.0
Vol % C_2+	0.00
$CH_4 / \sum C_2$+	N/A
$C_2 / \sum C_3$+	N/A
$C_3 / \sum n\text{-}C_{4+}$	N/A

Real Gross Heating Value (mj/m3) @15°C and 101.35 kPa	
Air Free as received	Moisture and Acid Gas Free
0.00	0.03

Relative Density	
Calc. Mol. Mass Ratio	Calc. Relative Density
0.9998	0.9998

Pseudo Critical Properties	As Received	Acid Gas Free
pPc (kPa)	3769	7370
pTc (°K)	133	304

Geological Origin of Natural Gas

Geological Formation	Depth Range (MD from KB of Well)	Probable Depth (MD from KB of Well)

Comments

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