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Shreveport, LA 71107  
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Fax: (318) 222-2425*

September 10, 2018

Mr. Todd Emmert  
Elm Springs, Inc.  
P. O. Box 58  
Shongaloo, LA 71072-0058

Re: LDNR-Gas Sampling Project  
Indigo Minerals, LLC  
Sampson EST 33 001 Well - Serial Number: 229084  
Section 33, Township 13 N, Range 15 W  
SONRIS GPS (Production Well): 32.07362427, -93.90796378

Dear Mr. Emmert:

Approach Environmental, LLC (Approach Environmental) was retained by the Louisiana Department of Natural Resources (LDNR) to conduct a natural gas sample at the referenced location. On November 9, 2017, Approach Environmental collected a gas sample from the referenced well to evaluate specific parameters requested by LDNR.

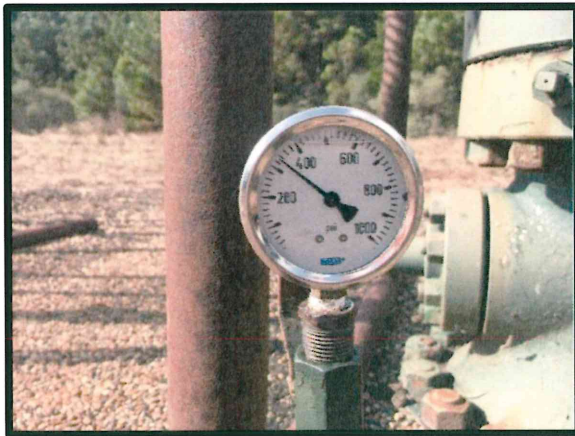
The gas sampling activities included photo documentation of the well, obtaining GPS Coordinates (Via SONRIS), gas sampling, and preparation of a brief letter report presenting the analytical data. The gas sample was collected by Approach Environmental's Environmental Specialist using laboratory-specific containers in accordance with laboratory and method-specific sampling protocol. The gas sample was collected from the well tubing via laboratory supplied, decontaminated cylinders capable of holding 1800 pounds of pressure per square inch (psi). Proper procedures included checking the pressure of the well or line to insure the pressure is below 1800 psi. Subsequently, the caps were removed from both ends of the cylinder, cleaned off, and the threads wrapped with Teflon tape. After wrapping the threads, the sampling port was then cracked until a small amount of gas was heard venting from the sampling point and was allowed to purge for approximately twenty (20) seconds. The cylinder was then attached to the sampling valve and snugged tight with a wrench. The valve was, then, opened for approximately 5-10 seconds to allow the cylinder to be pressurized up to the well pressure. After the cylinder was pressurized, the valve was closed and the outlet valve was opened on the cylinder to allow the gas to vent and purge the cylinder. This step was repeated three (3) times to allow for proper purging of the cylinder. After purging the cylinder,

the cylinder was once again pressurized, but for 20-30 seconds then closed off to trap the gas sample. All valves were, then, closed off and the cylinder was removed and labeled with the proper well and sampling documentation. Samples were, then, properly packaged and sent to ISOTECH Laboratory, an ISO 9001:2008 Certified company, for samples to be run by analytical methods NG2 Suite and Gas Comp., d13C of Methane, Ethane, Propane, and plus dD of Methane. Samples were also sent to Element laboratory, an ISO 17025, ISO 17020, ISO 17065, ISO 9001, AS 9100 and Nadcap accredited lab, for Extended Gas Analysis according to GPA method 2261 and 2286. The samples were submitted to each laboratory with chain-of-custody documentation.

The gas sample was collected from the well tubing, with a pressure of approximately 330 psi.

Photographs are shown below for future reference and the analytical laboratory report is attached for review and future reference.

Photographs taken by John Maggio on November 9, 2017.



Should you have any questions and/or comments, please do not hesitate to contact me at (318) 222-2424, via my cell at (318) 401-0085, or via e-mail at [marksm@approachenv.com](mailto:marksm@approachenv.com).

Sincerely,

Mark S. Moore  
Approach Environmental, L.L.C.

Encl./

## **Attachments Table of Contents**

### **Analytical Data Report**

\*Analytical report contains results for Mary Belle Smith 28 #2, Sampson EST 33 #1, J.B. Barr 28 #2, and Wanamaker #1.



ISOTECH LABORATORIES, LLC

1308 Parkland Court Champaign, IL 61821 • (877) 362-4190 • www.isotechlabs.com

Reset Form

#### SEND DATA TO:

Name: Mark S. Moore

Company: Approach Environmental, LLC

Address: 151 Freestate Blvd.  
Suite B  
Shreveport, LA 71107

Phone: 318-401-0085

Email: marksm@approachenv.com

Project: LDNR Emergency Gas Sampling

PO #:

Location: DeSoto Parish, LA

Sampled By: John Maggio

#### SEND INVOICE TO (if different from SEND DATA TO):

Name: same

Company: same

Address: P. O. Box 7192  
Shreveport, LA 71137-7192

Phone: same

Email: same

Standard ☒

Priority ☐

Rush ☐

Analysis Requested

### Sample Description

Container Number	Sample Identification	Date Sampled	Time	NG2 Suite and Gas Comp.	d13C of Meth., eth., prop.	plus dD of Methane	Comments
3043	Mary Belle Smith 28 #2 Alt (239295)	Nov-09-17	14:20	X	X	X	Meth=methane; Eth=Ethane; Prop=Propane
3053	Sampson Est 33 #1 (229084)	Nov-09-17	13:55	X	X	X	
3063	J B Barr 28 #2 (229457)	Nov-09-17	13:25	X	X	X	
3073	Wanamaker #1 (158504)	Nov-09-17	14:45	X	X	X	

### Chain-of-Custody Record

Signature	Company	Date	Time
John Maggio	Approach Env.	11/13/17	9:30
RNL Carriers			





Lab #: 637780      Job #: 36618      IS-99404      Co. Job#:   
 Sample Name: Mary Belle Smith 28 #2 Alt (239295)      Co. Lab#:   
 Company: Approach Environmental, LLC      Cylinder: 3043   
 API/Well:   
 Container: Cylinder   
 Field/Site Name: LDNR Emergency Gas Sampling   
 Location: DeSoto Parish, LA   
 Formation:   
 Sampling Point:   
 Date Sampled: 11/09/2017 14:20      Date Received: 11/15/2017      Date Reported: 1/03/2018

Component	Chemical mol. %	$\delta^{13}\text{C}$ ‰	$\delta\text{D}$ ‰	$\delta^{15}\text{N}$ ‰
Carbon Monoxide -----	nd			
Helium -----	nd			
Hydrogen -----	nd			
Argon -----	nd			
Oxygen -----	0.026			
Nitrogen -----	0.14			
Carbon Dioxide -----	2.00			
Methane -----	92.13	-39.51	-158.1	
Ethane -----	3.80	-27.12		
Ethylene -----	nd			
Propane -----	0.927	-24.94		
Propylene -----	nd			
Iso-butane -----	0.240			
N-butane -----	0.234			
Iso-pentane -----	0.145			
N-pentane -----	0.0748			
Hexanes + -----	0.288			

Total BTU/cu.ft. dry @ 60deg F & 14.73psia, calculated: 1064

Specific gravity, calculated: 0.620

nd = not detected. na = not analyzed. Isotopic composition of hydrogen is relative to VSMOW. Isotopic composition of carbon is relative to VPDB. All gas component carbon isotope values are reported on a scale defined by a two point calibration of LSVEC and NBS 19. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %.

Lab #: 637781      Job #: 36618      IS-99404      Co. Job#:   
 Sample Name: Sampson Est 33 #1 (229084)      Co. Lab#:   
 Company: Approach Environmental, LLC      Cylinder: 3053   
 API/Well:   
 Container: Cylinder   
 Field/Site Name: LDNR Emergency Gas Sampling   
 Location: DeSoto Parish, LA   
 Formation:   
 Sampling Point:   
 Date Sampled: 11/09/2017 13:55      Date Received: 11/15/2017      Date Reported: 1/03/2018

Component	Chemical mol. %	$\delta^{13}\text{C}$ ‰	$\delta\text{D}$ ‰	$\delta^{15}\text{N}$ ‰
Carbon Monoxide -----	nd			
Helium -----	0.0403			
Hydrogen -----	nd			
Argon -----	0.0074			
Oxygen -----	nd			
Nitrogen -----	2.55			
Carbon Dioxide -----	0.92			
Methane -----	95.81	-31.68	-119.3	
Ethane -----	0.410	-23.09		
Ethylene -----	nd			
Propane -----	0.0325			
Propylene -----	nd			
Iso-butane -----	0.0133			
N-butane -----	0.0142			
Iso-pentane -----	0.0069			
N-pentane -----	0.0124			
Hexanes + -----	0.188			

Total BTU/cu.ft. dry @ 60deg F & 14.73psia, calculated: 990

Specific gravity, calculated: 0.581

nd = not detected. na = not analyzed. Isotopic composition of hydrogen is relative to VSMOW. Isotopic composition of carbon is relative to VPDB. All gas component carbon isotope values are reported on a scale defined by a two point calibration of LSVEC and NBS 19. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %.

Lab #: 637782      Job #: 36618      IS-99404      Co. Job#:   
 Sample Name: J B Barr 28 #2 (229457)      Co. Lab#:   
 Company: Approach Environmental, LLC      Cylinder: 3063   
 API/Well:   
 Container: Cylinder   
 Field/Site Name: LDNR Emergency Gas Sampling   
 Location: DeSoto Parish, LA   
 Formation:   
 Sampling Point:   
 Date Sampled: 11/09/2017 13:25      Date Received: 11/15/2017      Date Reported: 1/03/2018

Component	Chemical mol. %	$\delta^{13}\text{C}$ ‰	$\delta\text{D}$ ‰	$\delta^{15}\text{N}$ ‰
Carbon Monoxide -----	nd			
Helium -----	0.0295			
Hydrogen -----	nd			
Argon -----	0.0060			
Oxygen -----	nd			
Nitrogen -----	2.76			
Carbon Dioxide -----	0.14			
Methane -----	93.06	-38.37	-149.7	
Ethane -----	2.51	-25.06		
Ethylene -----	nd			
Propane -----	0.784	-24.07		
Propylene -----	nd			
Iso-butane -----	0.225			
N-butane -----	0.232			
Iso-pentane -----	0.100			
N-pentane -----	0.0595			
Hexanes + -----	0.0914			

Total BTU/cu.ft. dry @ 60deg F & 14.73psia, calculated: 1034

Specific gravity, calculated: 0.598

nd = not detected. na = not analyzed. Isotopic composition of hydrogen is relative to VSMOW. Isotopic composition of carbon is relative to VPDB. All gas component carbon isotope values are reported on a scale defined by a two point calibration of LSVEC and NBS 19. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %.

Lab #: 637783      Job #: 36618      IS-99404      Co. Job#:   
 Sample Name: Wanamaker #1 (158504)      Co. Lab#:   
 Company: Approach Environmental, LLC      Cylinder: 3073   
 API/Well:   
 Container: Cylinder   
 Field/Site Name: LDNR Emergency Gas Sampling   
 Location: DeSoto Parish, LA   
 Formation:   
 Sampling Point:   
 Date Sampled: 11/09/2017 14:45      Date Received: 11/15/2017      Date Reported: 1/03/2018

Component	Chemical mol. %	$\delta^{13}\text{C}$ ‰	$\delta\text{D}$ ‰	$\delta^{15}\text{N}$ ‰
Carbon Monoxide -----	nd			
Helium -----	0.0303			
Hydrogen -----	2.75			
Argon -----	0.0058			
Oxygen -----	nd			
Nitrogen -----	2.16			
Carbon Dioxide -----	0.008			
Methane -----	91.80	-38.74	-155.2	
Ethane -----	2.12	-25.03		
Ethylene -----	0.0001			
Propane -----	0.601	-24.23		
Propylene -----	nd			
Iso-butane -----	0.154			
N-butane -----	0.160			
Iso-pentane -----	0.0667			
N-pentane -----	0.0420			
Hexanes + -----	0.104			

Total BTU/cu.ft. dry @ 60deg F & 14.73psia, calculated: 1012

Specific gravity, calculated: 0.575

nd = not detected. na = not analyzed. Isotopic composition of hydrogen is relative to VSMOW. Isotopic composition of carbon is relative to VPDB. All gas component carbon isotope values are reported on a scale defined by a two point calibration of LSVEC and NBS 19. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %.



# QUALITY ASSURANCE PLAN

for

Isotech Laboratories, Inc.  
1308 Parkland Court  
Champaign, IL 61821

Revised March 22, 2012

  
General Manager

3/22/2012

Date

  
QC Manager

3/22/2012

Date

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# GENERAL QA/QC PROCEDURES

## 1. SAMPLES

**1.1 Sampling Procedures** It is the responsibility of the person collecting a sample to follow a sound sampling procedure. This will ensure that the sample collected is representative of the whole. We at Isotech will provide advice on sampling methods, sample storage procedures, and sample size requirements.

**1.2 Sample Containers** Sample containers should be matched in size, type and condition to the anticipated analysis that will give best representation of the source, while preserving the sample integrity prior to analysis. Unless sample containers are provided by Isotech, the responsibility for adequate containers resides with the client. Again, in addition to being able to provide appropriate sample containers, shipping cartons and shipping instructions, Isotech will provide advice on sample containers/cartons and shipping procedures.

**1.3 Sample Custody** A completed "Chain of Custody" record is the responsibility of the client and, if required, should be submitted with the samples. Isotech will provide a "Chain of Custody/Request for Analysis" form if needed. Isotech assumes full responsibility for all samples received and stored for analysis at our laboratory. If any samples are removed from Isotech for additional analysis at other laboratories, a "Chain of Custody" form will be completed. All samples received for analysis are assigned a unique, non-duplicated laboratory number which is used as an identifier for each analysis performed.

## 2. INSTRUCTIONS AND PROCEDURES

**2.1 Instrument Operation Procedures** Analyses performed with manufactured analysis instruments are carried out by the methods either specified or recommended by the manufacturer of the instrument as identified in the instrument manual or provided by on-site training through the manufacturer's service technicians. Much of the operation of these instruments is controlled by personal computers utilizing software written and licensed by the manufacturers.

**2.2 Analytical Procedures** The analytical procedures used routinely at Isotech are described in written standard operating procedures (SOP's) for each analysis. Additional procedures may be used, as needed, in the process of satisfying a client's specific analysis requirements. These procedures will either follow published analytical methods, or methods developed at Isotech for a specific analysis. If the Isotech developed procedure becomes routine, then a standard operating procedure is written. All procedures are reviewed and approved by the laboratory supervisors. Various procedural tests and verifications performed are recorded in bound maintenance log books.

### 3. CALIBRATION AND STANDARDIZATION

**3.1 Calibration Procedure and Frequency** Depending on the analytical technique, instruments used for quantitative analyses are either calibrated at the beginning of every operating period or the calibration is checked by using a reference sample or a calibration standard. The instrument calibration is also checked at appropriate intervals during analyses. Specific instruments that form components of a sample preparation system are calibrated using duplicate sample analysis as well as analysis of a reference sample at appropriate intervals. Records of calibration results are kept in laboratory notebooks or other secure medium (see Documentation).

**3.2 Method Validation** Analytical methods are validated by one or more of the following techniques:

3.2.1 check or reference samples are analyzed and the results are compared with the internal documented or external certified (primary and secondary standards) values,

3.2.2 results from the candidate method are compared with those from another method known to be applicable and reliable, or

3.2.2 spiked samples and surrogate samples are analyzed and the method results are compared with the known concentrations.

**3.3 Check/Reference Samples** A check/reference sample is analyzed approximately every tenth analysis. This, in essence, results in a test of the method. Check/reference samples are chosen which have been analyzed multiple times over an extended period of time with consistent results.

**3.4 Standards** Primary standards are obtained from the International Atomic Energy Agency, Vienna, Austria, and certified by NIST (National Institute of Standards and Technology, formerly U.S. National Bureau of Standards) or directly from NIST. Secondary standards are obtained from commercially available sources recognized in the industry. Internal Reference standards are prepared by direct calibration against primary and secondary standards.

**3.5 Duplicate Samples** Duplicate analyses are performed approximately every tenth analysis. This duplicate sample analysis is performed approximately five analyses after the check/reference sample analysis is performed. Therefore, for a particular analysis procedure, a test of the method is performed every five analyses. This assures that at least 20% of all analyses are for maintaining QA/QC.

**3.6 Specific Routine Procedures to Assess Performance** Standard reference samples, chosen to match the submitted samples as closely as possible, in conjunction with duplicate samples and check samples, provide a matrix for performance evaluation. If a problem is detected with



the reference sample, then the problem is first addressed by checking the integrity of the sample itself. Other reference samples are analyzed to determine if the problem persists. If reference sample integrity is verified, further diagnostic testing is carried out until the cause of the discrepancy is identified.

Isotech willingly participates in round-robin testing whenever the opportunity arises and has participated in studies by IAEA and industry. Instrument calibration is carried out whenever analysis of internal standards and check samples suggests a potential problem.

**3.7 External Quality Control Checks** Blind duplicates, check samples, blanks, and spiked samples may be submitted by the client, and this practice is encouraged.

## **4. ANALYSES AND ANALYTICAL RESULTS**

**4.1 Data Reduction and Reporting** Calculations made in reducing raw data to reportable form are verified (preferably by a second person) before reporting the results to the client. If a computer program is used to perform calculations, the accuracy of the input data is verified by comparison with the raw data. In all cases where computer programs are used to make the calculations, the person making the calculations verifies that the proper program is used. Data reduction and calculation is performed automatically by the computers which control the instruments. Reported results are verified relative to the computer printouts.

**4.2 Hard Copy and Electronic Data Deliverables** Normally, final data is emailed to clients as an Excel workbook file, and also a PDF version of the data. Depending on the sample type, hard copy reports can be either a single page per sample, or can be in tabular format with multiple samples per page. Hard copy reports are not mailed to clients, unless clients specifically request them. Upon request, CD's will be submitted to clients in addition to the hard copy reports. Also, appropriate graphs will be provided upon request. Compositional analyses for natural gas samples are normalized when the Analysis Report is generated. Upon request a QA/QC report containing results for all check samples and duplicates as well as copies of raw data can be provided at additional cost.

**4.3 Documentation** All laboratory notes, observations, calibrations, manual calculations, and any other pertinent information are kept in bound laboratory notebooks or other secure recording medium. Computer programs used for data storage, retrieval, and calculations, which are developed within Isotech Laboratories, Inc., are documented well enough that someone not intimately familiar with the program development, but who is familiar with the programming language, can understand the operation of the program. Printed and dated copies of the current version and each previous version (insofar as possible) of the program are kept in the developer's files. These copies remain at and are the property of Isotech, should the developer leave employment of Isotech Laboratories, Inc. Electronic backup copies of currently-used computer programs are securely kept by the program's developer or principal user. Backup copies of analyses databases are made periodically. The frequency of making backup copies

depends on the frequency of updating the database, but the minimum frequency for making backup copies is weekly. All laboratory notebooks, data, computer programs, computerized databases, and any other means of recording data, observations, calculations, and other pertinent information developed at or on behalf of Isotech, remain the property of Isotech Laboratories, Inc., unless otherwise designated.

**4.4 Hard Copy Data Files and Storage** All pertinent paperwork associated with each batch of samples is stored in the client files. Typical paperwork can include chain of custody records, client analysis requests, email communication to/from clients regarding samples, final data, and cover letter mailed to client with final data. Data files are kept indefinitely unless clients request that we dispose of them.

## **5. MAINTENANCE AND REPAIR**

**5.1 Instruments** Each instrument or machine used to produce quantitative analysis results, or leading up to their production, undergoes periodic preventive maintenance according to manufacturer's instructions, or some established preventive maintenance schedule. Preventive maintenance may be done by laboratory personnel, manufacturer's representative, or a qualified third-party contractor, depending on the abilities of the laboratory operator and the complexity of the equipment. Records of repairs and preventive maintenance are kept by the appropriate laboratory personnel in files or notebooks. Records of equipment problems and solutions are kept in files or notebooks. The analyst is the person best qualified to recognize when the instrument or machine they operate is in need of repair, or the method they practice is in need of corrective action. Corrective action is needed when predetermined limits for data acceptability are exceeded. Analysts are also to use their experience and scientific judgment in deciding when corrective action is needed.

**5.2 Other Equipment** Other laboratory equipment such as vacuum pumps, ovens, test meters and non-instruments such as glassware are maintained by Isotech personnel. In most cases this is performed by the same person who utilizes the equipment for analysis. Visual checks backed by mechanical and electronic gauges provide constant maintenance checks directly to the operators.

## **6. REVIEW**

**6.1 Analytical Review** At the time of each analysis or sample preparation, the staff chemist performing the analysis reports anomalies to the QC Manager. Staff chemists are all trained on a variety of techniques and work closely together. Constant communication between staff members results in most problems being addressed when they occur. Unusual problems are brought to the attention of the management team. Whenever possible, a sample that is questionable for any reason is re-analyzed to verify results, regardless of when the sample

was analyzed initially. This means that more than 10% of samples will be duplicates if the data appears to be unusual in any way.

Before final reports are printed, data is checked to verify that the final data agrees with the raw printouts, and raw percentages for compositional analyses are checked to ensure that all components are identified. Reproducibility of duplicate isotopic samples is compared to stated precision limits. Analytical data is reviewed for anomalies by project coordinators and/or managers.

**6.2 Standard Operating Procedures (SOP's):** These procedures are developed from specific analytical methods for operating specified equipment to obtain high quality data reflective of each sample analyzed. In addition to revisions due to procedural or equipment changes these SOP's are reviewed by the QC Manager annually.

## **7. QA/QC PROBLEM REPORTING**

**7.1 Responsibilities** QA/QC is the responsibility of every person who collects or analyzes samples. If any Isotech Laboratories employee observes any QA/QC problem, that employee will discuss the problem with the analyst, QC Manager, Lab Manager or General Manager. No negative action will ever be brought against nor will accrue to any staff member who reports QA/QC problems.

## **8. SUBCONTRACT POLICY**

Samples for analysis of  $^{14}\text{C}$  (radiocarbon) are converted to purified carbon dioxide and then submitted to an established radiocarbon dating laboratory for the final analysis. When analyses are requested for which Isotech does not have either the necessary equipment or expertise to provide high quality results, these analyses too may, with the knowledge of the client, be submitted to a subcontract laboratory. Only established, reputable laboratories which maintain strict QA/QC control are utilized. All samples are prepared and packaged using techniques that have been recommended or approved by the subcontract laboratory. Analysis of reference samples and standards is the responsibility of the subcontract laboratory. Duplicate analyses of samples submitted to a subcontract laboratory should be requested by the client and will be charged as regular samples.

## APPENDICES: ANALYTICAL PROCEDURES

### I. Sample Preparation Procedures for Stable Isotope Analyses

#### A. Procedures for Stable Isotope Analysis of Water Samples

##### 1. $\delta^{13}\text{C}$ (Carbon Isotope Analysis) of Dissolved Inorganic Carbon (DIC)

###### Equipment and Supplies

Thermo GasBench II  
Thermo Delta V Plus  
12mL Exetainer<sup>®</sup> with septum cap  
Micro spin bar  
1mL syringe  
23G needle  
85% Phosphoric acid  
0.1N HCl

Method/Procedure The  $\delta^{13}\text{C}$  of DIC is determined by injecting up to 1 ml of sample water into a helium flushed 12mL Exetainer<sup>®</sup> containing 0.1mL of 85% phosphoric acid and a magnetic spin bar. Sample size is determined based on alkalinity, which is measured by titration with 0.1N HCl.

The sample is stirred for a minimum of one hour and then allowed to equilibrate for 24 hours. At time of analysis the sample vials are placed in the GasBench tray. The  $\text{CO}_2$  generated is flushed out of the vial via a two port needle. Water is removed by two nafion traps, and pure  $\text{CO}_2$  is separated using a GC column. The  $\text{CO}_2$ /helium mixture then enters the mass spectrometer and is compared against a reference standard a total of six times.

Maintenance Vials are recycled and the spin bars are thoroughly cleaned and reused. Gas flow rates through the GasBench system are periodically checked.

QA/QC At a minimum, every tenth analysis is a replicate. A check standard is analyzed every tenth analysis.

Calculation Calculations are performed by the software on the IRMS (Isotope Ratio Mass Spectrometer) at the time of analysis. Data normalization against internal lab standards is performed using Microsoft Excel.

Documentation All procedural tests and verifications performed are recorded in bound maintenance log books. All sample data including the date prepared with analyst identification are recorded on laboratory log sheets and in bound log books.

## **2. $\delta D$ (Hydrogen Isotope Analysis) and $\delta^{18}O$ (Oxygen Isotope Analysis) of $H_2O$**

### Equipment

3mL syringes  
0.2 micron syringe filters  
2mL glass vials with septum caps  
Picarro CRDS (cavity ringdown spectrometer) model L1102-i fitted with a Leap autosampler

Method/Procedure Water samples are individually filtered into 2mL vials with 0.2 micron syringe filters. If samples are high salinity brines, they should be vacuum distilled prior to loading. The vials are then loaded onto trays which are installed on the autosampler. Samples are analyzed by the CRDS in replicate in accordance with the manufacturer's recommendation.

QA/QC Two reference water samples are used to verify accuracy and reproducibility. These reference waters are analyzed approximately every tenth analysis. The system is calibrated by analysis of primary reference standards obtained from IAEA or NIST. At a minimum, every tenth sample analysis is a replicate.

Calculation Calculations are performed by the software on the CRDS at the time of analysis. Data normalization against internal lab standards is performed using Microsoft Excel.

Documentation All procedural tests, sample preparations and verifications performed are recorded in bound maintenance log books. All final data including the date prepared with analyst identification in bound log books.

## **3. $\delta^{15}N$ and $\delta^{18}O$ (Nitrogen and Oxygen Isotope Analysis) of Dissolved Nitrate**

### Equipment and Supplies

0.45 nylon filter paper  
Glass filtration apparatus  
1N HCl  
 $BaCl_2$   
Cation exchange resin  
Anion exchange resin  
1N HBr  
 $Ag_2O$   
Flasks



Stirbars  
Freezer  
Oven  
Freeze-dryer  
Teflon beakers  
Thermo Delta V Plus  
Mettler Toledo MX5 Ultra-Microbalance  
Thermo TC/EA  
Thermo ConFlo II

Method/Procedure Nitrate is extracted from groundwater samples and converted into  $\text{AgNO}_3$  using ion-exchange techniques. The nitrate concentration is determined using an Orion AquaFAST™ colorimeter. The appropriate sample size is filtered and placed on a hot plate to boil. The pH is adjusted to 1-3 using 1N HCl.  $\text{BaCl}_2$  is added to remove dissolved sulfates, and the sample volume is decreased to 250mL. Precipitated  $\text{BaSO}_4$  is filtered from the sample and placed into separatory funnels. The sample is allowed to flow through a cation column and then through the anion column, where nitrate is held within the column. 1N HBr is added to the column to strip the nitrate. The eluent is collected and silver oxide is added to create  $\text{AgNO}_3$ . The sample is filtered, frozen in a Teflon beaker, and placed in a freeze drying vacuum oven until only the  $\text{AgNO}_3$  crystals remain. The crystals are then analyzed using for  $\delta^{15}\text{N}$  using an EA-IRMS and analyzed for  $\delta^{18}\text{O}$  using a TC/EA-IRMS system.

Analysis of  $\delta^{15}\text{N}$  is performed using a Carlo Erba Elemental Analyzer. 1.2 milligrams of  $\text{AgNO}_3$  is weighed into tin boats and placed in an Autosampler with helium purge. The sample is flash combusted inside the combustion reactor, as shown in this reaction  $\text{N} + \text{O}_2 \rightarrow \text{N}_x\text{O}_y + \text{N}_2$ . The products of combustion reaction are then carried to the reduction reactor where excess oxygen is removed, and nitrogen oxides ( $\text{N}_x\text{O}_y$ ) are reduced to elemental nitrogen ( $\text{N}_2$ ). The  $\text{N}_2$  gas is introduced to the IRMS through a ConFlo II interface. Sample values are referenced against international standards.

Analysis of  $\delta^{18}\text{O}$  is performed using a Thermo TC/EA. 300 micrograms of  $\text{AgNO}_3$  is weighed into silver boats and placed in a zero blank autosampler. The sample is thermally converted to CO gas in the EA furnace. The CO gas is introduced into the IRMS through a ConFlo II interface. Sample values are referenced against international standards.

Maintenance Glassware is washed and rinsed with deionized water to remove residual sample and residual  $\text{AgNO}_3$ .

QA/QC At a minimum, every tenth sample preparation is a duplicate. Approximately every tenth EA/TCEA analysis a set of standards is analyzed after every ten samples, along with at least one check standard per analysis run.

Calculation Calculations are performed by the software on the IRMS (Isotope Ratio Mass Spectrometer) at the time of analysis. Data normalization against primary international standards is performed using Microsoft Excel.

Documentation All records of sample preparation and notes are hand written in bound log books. All sample data including the date prepared are stored electronically and in print.

Sample Handling Samples should be collected and frozen until analyzed. Samples should be shipped overnight in a cooler on ice. Filtering prior to shipment is preferred but is not required.

#### **4. $\delta^{34}\text{S}$ & $\delta^{18}\text{O}$ (Sulfur and Oxygen Isotope Analysis) of Dissolved Sulfate**

##### Equipment and Supplies

Thermo Delta V Plus  
Mettler Toledo MX5 Ultra-Microbalance  
Elementar Vario EL  
Thermo TC/EA  
Thermo ConFlo II  
Thermo AQUAFast II <sup>TM</sup> Colorimeter  
0.45 micron nylon filter  
1N HCl  
BaCl<sub>2</sub> solution  
Filtering apparatus  
Various sized beakers  
Drying oven  
Petri dishes  
Tin boats  
Silver boats

Method/Procedure The  $\delta^{34}\text{S}$  &  $\delta^{18}\text{O}$  of dissolved sulfate is determined by the barium sulfate precipitation technique. Prior to preparation the sulfate concentration must be obtained from the client or determined using a Thermo AQUAFast II <sup>TM</sup> colorimeter; a minimum sulfate concentration of 5ppm is required for this analysis. Once the sulfate concentration is known, the amount of sample needed to obtain 25mg of barium sulfate is weighed into a clean beaker. Samples are then filtered to remove particulate matter before being brought to a boiling temperature. Calcium carbonate in the sample is removed by adding 1N hydrochloric acid until the sample reaches a pH of 1-3. An appropriate amount of barium chloride solution is added based on the concentration of sulfate in the sample. The reaction is given sufficient time to complete under heat; a testing solution is used to ensure that all dissolved sulfate has precipitated. The precipitant is then filtered and dried, the final amount is weighed.

The  $\delta^{34}\text{S}$  of the dried barium sulfate is then determined by combustion to  $\text{SO}_2$  gas using an Elementar Vario EL EA. Approximately 1.2mg  $\text{BaSO}_4$  is weighed into a tin capsule and loaded into an autosampler. The sample is then combusted and passed over a reduction furnace. The resulting  $\text{SO}_2$  gas is passed through a ConFlo II interfaced to the IRMS, where it is compared against a reference gas.

Analysis of  $\delta^{18}\text{O}$  is performed using a Thermo TC/EA. Approximately 300 micrograms of  $\text{BaSO}_4$  is weighed into silver boats and placed in a zero blank autosampler. The sample is thermally converted to CO gas in the EA furnace. The CO gas is introduced into the IRMS through a ConFlo II interface. Sample values are referenced against international standards.

Maintenance Glassware is washed and rinsed with deionized water to remove residual  $\text{BaSO}_4$ .

QA/QC At a minimum, every tenth sample preparation is a duplicate. Approximately every tenth EA/TCEA analysis a set of standards is analyzed after every ten samples, along with at least one check standard per analysis run.

Calculation Calculations are performed by the software on the IRMS (Isotope Ratio Mass Spectrometer) at the time of analysis. Data normalization against primary international standards is performed using Microsoft Excel.

Documentation All records of sample preparation and notes are hand written in bound log books. All sample data including the date prepared are stored electronically and in print.

Sample Handling Samples should be collected and stored at  $4^\circ\text{C}$  until analyzed. Samples should be shipped overnight in a cooler on ice. Filtering prior to shipment is preferred but is not required.

## **B. Procedures for Stable Isotope Analysis of Gas Samples**

### **1. $\delta^{13}\text{C}$ and $\delta\text{D}$ (Carbon and Hydrogen Isotope Analysis) for Hydrocarbon Gases, Offline Prep Systems**

#### Equipment and Supplies

3 SRI 8610C Gas chromatographs  
Evacuated transfer system  
Copper oxide combustion furnace  
Dry ice  
Isopropyl alcohol  
Liquid nitrogen  
Electronic manometer  
Electronic vacuum gauge

Helium  
Oxygen  
Gas-oxygen torch

Method/Procedure The determination of carbon and hydrogen isotopic ratios for hydrocarbons in gas mixtures (e.g. natural gas) requires a sample preparation system capable of first separating the individual hydrocarbons and then quantitatively converting them into carbon dioxide (CO<sub>2</sub>) and water for mass-spectrometric analysis. There are 2 systems utilized for processing natural gases. The systems employed are helium purged flow systems consisting of two major units.

The first unit consists of sample injection syringes, SRI 8610C gas chromatographs, a personal computer, and several flow-control valves. This configuration separates the hydrocarbon of interest from the sample and channels it into the combustion-collection unit. The second unit is the combined combustion-collection unit which includes quartz combustion tubes filled with cupric oxide (CuO), and vacuum lines. This system converts the hydrocarbon of interest into CO<sub>2</sub> and water, which are then collected and purified for isotopic analysis.

The water of combustion is transferred into a length of Pyrex tubing that has been sealed at one end and contains a weighed quantity of zinc turnings. The sample tube is sealed off for later mass spectrometric analysis. Similarly, the CO<sub>2</sub> is then transferred into Pyrex tubing and sealed off for later mass spectrometric analysis.

Maintenance The packed columns are baked at manufacturer's recommended temperature when peak separation decreases. At the end of every work day, O<sub>2</sub> is flowed through the copper oxide combustion furnaces to regenerate the CuO. Valve o-ring seals within the evacuated transfer system are replaced as necessary.

Reference Samples The system is tested by analyzing a reference sample every tenth analysis performed.

Replication A duplicate analysis of one of the samples is performed approximately every tenth analysis. This duplicate analysis is performed approximately five analyses after the reference sample analysis is performed. Therefore, a test of the system operation is performed every five analyses.

Calculation The expected yield is calculated from the injection volume and the hydrocarbon concentration

Documentation All procedural tests, sample preparations and verifications performed are recorded in bound maintenance log books. All final data including the date prepared with analyst identification are recorded on laboratory log sheets and/or in bound log books. Digital copies of all chromatograms are stored and backed up regularly.

## 2. $\delta^{13}\text{C}$ (Carbon Isotope Analysis) of $\text{CO}_2$ , Offline Prep Method

Method/Procedure Preparation of samples for measurement of the  $\delta^{13}\text{C}$  of  $\text{CO}_2$  is performed on the same system as the hydrocarbons. The procedure is identical to that for the hydrocarbons, with two exceptions. First,  $\text{CO}_2$  does not pass through a combustion furnace; gas is channeled directly from the GC outlet to the collection trap. Second, there is no water of combustion.

## 3. GC-C-IRMS systems, $\delta^{13}\text{C}$ , $\delta\text{D}$ , and $\delta^{15}\text{N}$

### Equipment and Supplies

HP6890 GC interfaced to ThermoFinnigan Delta Plus Advantage

HP 6890/7890 interfaced to Thermo Scientific Delta V Plus

Customized autosampler

Method/Procedure The GC-C-IRMS systems, also referred to as “online” or “continuous flow”, consist of an Agilent GC combustion unit interfaced with a mass spectrometer (Delta V Plus or Delta Plus Advantage), and are used to analyze the carbon isotopic value of hydrocarbon components in gas samples. Samples are injected into the GC split/splitless injector either manually, or using customized autosamplers. The hydrocarbon components are separated by the GC column, and each individual component slated for isotopic analysis is combusted in a combustion furnace supplied by the instrument manufacturer. The resultant  $\text{CO}_2$  is introduced directly into the mass spectrometer, and Finnegan’s Isodat software is utilized for peak detection and quantification. Cryogenic focusing of hydrocarbons is achieved using liquid nitrogen, allowing the air to be removed, resulting in enriched concentrations of hydrocarbons.

Hydrogen isotopic values for methane are completed using the same system, but the gas is channeled through a high-temperature pyrolysis furnace instead of through the combustion furnace. The pyrolysis furnace converts methane into  $\text{H}_2$  and carbon, and the  $\text{H}_2$  gas is introduced directly into the mass spectrometer.

Nitrogen isotopic data for elemental nitrogen ( $\text{N}_2$ ) is generated using the same system.

Maintenance Septa on the GC inlet system are replaced daily when the system is operational. Pyrolysis and combustion tubes are replaced as needed. Combustion tubes are oxidized daily during analysis sequences.

Reference Samples Reference gases are analyzed at the start of each analysis sequence, and then at least 10% of all analyses during a sequence are check samples.

Replication At least 10% of client samples are analyzed in duplicate.

## C. Procedures for Stable Isotope Analysis of Solids and Liquids



## 1. $\delta^{13}\text{C}$ & $\delta^{18}\text{O}$ (Carbon and Oxygen Isotope Analysis) of Carbonate

### Equipment and Supplies

Thermo GasBench II  
Thermo Delta V Plus  
Mettler Toledo MX5 Ultra-Microbalance  
12mL Exetainer<sup>®</sup> with septum cap  
100% Phosphoric acid

Method/Procedure The  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  of carbonate is determined by weighing approximately 200 micrograms of sample into an Exetainer<sup>®</sup> fitted with a septum cap. The vials are placed in a temperature controlled sample block at 70°C and flushed with helium to purge any air from the vial.

The sample is reacted with 100% phosphoric acid for a minimum of one hour and then analyzed. The  $\text{CO}_2$  generated is flushed out of the vial via a two port needle. Water is removed by two nafion traps, and pure  $\text{CO}_2$  is separated using a GC column. The  $\text{CO}_2$ /helium mixture then enters the mass spectrometer and is compared against a reference standard a total of six times.

Maintenance Vials are rinsed to remove acid and the glass is recycled.

QA/QC At a minimum, every tenth analysis is a replicate. A set of standards is analyzed after every ten samples, along with at least one check standard per analysis run.

Calculation Calculations are performed by the software on the IRMS (Isotope Ratio Mass Spectrometer) at the time of analysis. Data normalization against internal lab standards is performed using Microsoft Excel.

Documentation All procedural tests and verifications performed are recorded in bound maintenance log books. All sample data including the date prepared are stored electronically and in print.

## 2. Organic Solids and Liquids $\delta^{13}\text{C}$ , $\delta^{18}\text{O}$ , $\delta^{15}\text{N}$ , $\delta^2\text{H}$ and $\delta^{34}\text{S}$

### Equipment and Supplies

Carlo Erba Elemental Analyzer connected to a Finnigan Delta S Mass Spectrometer  
ThermoElectron TCEA interfaced to a Thermo Electron Delta V Plus Mass Spectrometer  
Elementar EL Vario III interfaced to a Thermo Scientific Delta V Plus Mass Spectrometer

Method/Procedure The determination of carbon, nitrogen, oxygen, hydrogen, and sulfur isotopic ratios for organic solids and liquids is accomplished by combustion or pyrolysis of the materials for mass-spectrometric analysis. The systems employed are standard elemental analyzers with carousel auto samplers, connected to isotope ratio mass spectrometers through an interface supplied by the manufacturer. The combustion products of interest from the elemental analyzers are: carbon dioxide (CO<sub>2</sub>) for carbon isotope analysis, N<sub>2</sub> for nitrogen isotope analysis, and sulfur dioxide (SO<sub>2</sub>) for sulfur isotope analysis. Oxygen and hydrogen isotopic ratios are analyzed on the TCEA, which converts hydrogen from the organic materials to H<sub>2</sub> gas for hydrogen isotopic measurements, and oxygen within the organic materials is converted to carbon monoxide (CO) for oxygen isotope analysis.

Samples are weighed on a Mettler balance and loaded into a standard EA tin capsule for carbon, nitrogen, or sulfur isotopic analysis, or into a silver capsule for oxygen or hydrogen isotopic analysis. Once the samples are loaded into the EA, a run is started and all instrument control is done by software provided by the MS manufacturer. Samples are combusted as per normal EA operating procedures, and the CO<sub>2</sub>, N<sub>2</sub>, and SO<sub>2</sub> are separated by the EA. Similarly, the pyrolysis products H<sub>2</sub> and CO from the TCEA are separated within the instrument. The vents of the EA and the TCEA are connected to the mass spectrometers via the interface, where a small portion of the EA or TCEA output flows directly into the MS. The MS measures the isotopic value of the component of interest (CO<sub>2</sub>, N<sub>2</sub>, SO<sub>2</sub>, CO, or H<sub>2</sub>) and the final isotopic value is generated by software provided by the manufacturer.

Maintenance Ash is removed from the top of the combustion column in the EA or the top of the pyrolysis reactor in the TCEA as directed by the manufacturer, or when peak tailing becomes apparent. Combustion and reduction furnaces in the EA are replaced at appropriate intervals as outlined by the dealer, or when peak shape deteriorates. The TCEA contains glassy carbon, which is periodically replaced.

Reference Samples The systems are tested by analyzing at least one reference at least once per batch of 25 samples loaded into the auto sampler. A blank is also run at the start of each batch.

Replication Approximately 10% of all samples analyzed are replicates.

Documentation All final data including the date analyzed are recorded on laboratory log sheets and/or in bound log books. Digital copies of chromatograms are stored and backed up regularly.

## **II. Sample Preparation Procedures for Radiogenic Isotope Analyses**

### **A. Procedures for Radiogenic Isotope Analysis of Gases**

## 1. $^{14}\text{C}$ (Radiocarbon) and $^3\text{H}$ (Tritium) in $\text{CH}_4$ (Methane) by Radiometric Analysis

### Equipment

Peristaltic pump  
Flow meters  
Gas regulators  
Vacuum gauge  
Molecular sieve trap  
High temperature tube furnaces  
Quartz combustion chamber  
Vacuum traps and gauges  
Vacuum pumps  
Mercury manometer

### Method/Procedure

#### 1.1 Methane Combustion

The system used for tritium ( $^3\text{H}$ ) analysis of methane and for radiocarbon ( $^{14}\text{C}$ ) analysis of methane consists of a peristaltic pump, a  $\text{CO}_2$  removal unit, and a sample combustion/collection flow unit. The combustion/collection unit is composed of a tube furnace, a flow control valve, and a series of gas purification and collection traps. The system is attached to a vacuum manifold.

The gas sample enters the system through a flow control valve or is pumped in slowly by a peristaltic pump. The  $\text{CO}_2$  associated with the sample is absorbed by the molecular sieve and removed from the sample quantitatively. Methane in the sample is then carried through the combustion tube where it is reacted to  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .

The water of combustion is collected in a trap immediately after the combustion furnace by immersing the trap in a dry ice/isopropanol bath. Once the entire sample has been combusted, the frozen water of combustion is melted and transferred to a glass vial to await tritium analysis.

The  $\text{CO}_2$  formed by combustion is collected in two liquid nitrogen cooled traps, measured volumetrically, and transferred into a storage cylinder. Storage cylinders are effectively leak-tested during each use by evacuation prior to transferring the sample  $\text{CO}_2$ . Each cylinder is tagged with sample identification and is forwarded to a subcontractor for  $^{14}\text{C}$  analysis along with a chain-of-custody form.

#### 1.2 Tritium Analysis

The water of combustion from methane samples is ready to be analyzed in the liquid scintillation counter (LSC). There is no pre-treatment necessary for the sample, as it is essentially distilled water when it is collected.

The scintillation counting vials are prepared by pipetting 10 ml of commercial scintillation cocktail into a 20 ml plastic vial and then weighing to  $\pm 1$  mg. The sample is then pipetted or poured into the counting vial and the vial is re-weighed. If the amount of sample is less than 10ml, then tritium-free water is added to bring the total volume of water to about 10ml. Details of the tritium analysis procedure are given later in this document.

Maintenance After each sample, the molecular sieve is baked and evacuated at 350°C. The vacuum system is thoroughly evacuated to remove all residual gas and water vapor after each sample. The water trapping system is disassembled and thoroughly dried and evacuated after each sample.

Calibration/Standardization Gas storage volumes have been calibrated using known quantities of carbon dioxide gas. No further standardization of this system is necessary. Calibration and standardization of the final  $^{14}\text{C}$  analysis is performed by the subcontracted laboratory.

Replication and Reference Samples Replicate or reference sample analysis for these analyses are performed only when requested and supported by the client.

Calculation Yields are calculated by comparing the volume of  $\text{CO}_2$  generated and the weight of the water collected to the amount expected based on the amount of  $\text{CO}_2$  collected.  $^{14}\text{C}$  concentrations are determined by the subcontracted laboratory and corrected for isotope fractionation by Isotech's database program.

## **2. $^{14}\text{C}$ (Radiocarbon) in $\text{CH}_4$ and $\text{CO}_2$ by Accelerator Mass Spectrometry (AMS)**

### Equipment:

Same as for  $\delta^{13}\text{C}$  of  $\text{CO}_2$  and  $\delta^{13}\text{C}$  of Hydrocarbons.

### Method/Procedure:

The same method is employed for sample preparation as for  $\delta^{13}\text{C}$  of either  $\text{CH}_4$  or  $\text{CO}_2$ . Once the purified  $\text{CO}_2$  has been sealed into Pyrex tubing, the tube is tagged with a piece of label tape and sent to the subcontractor along with a chain of custody form for  $^{14}\text{C}$  analysis. When there is only enough material available for one sample preparation, the  $\delta^{13}\text{C}$  is first determined by MS analysis.

## **B. Procedures for Radiogenic Isotope Analysis of Water**

### **1. $^{14}\text{C}$ (Radiocarbon) in dissolved inorganic carbon (DIC) by Accelerator Mass Spectrometry (AMS)**

#### Equipment and Supplies

Vacuum pumps and gauges  
Glass and metal vacuum system  
Dry ice  
Isopropyl alcohol  
Liquid nitrogen  
Phosphoric acid  
Gas-Oxygen torch

Method/Procedure The  $^{14}\text{C}$  of DIC is determined by injecting sample water into an evacuated serum bottle containing 2mL of 85% phosphoric acid and a magnetic spin bar. Sample size is determined based on alkalinity, which is measured by titration with 0.1N HCl. The sample is stirred for a minimum of 15 minutes and then connected to the vacuum system via a needle port. The  $\text{CO}_2$  generated is liberated from the water and transferred through a trap cooled in a dry-ice/isopropyl-alcohol mixture (for  $\text{H}_2\text{O}$  removal) to a U-trap which is cooled in liquid nitrogen. The  $\text{CO}_2$  is then purified and cryogenically collected in Pyrex tubing. The tube is sealed off and tagged with a piece of labeled and sent to the subcontractor, along with a chain of custody form, for  $^{14}\text{C}$  analysis.

Maintenance The system is thoroughly evacuated between samples. Vials are washed and dried.

### **2. $^3\text{H}$ (Tritium) in $\text{H}_2\text{O}$**

#### Equipment

Vacuum pumps and gauges  
Distillation column  
Electrolytic enrichment cells  
Electrolysis power source and cooling system  
Liquid scintillation counting system  
Assorted chemicals and glassware  
Dry ice/ isopropyl alcohol  
Drying oven



Method/Procedure--Direct Counting of Higher Tritium Content Water (greater than 15 TU). Approximately 15ml of the water sample is treated with 0.1 M  $\text{KMnO}_4$  at 70°C for about an hour. This sample is then vacuum distilled. Ten ml of the distillate is accurately weighed and mixed with 10ml of an appropriate organic scintillator cocktail in a 20ml plastic vial and counted in a liquid scintillation spectrometer for 1000 minutes. Background and a NIST standard are also similarly counted and the tritium content calculated.

Method/Procedure--Enrichment of Lower Tritium Content Water (less than 15 TU). About 300 ml of the water sample is conventionally distilled to near completion. Exactly 200g is added to an enrichment cell along with 2ml of 9M tritium-free sodium hydroxide and is electrolytically enriched down to about 11-13 ml (final weight is exactly determined), and then neutralized with carbon dioxide for 20 minutes. The enrichment procedure is carried out under conditions of about 2°C and constant voltage of 4V. Ten ml of the enriched sample is accurately weighed and mixed with an appropriate organic scintillator cocktail in a 20 ml plastic vial and counted in a liquid scintillation spectrometer for 1000 minutes. Background and a NIST standard are also similarly counted and the tritium content calculated.

General QA/QC Procedures Critically reviewing TU/cpm/g of NIST standard versus existing data, critically reviewing background cpm versus existing data, and comparing data from splits of NIST and other samples with outside established laboratories. A criteria of exceeding 1 sigma limits from existing data triggers investigation of possible errors. Electrolytic enrichment cells are calibrated using working standards approximately every 6 months, or whenever duplicates prepared in different cells suggest a possible change in enrichment factor.

Maintenance The vacuum system is thoroughly evacuated between samples. All glassware and electrolytic cells are cleaned with deionized water and baked at about 130°C between samples.

Replication At a minimum, every tenth analysis is a replicate. Periodically a blind split is sent to another established tritium analysis laboratory for check purposes.

Reference Sample A NIST water standard (a dilution of NIST 4361B) is used for each sample set to verify accuracy and reproducibility. A glass-sealed high tritium sample is routinely checked to verify that the counter is operating satisfactorily. QA/QC plots are maintained for both standard and background counts using deviation of 1 sigma as a criteria for a more detailed evaluation of the data.

Calculation Calculations are performed utilizing a spreadsheet to calculate tritium concentration in TU on the date counted.

Documentation All procedural tests, sample preparations and verifications performed are recorded in bound maintenance log books. All final data including the date prepared, with analyst identification, are recorded on laboratory log sheets or in bound log books.

### III. Dual Inlet Mass Spectrometric Analysis

#### A. Measurement of $^{13}\text{C}/^{12}\text{C}$ and $^{18}\text{O}/^{16}\text{O}$ in $\text{CO}_2$

Equipment Finnigan MAT Delta S Isotope Ratio Mass Spectrometer

Method/Procedure Because  $^{13}\text{C}/^{12}\text{C}$  and  $^{18}\text{O}/^{16}\text{O}$  analyses are performed simultaneously, the procedure described here generates both measurements. A mass spectrometric analysis involves comparisons of a sample to a reference standard; in this case the comparisons are measurements of mass 44, 45, and 46, giving the both the oxygen and carbon isotopic compositions. This is accomplished by a dual inlet system where the sample and the reference standard are measured alternately. At the beginning of each day, a reference standard is introduced into the standard side of the inlet system, and this gas is generally used for the entire session. There are two different reference standards in aluminum cylinders which are permanently mounted on the MS inlet system. The sample to be analyzed against the standard is introduced into the system via an evacuated inlet system and tube-cracker. With the inlet system fully evacuated, the sample (which is sealed into  $\frac{1}{4}$ " Pyrex tubing) is introduced by breaking the glass sample tube and allowing the sample to fill a variable volume bellows. Once the sample has been introduced into the MS, the actual analysis is computer controlled using equipment obtained from the manufacturer. Each analysis is given a specific reference name and/or number, utilizing the lab number as the primary reference. Final results are calculated by the manufacturer's software, and are stored on the hard drive of the computer, recorded in a bound lab notebook, and stored as the computer generated printout.

Maintenance The source region of the MS is periodically disassembled and cleaned. The filament is replaced as needed. Oil levels in mechanical vacuum pumps are checked frequently and maintained at the proper level. Turbomolecular pumps are lubricated according to the manufacturer's recommendations.

Calibration/Standardization The first analysis of each session is a zero enrichment, where the working standard is analyzed against itself to check machine stability. Isotope ratio determination involves multiple direct comparisons of the sample to a reference standard (generally at least 6 comparisons). Stable carbon and oxygen isotope compositions are always reported as the difference between the ratios of the two isotopes of interest in the sample and the ratio in a primary reference standard. That is,

$$\delta X_{(\text{sample})} = [(R_{\text{sample}} - R_{\text{standard}}) / R_{\text{standard}}] \times 1000$$

Where X represents the isotope of interest,  $^{13}\text{C}$  or  $^{18}\text{O}$ , and R represents the ratio of  $^{13}\text{C}/^{12}\text{C}$ , or  $^{18}\text{O}/^{16}\text{O}$ . The  $\delta$  value is expressed in terms of per mil (‰), or parts per thousand.

In practice, the difference between the sample and an internal reference standard is measured and then the value relative to the primary standard is calculated by the instrument manufacturer's software. Two internal reference standards are used at Isotech, both of which have been calibrated multiple times relative to several standards (graphite, oil, carbonates, waters, etc.) available from the International Atomic Energy Agency and the National Institute of Standards and Technology.

Replication Because of replicate sample preparations, at least 10% of all analyses are replicates.

Reference Samples Because 10% of all samples prepared for stable isotope analysis are check samples or reference samples which have been previously analyzed, these samples also serve as check samples for the mass spectrometer.

Calculation All calculations are performed by the software obtained from the manufacturer.

## **B. Measurement of $^2\text{H}/^1\text{H}$ (Deuterium/Hydrogen) in $\text{H}_2$**

### Equipment

Finnigan Delta Plus XL isotope ratio mass spectrometer

Aluminum heating block

Personal computer

Method/Procedure The  $\text{H}_3$  factor, which is the portion of the mass 3 signal attributable to  $^1\text{H}-^1\text{H}-^1\text{H}$  (instead of  $^2\text{H}-^2\text{H}$ ), is determined before each run early in the day and periodically throughout the day based on machine performance (if the values start drifting, a new  $\text{H}_3$  factor is determined). The reference standard must be replenished at least once during an 8 hour period.

Water samples for deuterium/hydrogen analysis are sealed into 1/4" Pyrex tubing as  $\text{H}_2\text{O}$ , along with a measured quantity of zinc. Each sample tube is labeled and reacted in a heating block at  $500^\circ\text{C}$  for 35 minutes to generate hydrogen gas. Once the sample has been reacted, it is introduced into the sample side of the MS inlet system and analyzed against the working standard. Each analysis is given a unique label, using the lab number as the primary reference.

Once the sample has been introduced into the MS, the analysis is computer controlled. The raw result is calculated by the manufacturer's software and recorded into a bound lab notebook, as well as being stored on computer hard disk and computer generated printout of results.

Maintenance The source region of the MS is periodically disassembled and cleaned. The filament is replaced as needed. Oil levels in mechanical vacuum pumps are checked frequently and maintained at the proper level. Turbomolecular pumps are lubricated according to the manufacturer's recommendations.

Calibration/Standardization The first run each day is a zero-enrichment where the standard is run against itself to check machine stability. Stable hydrogen isotope compositions are always

reported as the difference between the ratios of the two isotopes of interest in the sample and the ratio in a primary reference standard. That is,

$$\delta D_{(\text{sample})} = [({}^2\text{H}/{}^1\text{H}_{\text{sample}} - {}^2\text{H}/{}^1\text{H}_{\text{standard}}) / {}^2\text{H}/{}^1\text{H}_{\text{standard}}] \times 1000$$

The  $\delta$  value is expressed in terms of per mil (‰), or parts per thousand.

In practice, the difference between the sample and an internal reference standard is measured and then the value relative to the primary standard is calculated by the instrument manufacturer's software. Two internal reference standards are used at Isotech which have been calibrated relative to several water standards available from the International Atomic Energy Agency and the National Institute of Standards and Technology.

Replication Because of replicate preparation of samples, at least 10% of all analyses are replicates.

Reference Samples Because 10% of all samples prepared for stable isotope analysis are check samples or reference samples which have been previously analyzed, these samples also serve as check samples for the mass spectrometer.

Calculation All calculations are performed by the manufacturer's computer software. The raw data is then converted to final data using a spreadsheet on a personal computer. The spreadsheets are stored on computer hard disk and a copy is attached to the raw printouts for each batch of analyses.

## IV. Gas Chromatographic Analysis of Gases

### A. Analysis of hydrocarbons

#### Equipment

Shimadzu 2010 Gas Chromatograph. This (complete) GC system is equipped with two 2010 instruments; one containing a thermal conductivity detector (TCD) and a flame ionization detector (FID), and the other containing dual TCD's. Data processing is done on GC solutions software and a personal computer.

Shimadzu 2014 Gas Chromatograph. This (partial) GC system is equipped with both thermal conductivity (TCD) and flame ionization (FID) detectors. Data processing is done on GC solutions software and a personal computer.

Method/Procedure The sample loop on the GC is evacuated between each sample. Samples are injected into the evacuated sample loop and adjusted to atmospheric pressure. Sample identification is entered into the GC solutions software and the run is initiated.

The Shimadzu 2010 and 2014 utilizes several different packed columns and valve switching to separate the various components. Instrument configuration was designed by Shimadzu specifically to meet the requirements of Isotech. Helium is used as the carrier gas. All valve switching during the analysis is computer-controlled. The resulting component peak areas are then quantified by the software (given raw percent values) by comparing them to previously run standards. The lab technician checks the raw total for each analysis to ensure that all components have been detected. The raw total can vary from day to day depending on atmospheric pressure, with acceptable raw totals of 96% to 104%. The lab technician also checks all baselines for accuracy from the chromatograms shown on the computer screen. This raw computer record is maintained for each sample corresponding to its individual lab number.

The raw percentage values for each sample are downloaded into the main sample database, and are normalized to 100% when the Analysis Report is generated.

Maintenance GC columns are periodically baked out according to manufacturer's instructions. Septa in the sampling valves are replaced as needed.

Calibration/Standardization Multiple reference gases are used for standardization of the Shimadzu gas chromatographs. All standards are analyzed on the same day during a new standardization to minimize the effects of barometric pressure variations. The minimum and maximum concentration used for calibration cover the range of the majority of natural gases submitted for analysis. At least four points are used for each component. For each new standardization, the peak area of each concentration for each compound is inserted into a

table within the GC Solutions software. This table is then accessed by the software, which uses point-to-point interpolation, to determine component concentrations for gas samples during analysis.

Reference Samples The reference sample used as the 1st run of each day and every tenth sample thereafter is representative of the majority of natural gas samples received for analysis. Data obtained for reference samples and expected results based on previous analyses can be provided as part of a QA/QC report.

Replication Every tenth analysis is a replicate. This replicate analysis is done approximately five samples following the check sample, thus a system check is performed at least every five analyses.

Calculation Each individual component for each sample is manually compared to the computer generated output to insure that the peak was labeled correctly and integrated correctly by the GC Solutions software.

## **B. Analysis of fixed gases**

### Equipment

Shimadzu 2010 Gas Chromatograph. This GC system is equipped with two 2010 instruments; one containing a thermal conductivity detector (TCD) and a flame ionization detector (FID), and the other containing dual TCD's but quantification of fixed gases is done using only the TCD's. Data processing is done on GC solutions software and a personal computer.

Shimadzu 2014 Gas Chromatograph. This GC system is equipped with both thermal conductivity (TCD) and flame ionization (FID) detectors but quantification of fixed gases is done using only the TCD. Data processing is done on GC solutions software and a personal computer.

Method/Procedure The procedure for analysis of fixed gases is identical to that for analysis of hydrocarbons, with one exception (for 2010 only). For separation of oxygen and argon, an external column on the Shimadzu 2010 is used. This column operates at -78 °C; therefore a dewar of dry ice/isopropyl alcohol is placed on the column before each run. The lab technician checks all baselines to verify peak integration. The Shimadzu 2014 system is not equipped with the external column, thus argon and oxygen values are reported as one value. Also the 2014 system cannot detect helium and can only quantify hydrogen at limited concentrations.

Maintenance GC columns are periodically baked out according to manufacturer's instructions. The septum on the injection valve is periodically replaced.

Calibration/Standardization Multiple reference gases are used for standardization of the Shimadzu gas chromatographs. All standards are analyzed on the same day during a new standardization to minimize the effects of barometric pressure variations. The minimum and maximum concentration used for calibration cover the range of the majority of natural gases submitted for analysis. At least four points are used for each component. For each new standardization, the peak area of each concentration for each compound is inserted into a table within the GC Solutions software. This table is then accessed by the software, which uses point-to-point interpolation, to determine component concentrations for gas samples during analysis.

Check Sample Multiple reference sample are used to verify instrument performance and calibration. Data obtained for reference samples and expected results based on previous analyses can be provided as part of a QA/QC report.

Replication Every tenth analysis is a duplicate. This duplicate analysis is performed approximately five samples following the check sample, thus a system check is performed at least every five analyses.

Calculation Each individual component for each sample is manually compared to the computer generated output to insure that the peak was labeled correctly and integrated correctly by the GC Solutions software.

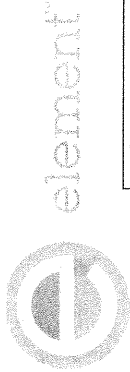
## **V. Radiocarbon Analysis of Prepared Samples**

Radiocarbon analyses of purified CO<sub>2</sub> samples prepared by Isotech are currently being subcontracted to either Beta Analytic Inc., Coral Gables, Florida or to Illinois State Geological Survey, Champaign, Illinois. Beta Analytic is the largest commercial radiocarbon dating laboratory in the world. The attached QA/QC plans have been provided by

BETA ANALYTIC INC  
University Branch  
4985 S.W. 74 Court  
Miami, FL 33155

Illinois State Geological Survey  
Natural Resources Building  
615 East Peabody Drive  
Champaign, IL 61820





## Chain of Custody

Laboratory  
Number:

<b>Client Information:</b>		<b>Billing Information:</b>		<b>PO Number:</b>		<b>Project Name/Number:</b>		<b>Page of</b>	
Approach Environmental, LLC		Same				LDNR Emergency Gas Sampling DeSoto Parish, LA		<b>Matrix Code</b>	
Mark S. Moore		P. O. Box 7192		Quote Number:		Sampler's Signature		DW = Drinking Water	
151 Freestate Blvd.		Shreveport, LA 71107		Ext:		Required QC Level		WW = Waste Water	
Suite B								GW = Ground Water	
318-401-0085		Ext:				Bill Monthly		AQ = Aqueous	
318-222-2425		marks@approachenv.com				<input type="checkbox"/> Yes		OT = Other	
marks@approachenv.com						<input type="checkbox"/> No		SL = Sludge	
						Shipping Method:		SOL = Solid	
						UPS / FedEx / Airborne		SO = Soil	
						DHL / Element / Hand / Mail		F = Food	
								NG = Natural Gas	
								NGL = Natural Gas Liquid	
								PW = Produced Water	
								CF = Completion Fluid	

Which Regulations Apply:	Turn Time	Collection Information	Container	Pres.	Requested Tests	Comments						
							Sample ID/Description	Date	Time	Grab / Composite	Matrix	
<input type="checkbox"/> RCRA <input type="checkbox"/> POTW <input type="checkbox"/> NPDES <input type="checkbox"/> USDA/FDA <input type="checkbox"/> RECAP/RISC	<input type="checkbox"/> Standard <input type="checkbox"/> RUSH <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Day <input type="checkbox"/> Other	(Rush turn times will incur a surcharge and must be pre-approved by lab.)	Quantity Type: Plastic, G=Glass, V=Vial	HCl, HNO <sub>3</sub> , H <sub>2</sub> SO <sub>4</sub> , NaOH, Na <sub>2</sub> SO <sub>3</sub>	Extended Gas Analysis (GPA 2261 and 2286)	Cnstr+Canister						
CV RA SUYY; MARY BELLE SMITH 28 #2-ALT (SN#239295)	11/6/17	14:20	Grab	NG	2	Cnstr	✓					
HOSS RA SU60; SAMPSON EST 33 #1 (SN#229084)	11/6/17	13:55	Grab	NG	2	Cnstr	✓					
P SUHH; J B BARR 28 #2 (SN#229457)	11/6/17	15:25	Grab	NG	2	Cnstr	✓					
ROD RA SUN; WANAMAKER #1 (SN#158504)	11/6/17	14:45	Grab	NG	2	Cnstr	✓					

Relinquished by	Date/Time	Received by	Date/Time	Field Notes:
<i>[Signature]</i>	11/6/17 15:45	Chamara Bell	11/6/17 3:44 p.m.	
1				
2				Received at lab on ice?
3				<input type="checkbox"/> Yes <input type="checkbox"/> No Temp:

All samples submitted to Element Materials Technology for analysis are accepted on a custodial basis only. Ownership of the material remains with the client submitting the samples. Element Materials Technology reserves the right to return unused sample portions.

2129 West Willow Street Scott, LA 70583 USA P 337-232-3568 F 337-232-3621	629 Washington St. Suite 300 Columbus, IN 47201-6231 USA P 812-375-0531 F 812-375-0731	2121 East Washington Boulevard Fort Wayne, IN 46803-1328 USA P 260-471-7000 F 260-471-7777	560 South Zimmer Road Warsaw, IN 46580-2368 USA P 574-267-3305 F 574-269-6569	3371 Cleveland Road, Suite 100A South Bend, IN 46628-9780 USA P 574-277-0707 F 574-273-5699	2417 W. Pinhook Rd Lafayette, LA 70508-3344 USA P 337-235-0483 F 337-233-6540
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Element Materials Technology  
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70583-5301 USA

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Mark Moore  
Approach Environmental  
151 Freestate BLVD  
Suite B  
Shreveport, La 71107

Date: 11/15/17  
Report Number: 235789  
RE: Certified Analysis

Dear Mr. Moore,

Element Materials Technology Scott, LLC received four samples collected in duplicate on 11/14/17.

In accordance with your instructions, Element Materials Technology Scott conducted the following analysis on samples submitted by your company. Unless otherwise noted, all analyses were conducted using industry approved methods, and all test results meet the requirements of TNI. All relevant sampling information can be found on the attached Chain of Custody Form.

Any deviation from the test method (such as failed QC or modification(s) made to the test procedure) or any other anomalies associated with the sample will be addressed in a case narrative. Any other exceptions with this report either will be footnoted in the results page(s) or the QC summary page(s).

Estimated uncertainty is available upon request. This report shall not be reproduced except in full, without the written approval of the laboratory.

Below is a list of LDEQ accredited components by GPA 2286-95. Any other component listed in the report is not part of the laboratory scope of accreditation.

Accredited Components (LELAP Certification No.:05034):

2-Methylbutane(Isopentane), methylpropane (Isobutane), BTEX in Natural Gas, Benzene, Calculated Gross BTU/Cubic Feet (Dry Basis), Calculated Gross BTU/Cubic Feet (Saturated Basis), Calculated Molecular Weight, Carbon dioxide, Compressibility Factor, Cyclohexane, Ethane, Ethylbenzene, GPM (in psia@60 F), Heat of combustion (btu), Heptanes Plus, Hexanes, Hexanes plus, Iso-Decanes, Iso-Heptanes, Iso-Hexanes, Iso-Nonanes, Iso-Octanes, Methane, Nitrogen, Propane, Relative Density, Toluene, Xylene (total), m-Xylene, n-Butane, n-Decane, n-Heptane, n-Hexane, n-Nonane, n-Octane, n-Pentane, o-Xylene, and p-Xylene.

If you have any questions regarding these test results, please feel free to call.

Tina Venable  
Customer Service Representative  
Element Materials Technology  
2129 West Willow Street  
Scott, LA 70583

Mark Moore  
Approach Environmental  
151 Freestate BLVD  
Suite B  
Shreveport, La 71107

Date: 11/14/17  
Report Number: 235789  
RE: Certified Analysis

### Case Narrative

The laboratory performed accredited analysis in accordance with SOP PCH ORG 2286 (BTEX and Extended Ranges in Natural Gas & BTU Determination for State Accredited Analysis), current revision. Prior to sample analysis, the laboratory analyzes Quality Control (QC) checks which must meet method acceptance criteria from GPA 2261, current revision. A sample duplicate analysis also is performed per batch for BTEX components by GPA 2286-95 and assessed against laboratory-derived acceptance criteria for repeatability given sufficient sample pressure and volume are available. Where sample pressure, volume or content prevents the successful analysis of duplicate samples, the laboratory will use duplicate Quality Control checks to demonstrate control of the laboratory's analytical system. Quality Control data is not included in this report but is available upon request.

Laboratory and sample-related exceptions that may impact the validity of data will be discussed in the exceptions section of this case narrative. Sample related QC exceptions also may be flagged on the report page(s). End users should consider QC exceptions when evaluating sample data against data quality objectives.

#### Exceptions:

All samples, except the following, from this workorder were within the laboratory's internal QC limits for closure:

Sample 235789-7 (Wanamaker #1) did not meet the laboratory's QC closure criteria most likely due to insufficient sample volume. The laboratory attempted analysis on both the primary and backup sample volumes. Upon notification, the client instructed the laboratory to narrate the exception and indicate the client will collect and submit a new sample for this fraction.

The batch sample duplicate analysis did not meet the laboratory's internal repeatability criteria for the C6+ components. This is most likely attributed to a rich sample. Dew point and temperature information also was not available for this sample. The laboratory used duplicate Quality Control checks to demonstrate repeatability and control of the laboratory's analytical system. The duplicate QC checks were within accepting limits.



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Gas Analysis Report No: 235789-5 -6

Reported Date: 11/29/2017

For: APPROACH ENVIRONMENTAL

Attn: MARK MOORE  
151 FREESTATE BLVD  
SUITE B  
SHREVEPORT, LA 71107

Sample Identification:

Company: APPROACH ENVIRONMENTAL

Field: BETHANY LONGSTREET

Lease: CV RA SUYY

STA # : MARY BELLE SMITH 28 #  
2-ALT

Sample Data: Date Collected: 10/09/2017 09:30 AM  
PSIG: 500

Date Received: 11/14/2017 By: JOHN MAGGIO  
Temp: N/P DEG. F.

Remarks:

CYL # 2033E

Sample Type: SPOT

Analyst: GG

Hydrocarbon Analysis - GPA 2261-13

Component Name		Mol Percent	GPM @ 14.730 PSIA
Carbon Dioxide	(CO2)	1.968	
Nitrogen	(N2)	0.059	
Methane	(C1)	91.909	
Ethane	(C2)	3.649	0.978
Propane	(C3)	0.970	0.268
Iso-Butane	(IC4)	0.260	0.085
N-Butane	(NC4)	0.275	0.087
Iso-Pentane	(IC5)	0.173	0.064
N-Pentane	(NC5)	0.096	0.035
Hexanes Plus	(C6+)	0.641	0.288
Total		100.000	

Mol Weight: 18.28  
BTU/LB: 22413.65

Ethane + GPM: 1.805  
Propane + GPM: 0.827  
Iso-Pentane + GPM: 0.387

Compressibility Factor: 0.9974  
Specific Gravity @ 60 Deg. F. (Air = 1) : 0.632

BTU/Cuft. (Real) 60 Deg. F. - PSIA:	14.650	14.696	14.730	15.025
Dry:	1079.0	1082.4	1084.9	1106.7
Sat:	1060.5	1063.9	1066.4	1087.8

Reviewed By:

  
Tina Venable, Customer Service Representative

Data Reviewer

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2129 W. Willow St. Scott, LA 70583 337-232-3568



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**Gas Analysis Report No:** 235789

235789-5 -22

**Date:** 11/29/2017

**For:** APPROACH ENVIRONMENTAL

Attn: MARK MOORE  
151 FREESTATE BLVD  
SUITE B  
SHREVEPORT, LA 71107

**Sample Identification:**  
**Company:** APPROACH ENVIRONMENTAL  
**Field:** BETHANY LONGSTREET  
**Lease:** CV RA SUYY

**STA # :** MARY BELLE SMITH 28 #2-ALT

**235789-5**

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
METHANE	0.0000	0.0000
ETHANE	0.0000	0.0000
PROPANE	0.0000	0.0000
ISO-BUTANE	0.0000	0.0000
N-BUTANE	0.0000	0.0000
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.0000	0.0000
ISOPENTANE	0.0000	0.0000
N-PENTANE	0.0000	0.0000
2,2-DIMETHYLBUTANE (NEOHEXANE)	0.0121	0.0547
2,3-DIMETHYLBUTANE CYCLOPENTANE	0.0177	0.0727
2-METHYLPENTANE	0.0472	0.2138
3-METHYLPENTANE	0.0283	0.1282
N-HEXANE	0.0477	0.2159
2,2-DIMETHYLPENTANE	0.0041	0.0218
METHYLCYCLOPENTANE	0.0175	0.0774
2,4-DIMETHYLPENTANE	0.0046	0.0241
2,2,3-TRIMETHYLBUTANE	0.0015	0.0077
BENZENE	0.0198	0.0814
3,3-DIMETHYLPENTANE	0.0022	0.0118
CYCLOHEXANE	0.0197	0.0869
2-METHYLHEXANE	0.0219	0.1152
2,3-DIMETHYLPENTANE	0.0059	0.0308
1,1-DIMETHYLCYCLOPENTANE 3-METHYLHEXANE	0.0227	0.1189

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
1,i3-DIMETHYLCYCLOPENTANE	0.0022	0.0113
1,c3-DIMETHYLCYCLOPENTANE 3-ETHYLPENTANE	0.0034	0.0176
1,i2-DIMETHYLCYCLOPENTANE 2,2,4-TRIMETHYLPENTANE	0.0032	0.0165
N-HEPTANE	0.0338	0.1779
METHYLCYCLOHEXANE 1,1,3-TRIMETHYLCYCLOPENTANE	0.0318	0.1664
2,2-DIMETHYLHEXANE		
1,C2-DIMETHYLCYCLOPENTANE	0.0009	0.0048
2,5-DIMETHYLHEXANE	0.0034	0.0202
2,4-DIMETHYLHEXANE 2,2,3-TRIMETHYLPENTANE	0.0056	0.0304
ETHYLCYCLOPENTANE		
1,i2,c4-TRIMETHYLCYCLOPENTANE 3,3-DIMETHYLHEXANE	0.0021	0.0122
1,i2,C3-TRIMETHYLCYCLOPENTANE	0.0005	0.0027
2,3,4-TRIMETHYLPENTANE	0.0001	0.0007
TOLUENE	0.0511	0.2473
2,3-DIMETHYLHEXANE	0.0023	0.0139
1,1,2-TRIMETHYLCYCLOPENTANE	0.0002	0.0013
2-METHYLHEPTANE	0.0154	0.0921
4-METHYLHEPTANE	0.0052	0.0314
3,4-DIMETHYLHEXANE	0.0007	0.0040
3-METHYLHEPTANE 3-ETHYLHEXANE	0.0157	0.0943
1,c3-DIMETHYLCYCLOHEXANE 1,c2,i3-TRIMETHYLCYCLOPENTANE	0.0044	0.0261
1,c2,i4-TRIMETHYLCYCLOPENTANE		
1,i4-DIMETHYLCYCLOHEXANE	0.0019	0.0113
2,2,5-TRIMETHYLHEXANE	0.0005	0.0032
1,1-DIMETHYLCYCLOHEXANE 1,methyl-i3-ETHYLCYCLOPENTANE	0.0012	0.0071
1-methyl-C3-ETHYLCYCLOPENTANE	0.0001	0.0009
1-methyl-i2-ETHYLCYCLOPENTANE 2,2,4-TRIMETHYLHEXANE	0.0002	0.0016
1-methyl-1-ETHYLCYCLOPENTANE CYCLOHEPTANE	0.0279	0.1674
N-OCTANE		
1,T2-DIMETHYLCYCLOCHEXANE	0.0018	0.0104
UNKNOWN	0.0001	0.0007
1,i3-DIMETHYLCYCLOHEXANE 1,c4-DIMETHYLCYCLOHEXANE	0.0012	0.0071
1,c2,c3-TRIMETHYLCYCLOPENTANE		
2,4,4-TRIMETHYLHEXANE	0.0000	0.0001
ISOPROPYLCYCLOPENTANE	0.0001	0.0006

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
UNKNOWN	0.0000	0.0000
2,2-DIMETHYLHEPTANE	0.0003	0.0018
2,4-DIMETHYLHEPTANE	0.0018	0.0115
1-methyl-c2-ETHYLCYCLOPENTANE		
2,2,3-TRIMETHYLHEXANE	0.0002	0.0016
1,c2-DIMETHYLCYCLOHEXANE	0.0030	0.0179
2,6-DIMETHYLHEPTANE		
N-PROPYLCYCLOPENTANE	0.0005	0.0031
1,c3,c5-TRIMETHYLCYCLOHEXANE		
2,5-DIMETHYLHEPTANE	0.0087	0.0523
3,5-DIMETHYLHEPTANE		
ETHYLCYCLOHEXANE		
1,1,3-TRIMETHYLCYCLOHEXANE	0.0008	0.0053
2,3,3-TRIMETHYLHEXANE		
3,3-DIMETHYLHEPTANE		
1,1,4-TRIMETHYLCYCLOHEXANE	0.0003	0.0019
UNKNOWN	0.0001	0.0004
2,3,4-TRIMETHYLHEXANE	0.0002	0.0015
ETHYLBENZENE	0.0032	0.0178
1,t2,t4-TRIMETHYLCYCLOHEXANE	0.0020	0.0133
1,c3,t5-TRIMETHYLCYCLOHEXANE		
2,3-DIMETHYLHEPTANE		
M-XYLENE	0.0476	0.2661
P-XYLENE		
3,4-DIMETHYLHEPTANE		
2-METHYLOCTANE	0.0088	0.0592
4-METHYLOCTANE		
UNKNOWN	0.0000	0.0000
3-METHYLOCTANE	0.0002	0.0010
UNKNOWN	0.0003	0.0020
1,t2,c3-TRIMETHYLCYCLOHEXANE	0.0004	0.0027
1,t2,c4-TRIMETHYLCYCLOHEXANE		
O-XYLENE	0.0077	0.0429
1,1,2-TRIMETHYLCYCLOHEXANE	0.0012	0.0083
UNKNOWN	0.0000	0.0000
ISOBUTYLCYCLOPENTANE	0.0006	0.0037
N-NONANE	0.0200	0.1346
UNKNOWN	0.0000	0.0000
1,c2,c3-TRIMETHYLCYCLOHEXANE	0.0000	0.0003
1,c2,t3-TRIMETHYLCYCLOHEXANE		
UNKNOWN	0.0000	0.0000
ISOPROPYLBENZENE	0.0007	0.0045
2,2-DIMETHYLOCTANE	0.0010	0.0071
ISOPROPYLCYCLOHEXANE	0.0023	0.0145
CYCLOOCTANE		
UNKNOWN	0.0003	0.0018

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
N-BUTYLCYCLOPENTANE	0.0027	0.0177
N-PROPYLCYCLOHEXANE		
3,3-DIMETHYLOCTANE	0.0002	0.0017
UNKNOWN	0.0000	0.0000
N-PROPYLBENZENE	0.0041	0.0261
UNKNOWN	0.0004	0.0031
M-ETHYLTOLUENE	0.0014	0.0090
P-ETHYLTOLUENE	0.0042	0.0268
2,3-DIMETHYLOCTANE		
4-METHYLNONANE	0.0008	0.0053
5-METHYLNONANE		
1,3,5-TRIMETHYLBENZENE		
2-METHYLNONANE	0.0010	0.0077
3-ETHYLOCTANE	0.0065	0.0489
O-ETHYLTOLUENE	0.0006	0.0043
3-METHYLNONANE		
UNKNOWN	0.0023	0.0160
1,2,4-TRIMETHYLBENZENE	0.0005	0.0035
t-BUTYLBENZENE		
METHYLCYCLOOCTANE		
tert-BUTYLCYCLOHEXANE	0.0024	0.0179
ISO-BUTYLCYCLOHEXANE	0.0004	0.0033
N-DECANE	0.0053	0.0393
ISOBUTYLBENZENE	0.0005	0.0033
sec-BUTYLBENZENE	0.0004	0.0025
UNKNOWN	0.0000	0.0000
1-METHYL-3-ISOPROPYLBENZENE	0.0006	0.0042
1,2,3-TRIMETHYLBENZENE	0.0008	0.0055
1-METHYL-4-ISOPROPYLBENZENE		
UNKNOWN	0.0000	0.0000
1-METHYL-2-ISOPROPYLBENZENE	0.0004	0.0031
UNKNOWN	0.0003	0.0023
N-BUTYLCYCLOHEXANE	0.0005	0.0037
UNKNOWN	0.0000	0.0000
1,3-DIETHYLBENZENE	0.0003	0.0023
1-METHYL-3-PROPYLBENZENE		
1,2-DIETHYLBENZENE	0.0004	0.0030
N-BUTYLBENZENE		
1-METHYL-4-PROPYLBENZENE		
1,4-DIETHYLBENZENE	0.0002	0.0014
1-METHYL-2-PROPYLBENZENE	0.0003	0.0020
1,4-DIMETHYL-2-ETHYLBENZENE	0.0002	0.0014
UNKNOWN	0.0000	0.0003



**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
1,2-DIMETHYL-4-ETHYLBENZENE	0.0000	0.0003
1,3-DIMETHYL-2-ETHYLBENZENE	0.0000	0.0002
UNKNOWN	0.0000	0.0000
1,2-DIMETHYL-3-ETHYLBENZENE	0.0000	0.0002
UNKNOWN	0.0000	0.0000
N-UNDECANE	0.0004	0.0030
UNKNOWN	0.0001	0.0007
1,2,4,5-TETRAMETHYLBENZENE	0.0000	0.0002
1,2,3,5-TETRAMETHYLBENZENE	0.0000	0.0002
UNKNOWN	0.0000	0.0000
1,2,3,4-TETRAMETHYLBENZENE	0.0000	0.0003
CYCLODECANE		
UNKNOWN	0.0000	0.0001
NAPHTHALENE	0.0001	0.0005
N-DODECANE	0.0000	0.0002
ISOTRIDECANES PLUS	0.0000	0.0000
<b>Total:</b>	<b>0.6410</b>	<b>3.3916</b>

TOTAL HEXANES	0.1532	0.6853
TOTAL HEPTANES	0.1625	0.7995
TOTAL OCTANES	0.1731	0.9496
TOTAL NONANES	0.1092	0.6576
TOTAL DECANES PLUS	0.0430	0.2996

**BTEX COMPONENTS**

N-HEXANE	0.0477	0.2159
BENZENE	0.0198	0.0814
TOLUENE	0.0511	0.2473
ETHYLBENZENE	0.0032	0.0178
XYLENE	0.0553	0.3090



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235789-5

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
METHANE	0.000	0.000
ETHANE	0.000	0.000
PROPANE	0.000	0.000
ISO-BUTANE	0.000	0.000
N-BUTANE	0.000	0.000
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.000	0.000
ISOPENTANE	0.000	0.000
N-PENTANE	0.000	0.000
2,2-DIMETHYLBUTANE (NEOHEXANE)	1.887	1.614
2,3-DIMETHYLBUTANE	2.764	2.143
CYCLOPENTANE		
2-METHYLPENTANE	7.371	6.303
3-METHYLPENTANE	4.422	3.781
N-HEXANE	7.446	6.366
2,2-DIMETHYLPENTANE	0.647	0.643
METHYLCYCLOPENTANE	2.735	2.283
2,4-DIMETHYLPENTANE	0.715	0.711
2,2,3-TRIMETHYLBUTANE	0.229	0.228
BENZENE	3.096	2.399
3,3-DIMETHYLPENTANE	0.349	0.347
CYCLOHEXANE	3.070	2.563
2-METHYLHEXANE	3.416	3.396
2,3-DIMETHYLPENTANE	0.914	0.909
1,1-DIMETHYLCYCLOPENTANE	3.535	3.507
3-METHYLHEXANE		
1,1,3-DIMETHYLCYCLOPENTANE	0.341	0.332
1,3-DIMETHYLCYCLOPENTANE	0.533	0.520
3-ETHYLPENTANE		
1,2-DIMETHYLCYCLOPENTANE	0.492	0.487
2,2,4-TRIMETHYLPENTANE		
N-HEPTANE	5.276	5.245
METHYLCYCLOHEXANE	4.961	4.905
1,1,3-TRIMETHYLCYCLOPENTANE		

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
2,2-DIMETHYLHEXANE		
1,C2-DIMETHYLCYCLOPENTANE	0.146	0.143
2,5-DIMETHYLHEXANE	0.527	0.597
2,4-DIMETHYLHEXANE	0.878	0.898
2,2,3-TRIMETHYLPENTANE		
ETHYLCYCLOPENTANE		
1,t2,c4-TRIMETHYLCYCLOPENTANE	0.324	0.361
3,3-DIMETHYLHEXANE		
1,t2,C3-TRIMETHYLCYCLOPENTANE	0.072	0.080
2,3,4-TRIMETHYLPENTANE	0.018	0.021
TOLUENE	7.976	7.291
2,3-DIMETHYLHEXANE	0.361	0.409
1,1,2-TRIMETHYLCYCLOPENTANE	0.033	0.037
2-METHYLHEPTANE	2.396	2.715
4-METHYLHEPTANE	0.816	0.925
3,4-DIMETHYLHEXANE	0.103	0.117
3-METHYLHEPTANE	2.454	2.781
3-ETHYLHEXANE		
1,c3-DIMETHYLCYCLOHEXANE	0.692	0.770
1,c2,t3-TRIMETHYLCYCLOPENTANE		
1,c2,t4-TRIMETHYLCYCLOPENTANE		
1,t4-DIMETHYLCYCLOHEXANE	0.299	0.332
2,2,5-TRIMETHYLHEXANE	0.075	0.095
1,1-DIMETHYLCYCLOHEXANE	0.187	0.208
1,methyl-t3-ETHYLCYCLOPENTANE		
1-methyl-C3-ETHYLCYCLOPENTANE	0.023	0.026
1-methyl-t2-ETHYLCYCLOPENTANE	0.039	0.046
2,2,4-TRIMETHYLHEXANE		
1-methyl-1-ETHYLCYCLOPENTANE	4.355	4.935
CYCLOHEPTANE		
N-OCTANE		
1,T2-DIMETHYLCYCLOCHEXANE	0.275	0.307
UNKNOWN	0.015	0.019
1,t3-DIMETHYLCYCLOHEXANE	0.189	0.210
1,c4-DIMETHYLCYCLOHEXANE		
1,c2,c3-TRIMETHYLCYCLOPENTANE		
2,4,4-TRIMETHYLHEXANE	0.002	0.003
ISOPROPYLCYCLOPENTANE	0.015	0.016
UNKNOWN	0.000	0.000
2,2-DIMETHYLHEPTANE	0.042	0.053
2,4-DIMETHYLHEPTANE	0.285	0.340
1-methyl-c2-ETHYLCYCLOPENTANE		
2,2,3-TRIMETHYLHEXANE	0.037	0.047

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
1,c2-DIMETHYLCYCLOHEXANE	0.461	0.528
2,6-DIMETHYLHEPTANE		
N-PROPYLCYCLOPENTANE	0.078	0.092
1,c3,c5-TRIMETHYLCYCLOHEXANE		
2,5-DIMETHYLHEPTANE	1.364	1.541
3,5-DIMETHYLHEPTANE		
ETHYLCYCLOHEXANE		
1,1,3-TRIMETHYLCYCLOHEXANE	0.124	0.157
2,3,3-TRIMETHYLHEXANE		
3,3-DIMETHYLHEPTANE		
1,1,4-TRIMETHYLCYCLOHEXANE	0.044	0.055
UNKNOWN	0.009	0.011
2,3,4-TRIMETHYLHEXANE	0.035	0.044
ETHYLBENZENE	0.500	0.526
1,t2,t4-TRIMETHYLCYCLOHEXANE	0.314	0.393
1,c3,t5-TRIMETHYLCYCLOHEXANE		
2,3-DIMETHYLHEPTANE		
M-XYLENE	7.418	7.846
P-XYLENE		
3,4-DIMETHYLHEPTANE		
2-METHYLOCTANE	1.372	1.746
4-METHYLOCTANE		
UNKNOWN	0.000	0.000
3-METHYLOCTANE	0.024	0.031
UNKNOWN	0.042	0.059
1,t2,c3-TRIMETHYLCYCLOHEXANE	0.064	0.080
1,t2,c4-TRIMETHYLCYCLOHEXANE		
O-XYLENE	1.202	1.266
1,1,2-TRIMETHYLCYCLOHEXANE	0.195	0.244
UNKNOWN	0.000	0.000
ISOBUTYLCYCLOPENTANE	0.088	0.110
N-NONANE	3.119	3.969
UNKNOWN	0.000	0.000
1,c2,c3-TRIMETHYLCYCLOHEXANE	0.007	0.009
1,c2,t3-TRIMETHYLCYCLOHEXANE		
UNKNOWN	0.000	0.000
ISOPROPYLBENZENE	0.110	0.131
2,2-DIMETHYLOCTANE	0.148	0.209
ISOPROPYLCYCLOHEXANE	0.362	0.429
CYCLOOCTANE		
UNKNOWN	0.039	0.052
N-BUTYLCYCLOPENTANE	0.417	0.522
N-PROPYLCYCLOHEXANE		
3,3-DIMETHYLOCTANE	0.035	0.049

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
UNKNOWN	0.000	0.000
N-PROPYLBENZENE	0.645	0.769
UNKNOWN	0.068	0.090
M-ETHYLTOLUENE	0.222	0.265
P-ETHYLTOLUENE	0.661	0.789
2,3-DIMETHYLOCTANE		
4-METHYLNONANE	0.122	0.156
5-METHYLNONANE		
1,3,5-TRIMETHYLBENZENE		
2-METHYLNONANE	0.160	0.226
3-ETHYLOCTANE	1.022	1.442
O-ETHYLTOLUENE	0.097	0.126
3-METHYLNONANE		
UNKNOWN	0.353	0.471
1,2,4-TRIMETHYLBENZENE	0.083	0.103
t-BUTYLBENZENE		
METHYLCYCLOOCTANE		
tert-BUTYLCYCLOHEXANE	0.380	0.528
ISO-BUTYLCYCLOHEXANE	0.069	0.096
N-DECANE	0.820	1.158
ISOBUTYLBENZENE	0.074	0.098
sec-BUTYLBENZENE	0.055	0.074
UNKNOWN	0.000	0.000
1-METHYL-3-ISOPROPYLBENZENE	0.093	0.124
1,2,3-TRIMETHYLBENZENE	0.131	0.162
1-METHYL-4-ISOPROPYLBENZENE		
UNKNOWN	0.000	0.000
1-METHYL-2-ISOPROPYLBENZENE	0.068	0.090
UNKNOWN	0.043	0.067
N-BUTYLCYCLOHEXANE	0.079	0.110
UNKNOWN	0.000	0.000
1,3-DIETHYLBENZENE	0.052	0.069
1-METHYL-3-PROPYLBENZENE		
1,2-DIETHYLBENZENE	0.065	0.087
N-BUTYLBENZENE		
1-METHYL-4-PROPYLBENZENE		
1,4-DIETHYLBENZENE	0.030	0.040
1-METHYL-2-PROPYLBENZENE	0.044	0.058
1,4-DIMETHYL-2-ETHYLBENZENE	0.032	0.042
UNKNOWN	0.005	0.008
1,2-DIMETHYL-4-ETHYLBENZENE	0.007	0.009

**CAPILLARY ANALYSIS - METHOD GPA 2286-95  
HEAVY END FRACTION**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
1,3-DIMETHYL-2-ETHYLBENZENE	0.005	0.006
UNKNOWN	0.000	0.000
1,2-DIMETHYL-3-ETHYLBENZENE	0.005	0.007
UNKNOWN	0.000	0.000
N-UNDECANE	0.058	0.089
UNKNOWN	0.012	0.019
1,2,4,5-TETRAMETHYLBENZENE	0.005	0.007
1,2,3,5-TETRAMETHYLBENZENE	0.005	0.006
UNKNOWN	0.001	0.001
1,2,3,4-TETRAMETHYLBENZENE	0.007	0.009
CYCLODECANE		
UNKNOWN	0.002	0.004
NAPHTHALENE	0.012	0.015
N-DODECANE	0.004	0.007
ISOTRIDECANES PLUS	0.000	0.000
<b>Total:</b>	<b>100.000</b>	<b>100.000</b>

<b>Specific Gravity @ 60 Deg. F. (Air = 1)</b>	3.4662
<b>Molecular Weight</b>	100.87
<b>Compressibility Factor</b>	0.8287
<b>Summation Factor</b>	0.1080
<b>Cu. Ft. Vapor/Gal @ 14.696 &amp; 60 Deg. F.</b>	23.968
<b>Cu. Ft. Vapor/Gal @ 14.730 &amp; 60 Deg. F.</b>	23.913
<b>Cu. Ft. Vapor/Gal @ 14.650 &amp; 60 Deg. F.</b>	24.044
<b>Btu/cu. Ft. @ 14.696 PSIA, Dry</b>	5359.87
<b>Btu/cu. Ft. @ 14.730 PSIA, Dry</b>	5372.27
<b>BTU/LB</b>	20188



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Gas Analysis Report No: 235789-6 -6

Reported Date: 11/29/2017

For: APPROACH ENVIRONMENTAL

Attn: MARK MOORE  
151 FREESTATE BLVD  
SUITE B  
SHREVEPORT, LA 71107

Sample Identification:

Company: APPROACH ENVIRONMENTAL

Field: BETHANY LONGSTREET

Lease: HOSS RA SU60

STA # : SAMPSON EST 33 #1

Sample Data: Date Collected: 11/09/2017 01:55 PM Date Received: 11/14/2017 By: JOHN MAGGIO  
PSIG: 330 Temp: N/P DEG. F.

Remarks:

CYL # 10396

Sample Type: SPOT

Analyst: GG

Hydrocarbon Analysis - GPA 2261-13

Component Name		Mol Percent	GPM @ 14.730 PSIA
Carbon Dioxide	(CO2)	0.906	
Nitrogen	(N2)	2.607	
Methane	(C1)	95.811	
Ethane	(C2)	0.380	0.102
Propane	(C3)	0.032	0.009
Iso-Butane	(IC4)	0.014	0.005
N-Butane	(NC4)	0.018	0.006
Iso-Pentane	(IC5)	0.006	0.002
N-Pentane	(NC5)	0.012	0.004
Hexanes Plus	(C6+)	0.214	0.098
Total		100.000	

Mol Weight: 16.87

BTU/LB: 22236.61

Ethane + GPM: 0.226

Propane + GPM: 0.124

Iso-Pentane + GPM: 0.104

Compressibility Factor: 0.9980

Specific Gravity @ 60 Deg. F. (Air = 1) : 0.583

BTU/Cuft. (Real) 60 Deg. F. - PSIA:	14.650	14.696	14.730	15.025
Dry:	987.5	990.6	992.9	1012.8
Sat:	970.6	973.6	975.9	995.5

Reviewed By:

  
Tina Venable, Customer Service Representative

Data Reviewer

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Gas Analysis Report No: 235789

235789-6 -22

Date: 11/29/2017

For: APPROACH ENVIRONMENTAL

Attn: MARK MOORE  
151 FREESTATE BLVD  
SUITE B  
SHREVEPORT, LA 71107

Sample Identification:

Company: APPROACH ENVIRONMENTAL

Field: BETHANY LONGSTREET

Lease: HOSS RA SU60

STA # : SAMPSON EST 33 #1

235789-6

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
METHANE	0.0000	0.0000
ETHANE	0.0000	0.0000
PROPANE	0.0000	0.0000
ISO-BUTANE	0.0000	0.0000
N-BUTANE	0.0000	0.0000
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.0000	0.0000
ISOPENTANE	0.0000	0.0000
N-PENTANE	0.0000	0.0000
2,2-DIMETHYLBUTANE (NEOHEXANE)	0.0049	0.0228
2,3-DIMETHYLBUTANE	0.0012	0.0049
CYCLOPENTANE		
2-METHYLPENTANE	0.0048	0.0224
3-METHYLPENTANE	0.0025	0.0114
N-HEXANE	0.0119	0.0549
2,2-DIMETHYLPENTANE	0.0017	0.0090
METHYLCYCLOPENTANE	0.0003	0.0014
2,4-DIMETHYLPENTANE	0.0009	0.0050
2,2,3-TRIMETHYLBUTANE	0.0003	0.0016
BENZENE	0.0223	0.0935
3,3-DIMETHYLPENTANE	0.0012	0.0062
CYCLOHEXANE	0.0011	0.0050
2-METHYLHEXANE	0.0051	0.0272
2,3-DIMETHYLPENTANE	0.0010	0.0056
1,1-DIMETHYLCYCLOPENTANE	0.0051	0.0275
3-METHYLHEXANE		



**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
1,i3-DIMETHYLCYCLOPENTANE	0.0001	0.0005
1,c3-DIMETHYLCYCLOPENTANE 3-ETHYLPENTANE	0.0004	0.0022
1,i2-DIMETHYLCYCLOPENTANE 2,2,4-TRIMETHYLPENTANE	0.0002	0.0012
N-HEPTANE	0.0165	0.0890
METHYLCYCLOHEXANE 1,1,3-TRIMETHYLCYCLOPENTANE 2,2-DIMETHYLHEXANE	0.0015	0.0082
1,C2-DIMETHYLCYCLOPENTANE	0.0002	0.0011
2,5-DIMETHYLHEXANE	0.0013	0.0081
2,4-DIMETHYLHEXANE 2,2,3-TRIMETHYLPENTANE ETHYLCYCLOPENTANE	0.0018	0.0101
1,i2,c4-TRIMETHYLCYCLOPENTANE 3,3-DIMETHYLHEXANE	0.0010	0.0057
1,i2,C3-TRIMETHYLCYCLOPENTANE	0.0002	0.0010
2,3,4-TRIMETHYLPENTANE	0.0001	0.0004
TOLUENE	0.0006	0.0029
2,3-DIMETHYLHEXANE	0.0008	0.0048
1,1,2-TRIMETHYLCYCLOPENTANE	0.0001	0.0004
2-METHYLHEPTANE	0.0082	0.0501
4-METHYLHEPTANE	0.0027	0.0165
3,4-DIMETHYLHEXANE	0.0002	0.0014
3-METHYLHEPTANE 3-ETHYLHEXANE	0.0068	0.0419
1,c3-DIMETHYLCYCLOHEXANE 1,c2,i3-TRIMETHYLCYCLOPENTANE 1,c2,i4-TRIMETHYLCYCLOPENTANE	0.0003	0.0020
1,i4-DIMETHYLCYCLOHEXANE	0.0002	0.0010
2,2,5-TRIMETHYLHEXANE	0.0003	0.0022
1,1-DIMETHYLCYCLOHEXANE 1,methyl-i3-ETHYLCYCLOPENTANE	0.0004	0.0022
1-methyl-C3-ETHYLCYCLOPENTANE	0.0000	0.0001
1-methyl-i2-ETHYLCYCLOPENTANE 2,2,4-TRIMETHYLHEXANE	0.0001	0.0005
1-methyl-1-ETHYLCYCLOPENTANE CYCLOHEPTANE	0.0205	0.1260
N-OCTANE		
1,T2-DIMETHYLCYCLOCHEXANE	0.0002	0.0014
UNKNOWN	0.0001	0.0005
1,i3-DIMETHYLCYCLOHEXANE 1,c4-DIMETHYLCYCLOHEXANE 1,c2,c3-TRIMETHYLCYCLOPENTANE	0.0001	0.0006
2,4,4-TRIMETHYLHEXANE	0.0000	0.0001
ISOPROPYLCYCLOPENTANE	0.0000	0.0002

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
UNKNOWN	0.0002	0.0012
2,2-DIMETHYLHEPTANE	0.0012	0.0086
2,4-DIMETHYLHEPTANE	0.0015	0.0098
1-methyl-c2-ETHYLCYCLOPENTANE		
2,2,3-TRIMETHYLHEXANE	0.0002	0.0013
1,c2-DIMETHYLCYCLOHEXANE	0.0034	0.0210
2,6-DIMETHYLHEPTANE		
N-PROPYLCYCLOPENTANE	0.0001	0.0006
1,c3,c5-TRIMETHYLCYCLOHEXANE		
2,5-DIMETHYLHEPTANE	0.0043	0.0265
3,5-DIMETHYLHEPTANE		
ETHYLCYCLOHEXANE		
1,1,3-TRIMETHYLCYCLOHEXANE	0.0007	0.0047
2,3,3-TRIMETHYLHEXANE		
3,3-DIMETHYLHEPTANE		
1,1,4-TRIMETHYLCYCLOHEXANE	0.0002	0.0011
UNKNOWN	0.0000	0.0002
2,3,4-TRIMETHYLHEXANE	0.0002	0.0011
ETHYLBENZENE	0.0018	0.0103
1,12,14-TRIMETHYLCYCLOHEXANE	0.0012	0.0084
1,c3,t5-TRIMETHYLCYCLOHEXANE		
2,3-DIMETHYLHEPTANE		
M-XYLENE	0.0117	0.0669
P-XYLENE		
3,4-DIMETHYLHEPTANE		
2-METHYLOCTANE	0.0062	0.0426
4-METHYLOCTANE		
UNKNOWN	0.0000	0.0000
3-METHYLOCTANE	0.0002	0.0012
UNKNOWN	0.0000	0.0000
1,12,c3-TRIMETHYLCYCLOHEXANE	0.0004	0.0024
1,12,c4-TRIMETHYLCYCLOHEXANE		
O-XYLENE	0.0001	0.0007
1,1,2-TRIMETHYLCYCLOHEXANE	0.0003	0.0020
UNKNOWN	0.0000	0.0000
ISOBUTYLCYCLOPENTANE	0.0002	0.0011
N-NONANE	0.0207	0.1423
UNKNOWN	0.0002	0.0016
1,c2,c3-TRIMETHYLCYCLOHEXANE	0.0000	0.0003
1,c2,t3-TRIMETHYLCYCLOHEXANE		
UNKNOWN	0.0000	0.0000
ISOPROPYLBENZENE	0.0001	0.0008
2,2-DIMETHYLOCTANE	0.0007	0.0053
ISOPROPYLCYCLOHEXANE	0.0023	0.0150
CYCLOOCTANE		
UNKNOWN	0.0004	0.0026

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
N-BUTYLCYCLOPENTANE	0.0027	0.0180
N-PROPYLCYCLOHEXANE		
3,3-DIMETHYLOCTANE	0.0003	0.0022
UNKNOWN	0.0000	0.0000
N-PROPYLBENZENE	0.0046	0.0299
UNKNOWN	0.0005	0.0040
M-ETHYLTOLUENE	0.0005	0.0031
P-ETHYLTOLUENE	0.0020	0.0131
2,3-DIMETHYLOCTANE		
4-METHYLNONANE	0.0010	0.0066
5-METHYLNONANE		
1,3,5-TRIMETHYLBENZENE		
2-METHYLNONANE	0.0026	0.0196
3-ETHYLOCTANE	0.0026	0.0195
O-ETHYLTOLUENE	0.0023	0.0160
3-METHYLNONANE		
UNKNOWN	0.0001	0.0006
1,2,4-TRIMETHYLBENZENE	0.0004	0.0024
t-BUTYLBENZENE		
METHYLCYCLOOCTANE		
tert-BUTYLCYCLOHEXANE	0.0003	0.0026
ISO-BUTYLCYCLOHEXANE	0.0002	0.0017
N-DECANE	0.0042	0.0323
ISOBUTYLBENZENE	0.0001	0.0011
sec-BUTYLBENZENE	0.0001	0.0010
UNKNOWN	0.0000	0.0000
1-METHYL-3-ISOPROPYLBENZENE	0.0003	0.0018
1,2,3-TRIMETHYLBENZENE	0.0003	0.0021
1-METHYL-4-ISOPROPYLBENZENE		
UNKNOWN	0.0000	0.0000
1-METHYL-2-ISOPROPYLBENZENE	0.0004	0.0027
UNKNOWN	0.0001	0.0009
N-BUTYLCYCLOHEXANE	0.0002	0.0018
UNKNOWN	0.0000	0.0000
1,3-DIETHYLBENZENE	0.0000	0.0003
1-METHYL-3-PROPYLBENZENE		
1,2-DIETHYLBENZENE	0.0001	0.0004
N-BUTYLBENZENE		
1-METHYL-4-PROPYLBENZENE		
1,4-DIETHYLBENZENE	0.0001	0.0005
1-METHYL-2-PROPYLBENZENE	0.0001	0.0006
1,4-DIMETHYL-2-ETHYLBENZENE	0.0001	0.0005
UNKNOWN	0.0000	0.0000

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
1,2-DIMETHYL-4-ETHYLBENZENE	0.0000	0.0000
1,3-DIMETHYL-2-ETHYLBENZENE	0.0000	0.0001
UNKNOWN	0.0000	0.0000
1,2-DIMETHYL-3-ETHYLBENZENE	0.0000	0.0001
UNKNOWN	0.0000	0.0000
N-UNDECANE	0.0002	0.0013
UNKNOWN	0.0000	0.0000
1,2,4,5-TETRAMETHYLBENZENE	0.0000	0.0000
1,2,3,5-TETRAMETHYLBENZENE	0.0000	0.0001
UNKNOWN	0.0000	0.0000
1,2,3,4-TETRAMETHYLBENZENE	0.0000	0.0002
CYCLODECANE		
UNKNOWN	0.0000	0.0000
NAPHTHALENE	0.0000	0.0001
N-DODECANE	0.0000	0.0001
ISOTRIDECANES PLUS	0.0000	0.0000
<b>Total:</b>	<b>0.2140</b>	<b>1.2475</b>

TOTAL HEXANES	0.0252	0.1164
TOTAL HEPTANES	0.0563	0.2749
TOTAL OCTANES	0.0475	0.2882
TOTAL NONANES	0.0549	0.3554
TOTAL DECANES PLUS	0.0301	0.2126

**BTEX COMPONENTS**

N-HEXANE	0.0119	0.0549
BENZENE	0.0223	0.0935
TOLUENE	0.0006	0.0029
ETHYLBENZENE	0.0018	0.0103
XYLENE	0.0118	0.0675



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235789-6

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
METHANE	0.000	0.000
ETHANE	0.000	0.000
PROPANE	0.000	0.000
ISO-BUTANE	0.000	0.000
N-BUTANE	0.000	0.000
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.000	0.000
ISOPENTANE	0.000	0.000
N-PENTANE	0.000	0.000
2,2-DIMETHYLBUTANE (NEOHEXANE)	2.307	1.832
2,3-DIMETHYLBUTANE	0.547	0.394
CYCLOPENTANE		
2-METHYLPENTANE	2.264	1.797
3-METHYLPENTANE	1.147	0.911
N-HEXANE	5.543	4.400
2,2-DIMETHYLPENTANE	0.783	0.722
METHYLCYCLOPENTANE	0.144	0.112
2,4-DIMETHYLPENTANE	0.432	0.398
2,2,3-TRIMETHYLBUTANE	0.136	0.125
BENZENE	10.418	7.496
3,3-DIMETHYLPENTANE	0.539	0.498
CYCLOHEXANE	0.516	0.400
2-METHYLHEXANE	2.364	2.182
2,3-DIMETHYLPENTANE	0.490	0.453
1,1-DIMETHYLCYCLOPENTANE	2.392	2.204
3-METHYLHEXANE		
1,1,3-DIMETHYLCYCLOPENTANE	0.047	0.043
1,3-DIMETHYLCYCLOPENTANE	0.190	0.172
3-ETHYLPENTANE		
1,1,2-DIMETHYLCYCLOPENTANE	0.106	0.097
2,2,4-TRIMETHYLPENTANE		
N-HEPTANE	7.728	7.133
METHYLCYCLOHEXANE	0.720	0.661
1,1,3-TRIMETHYLCYCLOPENTANE		

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
2,2-DIMETHYLHEXANE		
1,C2-DIMETHYLCYCLOPENTANE	0.094	0.085
2,5-DIMETHYLHEXANE	0.615	0.647
2,4-DIMETHYLHEXANE	0.849	0.806
2,2,3-TRIMETHYLPENTANE		
ETHYLCYCLOPENTANE		
1,t2,c4-TRIMETHYLCYCLOPENTANE	0.445	0.460
3,3-DIMETHYLHEXANE		
1,t2,C3-TRIMETHYLCYCLOPENTANE	0.080	0.083
2,3,4-TRIMETHYLPENTANE	0.027	0.028
TOLUENE	0.278	0.236
2,3-DIMETHYLHEXANE	0.368	0.387
1,1,2-TRIMETHYLCYCLOPENTANE	0.034	0.036
2-METHYLHEPTANE	3.819	4.019
4-METHYLHEPTANE	1.260	1.326
3,4-DIMETHYLHEXANE	0.105	0.111
3-METHYLHEPTANE	3.195	3.362
3-ETHYLHEXANE		
1,c3-DIMETHYLCYCLOHEXANE	0.156	0.161
1,c2,t3-TRIMETHYLCYCLOPENTANE		
1,c2,t4-TRIMETHYLCYCLOPENTANE		
1,t4-DIMETHYLCYCLOHEXANE	0.074	0.076
2,2,5-TRIMETHYLHEXANE	0.150	0.178
1,1-DIMETHYLCYCLOHEXANE	0.174	0.180
1,methyl-t3-ETHYLCYCLOPENTANE		
1-methyl-C3-ETHYLCYCLOPENTANE	0.011	0.011
1-methyl-t2-ETHYLCYCLOPENTANE	0.034	0.038
2,2,4-TRIMETHYLHEXANE		
1-methyl-1-ETHYLCYCLOPENTANE	9.602	10.104
CYCLOHEPTANE		
N-OCTANE		
1,T2-DIMETHYLCYCLOCHEXANE	0.108	0.112
UNKNOWN	0.034	0.040
1,t3-DIMETHYLCYCLOHEXANE	0.050	0.051
1,c4-DIMETHYLCYCLOHEXANE		
1,c2,c3-TRIMETHYLCYCLOPENTANE		
2,4,4-TRIMETHYLHEXANE	0.006	0.007
ISOPROPYLCYCLOPENTANE	0.018	0.019
UNKNOWN	0.082	0.097
2,2-DIMETHYLHEPTANE	0.580	0.686
2,4-DIMETHYLHEPTANE	0.707	0.783
1-methyl-c2-ETHYLCYCLOPENTANE		
2,2,3-TRIMETHYLHEXANE	0.085	0.100

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
1,c2-DIMETHYLCYCLOHEXANE	1.585	1.685
2,6-DIMETHYLHEPTANE		
N-PROPYLCYCLOPENTANE	0.045	0.049
1,c3,c5-TRIMETHYLCYCLOHEXANE		
2,5-DIMETHYLHEPTANE	2.026	2.124
3,5-DIMETHYLHEPTANE		
ETHYLCYCLOHEXANE		
1,1,3-TRIMETHYLCYCLOHEXANE	0.324	0.379
2,3,3-TRIMETHYLHEXANE		
3,3-DIMETHYLHEPTANE		
1,1,4-TRIMETHYLCYCLOHEXANE	0.076	0.088
UNKNOWN	0.017	0.020
2,3,4-TRIMETHYLHEXANE	0.074	0.088
ETHYLBENZENE	0.840	0.822
1,t2,t4-TRIMETHYLCYCLOHEXANE	0.576	0.670
1,c3,t5-TRIMETHYLCYCLOHEXANE		
2,3-DIMETHYLHEPTANE		
M-XYLENE	5.460	5.362
P-XYLENE		
3,4-DIMETHYLHEPTANE		
2-METHYLOCTANE	2.893	3.417
4-METHYLOCTANE		
UNKNOWN	0.000	0.000
3-METHYLOCTANE	0.084	0.099
UNKNOWN	0.000	0.000
1,t2,c3-TRIMETHYLCYCLOHEXANE	0.165	0.192
1,t2,c4-TRIMETHYLCYCLOHEXANE		
O-XYLENE	0.053	0.052
1,1,2-TRIMETHYLCYCLOHEXANE	0.136	0.158
UNKNOWN	0.000	0.000
ISOBUTYLCYCLOPENTANE	0.073	0.085
N-NONANE	9.658	11.411
UNKNOWN	0.096	0.125
1,c2,c3-TRIMETHYLCYCLOHEXANE	0.019	0.022
1,c2,t3-TRIMETHYLCYCLOHEXANE		
UNKNOWN	0.000	0.000
ISOPROPYLBENZENE	0.059	0.065
2,2-DIMETHYLOCTANE	0.324	0.424
ISOPROPYLCYCLOHEXANE	1.094	1.201
CYCLOOCTANE		
UNKNOWN	0.166	0.205
N-BUTYLCYCLOPENTANE	1.241	1.443
N-PROPYLCYCLOHEXANE		
3,3-DIMETHYLOCTANE	0.133	0.175

**CAPILLARY ANALYSIS - METHOD GPA 2286-95  
HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
UNKNOWN	0.000	0.000
N-PROPYLBENZENE	2.164	2.396
UNKNOWN	0.256	0.317
M-ETHYLTOLUENE	0.222	0.246
P-ETHYLTOLUENE	0.950	1.052
2,3-DIMETHYLOCTANE		
4-METHYLNONANE	0.448	0.532
5-METHYLNONANE		
1,3,5-TRIMETHYLBENZENE		
2-METHYLNONANE	1.202	1.574
3-ETHYLOCTANE	1.193	1.564
O-ETHYLTOLUENE	1.058	1.280
3-METHYLNONANE		
UNKNOWN	0.036	0.045
1,2,4-TRIMETHYLBENZENE	0.165	0.190
t-BUTYLBENZENE		
METHYLCYCLOOCTANE		
tert-BUTYLCYCLOHEXANE	0.163	0.210
ISO-BUTYLCYCLOHEXANE	0.105	0.136
N-DECANE	1.974	2.587
ISOBUTYLBENZENE	0.069	0.086
sec-BUTYLBENZENE	0.064	0.079
UNKNOWN	0.000	0.000
1-METHYL-3-ISOPROPYLBENZENE	0.119	0.147
1,2,3-TRIMETHYLBENZENE	0.149	0.171
1-METHYL-4-ISOPROPYLBENZENE		
UNKNOWN	0.000	0.000
1-METHYL-2-ISOPROPYLBENZENE	0.175	0.216
UNKNOWN	0.048	0.069
N-BUTYLCYCLOHEXANE	0.111	0.143
UNKNOWN	0.000	0.000
1,3-DIETHYLBENZENE	0.017	0.021
1-METHYL-3-PROPYLBENZENE		
1,2-DIETHYLBENZENE	0.026	0.032
N-BUTYLBENZENE		
1-METHYL-4-PROPYLBENZENE		
1,4-DIETHYLBENZENE	0.031	0.039
1-METHYL-2-PROPYLBENZENE	0.037	0.046
1,4-DIMETHYL-2-ETHYLBENZENE	0.030	0.038
UNKNOWN	0.002	0.003
1,2-DIMETHYL-4-ETHYLBENZENE	0.003	0.003



**CAPILLARY ANALYSIS - METHOD GPA 2286-95  
HEAVY END FRACTION**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
1,3-DIMETHYL-2-ETHYLBENZENE	0.003	0.004
UNKNOWN	0.000	0.000
1,2-DIMETHYL-3-ETHYLBENZENE	0.006	0.007
UNKNOWN	0.000	0.000
N-UNDECANE	0.075	0.108
UNKNOWN	0.000	0.000
1,2,4,5-TETRAMETHYLBENZENE	0.003	0.003
1,2,3,5-TETRAMETHYLBENZENE	0.003	0.004
UNKNOWN	0.001	0.001
1,2,3,4-TETRAMETHYLBENZENE	0.011	0.014
CYCLODECANE		
UNKNOWN	0.000	0.000
NAPHTHALENE	0.008	0.009
N-DODECANE	0.003	0.005
ISOTRIDECANES PLUS	0.000	0.000
<b>Total:</b>	<b>100.000</b>	<b>100.000</b>

<b>Specific Gravity @ 60 Deg. F. (Air = 1)</b>	3.7332
<b>Molecular Weight</b>	108.62
<b>Compressibility Factor</b>	0.8082
<b>Summation Factor</b>	0.1142
<b>Cu. Ft. Vapor/Gal @ 14.696 &amp; 60 Deg. F.</b>	22.605
<b>Cu. Ft. Vapor/Gal @ 14.730 &amp; 60 Deg. F.</b>	22.553
<b>Cu. Ft. Vapor/Gal @ 14.650 &amp; 60 Deg. F.</b>	22.676
<b>Btu/cu. Ft. @ 14.696 PSIA, Dry</b>	5792.27
<b>Btu/cu. Ft. @ 14.730 PSIA, Dry</b>	5805.67
<b>BTU/LB</b>	20202



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Gas Analysis Report No: 235789-8 -6

Reported Date: 11/29/2017

For: APPROACH ENVIRONMENTAL

Attn: MARK MOORE  
151 FREESTATE BLVD  
SUITE B  
SHREVEPORT, LA 71107

Sample Identification:

Company: APPROACH ENVIRONMENTAL

Field: BETHANY LONGSTREET

Lease: P SUHH

STA #: J B BARR 28 #2

Sample Data: Date Collected: 11/09/2017 01:25 PM  
PSIG: 360

Date Received: 11/14/2017 By: JOHN MAGGIO  
Temp: N/P DEG. F.

Remarks:

CYL # 1099

Sample Type: SPOT

Analyst: GG

Hydrocarbon Analysis - GPA 2261-13

Component Name	Mol Percent	GPM @ 14.730 PSIA
Carbon Dioxide (CO2)	0.121	
Nitrogen (N2)	2.812	
Methane (C1)	93.153	
Ethane (C2)	2.376	0.637
Propane (C3)	0.773	0.213
Iso-Butane (IC4)	0.226	0.074
N-Butane (NC4)	0.243	0.077
Iso-Pentane (IC5)	0.106	0.039
N-Pentane (NC5)	0.066	0.024
Hexanes Plus (C6+)	0.124	0.054
Total	100.000	

Mol Weight: 17.35

BTU/LB: 22543.59

Ethane + GPM: 1.118

Propane + GPM: 0.481

Iso-Pentane + GPM: 0.117

Compressibility Factor: 0.9978

Specific Gravity @ 60 Deg. F. (Air = 1): 0.600

BTU/Cuft. (Real) 60 Deg. F. - PSIA:	14.650	14.696	14.730	15.025
Dry:	1029.9	1033.2	1035.6	1056.3
Sat:	1012.3	1015.5	1017.9	1038.3

Reviewed By:

  
Tina Venable, Customer Service Representative

Data Reviewer

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**Gas Analysis Report No:** 235789

235789-8 -22

**Date:** 11/29/2017

**For:** APPROACH ENVIRONMENTAL

Attn: MARK MOORE  
151 FREESTATE BLVD  
SUITE B  
SHREVEPORT, LA 71107

**Sample Identification:**

**Company:** APPROACH ENVIRONMENTAL

**Field:** BETHANY LONGSTREET

**Lease:** P SUHH

**STA # :** J B BARR 28 #2

**235789-8**

**CAPILLARY ANALYSIS - METHOD GPA 2286-95  
COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
METHANE	0.0000	0.0000
ETHANE	0.0000	0.0000
PROPANE	0.0000	0.0000
ISO-BUTANE	0.0000	0.0000
N-BUTANE	0.0000	0.0000
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.0000	0.0000
ISOPENTANE	0.0000	0.0000
N-PENTANE	0.0000	0.0000
2,2-DIMETHYLBUTANE (NEOHEXANE)	0.0067	0.0319
2,3-DIMETHYLBUTANE CYCLOPENTANE	0.0061	0.0263
2-METHYLPENTANE	0.0176	0.0840
3-METHYLPENTANE	0.0098	0.0467
N-HEXANE	0.0170	0.0813
2,2-DIMETHYLPENTANE	0.0014	0.0079
METHYLCYCLOPENTANE	0.0035	0.0161
2,4-DIMETHYLPENTANE	0.0014	0.0075
2,2,3-TRIMETHYLBUTANE	0.0005	0.0030
BENZENE	0.0019	0.0084
3,3-DIMETHYLPENTANE	0.0007	0.0037
CYCLOHEXANE	0.0036	0.0170
2-METHYLHEXANE	0.0050	0.0276
2,3-DIMETHYLPENTANE	0.0014	0.0079
1,1-DIMETHYLCYCLOPENTANE 3-METHYLHEXANE	0.0049	0.0274

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
1,t3-DIMETHYLCYCLOPENTANE	0.0003	0.0019
1,c3-DIMETHYLCYCLOPENTANE 3-ETHYLPENTANE	0.0006	0.0032
1,t2-DIMETHYLCYCLOPENTANE 2,2,4-TRIMETHYLPENTANE	0.0007	0.0037
N-HEPTANE	0.0069	0.0384
METHYLCYCLOHEXANE 1,1,3-TRIMETHYLCYCLOPENTANE	0.0038	0.0210
2,2-DIMETHYLHEXANE		
1,C2-DIMETHYLCYCLOPENTANE	0.0002	0.0009
2,5-DIMETHYLHEXANE	0.0006	0.0036
2,4-DIMETHYLHEXANE 2,2,3-TRIMETHYLPENTANE	0.0010	0.0056
ETHYLCYCLOPENTANE		
1,t2,c4-TRIMETHYLCYCLOPENTANE 3,3-DIMETHYLHEXANE	0.0004	0.0022
1,t2,C3-TRIMETHYLCYCLOPENTANE	0.0001	0.0006
2,3,4-TRIMETHYLPENTANE	0.0001	0.0003
TOLUENE	0.0009	0.0048
2,3-DIMETHYLHEXANE	0.0003	0.0020
1,1,2-TRIMETHYLCYCLOPENTANE	0.0001	0.0004
2-METHYLHEPTANE	0.0024	0.0154
4-METHYLHEPTANE	0.0007	0.0045
3,4-DIMETHYLHEXANE	0.0001	0.0006
3-METHYLHEPTANE 3-ETHYLHEXANE	0.0020	0.0128
1,c3-DIMETHYLCYCLOHEXANE 1,c2,t3-TRIMETHYLCYCLOPENTANE	0.0004	0.0025
1,c2,t4-TRIMETHYLCYCLOPENTANE		
1,t4-DIMETHYLCYCLOHEXANE	0.0002	0.0013
2,2,5-TRIMETHYLHEXANE	0.0001	0.0006
1,1-DIMETHYLCYCLOHEXANE 1,methyl-t3-ETHYLCYCLOPENTANE	0.0001	0.0009
1-methyl-C3-ETHYLCYCLOPENTANE	0.0000	0.0000
1-methyl-t2-ETHYLCYCLOPENTANE 2,2,4-TRIMETHYLHEXANE	0.0001	0.0004
1-methyl-1-ETHYLCYCLOPENTANE CYCLOHEPTANE	0.0037	0.0234
N-OCTANE		
1,T2-DIMETHYLCYCLOCHEXANE	0.0002	0.0012
UNKNOWN	0.0000	0.0001
1,t3-DIMETHYLCYCLOHEXANE 1,c4-DIMETHYLCYCLOHEXANE	0.0001	0.0006
1,c2,c3-TRIMETHYLCYCLOPENTANE		
2,4,4-TRIMETHYLHEXANE	0.0000	0.0001
ISOPROPYLCYCLOPENTANE	0.0000	0.0001

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
UNKNOWN	0.0000	0.0003
2,2-DIMETHYLHEPTANE	0.0002	0.0016
2,4-DIMETHYLHEPTANE	0.0003	0.0019
1-methyl-c2-ETHYLCYCLOPENTANE		
2,2,3-TRIMETHYLHEXANE	0.0001	0.0004
1,c2-DIMETHYLCYCLOHEXANE	0.0006	0.0036
2,6-DIMETHYLHEPTANE		
N-PROPYLCYCLOPENTANE	0.0001	0.0004
1,c3,c5-TRIMETHYLCYCLOHEXANE		
2,5-DIMETHYLHEPTANE	0.0010	0.0063
3,5-DIMETHYLHEPTANE		
ETHYLCYCLOHEXANE		
1,1,3-TRIMETHYLCYCLOHEXANE	0.0002	0.0012
2,3,3-TRIMETHYLHEXANE		
3,3-DIMETHYLHEPTANE		
1,1,4-TRIMETHYLCYCLOHEXANE	0.0000	0.0003
UNKNOWN	0.0000	0.0001
2,3,4-TRIMETHYLHEXANE	0.0000	0.0003
ETHYLBENZENE	0.0001	0.0008
1,t2,t4-TRIMETHYLCYCLOHEXANE	0.0003	0.0024
1,c3,t5-TRIMETHYLCYCLOHEXANE		
2,3-DIMETHYLHEPTANE		
M-XYLENE	0.0024	0.0140
P-XYLENE		
3,4-DIMETHYLHEPTANE		
2-METHYLOCTANE	0.0010	0.0071
4-METHYLOCTANE		
UNKNOWN	0.0000	0.0001
3-METHYLOCTANE	0.0000	0.0002
UNKNOWN	0.0000	0.0000
1,t2,c3-TRIMETHYLCYCLOHEXANE	0.0001	0.0007
1,t2,c4-TRIMETHYLCYCLOHEXANE		
O-XYLENE	0.0001	0.0007
1,1,2-TRIMETHYLCYCLOHEXANE	0.0001	0.0008
UNKNOWN	0.0000	0.0000
ISOBUTYLCYCLOPENTANE	0.0001	0.0004
N-NONANE	0.0025	0.0179
UNKNOWN	0.0000	0.0002
1,c2,c3-TRIMETHYLCYCLOHEXANE	0.0000	0.0001
1,c2,t3-TRIMETHYLCYCLOHEXANE		
UNKNOWN	0.0000	0.0000
ISOPROPYLBENZENE	0.0000	0.0002
2,2-DIMETHYLOCTANE	0.0001	0.0009
ISOPROPYLCYCLOHEXANE	0.0003	0.0019
CYCLOOCTANE		
UNKNOWN	0.0000	0.0003

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

COMPONENT NAME	MOL %	WEIGHT %
N-BUTYLCYCLOPENTANE	0.0003	0.0024
N-PROPYLCYCLOHEXANE		
3,3-DIMETHYLOCTANE	0.0001	0.0008
UNKNOWN	0.0000	0.0002
N-PROPYLBENZENE	0.0006	0.0040
UNKNOWN	0.0001	0.0009
M-ETHYLTOLUENE	0.0001	0.0004
P-ETHYLTOLUENE	0.0003	0.0021
2,3-DIMETHYLOCTANE		
4-METHYLNONANE	0.0002	0.0011
5-METHYLNONANE		
1,3,5-TRIMETHYLBENZENE		
2-METHYLNONANE	0.0004	0.0030
3-ETHYLOCTANE	0.0005	0.0036
O-ETHYLTOLUENE	0.0004	0.0028
3-METHYLNONANE		
UNKNOWN	0.0000	0.0001
1,2,4-TRIMETHYLBENZENE	0.0001	0.0004
t-BUTYLBENZENE		
METHYLCYCLOOCTANE		
tert-BUTYLCYCLOHEXANE	0.0001	0.0006
ISO-BUTYLCYCLOHEXANE	0.0000	0.0003
N-DECANE	0.0014	0.0108
ISOBUTYLBENZENE	0.0000	0.0001
sec-BUTYLBENZENE	0.0001	0.0005
UNKNOWN	0.0000	0.0001
1-METHYL-3-ISOPROPYLBENZENE	0.0001	0.0008
1,2,3-TRIMETHYLBENZENE	0.0001	0.0009
1-METHYL-4-ISOPROPYLBENZENE		
UNKNOWN	0.0000	0.0000
1-METHYL-2-ISOPROPYLBENZENE	0.0003	0.0019
UNKNOWN	0.0001	0.0007
N-BUTYLCYCLOHEXANE	0.0001	0.0006
UNKNOWN	0.0001	0.0006
1,3-DIETHYLBENZENE	0.0000	0.0003
1-METHYL-3-PROPYLBENZENE		
1,2-DIETHYLBENZENE	0.0001	0.0011
N-BUTYLBENZENE		
1-METHYL-4-PROPYLBENZENE		
1,4-DIETHYLBENZENE	0.0001	0.0009
1-METHYL-2-PROPYLBENZENE	0.0002	0.0013
1,4-DIMETHYL-2-ETHYLBENZENE	0.0001	0.0011
UNKNOWN	0.0000	0.0000

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**COMPONENT AS % OF TOTAL SAMPLE**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
1,2-DIMETHYL-4-ETHYLBENZENE	0.0000	0.0001
1,3-DIMETHYL-2-ETHYLBENZENE	0.0000	0.0001
UNKNOWN	0.0000	0.0000
1,2-DIMETHYL-3-ETHYLBENZENE	0.0000	0.0002
UNKNOWN	0.0000	0.0000
N-UNDECANE	0.0005	0.0045
UNKNOWN	0.0000	0.0000
1,2,4,5-TETRAMETHYLBENZENE	0.0000	0.0001
1,2,3,5-TETRAMETHYLBENZENE	0.0000	0.0001
UNKNOWN	0.0000	0.0001
1,2,3,4-TETRAMETHYLBENZENE	0.0001	0.0006
CYCLODECANE		
UNKNOWN	0.0000	0.0000
NAPHTHALENE	0.0000	0.0003
N-DODECANE	0.0000	0.0001
ISOTRIDECANES PLUS	0.0000	0.0000
<b>Total:</b>	<b>0.1240</b>	<b>0.6656</b>

TOTAL HEXANES	0.0571	0.2701
TOTAL HEPTANES	0.0329	0.1737
TOTAL OCTANES	0.0174	0.1050
TOTAL NONANES	0.0094	0.0624
TOTAL DECANES PLUS	0.0072	0.0544

**BTEX COMPONENTS**

N-HEXANE	0.0170	0.0813
BENZENE	0.0019	0.0084
TOLUENE	0.0009	0.0048
ETHYLBENZENE	0.0001	0.0008
XYLENE	0.0025	0.0148



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235789-8

CAPILLARY ANALYSIS - METHOD GPA 2286-95  
HEAVY END FRACTION

COMPONENT NAME	MOL %	WEIGHT %
METHANE	0.000	0.000
ETHANE	0.000	0.000
PROPANE	0.000	0.000
ISO-BUTANE	0.000	0.000
N-BUTANE	0.000	0.000
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.000	0.000
ISOPENTANE	0.000	0.000
N-PENTANE	0.000	0.000
2,2-DIMETHYLBUTANE (NEOHEXANE)	5.382	4.791
2,3-DIMETHYLBUTANE CYCLOPENTANE	4.888	3.946
2-METHYLPENTANE	14.184	12.625
3-METHYLPENTANE	7.877	7.012
N-HEXANE	13.718	12.210
2,2-DIMETHYLPENTANE	1.149	1.189
METHYLCYCLOPENTANE	2.791	2.426
2,4-DIMETHYLPENTANE	1.090	1.128
2,2,3-TRIMETHYLBUTANE	0.431	0.446
BENZENE	1.565	1.263
3,3-DIMETHYLPENTANE	0.543	0.562
CYCLOHEXANE	2.933	2.550
2-METHYLHEXANE	4.011	4.151
2,3-DIMETHYLPENTANE	1.143	1.183
1,1-DIMETHYLCYCLOPENTANE 3-METHYLHEXANE	3.982	4.113
1,1,3-DIMETHYLCYCLOPENTANE	0.277	0.281
1,3-DIMETHYLCYCLOPENTANE 3-ETHYLPENTANE	0.476	0.484
1,2-DIMETHYLCYCLOPENTANE 2,2,4-TRIMETHYLPENTANE	0.534	0.551
N-HEPTANE	5.578	5.773
METHYLCYCLOHEXANE 1,1,3-TRIMETHYLCYCLOPENTANE	3.062	3.151



**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
2,2-DIMETHYLHEXANE		
1,C2-DIMETHYLCYCLOPENTANE	0.139	0.141
2,5-DIMETHYLHEXANE	0.463	0.547
2,4-DIMETHYLHEXANE	0.785	0.836
2,2,3-TRIMETHYLPENTANE		
ETHYLCYCLOPENTANE		
1,t2,c4-TRIMETHYLCYCLOPENTANE	0.284	0.329
3,3-DIMETHYLHEXANE		
1,t2,C3-TRIMETHYLCYCLOPENTANE	0.079	0.092
2,3,4-TRIMETHYLPENTANE	0.042	0.049
TOLUENE	0.763	0.726
2,3-DIMETHYLHEXANE	0.252	0.297
1,1,2-TRIMETHYLCYCLOPENTANE	0.046	0.053
2-METHYLHEPTANE	1.955	2.307
4-METHYLHEPTANE	0.579	0.683
3,4-DIMETHYLHEXANE	0.076	0.090
3-METHYLHEPTANE	1.627	1.919
3-ETHYLHEXANE		
1,c3-DIMETHYLCYCLOHEXANE	0.329	0.381
1,c2,t3-TRIMETHYLCYCLOPENTANE		
1,c2,t4-TRIMETHYLCYCLOPENTANE		
1,t4-DIMETHYLCYCLOHEXANE	0.162	0.188
2,2,5-TRIMETHYLHEXANE	0.072	0.095
1,1-DIMETHYLCYCLOHEXANE	0.113	0.131
1,methyl-t3-ETHYLCYCLOPENTANE		
1-methyl-C3-ETHYLCYCLOPENTANE	0.000	0.000
1-methyl-t2-ETHYLCYCLOPENTANE	0.053	0.066
2,2,4-TRIMETHYLHEXANE		
1-methyl-1-ETHYLCYCLOPENTANE	2.984	3.520
CYCLOHEPTANE		
N-OCTANE		
1,T2-DIMETHYLCYCLOCHEXANE	0.155	0.180
UNKNOWN	0.016	0.021
1,t3-DIMETHYLCYCLOHEXANE	0.077	0.089
1,c4-DIMETHYLCYCLOHEXANE		
1,c2,c3-TRIMETHYLCYCLOPENTANE		
2,4,4-TRIMETHYLHEXANE	0.007	0.009
ISOPROPYLCYCLOPENTANE	0.015	0.017
UNKNOWN	0.035	0.046
2,2-DIMETHYLHEPTANE	0.182	0.241
2,4-DIMETHYLHEPTANE	0.232	0.288
1-methyl-c2-ETHYLCYCLOPENTANE		
2,2,3-TRIMETHYLHEXANE	0.050	0.066

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
1,c2-DIMETHYLCYCLOHEXANE	0.458	0.545
2,6-DIMETHYLHEPTANE		
N-PROPYLCYCLOPENTANE	0.046	0.056
1,c3,c5-TRIMETHYLCYCLOHEXANE		
2,5-DIMETHYLHEPTANE	0.805	0.946
3,5-DIMETHYLHEPTANE		
ETHYLCYCLOHEXANE		
1,1,3-TRIMETHYLCYCLOHEXANE	0.138	0.181
2,3,3-TRIMETHYLHEXANE		
3,3-DIMETHYLHEPTANE		
1,1,4-TRIMETHYLCYCLOHEXANE	0.039	0.051
UNKNOWN	0.009	0.012
2,3,4-TRIMETHYLHEXANE	0.029	0.039
ETHYLBENZENE	0.111	0.122
1,t2,t4-TRIMETHYLCYCLOHEXANE	0.273	0.357
1,c3,t5-TRIMETHYLCYCLOHEXANE		
2,3-DIMETHYLHEPTANE		
M-XYLENE	1.913	2.106
P-XYLENE		
3,4-DIMETHYLHEPTANE		
2-METHYLOCTANE	0.810	1.073
4-METHYLOCTANE		
UNKNOWN	0.006	0.008
3-METHYLOCTANE	0.023	0.031
UNKNOWN	0.000	0.000
1,t2,c3-TRIMETHYLCYCLOHEXANE	0.076	0.099
1,t2,c4-TRIMETHYLCYCLOHEXANE		
O-XYLENE	0.101	0.110
1,1,2-TRIMETHYLCYCLOHEXANE	0.088	0.114
UNKNOWN	0.000	0.000
ISOBUTYLCYCLOPENTANE	0.043	0.056
N-NONANE	2.026	2.684
UNKNOWN	0.025	0.037
1,c2,c3-TRIMETHYLCYCLOHEXANE	0.008	0.010
1,c2,t3-TRIMETHYLCYCLOHEXANE		
UNKNOWN	0.000	0.000
ISOPROPYLBENZENE	0.025	0.031
2,2-DIMETHYLOCTANE	0.088	0.129
ISOPROPYLCYCLOHEXANE	0.234	0.288
CYCLOOCTANE		
UNKNOWN	0.037	0.051
N-BUTYLCYCLOPENTANE	0.278	0.363
N-PROPYLCYCLOHEXANE		
3,3-DIMETHYLOCTANE	0.085	0.125

**CAPILLARY ANALYSIS - METHOD GPA 2286-95**  
**HEAVY END FRACTION**

COMPONENT NAME	MOL %	WEIGHT %
UNKNOWN	0.025	0.035
N-PROPYLBENZENE	0.481	0.597
UNKNOWN	0.100	0.139
M-ETHYLTOLUENE	0.054	0.067
P-ETHYLTOLUENE	0.251	0.312
2,3-DIMETHYLOCTANE		
4-METHYLNONANE	0.125	0.167
5-METHYLNONANE		
1,3,5-TRIMETHYLBENZENE		
2-METHYLNONANE	0.302	0.444
3-ETHYLOCTANE	0.366	0.537
O-ETHYLTOLUENE	0.314	0.426
3-METHYLNONANE		
UNKNOWN	0.012	0.016
1,2,4-TRIMETHYLBENZENE	0.051	0.066
t-BUTYLBENZENE		
METHYLCYCLOOCTANE		
tert-BUTYLCYCLOHEXANE	0.062	0.090
ISO-BUTYLCYCLOHEXANE	0.032	0.047
N-DECANE	1.102	1.620
ISOBUTYLBENZENE	0.011	0.015
sec-BUTYLBENZENE	0.051	0.070
UNKNOWN	0.005	0.008
1-METHYL-3-ISOPROPYLBENZENE	0.082	0.113
1,2,3-TRIMETHYLBENZENE	0.108	0.139
1-METHYL-4-ISOPROPYLBENZENE		
UNKNOWN	0.000	0.000
1-METHYL-2-ISOPROPYLBENZENE	0.207	0.287
UNKNOWN	0.068	0.110
N-BUTYLCYCLOHEXANE	0.059	0.085
UNKNOWN	0.055	0.089
1,3-DIETHYLBENZENE	0.037	0.051
1-METHYL-3-PROPYLBENZENE		
1,2-DIETHYLBENZENE	0.119	0.165
N-BUTYLBENZENE		
1-METHYL-4-PROPYLBENZENE		
1,4-DIETHYLBENZENE	0.102	0.142
1-METHYL-2-PROPYLBENZENE	0.142	0.197
1,4-DIMETHYL-2-ETHYLBENZENE	0.115	0.159
UNKNOWN	0.000	0.000
1,2-DIMETHYL-4-ETHYLBENZENE	0.007	0.010

**CAPILLARY ANALYSIS - METHOD GPA 2286-95  
HEAVY END FRACTION**

<b>COMPONENT NAME</b>	<b>MOL %</b>	<b>WEIGHT %</b>
1,3-DIMETHYL-2-ETHYLBENZENE	0.006	0.008
UNKNOWN	0.003	0.004
1,2-DIMETHYL-3-ETHYLBENZENE	0.025	0.035
UNKNOWN	0.000	0.000
N-UNDECANE	0.422	0.681
UNKNOWN	0.002	0.003
1,2,4,5-TETRAMETHYLBENZENE	0.016	0.022
1,2,3,5-TETRAMETHYLBENZENE	0.015	0.020
UNKNOWN	0.009	0.016
1,2,3,4-TETRAMETHYLBENZENE	0.061	0.087
CYCLODECANE		
UNKNOWN	0.000	0.000
NAPHTHALENE	0.031	0.041
N-DODECANE	0.007	0.012
ISOTRIDECANES PLUS	0.000	0.000
<b>Total:</b>	<b>100.000</b>	<b>100.000</b>

<b>Specific Gravity @ 60 Deg. F. (Air = 1)</b>	3.3296
<b>Molecular Weight</b>	96.92
<b>Compressibility Factor</b>	0.8617
<b>Summation Factor</b>	0.0970
<b>Cu. Ft. Vapor/Gal @ 14.696 &amp; 60 Deg. F.</b>	23.592
<b>Cu. Ft. Vapor/Gal @ 14.730 &amp; 60 Deg. F.</b>	23.538
<b>Cu. Ft. Vapor/Gal @ 14.650 &amp; 60 Deg. F.</b>	23.666
<b>Btu/cu. Ft. @ 14.696 PSIA, Dry</b>	5249.53
<b>Btu/cu. Ft. @ 14.730 PSIA, Dry</b>	5261.67
<b>BTU/LB</b>	20608

335789-1 335789-5 ext stat

Date 10/9/17 By JOHN MAGNIE For APPROACH ENV. Element 335789-1

Sample ID: Company \_\_\_\_\_  
 Field Bethany Lockstreet  
 Lease CV RA SURV; MARY BELLE SMITH 28 #2 ALT  
 Sta. # \_\_\_\_\_ Comp \_\_\_\_\_ Spot \_\_\_\_\_  
 Eff. Date From: \_\_\_\_\_ To: \_\_\_\_\_

Sample of (circle) GAS LIQUID WATER  
 Bottle # 80332 PSIG 500 Temp. \_\_\_\_\_ D. Pt. \_\_\_\_\_  
 H2S ppm \_\_\_\_\_ H2S % \_\_\_\_\_ Remarks: Time 9:30  
W/bu 838

2129 W. Willow St. Scott, LA 70583 Phone (337) 232-3568  
 NOV 14 2017

State Certified

335789-2 335789-6 ext stat

Date 11/9/17 By JOHN MAGNIE For APPROACH ENV. Element 335789-2

Sample ID: Company INDIGO MINERALS  
 Field Bethany Lockstreet  
 Lease HUSS RA SURV; Sampson Est 33 #1 / SN # 229084  
 Sta. # \_\_\_\_\_ Comp \_\_\_\_\_ Spot \_\_\_\_\_  
 Eff. Date From: \_\_\_\_\_ To: \_\_\_\_\_

Sample of (circle) GAS LIQUID WATER  
 Bottle # 10396 PSIG 330 Temp. \_\_\_\_\_ D. Pt. \_\_\_\_\_  
 H2S ppm \_\_\_\_\_ H2S % \_\_\_\_\_ Remarks: Time 13:55  
W/bu 1211

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 NOV 14 2017

State Certified

335789-4 335789-8 ext stat

Date 11/9/17 By JOHN MAGNIE For APPROACH ENV. Element 335789-4

Sample ID: Company INDIGO MINERALS  
 Field Bethany Lockstreet  
 Lease P SURV; JB BARR 28 #2 / SN # 229457  
 Sta. # \_\_\_\_\_ Comp \_\_\_\_\_ Spot \_\_\_\_\_  
 Eff. Date From: \_\_\_\_\_ To: \_\_\_\_\_

Sample of (circle) GAS LIQUID WATER  
 Bottle # 1099 PSIG 80 Temp. \_\_\_\_\_ D. Pt. \_\_\_\_\_  
 H2S ppm \_\_\_\_\_ H2S % \_\_\_\_\_ Remarks: Time 13:25  
W/bu 81050  
wet

2129 W. Willow St. Scott, LA 70583 Phone (337) 232-3568  
 NOV 14 2017


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# Chain of Custody

Laboratory Number:

235749

<b>Client Information:</b>		<b>Billing Information:</b>		<b>PO Number:</b>	<b>Project Name/Number:</b>
Company Name: Approach Environmental, LLC		Same			LDNR Emergency Gas Sampling DeSoto Parish, LA
Contact Name: Mark S. Moore				Quote Number:	 Sampler's Signature
Address: 151 Freestate Blvd.		P. O. Box 7192		ELA0006850Q/0	
Suite B				Required QC Level	
City, State Zip: Shreveport, LA 71107		Shreveport, LA 71137-7192			
Phone Number: 318-401-0085		Ext:		Bill Monthly	Shipping Method:
Fax Number: 318-222-2425				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	UPS / FedEx / Airborne DHL / Element / Hand / Mail
E-mail Address: marksm@approachenv.com		marksm@approachenv.com			
<b>Page of</b>					
<b>Matrix Code</b>					
DW = Drinking Water WW = Waste Water GW = Ground Water AQ = Aqueous OT = Other SL = Sludge O = Oil F = Food NG = Natural Gas NGL = Natural Gas Liquid PW = Produced Water CF = Completion Fluid					

[illegible]

	Relinquished by	Date/Time	Received by	Date/Time	Field Notes:
1	Chamara Bell	11/6/17 15:45	Chamara Bell	11/6/17 3:44 p.m.	Received at lab on ice?
2	Chamara Bell	11/13/17 1:00 p.m.	April Leeger	11/13/17 1:00 p.m.	<input type="checkbox"/> Yes <input type="checkbox"/> No Temp:
3					

All samples submitted to Element Materials Technology for analysis are accepted on a custodial basis only. Ownership of the material remains with the client submitting the samples. Element Materials Technology reserves the right to return unused sample portions.

2129 West Willow Street	629 Washington St, Suite 300	2121 East Washington Boulevard	560 South Zimmer Road	3371 Cleveland Road, Suite 100A	2417 W. Pinhook Rd
Scott, LA	Columbus, IN	Fort Wayne, IN	Warsaw, IN	South Bend, IN	Lafayette, LA
70583 USA	47201-6231 USA	46803-1328 USA	46580-2368 USA	46628-9780 USA	70508-3344 USA
P 337-232-3568	P 812-375-0531	P 260-471-7000	P 574-267-3305	P 574-277-0707	P 337-235-0483
F 337-232-3621	F 812-375-0731	F 260-471-7777	F 574-260-5560	F 574-273-5500	F 337-232-5800



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## GRAVIMETRIC CERTIFICATE

ELEMENT MATERIALS TECHNOLOGY  
TREVOR JUDICE  
2129 WEST WILLOW ST  
SCOTT, LA 70583  
ELEMENT MATERIALS TECHNOLOGY

CUSTOM GRAVIMETRIC BLEND

DATE: September 21, 2015 *note*  
ORDER NUMBER: SCOTT LOCATION

CYL NO: RD504972

QC NO: 082914-JB1  
SCF = 29.8

COMPONENT	REQUESTED MOLE %	ACTUAL MOLE %	ACTUAL WT %
HEXANES + SLXII	0.300	0.300	1.345
N-PENTANE	1.000	1.000	3.503
ISOPENTANE	1.000	0.999	3.500
N-BUTANE	1.500	1.499	4.231
ISOBUTANE	1.500	1.497	4.225
PROPANE	2.500	2.501	5.355
ETHANE	4.000	4.035	5.891
CARBON DIOXIDE	1.500	1.501	3.208
NITROGEN	2.000	2.002	2.723
METHANE	84.600	84.580	65.885
OXYGEN	0.100	0.086	0.134

TOTAL	100.000	100.000	100.000
MOLECULAR WEIGHT:	20.5943		
COMPRESSIBILITY FACTOR:	0.9968	BTU:	14.696 14.650 14.730 15.025
SPECIFIC GRAVITY ( IDEAL ):	0.7112	IDEAL:	1181.300 1177.602 1184.033 1207.746
SPECIFIC GRAVITY ( REAL ):	0.7135	REAL:	1185.100 1181.400 1187.800 1211.600
CGA 510 PSIA 115 PSIG 100		DP ( DEG F ):	40

DOC CONTROL #: PETRO - F009.000

Manufactured gravimetric blend with NIST traceable balance.

GPA 2261, GPA 2145 and GPA 2198

Expiration Date: NOT APPLICABLE

  
Trevor Judice Operations Manager