# Department of Environmental Quality

*To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.*

DEQ

Matthew H. Mead, Governor

Todd Parfitt, Director


March 31, 2016

Mr. Charles Cornell
Sr. Regulatory Lead
Jonah Energy LLC
707 17th Street, Suite 2700
Denver, CO 80202

Permit No. **P0020602**

Dear Mr. Cornell:

The Division of Air Quality of the Wyoming Department of Environmental Quality has completed final review of Jonah Energy LLC's application to modify the drill rig fleet located in the Jonah and Pinedale Anticline Development Area (JPDA) in Sublette County, Wyoming. The current drill rig fleet is authorized under CT-8122A3 to operate with a total actual annual $NO_x$ emissions from all drill rig engines and boilers associated with the Jonah Energy LLC Drill Rig Fleet of 282.0 tons per year (tpy). Jonah Energy LLC is requesting to modify the drill rig fleet to 200.0 tpy total actual annual $NO_x$ emissions from all drill rig engines and boilers associated with the Jonah Energy LLC Drill Rig Fleet.

Following this agency's proposed approval of the request as published February 19, 2016, and in accordance with Chapter 6, Section 2(m) of the Wyoming Air Quality Standards and Regulations, the public was afforded a thirty (30) day period in which to submit comments concerning the proposed modification, and an opportunity for a public hearing. No comments have been received. Therefore, on the basis of the information provided to us, approval to modify the Drill Rig Fleet as described in the application is hereby granted pursuant to Chapter 6, Section 2 of the regulations with the following conditions:

1. That authorized representatives of the Division of Air Quality be given permission to enter and inspect any property, premise or place on or at which an air pollution source is located or is being constructed or installed for the purpose of investigating actual or potential sources of air pollution and for determining compliance or non-compliance with any rules, standards, permits or orders.

2. That all substantive commitments and descriptions set forth in the application for this permit, unless superseded by a specific condition of this permit, are incorporated herein by this reference and are enforceable as conditions of this permit.

3. That all notifications, reports and correspondences associated with this permit shall be submitted to the Stationary Source Compliance Program Manager. Submissions may be done electronically through https://airimpact.wyo.gov to satisfy requirements of this permit.

4. This permit only applies to the Jonah Energy LLC Drill Rig Fleet while operating in the Jonah and Pinedale Anticline Development Area (JPDA) and Normally Pressurized Lance (NPL). The permit conditions contained herein are only enforceable while operating drill rigs in the JPDA and NPL.

   i. The JPDA and NPL area consists of 109W & R110W in T34N, R109W & R110W in T33N, R108W, R109W & R110W in T32N, R108W, R109W & R110W in T31N, R107W, R108W & R109W in T30N, R107W, R108W, R109W, & R110W in T29N, R107W, R108W, R109W, & R110W in T28N, and R107W, R108W & R109W in T27N.

5. That written notification of the actual date of initial start-up for each drill rig/engine/boiler is required fifteen (15) days after start-up as defined in Condition 9. Such notification shall be submitted on a complete AQD-RIG Installation/Removal form. The form can be downloaded from the Air Quality website http://deq.wyoming.gov/aqd or obtained from the Air Quality Division.

6. That upon removal of a drill rig/engine/boiler from the JPDA/NPL, written notification is required within fifteen (15) days of removal. Such notification shall be submitted on a complete AQD-RIG Installation/Removal form.

7. That emissions shall be limited as follows:

   i. Total actual annual $NO_x$ emissions from all drill rig engines and boilers associated with the Jonah Energy LLC Drill Rig Fleet shall not exceed 200.0 tons per year (tpy) $NO_x$.

   ii. Emissions from the natural gas fired drill rig engines in the Jonah Energy LLC Drill Rig Fleet shall not exceed the values in the following table.

| Equipment | $NO_x$ g/hp-hr | CO g/hp-hr | Formaldehyde g/hp-hr |
|---|---|---|---|
| Natural Gas Engines | 1.49 | 0.5 | 0.07 |

      1. Lean burn engines shall be equipped with oxidation catalyst.

      2. Rich burn engines shall be equipped with NSCR and an AFRC.

   iii. Total actual annual $NO_x$ emissions from engines on any diesel fired drill rig in the Jonah Energy LLC Drill Rig Fleet shall not exceed 10 tpy per drill rig.

      1. Drill rig engines equipped with SCR shall have a minimum $NO_x$ control efficiency of ninety percent (90%).

8. Ammonia slip from each SCR air pollution control system shall not exceed 10 $ppm_v$ at fifteen percent (15%) $O_2$ as measured by initial and periodic testing.

9. Jonah Energy LLC shall conduct an initial performance test for each drill rig engine no later than ninety (90) days after start-up. Startup shall be defined as follows:

   i. For drill rig engines in service when CT-8122 was issued, the start-up date shall be January 4, 2010.

   ii. For all other drill rig engines, the start-up date shall be the date the rig commences drilling at the first well.

10. Initial performance testing as required by Condition 9 of this permit shall be conducted on the drill rig engines as follows:

    i. Natural gas fired engines

    <u>$NO_x$ and CO Emissions</u>: Testing for $NO_x$ and CO emissions shall consist of three (3) 1-hour tests following EPA approved reference methods or the State of Wyoming's Portable Analyzer protocol to determine compliance with the g/hp-hr limits. Results shall be reported in terms of g/hp-hr. Emissions shall be calculated using the following equations:

$$g/hp\text{-}hr\ NO_X = (ppm\ NO_{X_{corrected}})(1.19x10^{-7})(F_factor)\left(\frac{20.9}{20.9 - O_2\%_{corrected}}\right)$$
$$(Brake\ Specific\ Fuel\ Consumption(Btu/hp-hr))(10^{-6})(454)$$

$$g/hp\text{-}hr\ CO = (ppm\ CO_{corrected})(7.27x10^{-8})(F_factor)\left(\frac{20.9}{20.9 - O_2\%_{corrected}}\right)$$
$$(Brake\ Specific\ Fuel\ Consumption(Btu/hp-hr))(10^{-6})(454)$$

    <u>VOC Emissions</u>: Testing for VOCs shall be conducted in accordance with a Division approved test method for one (1) engine of each engine type in the fleet.

    <u>Formaldehyde Emissions (Lean Burn Engines Only):</u> Each engine shall be tested for formaldehyde. Testing shall consist of three (3) 1-hour tests following EPA approved reference methods or a Division approved formaldehyde test method. Emissions shall be calculated using the following equation:

$$g/hp\text{-}hr\ HCHO = (ppm\ HCHO_{corrected})(7.79x10^{-8})(F_factor)\left(\frac{20.9}{20.9 - O_2\%_{corrected}}\right)$$
$$(Brake\ Specific\ Fuel\ Consumption(Btu/hp-hr))(10^{-6})(454)$$

ii. For diesel-fired drill rig engines equipped with SCR

$NO_x$ Emissions: Compliance testing for $NO_x$ shall be conducted in accordance with EPA approved reference methods or the State of Wyoming's Portable Analyzer Protocol. Testing shall consist of three (3) runs conducted at the inlet and outlet of the SCR system to determine the $NO_x$ control efficiency. Results shall be reported in terms of percent control efficiency and g/hp-hr. Emissions shall be calculated using the following equation:

$$g/hp\text{-}hr\ NO_X = (ppm\ NO_{X_{corrected}})(1.19x\,10^{-7})(F_factor)\left(\frac{20.9}{20.9 - O_2\%_{corrected}}\right)$$
$$(Brake\ Specific\ Fuel\ Consumption(Btu/hp-hr))(10^{-6})(454)$$

CO Emissions: Testing for CO shall be conducted in accordance with EPA approved reference methods or the State of Wyoming's Portable Analyzer protocol. Results shall be submitted in terms of g/hp-hr. Brake Specific Fuel Consumption (BSFC) shall be provided in the report.

$$g/hp\text{-}hr\ CO = (ppm\ CO_{corrected})(7.27x\,10^{-8})(F_factor)\left(\frac{20.9}{20.9 - O2\%_{corrected}}\right)$$
$$(Brake\ Specific\ Fuel\ Consumption(Btu/hp-hr))(10^{-6})(454)$$

VOC Emissions: Compliance testing for VOCs shall be conducted in accordance with a Division approved test method for one (1) engine of each engine type in the fleet.

Ammonia Slip: Compliance testing for ammonia slip shall be conducted using Draeger-Tube detectors or other methods as approved by the Administrator.

Formaldehyde Emissions: Testing for formaldehyde shall be conducted in accordance with a Division approved test method for one (1) engine of each engine type in the fleet.

Urea flow (gph and /or liters per hour), engine load (%) and/or boost pressure (psi), and catalyst inlet temperature (°F and/or °C) shall be recorded during each run and submitted with the test report. Brake specific fuel consumption (BSFC) shall be reported with the results for the initial performance test.

A test protocol shall be submitted for review and approval prior to testing. Notification of the test date shall be provided to the Division fifteen (15) days prior to testing. Results shall be submitted to the Division within forty-five (45) days of completion. Engine load (%) and brake specific fuel consumption (BSFC) shall be provided in the report.

11. That Jonah Energy LLC shall follow the testing requirements as follows for each drill rig engine:

    i. For natural gas engines, each drill rig engine shall be tested semi-annually. The first semi-annual test is required six (6) months after completion of the initial performance tests required under Condition 9. Testing for $NO_x$ and CO shall be conducted in accordance with EPA approved reference methods or the State of Wyoming's Portable Analyzer protocol. Compliance with the CO limits is considered verification that the VOC and formaldehyde emissions for the lean burn engines are controlled. Emissions shall be calculated using the equations listed in Condition 10.

    ii. For drill rig engines equipped with SCR, each drill rig engine shall be tested quarterly. The first quarterly test is required the following calendar quarter after completion of the initial performance tests specified under Condition 10.

        1. Testing for $NO_x$ shall be conducted in accordance with EPA approved reference methods or the State of Wyoming's Portable Analyzer protocol. Testing shall consist of one (1) ten (10) minute run conducted at the inlet and outlet of the SCR system to determine the $NO_x$ control efficiency. Results shall be submitted in terms of percent control efficiency and g/hp-hr. Brake Specific Fuel Consumption (BSFC) shall be provided in the report. Emissions shall be calculated using the equation listed in Condition 10.

        2. Testing for ammonia slip shall be conducted using Draeger-Tube detectors or other methods as approved by the Administrator.

        3. Urea flow (gph and /or liters per hour), engine load (%) and/or boost pressure (psi), and catalyst inlet temperature (°F and/or °C) shall be recorded during each run and submitted with the test report.

    iii. A test protocol shall be submitted for review and approval prior to testing. Notification of the test date shall be provided to the Division fifteen (15) days prior to the testing. Results shall be submitted to the Division with forty-five (45) days of completing the tests. The engine load (%) and brake specific fuel consumption (BSFC) shall be provided in the report.

    iv. The Air Quality Division shall be notified within twenty-four (24) hours of the testing/monitoring required by this condition that shows operation outside the permitted emission limits. By no later than seven (7) calendar days of such testing/monitoring event, the owner or operator shall repair and retest/monitor the affected engine to demonstrate that the engine has been returned to operation within the permitted emission limits. Compliance with this permit condition regarding repair and retesting/monitoring shall not be deemed to limit the authority of the Air Quality Division to cite the owner or operator for an exceedance of the permitted emission limits for any testing/monitoring required by this condition which shows noncompliance.

12. That Jonah Energy LLC shall follow the monitoring and maintenance requirements as follows:

    i. For natural gas-fired engines equipped with an oxidation catalyst or NSCR catalyst, operate and maintain the engine, air pollution control equipment, and monitoring equipment according to good air pollution control practices at all times, including startup, shutdown, and malfunction.

    ii. For diesel-fired engines equipped with an SCR catalyst, operate and maintain the engine, SCR system and monitoring equipment according to good air pollution control practices at all times, including startup, shutdown, and malfunction. The SCR system shall be operated at all times the drill rig is operating in the JPDA or NPL, except when the engine catalyst inlet temperature is less than 500°F. Records shall be kept to document periods when the SCR system is not operating and the engine is operating. The records shall include date, duration and cause.

    iii. Operate the SCR Emission Control System in accordance with the manufacturer's recommendations which includes visually inspecting the catalysts and cleaning as necessary. Records shall be maintained of catalyst maintenance and replacement. Upon replacement of the catalyst, performance tests as specified by Condition 10 shall be conducted.

    iv. For drill rigs in use equipped with a SCR system, records of urea flow (gph and /or liters per hour), engine load (%) and/or boost pressure (psi), and catalyst inlet temperature (°F and/or °C) shall be recorded, at minimum, daily when the engine is operating. Records of interim spot checks conducted to verify catalyst condition and any maintenance or corrective actions shall be kept for a period of at least five (5) years and shall be made available to the Division upon request.

    v. All drill rigs in use equipped with a SCR system shall be equipped with a datalogger to record urea flow (gph and /or liters per hour), engine load (%) and/or boost pressure (psi), and catalyst inlet temperature (°F and/or °C). Upon startup, new drill rig engines equipped with SCR require a datalogger. Data shall be recorded on an interval of fifteen (15) minutes or less. Records shall be kept for a period of at least five (5) years and shall be made available to the Division upon request.

13. Jonah Energy LLC shall keep records of the following for each well drilled.

    i. Drill Rig ID
    ii. Well API number
    iii. Well name
    iv. Well location (longitude, latitude, elevation)
    v. Drilling start and end dates
    vi. Field name
    vii. Equipment description, controls, and site rating
    viii. Brake specific fuel consumption (BSFC)
    ix. Total fuel usage for drill rig engines and boilers recorded on a daily basis
    x. Heat content and sulfur content of fuel burned recorded from supplier certification
    xi. Actual emissions for $NO_x$, CO, VOC, $SO_2$, $PM_{10}$, ammonia, and formaldehyde

        1. For engines, emissions shall be based on fuel consumption, g/hp-hr emission rates, and BSFC. Information recorded in Condition 12 regarding catalyst operation shall also be utilized to calculate emissions from the engines.

        2. For boilers, emissions shall be based on fuel consumption, lb/MMBtu rates or AP-42 factors converted to lb/MMBtu, and BSFC

    The format presented in Appendix A shall be utilized to satisfy reporting requirements for the Division's annual emission inventory, which shall be submitted by March 31 of the following calendar year.

14. That drill rigs, boilers or engines that are subject to the conditions of this permit may be replaced without modifying this permit. Jonah Energy LLC shall provide notifications as required by Conditions 5 and 6 of this permit. The replacement drill rig/engine(s)/boiler(s) shall comply with the conditions of this permit.

15. All records required under this permit shall be kept for a period of at least five (5) years and shall be made available to the Division upon request.

16. That should drill rig engine(s) meet the definition of a stationary source, Jonah Energy LLC shall comply with all state and federal regulations applicable for stationary sources.

17. Jonah Energy LLC shall comply with all local, state, and federal rules and regulations applicable to the Drill Rig Fleet.

18. Effective upon permit issuance, this permit shall supersede Air Quality Permit CT-8122A3 for the Drill Rig Fleet.

It must be noted that this approval does not relieve you of your obligation to comply with all applicable county, state, and federal standards, regulations or ordinances. Special attention must be given to Chapter 6, Section 2 of the Wyoming Air Quality Standards and Regulations. Any appeal of this permit as a final action of the Department must be made to the Environmental Quality Council within sixty (60) days of permit issuance per Section 16, Chapter I, General Rules of Practice and Procedure, Department of Environmental Quality.

If we may be of further assistance to you, please feel free to contact this office.

Sincerely,

Nancy E. Vehr
Administrator
Air Quality Division

Todd Parfitt
Director
Dept. of Environmental Quality.

# Appendix A

Drill Rig Emission Reporting Form

# Drill Rig Emissions - 2009

## Diesel Fuel Consumption

(Sample data entries provided below for January through December 2009)

### 2009 Drill Rig Diesel Fuel Consumption

| January | Rig #1 (gallons) | Rig #2 (gallons) | Rig #3 (gallons) | Rig #4 (gallons) | Rig #5 (gallons) | Rig #6 (gallons) |
|---|---|---|---|---|---|---|
| 1 | 1,600 | 1,850 | 1,572 | 1,800 | 2,070 | 1,755 |
| 2 | 1,700 | 2,054 | 2,390 | 1,800 | 1,380 | 1,990 |
| 3 | 1,500 | 1,848 | 1,572 | 1,800 | 2,070 | 1,726 |
| 4 | 1,500 | 1,221 | 1,889 | 1,440 | 1,380 | 1,274 |
| 5 | 1,600 | 1,848 | 1,753 | 1,800 | 2,300 | 1,345 |
| 6 | 1,000 | 2,054 | 1,591 | 1,620 | 1,840 | 978 |
| 7 | 600 | 1,848 | 1,591 | 1,620 | 1,870 | [illegible] |
| 8 | 1,000 | 2,054 | 1,462 | 1,400 | 1,840 | [illegible] |
| 9 | 1,200 | 811 | 1,809 | 1,620 | 1,610 | [illegible] |
| 10 | 1,200 | 1,848 | 1,572 | 1,620 | 1,840 | [illegible] |
| 11 | 1,500 | 1,233 | 1,594 | 1,440 | 1,610 | 1,761 |
| 12 | 1,200 | 1,027 | 1,978 | 1,440 | 1,840 | [illegible] |
| 13 | 1,300 | [illegible] | 1,897 | 1,800 | 1,840 | [illegible] |
| 14 | 1,300 | [illegible] | 2,341 | 1,700 | [illegible] | [illegible] |
| 15 | 1,122 | [illegible] | 1,992 | 1,440 | [illegible] | [illegible] |
| 16 | 1,496 | [illegible] | 1,580 | 1,800 | [illegible] | [illegible] |
| 17 | 1,122 | [illegible] | 1,343 | 1,620 | [illegible] | [illegible] |
| 18 | 1,122 | [illegible] | 1,134 | 1,080 | [illegible] | [illegible] |
| 19 | 855 | [illegible] | [illegible] | 2,340 | [illegible] | [illegible] |
| 20 | 1,496 | [illegible] | [illegible] | 1,860 | [illegible] | [illegible] |
| 21 | 1,870 | [illegible] | [illegible] | 2,180 | [illegible] | [illegible] |
| 22 | 1,663 | [illegible] | [illegible] | 1,980 | [illegible] | [illegible] |
| 23 | 1,496 | [illegible] | [illegible] | 1,580 | [illegible] | [illegible] |
| 24 | 2,203 | [illegible] | [illegible] | 1,620 | [illegible] | [illegible] |
| 25 | 1,309 | [illegible] | [illegible] | 1,280 | [illegible] | [illegible] |
| 26 | 1,496 | [illegible] | [illegible] | 900 | [illegible] | [illegible] |
| 27 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 28 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 29 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 30 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 31 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) |
| Subtotal | 41,995 | 56,834 | 50,639 | 51,200 | 57,000 | 47,178 |

| Rig | Wells | Jan (gallons) | Totals (gallons) |
|---|---|---|---|
| Rig #1 | Well #1 | 41,995 | 41,995 |
| | [illegible] | - | - |
| | | | 41,995 |
| Rig #2 | Well #3 | 19,696 | 19,696 |
| | [illegible] | 37,138 | 37,138 |
| | Well #5 | - | - |
| | | | 56,834 |
| Rig #3 | Well #6 | 31,060 | 31,060 |
| | [illegible] | 19,579 | 19,579 |
| | Well #8 | - | - |
| | | | 50,639 |
| Rig #4 | Well #9 | 42,580 | 42,580 |
| | [illegible] | 8,620 | 8,620 |
| | Well #11 | - | - |
| | | | 51,200 |
| Rig #5 | Well #12 | 23,490 | 23,490 |
| | [illegible] | 33,510 | 33,510 |
| | Well #14 | - | - |
| | | | 57,000 |
| Rig #6 | Well #15 | 9,068 | 9,068 |
| | [illegible] | 38,110 | 38,110 |
| | Well #17 | - | - |
| | [illegible] | - | - |
| | | | 47,178 |

| February | Rig #1 (gallons) | Rig #2 (gallons) | Rig #3 (gallons) | Rig #4 (gallons) | Rig #5 (gallons) | Rig #6 (gallons) |
|---|---|---|---|---|---|---|
| 1 | 1,600 | 1,850 | 1,572 | 1,800 | 2,070 | 1,755 |
| 2 | 1,700 | 2,054 | 2,390 | 1,800 | 1,380 | 1,990 |
| 3 | 1,500 | 1,848 | 1,572 | 1,800 | 2,070 | 1,726 |
| 4 | 1,500 | 1,221 | 1,889 | 1,440 | 1,380 | 1,274 |
| 5 | 1,600 | 1,848 | 1,753 | 1,600 | 2,300 | 1,345 |
| 6 | 1,000 | 2,054 | 1,591 | 1,620 | 1,840 | 978 |
| 7 | 600 | 1,848 | 1,591 | 1,620 | 1,870 | [illegible] |
| 8 | 1,000 | 2,054 | 1,462 | 1,400 | 1,840 | [illegible] |
| 9 | 1,200 | 811 | 1,809 | 1,620 | 1,610 | [illegible] |
| 10 | 1,200 | 1,848 | 1,572 | 1,620 | 1,840 | [illegible] |
| 11 | 1,500 | 1,233 | 1,594 | 1,440 | 1,610 | [illegible] |
| 12 | 1,200 | 1,027 | 1,978 | 1,440 | 1,840 | [illegible] |
| 13 | 1,300 | [illegible] | 1,897 | 1,800 | 1,840 | [illegible] |
| 14 | 1,300 | [illegible] | 2,341 | 1,700 | [illegible] | [illegible] |
| 15 | 1,122 | [illegible] | 1,992 | 1,440 | [illegible] | [illegible] |
| 16 | 1,496 | [illegible] | 1,580 | 1,800 | [illegible] | [illegible] |
| 17 | 1,122 | [illegible] | 1,343 | 1,620 | [illegible] | [illegible] |
| 18 | 1,122 | [illegible] | 1,134 | 1,080 | [illegible] | [illegible] |
| 19 | 855 | [illegible] | [illegible] | 2,340 | [illegible] | [illegible] |
| 20 | 1,496 | [illegible] | [illegible] | 1,860 | [illegible] | [illegible] |
| 21 | 1,870 | [illegible] | [illegible] | 2,180 | [illegible] | [illegible] |
| 22 | 1,663 | [illegible] | [illegible] | 1,980 | [illegible] | [illegible] |
| 23 | 1,496 | [illegible] | [illegible] | 1,580 | [illegible] | [illegible] |
| 24 | 2,203 | [illegible] | [illegible] | 1,620 | [illegible] | [illegible] |
| 25 | 1,309 | [illegible] | [illegible] | 1,280 | [illegible] | [illegible] |
| 26 | 1,496 | [illegible] | [illegible] | 900 | [illegible] | [illegible] |
| 27 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 28 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) |
| Subtotal | 38,068 | 50,672 | 45,815 | 45,260 | 51,480 | 44,871 |

| Rig | Wells | Feb (gallons) | Totals (gallons) |
|---|---|---|---|
| Rig #1 | Well #1 | 38,068 | 38,068 |
| | [illegible] | - | - |
| | | | 38,068 |
| Rig #2 | Well #3 | 19,696 | 19,696 |
| | [illegible] | 30,976 | 30,976 |
| | Well #5 | - | - |
| | | | 50,672 |
| Rig #3 | Well #6 | 31,060 | 31,060 |
| | [illegible] | 14,755 | 14,755 |
| | Well #8 | - | - |
| | | | 45,815 |
| Rig #4 | Well #9 | 42,580 | 42,580 |
| | [illegible] | 2,680 | 2,680 |
| | Well #11 | - | - |
| | | | 45,260 |
| Rig #5 | Well #12 | 23,490 | 23,490 |
| | [illegible] | 27,990 | 27,990 |
| | Well #14 | - | - |
| | | | 51,480 |
| Rig #6 | Well #15 | 9,068 | 9,068 |
| | [illegible] | 35,803 | 35,803 |
| | Well #17 | - | - |
| | [illegible] | - | - |
| | | | 44,871 |

| March | Rig #1 (gallons) | Rig #2 (gallons) | Rig #3 (gallons) | Rig #4 (gallons) | Rig #5 (gallons) | Rig #6 (gallons) |
|---|---|---|---|---|---|---|
| 1 | 1,500 | [illegible] | [illegible] | [illegible] | [illegible] | 781 |
| 2 | 800 | [illegible] | [illegible] | [illegible] | [illegible] | 1,587 |
| 3 | 900 | [illegible] | [illegible] | [illegible] | [illegible] | 2,498 |
| 4 | 1,200 | [illegible] | [illegible] | [illegible] | [illegible] | 888 |
| 5 | 800 | [illegible] | [illegible] | [illegible] | [illegible] | 1,303 |
| 6 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1,945 |
| 7 | [illegible] | [illegible] | [illegible] | [illegible] | 1,080 | 1,591 |
| 8 | [illegible] | 821 | [illegible] | [illegible] | 460 | 1,977 |
| 9 | [illegible] | 1,233 | [illegible] | [illegible] | 690 | 2,152 |
| 10 | [illegible] | 1,232 | [illegible] | [illegible] | 1,610 | 1,733 |
| 11 | [illegible] | 1,849 | [illegible] | [illegible] | 2,070 | 1,783 |
| 12 | [illegible] | 1,643 | [illegible] | [illegible] | 1,840 | 1,594 |
| 13 | [illegible] | 1,849 | [illegible] | [illegible] | 1,840 | 1,958 |
| 14 | [illegible] | 1,232 | [illegible] | [illegible] | 1,780 | 1,685 |
| 15 | [illegible] | 1,648 | 1,250 | [illegible] | 1,610 | 1,959 |
| 16 | [illegible] | 2,054 | 1,860 | [illegible] | 1,610 | 1,990 |
| 17 | [illegible] | 1,643 | 1,178 | [illegible] | 1,840 | 2,364 |
| 18 | [illegible] | 1,848 | 1,591 | [illegible] | 1,560 | 1,878 |
| 19 | [illegible] | 2,054 | 1,591 | [illegible] | 2,070 | 1,172 |
| 20 | [illegible] | 811 | 1,562 | [illegible] | 1,870 | 600 |
| 21 | [illegible] | 1,848 | 1,701 | [illegible] | 2,070 | 600 |
| 22 | [illegible] | 1,643 | 1,168 | [illegible] | 1,870 | 750 |
| 23 | [illegible] | 2,054 | 1,587 | [illegible] | 1,560 | 950 |
| 24 | [illegible] | 2,054 | 1,594 | [illegible] | 2,070 | 1,012 |
| 25 | [illegible] | 1,232 | 1,572 | 750 | 2,070 | 720 |
| 26 | [illegible] | 800 | 1,705 | 1,260 | 1,970 | 650 |
| 27 | [illegible] | 1,438 | 1,158 | 1,980 | 1,380 | 620 |
| 28 | [illegible] | 1,848 | 1,580 | 1,720 | 1,610 | [illegible] |
| 29 | [illegible] | 2,054 | 1,398 | 1,320 | 1,840 | [illegible] |
| 30 | [illegible] | 2,540 | 1,974 | 1,620 | 1,610 | [illegible] |
| 31 | [illegible] | 1,428 | 1,121 | 1,620 | 1,380 | [illegible] |
| Subtotal | 37,022 | 49,512 | 48,035 | 47,670 | 51,890 | 42,855 |

| Rig | Wells | Mar (gallons) | Totals (gallons) |
|---|---|---|---|
| Rig #1 | Well #1 | 5,200 | 5,200 |
| | [illegible] | 31,822 | 31,822 |
| | | | 37,022 |
| Rig #2 | Well #3 | - | - |
| | [illegible] | 10,656 | 10,656 |
| | Well #5 | 38,856 | 38,856 |
| | | | 49,512 |
| Rig #3 | Well #6 | - | - |
| | [illegible] | 22,447 | 22,447 |
| | Well #8 | 25,588 | 25,588 |
| | | | 48,035 |
| Rig #4 | Well #9 | - | - |
| | [illegible] | 37,400 | 37,400 |
| | Well #11 | 10,270 | 10,270 |
| | | | 47,670 |
| Rig #5 | Well #12 | - | - |
| | [illegible] | 10,730 | 10,730 |
| | Well #14 | 41,160 | 41,160 |
| | | | 51,890 |
| Rig #6 | Well #15 | - | - |
| | [illegible] | - | - |
| | Well #17 | 38,736 | 38,736 |
| | [illegible] | 4,119 | 4,119 |
| | | | 42,855 |

# Drill Rig Emissions - 2009

## Natural Gas Consumption

(Sample data entries provided below for January through December 2009)

### 2009 Drill Rig Natural Gas Consumption

| January | Rig #1 (gallons) | Rig #2 (gallons) | Rig #3 (gallons) | Rig #4 (gallons) | Rig #5 (gallons) | Rig #6 (gallons) |
|---|---|---|---|---|---|---|
| 1 | 1,600 | 1,850 | 1,572 | 1,800 | 2,070 | 1,755 |
| 2 | 1,700 | 2,054 | 2,390 | 1,800 | 1,380 | 1,990 |
| 3 | 1,500 | 1,848 | 1,572 | 1,800 | 2,070 | 1,726 |
| 4 | 1,500 | 1,221 | 1,889 | 1,440 | 1,380 | 1,274 |
| 5 | 1,600 | 1,848 | 1,753 | 1,800 | 2,300 | 1,345 |
| 6 | 1,000 | 2,054 | 1,591 | 1,620 | 1,840 | 978 |
| 7 | 600 | 1,848 | 1,591 | 1,620 | 1,870 | [illegible] |
| 8 | 1,000 | 2,054 | 1,462 | 1,400 | 1,840 | [illegible] |
| 9 | 1,200 | 811 | 1,809 | 1,620 | 1,610 | [illegible] |
| 10 | 1,200 | 1,848 | 1,572 | 1,620 | 1,840 | [illegible] |
| 11 | 1,500 | 1,233 | 1,594 | 1,440 | 1,610 | [illegible] |
| 12 | 1,200 | 1,027 | 1,978 | 1,440 | 1,840 | [illegible] |
| 13 | 1,300 | [illegible] | 1,897 | 1,800 | 1,840 | [illegible] |
| 14 | 1,300 | [illegible] | 2,341 | 1,700 | [illegible] | [illegible] |
| 15 | 1,122 | [illegible] | 1,992 | 1,440 | [illegible] | [illegible] |
| 16 | 1,496 | [illegible] | 1,580 | 1,800 | [illegible] | [illegible] |
| 17 | 1,122 | [illegible] | 1,343 | 1,620 | [illegible] | [illegible] |
| 18 | 1,122 | [illegible] | 1,134 | 1,080 | [illegible] | [illegible] |
| 19 | 855 | [illegible] | [illegible] | 2,340 | [illegible] | [illegible] |
| 20 | 1,496 | [illegible] | 787 | 1,860 | [illegible] | [illegible] |
| 21 | 1,870 | [illegible] | [illegible] | 2,160 | [illegible] | [illegible] |
| 22 | 1,663 | [illegible] | [illegible] | 1,980 | [illegible] | [illegible] |
| 23 | 1,496 | [illegible] | [illegible] | 1,580 | [illegible] | [illegible] |
| 24 | 2,203 | [illegible] | [illegible] | 1,620 | [illegible] | [illegible] |
| 25 | 1,309 | [illegible] | [illegible] | 1,280 | [illegible] | [illegible] |
| 26 | 1,496 | [illegible] | [illegible] | 900 | [illegible] | [illegible] |
| 27 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 28 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 29 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 30 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 31 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) |
| Subtotal | 41,995 | 56,834 | 50,639 | 51,200 | 57,000 | 47,178 |

| Rig | Wells | Jan (gallons) | Totals (gallons) |
|---|---|---|---|
| Rig #1 | Well #1 | 41,995 | 41,995 |
| | Well #2 | - | - |
| | | | 41,995 |
| Rig #2 | Well #3 | 19,696 | 19,696 |
| | Well #4 | 37,138 | 37,138 |
| | Well #5 | - | - |
| | | | 56,834 |
| Rig #3 | Well #6 | 31,060 | 31,060 |
| | Well #7 | 19,579 | 19,579 |
| | Well #8 | - | - |
| | | | 50,639 |
| Rig #4 | Well #9 | 42,580 | 42,580 |
| | Well #10 | 8,620 | 8,620 |
| | Well #11 | - | - |
| | | | 51,200 |
| Rig #5 | Well #12 | 23,490 | 23,490 |
| | Well #13 | 33,510 | 33,510 |
| | Well #14 | - | - |
| | | | 57,000 |
| Rig #6 | Well #15 | 9,068 | 9,068 |
| | Well #16 | 38,110 | 38,110 |
| | Well #17 | - | - |
| | Well #18 | - | - |
| | | | 47,178 |

| February | Rig #1 (gallons) | Rig #2 (gallons) | Rig #3 (gallons) | Rig #4 (gallons) | Rig #5 (gallons) | Rig #6 (gallons) |
|---|---|---|---|---|---|---|
| 1 | 1,600 | 1,850 | 1,572 | 1,800 | 2,070 | 1,755 |
| 2 | 1,700 | 2,054 | 2,390 | 1,800 | 1,380 | 1,990 |
| 3 | 1,500 | 1,848 | 1,572 | 1,800 | 2,070 | 1,726 |
| 4 | 1,500 | 1,221 | 1,889 | 1,440 | 1,380 | 1,274 |
| 5 | 1,600 | 1,848 | 1,753 | 1,800 | 2,300 | 1,345 |
| 6 | 1,000 | 2,054 | 1,591 | 1,620 | 1,840 | 978 |
| 7 | 600 | 1,848 | 1,591 | 1,620 | 1,870 | [illegible] |
| 8 | 1,000 | 2,054 | 1,462 | 1,400 | 1,840 | [illegible] |
| 9 | 1,200 | 811 | 1,809 | 1,620 | 1,610 | [illegible] |
| 10 | 1,200 | 1,848 | 1,572 | 1,620 | 1,840 | [illegible] |
| 11 | 1,500 | 1,233 | 1,594 | 1,440 | 1,610 | [illegible] |
| 12 | 1,200 | 1,027 | 1,978 | 1,440 | 1,840 | [illegible] |
| 13 | 1,300 | [illegible] | 1,897 | 1,800 | 1,840 | [illegible] |
| 14 | 1,300 | [illegible] | 2,341 | 1,700 | [illegible] | [illegible] |
| 15 | 1,122 | [illegible] | 1,992 | 1,440 | [illegible] | [illegible] |
| 16 | 1,496 | [illegible] | 1,580 | 1,800 | [illegible] | [illegible] |
| 17 | 1,122 | [illegible] | 1,343 | 1,620 | [illegible] | [illegible] |
| 18 | 1,122 | [illegible] | 1,134 | 1,080 | [illegible] | [illegible] |
| 19 | 855 | [illegible] | [illegible] | 2,340 | [illegible] | [illegible] |
| 20 | 1,496 | [illegible] | 787 | 1,860 | [illegible] | [illegible] |
| 21 | 1,870 | [illegible] | [illegible] | 2,160 | [illegible] | [illegible] |
| 22 | 1,663 | [illegible] | [illegible] | 1,980 | [illegible] | [illegible] |
| 23 | 1,496 | [illegible] | [illegible] | 1,580 | [illegible] | [illegible] |
| 24 | 2,203 | [illegible] | [illegible] | 1,620 | [illegible] | [illegible] |
| 25 | 1,309 | [illegible] | [illegible] | 1,280 | [illegible] | [illegible] |
| 26 | 1,496 | [illegible] | [illegible] | 900 | [illegible] | [illegible] |
| 27 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 28 | 1,309 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) | (gallons) |
| Subtotal | 38,068 | 50,672 | 45,815 | 45,260 | 51,480 | 44,871 |

| Rig | Wells | Feb (gallons) | Totals (gallons) |
|---|---|---|---|
| Rig #1 | Well #1 | 38,068 | 38,068 |
| | Well #2 | - | - |
| | | | 38,068 |
| Rig #2 | Well #3 | 19,696 | 19,696 |
| | Well #4 | 30,976 | 30,976 |
| | Well #5 | - | - |
| | | | 50,672 |
| Rig #3 | Well #6 | 31,060 | 31,060 |
| | Well #7 | 14,755 | 14,755 |
| | Well #8 | - | - |
| | | | 45,815 |
| Rig #4 | Well #9 | 42,580 | 42,580 |
| | Well #10 | 2,680 | 2,680 |
| | Well #11 | - | - |
| | | | 45,260 |
| Rig #5 | Well #12 | 23,490 | 23,490 |
| | Well #13 | 27,990 | 27,990 |
| | Well #14 | - | - |
| | | | 51,480 |
| Rig #6 | Well #15 | 9,068 | 9,068 |
| | Well #16 | 35,803 | 35,803 |
| | Well #17 | - | - |
| | Well #18 | - | - |
| | | | 44,871 |

| March | Rig #1 (gallons) | Rig #2 (gallons) | Rig #3 (gallons) | Rig #4 (gallons) | Rig #5 (gallons) | Rig #6 (gallons) |
|---|---|---|---|---|---|---|
| 1 | 1,500 | [illegible] | [illegible] | [illegible] | [illegible] | 781 |
| 2 | 800 | [illegible] | [illegible] | [illegible] | [illegible] | 1,587 |
| 3 | 900 | [illegible] | [illegible] | [illegible] | [illegible] | 2,498 |
| 4 | 1,200 | [illegible] | [illegible] | [illegible] | [illegible] | 886 |
| 5 | 600 | [illegible] | [illegible] | [illegible] | [illegible] | 1,303 |
| 6 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1,945 |
| 7 | [illegible] | [illegible] | [illegible] | [illegible] | 1,080 | 1,591 |
| 8 | [illegible] | 821 | [illegible] | [illegible] | 460 | 1,977 |
| 9 | [illegible] | 1,233 | [illegible] | [illegible] | 690 | 2,152 |
| 10 | [illegible] | 1,232 | [illegible] | [illegible] | 1,610 | 1,733 |
| 11 | [illegible] | 1,849 | [illegible] | [illegible] | 2,070 | 1,783 |
| 12 | [illegible] | 1,643 | [illegible] | [illegible] | 1,840 | 1,594 |
| 13 | [illegible] | 1,849 | [illegible] | [illegible] | 1,840 | 1,956 |
| 14 | [illegible] | 1,232 | [illegible] | [illegible] | 1,780 | 1,685 |
| 15 | [illegible] | 1,648 | 1,250 | [illegible] | 1,610 | 1,959 |
| 16 | [illegible] | 2,054 | 1,860 | [illegible] | 1,610 | 1,990 |
| 17 | [illegible] | 1,643 | 1,176 | [illegible] | 1,840 | 2,364 |
| 18 | [illegible] | 1,848 | 1,591 | [illegible] | 1,560 | 1,678 |
| 19 | [illegible] | 2,054 | 1,591 | [illegible] | 2,070 | 1,172 |
| 20 | [illegible] | 811 | 1,562 | [illegible] | 1,670 | 600 |
| 21 | [illegible] | 1,848 | 1,701 | [illegible] | 2,070 | 600 |
| 22 | [illegible] | 1,643 | 1,168 | [illegible] | 1,870 | 750 |
| 23 | [illegible] | 2,054 | 1,587 | [illegible] | 1,560 | 950 |
| 24 | [illegible] | 2,054 | 1,584 | [illegible] | 2,070 | 1,012 |
| 25 | [illegible] | 1,232 | 1,572 | 750 | 2,070 | 720 |
| 26 | [illegible] | 800 | 1,705 | 1,260 | 1,970 | 650 |
| 27 | [illegible] | 1,438 | 1,158 | 1,980 | 1,380 | 620 |
| 28 | [illegible] | 1,848 | 1,580 | 1,720 | 1,610 | [illegible] |
| 29 | [illegible] | 2,054 | 1,398 | 1,320 | 1,840 | [illegible] |
| 30 | [illegible] | 2,540 | 1,974 | 1,620 | 1,610 | [illegible] |
| 31 | [illegible] | 1,428 | 1,121 | 1,620 | 1,380 | [illegible] |
| Subtotal | 37,022 | 49,512 | 48,035 | 47,670 | 51,890 | 42,855 |

| Rig | Wells | Mar (gallons) | Totals (gallons) |
|---|---|---|---|
| Rig #1 | Well #1 | 5,200 | 5,200 |
| | Well #2 | 31,822 | 31,822 |
| | | | 37,022 |
| Rig #2 | Well #3 | - | - |
| | Well #4 | 10,656 | 10,656 |
| | Well #5 | 38,856 | 38,856 |
| | | | 49,512 |
| Rig #3 | Well #6 | - | - |
| | Well #7 | 22,447 | 22,447 |
| | Well #8 | 25,588 | 25,588 |
| | | | 48,035 |
| Rig #4 | Well #9 | - | - |
| | Well #10 | 37,400 | 37,400 |
| | Well #11 | 10,270 | 10,270 |
| | | | 47,670 |
| Rig #5 | Well #12 | - | - |
| | Well #13 | 10,730 | 10,730 |
| | Well #14 | 41,160 | 41,160 |
| | | | 51,890 |
| Rig #6 | Well #15 | - | - |
| | Well #16 | - | - |
| | Well #17 | 38,736 | 38,736 |
| | Well #18 | 4,119 | 4,119 |
| | | | 42,855 |

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| tion (WGS84) | | Well Name | Field Name | Well Spud Date | Formation | Drilling Start Date | Drilling End Date | Well Depth | Site Rating | Hours Operated to Drill Well | Natural Gas Use per Well | Heat Content Natural Gas | Diesel Fuel Use per Well | Heat Content Diesel Fuel | Diesel Sulfur Content | Heat Input of Fuel | BSFC | Drill Rig Emission Factors | | | | | Emissions from Drilling | | | | | | Stack Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long | Elev | | | | | | | | | | | | | | | | | $NO_x$ | CO | VOC | $PM_{10}$ | HCHO | $NO_x$ | CO | VOC | $PM_{10}$ | HCHO | $SO_2$ | Height | Temp | Velocity | Diameter |
| | feet | | | | | | | | hp or (MMBtu/hr) | | mscf | Btu/scf | gal | Btu/gal | $ppm_w$ | MMBtu | Btu/hp-hr | g/hp-hr* or (lb/MMBtu)** | | | | | Tons per Well | | | | | | ft | °F | ft/sec | ft |
| -109.70750 | 7,179 | Stud Horse Butte 41-22 | Jonah | 12/16/07 | Lance | 2/3/08 | 2/14/08 | 11,751 | 1,476 | 288 | | 1,000 | 15,431 | 130,000 | 500 | 2,006 | 7,389 | 4.80 | 8.50 | 1.00 | 0.40 | 0.00 | 1.44 | 2.54 | 0.30 | 0.12 | 0.00 | 0.05 | 16.40 | 630.55 | 98.40 | 0.66 |
| | | | | | | | | | 1,476 | 288 | | 1,000 | 15,431 | 130,000 | 500 | 2,006 | 7,389 | 4.80 | 8.50 | 1.00 | 0.40 | 0.00 | 1.44 | 2.54 | 0.30 | 0.12 | 0.00 | 0.05 | 16.40 | 630.55 | 98.40 | 0.66 |
| | | | | | | | | | (6.3) | 144 | | 1,000 | 4,209 | 130,000 | 500 | 547 | 7,000 | (0.15) | (0.036) | (0.0022) | (0.015) | (0.00045) | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 13.00 | 344.00 | 17.50 | 1.29 |
| -109.70708 | 7,187 | Stud Horse Butte 41-22 | Jonah | 12/13/07 | Lance | 2/24/08 | 3/6/08 | 11,679 | 1,476 | 264 | | 1,000 | 3,628 | 130,000 | 500 | 472 | 6,782 | 4.80 | 8.50 | 1.00 | 0.40 | 0.00 | 0.37 | 0.65 | 0.08 | 0.03 | 0.00 | 0.01 | 16.40 | 630.55 | 98.40 | 0.66 |
| | | | | | | | | | 1,476 | 264 | | 1,000 | 3,628 | 130,000 | 500 | 472 | 6,782 | 4.80 | 8.50 | 1.00 | 0.40 | 0.00 | 0.37 | 0.65 | 0.08 | 0.03 | 0.00 | 0.01 | 16.40 | 630.55 | 98.40 | 0.66 |
| | | | | | | | | | (6.3) | 123 | | 1,000 | 1,062 | 130,000 | 500 | 137 | 6,200 | (0.15) | (0.036) | (0.0022) | (0.015) | (0.00045) | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.00 | 344.00 | 17.50 | 1.29 |
| Rig #1 - H&P 000 (Continue for next well drilled using Rig #1 – following the above format) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| -109.70761 | 7,179 | Stud Horse Butte 21-22 | Jonah | 12/13/07 | Lance | 2/13/08 | 2/24/08 | 11,638 | 1,476 | 288 | | 1,000 | 15,431 | 130,000 | 500 | 2,006 | 7,389 | 4.80 | 8.50 | 1.00 | 0.40 | 0.00 | 1.44 | 2.54 | 0.30 | 0.12 | 0.00 | 0.05 | 16.40 | 630.55 | 98.40 | 0.66 |
| | | | | | | | | | 1,476 | 288 | | 1,000 | 15,431 | 130,000 | 500 | 2,006 | 7,389 | 4.80 | 8.50 | 1.00 | 0.40 | 0.00 | 1.44 | 2.54 | 0.30 | 0.12 | 0.00 | 0.05 | 16.40 | 630.55 | 98.40 | 0.66 |
| | | | | | | | | | (6.3) | 144 | | 1,000 | 4,209 | 130,000 | 500 | 547 | 7,000 | (0.15) | (0.036) | (0.0022) | (0.015) | (0.00045) | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 13.00 | 344.00 | 17.50 | 1.29 |
| Rig #2 - H&P 001 (Continue for next well drilled using Rig #2 – following the above format) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

2017-004853-00177