

COAL MINE METHANE CAPTURE AND USE PROJECT AT NORTH ANTELOPE ROCHELLE COAL MINE COMPLEX



Document Prepared By: Blue Source LLC.

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1 PROJECT DETAILS

1.1 Summary Description of Project

The Project is located within the lease boundaries of an active open cast mine south of Gillette, Wyoming. Peabody Natural Gas, LLC (PNG) and Powder River Coal, LLC (PRC) are wholly owned subsidiaries of Peabody Energy Corporation. PRC owns all mineral and environmental attributes associated with coal mine methane. PNG controls operation of the coal bed methane recovery Project for PRC.

Recognizing that methane is released as a by-product of mining coal, Peabody Energy Corporation directed its subsidiary Peabody Natural Gas, LLC (PNG) to attempt to pre-drain the methane from the coal prior to mining beginning in 2002. Prior to this, all methane contained in the coal was passively vented to the atmosphere through the open cast mine's highwall or face. PNG has made substantial investments to develop an appropriate pre-drainage mining plan and build the necessary infrastructure to produce, compress, meter, and transport the methane to the nearest natural gas pipeline. A total of 47 wells were drilled within the mine lease boundary and up to a total of 1,300 hp of compression was installed by PNG to capture methane from the coal prior to mining.

The active collection system consists of a network of gas extraction wells, laterals, and header pipes to extract the methane, dewatering pumps, and compressors. The PDD provides additional details regarding the site and the gas collection system.

The methane is compressed and transported to a natural gas pipeline where it is distributed to a national natural gas grid for use as fuel. Beginning in 2002 methane was sold to Kinder Morgan until early 2003 when gas sales were split between Kinder Morgan and Western/Anadarko. Since 2005, all Project gas sales have been handled by Western/Anadarko.

As of October 31, 2007 the end of the 1st monitoring period, 30 wells were in production. Several wells have been shut in since the credit start date (March 28, 2006) because 1) the wells were in the path of the mining advance, were plugged, and eventually mined through; or 2) the wells exhibited high concentrations of air resulting from the intersection by coal mining activities. As of April 1, 2009, there were no longer any wells in production.

No emission reductions from CBM utilization and or destruction can be claimed until the mining activity enters the zone of influence of the well or when the well is mined through. Because of the shallow depths and high coal permeability, the pre-drainage wells communicate with the mine face much sooner than deep underground coal seams. Evidence has shown that the gas from the wells located within approximately 2000 feet of the mine face contain up to 60-70% air. Because of this, the project considers the well to be in full communication with the mine face (before it's actually mined through). The date that the well is shut in due to high concentrations of air is considered to be intersected by coal mining activities. As a result, emission reductions based on cumulative methane capture by the eligible wells are credited the year in which the wells are shut in.

The Project was validated in accordance with the requirements of the Voluntary Carbon Standard (VCS 2007.1) (VRM00001) and an approved revision of the UNFCCC's CDM methodology ACM0008 in March 2009.

Table 1. Well ID & Shut in Date below provides a summary the eligible wells that were shut in during the reporting period of March 2006-October 2007. Table 2- Summary of Emission Reductions demonstrate the emission reductions generated by the project activity from March 28th 2006-October 31st 2007.

Table 1: Well ID & Shut in Date

Well ID	Shut in Date
VEG State 22-30	June 1, 2006
VEG Federal 12-25	October 8, 2007
VEG Federal 23-25	October 8, 2007
VEG Federal 34-25	October 8, 2007
VEG Federal 43-25	October 8, 2007
Federal 21-2-41-71	October 11, 2007

Table 2: Summary of Emission Reductions (tonnes CO₂e)

	2006	2007
Baseline Emissions	8,541	218,410
Project Emissions	1,250	31,951
Total Emission Reductions	7,291 (tCO₂E)	186,459 (tCO₂E)

1.2 Sectoral Scope and Project Type

- Mining/Mineral production, Sectoral Scope 8
- Individual Project

1.3 Project Proponent

Peabody Natural Gas, LLC (PNG) and Powder River Coal, LLC (PRC) are wholly owned subsidiaries of Peabody Energy Corporation. PRC owns all mineral and environmental attributes associated with coal mine methane. PNG controls operation of the coal bed methane recovery Project for PRC.

Project Proponent(s):

Organization name	Peabody Natural Gas, LLC (PNG)
Contact person	Josh Price
Title	Dir. Mine Services & Tech Support
Address	1013 East Boxelder; Gillette, Wyoming 82718
Telephone	307-687-3960
Email	jprice@peabodyenergy.com

1.4 Other Entities Involved in the Project

Blue Source LLC (“Blue Source”) has been contracted by Peabody Natural Gas to create and monetize the greenhouse gas (GHG) emission reduction credits generated by the Project.

Organization name	Blue Source
Role in the project	Project Developer
Contact person	Kevin Townsend
Title	Chief Commercial Officer
Address	1935 East Vine St, Suite 300; Murray UT 84121
Telephone	801-438-1540
Email	ktownsend@bluesource.com

1.5 Project Start Date

PNG began pre-draining methane from the NARM coal mine with an initial set of pilot wells drilled in October 2001. Based on the success of these pilot wells, a decision was made to invest significant capital to drill additional wells in 2002 and subsequent years. Methane began flowing through the pipeline to be destroyed March 2002, therefore the project start date is March 1, 2002.

1.6 Project Crediting Period

The crediting period is from March 28, 2006 to March 27, 2016.

1.7 Project Location

The Project is located within the lease boundaries of an active open cast mine south of Gillette, Wyoming. The GPS Coordinates are: 43.547282, -105.3204022

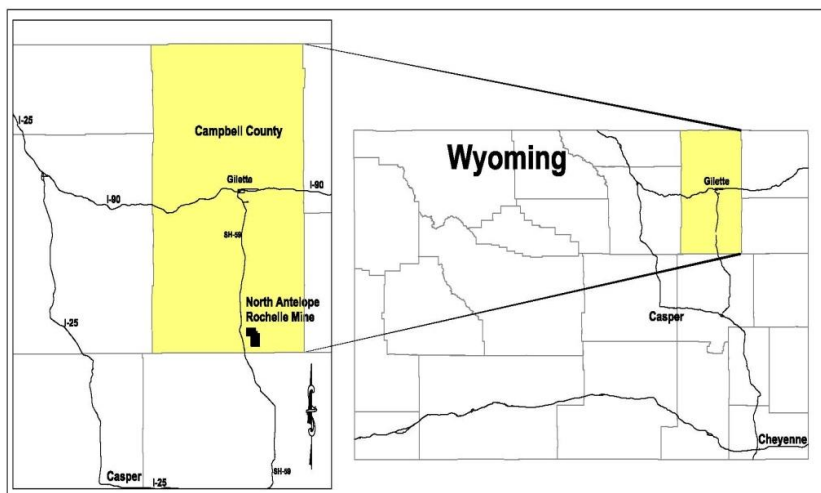
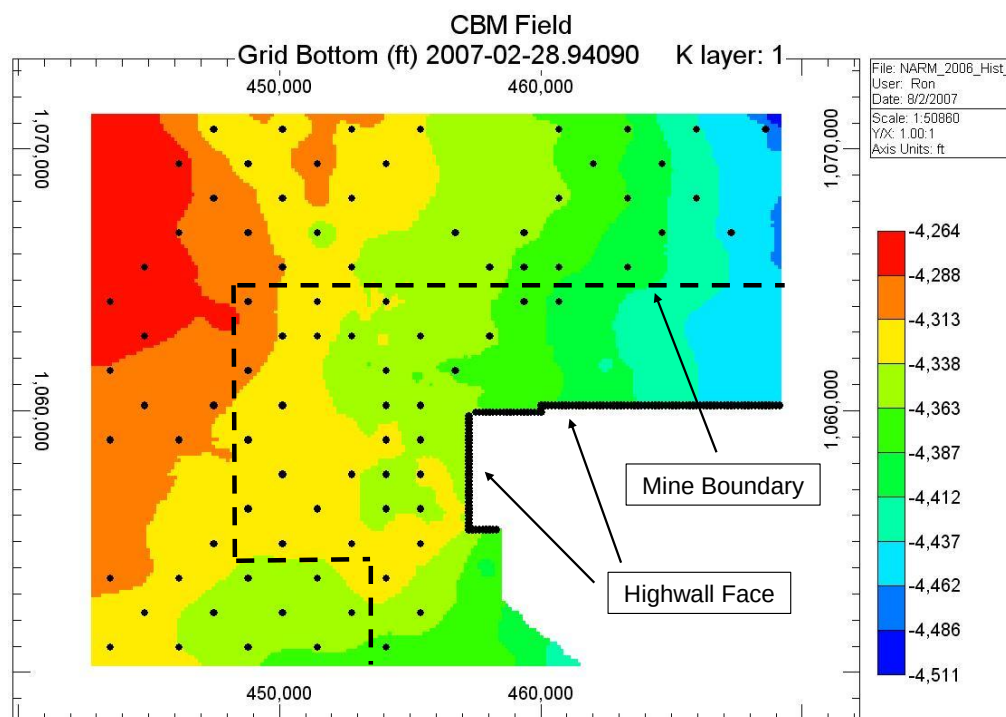


Figure 1. Location of NARM Coal Mine in Campbell County, State of Wyoming, USA**Figure 2. Map of NARM boundary – all wells within the boundary are PNG. The colors represent the elevation of the bottom of the mined coal seam**

1.8 Title and Reference of Methodology

The following methodology was used for this project:

- Consolidated baseline methodology CDM ACM0008– Version 5: Consolidated methodology for coal bed methane, coal mine methane and ventilation air capture and use for power (electrical or motive) and heat and/or destruction by flaring of catalytic oxidation
- Validated methodology revision (VRM0001) to include Pre-drainage of Methane from an active Open Cast Mine as a Methane Emission Reduction Activity was used for this project

1.9 Other Programs

This project is not registered under any other emission trading/ GHG programs for the destruction of methane gas from the coal mine methane.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The emission reductions generated by the project from March 26, 2006 to October 31, 2007 were verified and registered with the VCS. This monitoring report is in addition to the previous monitoring report covering the same verification period and vintage. Blue Source received an exemption letter from VCS which can be provided upon request for more information. This monitoring report includes the emission reductions generated in October 2007 from six wells that were shut-in in October 2007 but were not included in the 2006-2007 monitoring report. As of April 1, 2009 there were no longer any wells in production.

2.2 Deviations

2.2.1- Methodology Deviations

There are a couple minor deviations to the monitoring plan that were all approved at Validation and do not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in compliance with the applied methodology.

These deviations from the methodology relate to data and parameters monitored.

- Electricity consumption was not measured continuously. Separate meters were not installed on each compressor or electric pump to monitor Project emissions for electricity consumption. Electricity consumption is estimated using equipment runtime and horsepower.
- To be conservative, the project emissions are calculated by assuming the compressors operate continuously. This is similar for fossil fuel consumption. Fossil fuel consumption is estimated using vehicle miles driven and fuel economy.
- The methane content is determined onsite at the gas sales point on a periodic basis. The gas composition in the coal seam may vary slightly from place to place but is generally consistent. One study cited in the PDD showed that desorption testing data from two CBM wells located approximately one mile apart reported similar gas composition values. The monitoring of methane content is consistent with buyers' requirements. Additionally, a conservative approach was used in the emission reduction calculations based on the periodic methane readings (i.e., the lower of the two values measured before and after the time period in which a methane reading was not collected was used).

2.2.2 –Project Description Deviations

There are a couple minor project description deviations to the monitoring plan that do not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in compliance with the applied methodology.

These deviations from the project description are:

- The project description indicates that the flow will be accounted for by using Enertia, which allocates gas production back to each individual well. This monitoring period data submitted to Wyoming Oil and Gas Conservation Commission is used instead. This data is considered regulatory data and is more conservative than the Enertia flow data. This does not impact the

applicability of the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in compliance with the applied methodology.

- The project description indicates that the metered volumes of mine methane will be documented by sales meters which are maintained by the buyer of the gas. Since buyers have changed over the years, calibration records dating back to project start date may be unavailable. Calibration certificates were provided for one of the meters. However for the other meters, these are assumed to be within tolerance for a couple of reasons. Contractually PNG had in place with its buyers a semi-annual calibration of the equipment. It was reported that no calibration events were outside the 3% threshold. Also since the buyers of the gas were paying hundreds of thousands of dollars every month, the transactional confidence supports the fact that these semi-annual calibration events took place.
- The project description indicates that the mine methane concentration equipment will be calibrated before use as necessary. Since buyers have several CG units and buyers have changed over the years, calibration records dating back to project start date are unavailable. However these meters are assumed to be within tolerance for a couple of reasons. Contractually PNG had in place with its buyers a semi-annual calibration of the equipment. It was reported that no calibration events were outside the 3% threshold. Also since the buyers of the gas were paying hundreds of thousands of dollars every month, the transactional confidence supports the fact that these semi-annual calibration events took place.
- The project description indicates that Blue Source is the project proponent. However, VCS's definition of Project Proponent has changed over the years, whereas Blue Source is no longer the project Proponent. Instead, the new Project Proponent is Peabody Natural Gas a wholly owned subsidiary of Peabody Energy Corporation. This does not impact the project conservativeness in anyway.

2.3 Grouped Project

This section is not applicable as the project is an individual project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

A listing of the variables that are estimated or quantified using emission factors or default values is provided below

Data / Parameter:	GWP _{CH₄}
Data unit:	tCO ₂ e/tCH ₄
Description:	Global warming potential of CH ₄
Source of data:	IPCC
Value of data applied:	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Justification of choice of data or description of	IPCC

measurement methods and procedures applied	
Purpose of data:	Baseline and Project Emissions
Any comment:	N/A

Data / Parameter:	Eff_i
Data unit:	Dimensionless
Description:	Efficiency of methane destruction/leakage in gas pipelines
Source of data:	ACM0008, ver. 5, p. 13
Value of data applied:	0.985
Justification of choice of data or description of measurement methods and procedures applied	IPCC
Purpose of data:	Baseline and Project Emissions
Any comment:	N/A

Data / Parameter:	CEF_{CH_4}
Data unit:	Dimensionless (t CO ₂ / t CH ₄)
Description:	CO ₂ emissions factor for combusted methane
Source of data:	ACM0008, ver. 5, p. 11
Value of data applied:	2.75
Justification of choice of data or description of measurement methods and procedures applied	IPCC
Purpose of data:	Baseline and Project Emissions
Any comment:	N/A

Data / Parameter:	NCVi
Data unit:	TJ / GJ
Description:	The net calorific value (energy content) per mass or volume unit of fuel i (motor gasoline).
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	44.3
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of the Data:	N/A
Any comment:	N/A

Data / Parameter:	$EF_{CO_2,L,v}$
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Data unit:	tCO ₂ /TJ
Description:	Energy content of natural gas
Source of data:	The CO ₂ emission factor per unit of energy of the fuel <i>i</i> (motor gasoline) in year <i>y</i> .
Value applied:	69.3
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value
Purpose of the Data	N/A
Any comment:	N/A

Data / Parameter:	EF _{ELEC}
Data unit:	t CO ₂ / MWh
Description:	CO ₂ emission factor for the NWPP (State of Wyoming) power grid
Source of data:	Following the CDM Annex 7 “Tool to calculate baseline, project and / or leakage emissions from electricity consumption” Option A2, regional values are used as the default value provided by the tool was not representative of the emission intensity of grid-connected electricity generation in the United States. The emission factor is sourced from the US EPA's Emissions & Generation Resource Integrated Database (eGrid) 2014, Version 1.1: Year 2010 Summary Tables. Emission factor for NWPP.
Value applied:	0.3822 tonnes CO ₂ / MMBtu
Justification of choice of data or description of measurement methods and procedures applied	US EPA number
Purpose of the Data	This is used for baseline emissions
Any comment:	Value will be reviewed annually to ensure it is appropriate or following any future revision of the US EPA emission factors, as applicable.

3.2 Data and Parameters Monitored

Data / Parameter:	T
Data unit:	m
Description:	Total thickness of coal in longwall or open cast mine face emission zone
Source of data:	Geology report and drilling records
Value applied:	N/A

Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of the data:	This is used for baseline emissions
Any comment:	N/A

Data / Parameter:	AOw
Data unit:	m ²
Description:	Area of overlap with longwall panel or open cast mine face
Source of data:	Recorded
Value of data applied:	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of the data:	Project Emissions
Any comment:	

Data / Parameter:	PC _{CH4}
Data unit:	%
Description:	Concentration (in mass) of methane in extracted gas (%)
Source of data:	Measured
Description of measurement methods and procedures to be applied:	The methane concentration is measured by the gas chromatograph
Frequency of Monitoring/Recording	Monthly
Value Monitored	85.410%
Monitoring Equipment	Varian CP 4900 portable atomic adsorption equipment
QA/QC procedures:	Calibrated as necessary prior to use
Purpose of the data	Calculation of baseline emissions
Calculation Method:	95% Confidence Interval of Monthly Measured values
Any comment:	95% lower confidence level is calculated by using the individual monthly methane readings.

Data / Parameter:	PC _{NMHC}
Data unit:	%

Description:	NMHC Concentration (in mass) in extracted coal mine gas
Source of data:	Measurements
Value of data applied:	Assumed to be zero for ex ante estimates. Monthly measurements indicate NMHC concentration in gas to be around 0.1%.
Justification of choice of data or description of measurement methods and procedures applied	Measured, using concentration meters, optical and calorific, on wet basis Measured monthly to check if more than 1% concentration
Purpose of data:	Baseline & Project Emissions
Any comment:	Gas detector will be subject to a regular maintenance regime to ensure accuracy. Data will be kept during the crediting period and two years after. Data will be aggregated monthly/yearly. Gas detector will be subject to a regular maintenance regime to ensure accuracy.

Data / Parameter:	MM _{PL}
Data unit:	tCH ₄
Description:	Methane sent to pipeline
Source of data:	Measured
Description of measurement methods and procedures to be applied:	Power River Coal Company staff visit the site each day and record the 24 hr gas volume and the cumulative gas volume from the meter. This information is transferred to an excel spreadsheet. This information is imported into an oil & gas software program called "Enertia", which allocates gas production back to each individual well.
Frequency of Monitoring/Recording	Calculated from measured data on gas flow rate, temperature, pressure, and methane content.
Value Monitored	2006: 406.7143 2007: 10,400.5238
Monitoring Equipment	Flow meter- ABB Total Flow XFC 6413
QA/QC procedures:	Meters will be subject to a regular semi-annual calibration and maintenance to ensure accuracy.
Purpose of the data	Calculation of baseline emissions
Calculation Method:	See details in spreadsheet CMM_Addendum Calculations_07.14.15.xls
Any comment:	Flow meters will record gas volumes, pressure and temperature. The flow meter would compensate automatically for pressure and temperature to determine normalized flow rate. Data will be calculated continuously electronically and will be kept during the crediting period and two years after. Data will be aggregated monthly/yearly.

Data / Parameter:	CBM _{ei,y}
Data unit:	tCH ₄
Description:	Eligible CBM captured, sent to and destroyed by use i in the baseline scenario in year y.
Source of data:	Measured
Description of	Power River Coal Company staff visit the site each day and

measurement methods and procedures to be applied:	record the 24 hr gas volume and the cumulative gas volume from the meter. This information is transferred to an excel spreadsheet. This information is imported into an oil & gas software program called "Enertia", which allocates gas production back to each individual well.
Frequency of Monitoring/Recording	Yearly
Value Monitored	2006: 406.7143 2007: 10,400.5238
Monitoring Equipment	Flow meter- ABB Total Flow XFC 6413
QA/QC procedures:	Meters will be subject to a regular semi-annual calibration and maintenance to ensure accuracy.
Purpose of the data	Calculation of baseline emissions
Calculation Method:	See details in spreadsheet CMM_Addendum Calculations_07.14.15.xls
Any comment:	Flow meters will record gas volumes, pressure and temperature. The flow meter would compensate automatically for pressure and temperature to determine normalized flow rate. Data will be calculated continuously electronically and will be kept during the crediting period and two years after. Data will be aggregated monthly/yearly.

Data / Parameter:	V _c
Data unit:	M ³ /day
Description:	Cumulative Flow from all wells
Source of data:	Measured
Description of measurement methods and procedures to be applied:	The flow from all wells is measured by a Flow meter-
Frequency of Monitoring/Recording	Monthly
Value Monitored	18-32,001 mcf
Monitoring Equipment	ABB Total Flow XFC 6413
QA/QC procedures:	Flow meter calibrated on a semi-annual basis
Purpose of the data	Calculation of baseline emissions
Calculation Method:	Measured
Any comment:	"All wells" includes only those wells in this verification period (6 wells)

3.3 Description of the Monitoring Plan

The organizational structure, responsibilities, and competencies of personnel that carried out the monitoring activities for Peabody were as follows:

Peabody Natural Gas, LLC (PNG) Manager of Natural Gas Operations

Gillette, Wyoming: Responsible for all Field Operations and contract service providers

Contract Pumping Service: In the field each day going to each well, records daily well production, general maintenance well equipment, records activity and any needed repairs files monthly report with Gillette and Golden

Contract Chart Integrator Service: receives Barton Charts each month from all wells, examines and records total volume for the month for each well, sent to Gillette and Golden offices.

Purchaser/Gas Purchase Contract: Custody Transfer Meter Sales Inlet records total daily volume from all wells. Monthly volume statement sent to Golden office and Monthly settlement statement sent to Golden office

General and Administrative Office Golden, Colorado: Oil, Gas and CBM business is maintained on an Oil and Gas software program called Enertia. The software resides on the parent Corporate site in St Louis. Accounting, Land, Legal and Production departments are located in the Golden office.

Oil, Gas and CBM well production and sales are maintained and monitored between both the Production Department and Accounting Department. The monthly well volumes from the Barton chart records along with the initial monthly inlet sales volume statement from the gas purchaser are reviewed and imported into Enertia by the Production Department. The software program then allocates the inlet sales volume to each well using the Barton chart well records. Accounting Department receives from the Purchaser the monthly inlet sales volume statement, effective dated gas analysis report and the monthly settlement statement. Using these reports, Production Department input and the Gas Purchase Contract the following are controlled to the Settlement Statement which is the final document for payment. The Total Volume Mcf, Btu value, MMBtu volume and all pricing were controlled. Once all items were verified the Accounting Department imports the Production Departments well allocation of the sales inlet volume into the Accounting revenue program and enters the additional items of Pressure Base, Btu, MMBtu volume and all pricing and values. The Revenue program allocates all the additional items entered to each well based the wells volume to the total sales inlet volume. The Production Department files the allocated well volumes to WOGCC with Form 2. Peabody Natural Gas used a third party to operate the project wells and file the WOGCC Form 2 from the start of the project until July, 2005. In July PNG took on the operational and filing role until the end of the project. The Accounting Department files and pays taxes and the ownership of each well based on the allocated volume and values. While there were many eyes checking to ensure accuracy of the data there were not documented internal verifications/audits performed. Also sampling approaches are not applicable to this project.

The Pumping Service reports, Barton well charts, meter calibration reports, well gas sample analysis were maintained in the Gillette office of Manager of Natural Gas Operations.

Purchaser Custody Transfer Meter at Sales Inlet - measures total daily flow from all project wells and is the total flow for allocation to individual wells and payment each month. This meter installed and owned by Purchaser.

Gas Measurement: Meter is tested and calibrated at least semi-annually per Gas Purchase Contract. Producer (PNG) can have the test done upon notification to Purchaser at any time. If a test indicates an error exceeding 2%, measurements will be adjusted back to the previous meter test. No tests were found in error exceeding 2%.

Gas Quality Composition: A complete gas composition analysis is to be performed at least semi-annually per Gas Purchase Contract to determine the methane and NMHC fractions using Varian CP 4900 portable atomic absorption equipment. It includes a Micro-2 column gas chromatograph and provides analysis for 10 components in the gas stream. The portable analyzers are calibrated as necessary prior to use. These analyses were performed on quarterly to monthly basis over life of the project.

For Measurement and Quality Composition each party has the right to be present for testing and calibrating of either party's measurement equipment.

All data is maintained by the Purchaser in their offices.

PNG Individual well meters – measures daily flow from the individual well and is the basis for allocation of the Sales Inlet total flow to each well. These meters owned and installed by PNG.

Individual well flow information is determined using a Barton chart recorder (Models 202A or 202E). The Barton Chart recorders are typically calibrated on a quarterly basis by RMS Instrument and Electric, LLC. Charts are sent to a consulting integrator service for review and reading of the monthly volume flows.

All support documents and reports for State and Federal agencies were maintained in the Golden Office. The purpose of monitoring is to measure the quantity of methane captured by the Project Activity that would have been released to the atmosphere in the baseline condition.

The baseline emissions are monitored using continuous gas flow meters at the sales meter. The flow meters are calibrated semi-annually according to manufacturer's specifications. Calibration records of the sales meter are maintained by buyer(s) of the metered volumes. As is typical for custody transfer meters in the industry, the buyers maintain and calibrate these meters to ensure the measurements are accurate and that they receive the correct quantity of gas for which they are invoiced. Since buyers have changed over the years, calibration records dating back to project start date in 2002 may be unavailable. However, owing to the critical nature of these measurements to the transaction of gas sales between buyer and seller we believe the metered values are accurate even during those time-periods.

The gas composition in the coal seam may vary slightly from place to place but is generally consistent. In one study¹, desorption testing data from two CBM wells located approximately one mile apart reported similar gas composition values. A complete gas composition analysis is performed once each month (see footnote for Table 7 for missing month data) to determine the methane and NMHC fractions using Varian CP 4900 portable atomic absorption equipment. It includes a Micro-2 column gas chromatograph and provides analysis for 10 components in the gas stream. The portable analyzers are calibrated as necessary prior to use. Since the buyer has several GC units monitoring gas samples in the field at any one time and the buyers have changed over the years, unit-specific calibration records for the GC units are not always traceable. The Varian CP 4900 units include rugged hardware that ensures stable operation in the laboratory or in the field. These units maintain their calibration over time as reflected by the as-found calibration results in the available calibration records. Methane concentrations measured by the GC are typically in the range of 60-95 percent (by vol.), which is in the instrument's normal operating range and significantly higher than its detection limit. Thus relative errors caused by small drifts in calibration are not as significant when compared to errors in measurements made close to the instrument's detection limit.

In addition to the measurement of hydrocarbon specie concentrations, the gas analysis also provides nitrogen, and carbon dioxide concentrations and heating value data. Per contract, the buyer exercises tight limits on nitrogen and carbon dioxide concentrations and heating value to ensure the gas meets minimum requirements. Gas heating value is also the determinant of the value the buyers pay for

¹ Mavor et al., Powder River Basin Ft. Union Coal Reservoir Properties and Production Decline Analysis, SPE, Paper No. 84427, 2003.

purchased volumes. For example, one buyer's gas specification includes a maximum value of 3% (by vol) for carbon dioxide. The GC unit would have to be calibrated adequately to ensure the purchased gas stream meets this requirement.

The quality of instrumentation used, evidence of its ability to maintain its calibration over time, and the buyers' need for consistent gas quality all indicate that the GC equipment were operated in a well calibrated mode during the project creation period.

Powder River Coal Company staff visit the site each day and record the 24 hour gas volume and the cumulative gas volume from the meter. This information is transferred to an Excel spreadsheet and saved on the computer system at Powder River Coal Company's office in Gillette, Wyoming. The information is imported into an oil & gas software program called "Enertia", which allocates gas production back to each of the individual wells.

The project emissions related to electricity consumption are estimated using equipment runtime, horsepower, and Wyoming electric grid emission factors. To be conservative, the project emissions were calculated by assuming the compressors operate continuously at rated horsepower.

The project emissions related to fossil fuel consumption are estimated using vehicle miles driven, fuel economy, and IPCC emission factors for motor gasoline. The daily site visit is part of a larger maintenance route completed each day by Powder River Coal Company personnel. The miles allocated to NARM project emissions are based on historical information.

The project emissions related to methane destruction in end use applications was based on a destruction efficiency of 98.5 percent per the methodology. The CO₂e emissions related to the remaining 1.5 percent of uncombusted methane are also included under project emissions.

Blue Source has the responsibility and authority for registration of VCU's generated by this project. Peabody is responsible for measurement and monitoring of the required project parameters Table 3 describes the monitoring variables and how they are recorded and documented.

Table 3 – Monitoring Procedures

Data Variable	Data Unit	Measured Calculated Estimated	Recording Frequency	Party Responsible
Gas volume	volume	Measured	Daily	PNG ¹
Methane concentration	mass	Measured	Monthly ²	PNG
NMHC concentration	mass	Measured	Monthly	PNG
Fossil fuel used	Gallons	Calculated	Monthly	PNG
Electricity used	kW-hr	Calculated	Monthly	PNG

¹ PNG=Peabody Natural Gas, LLC

² For missing data, the lower of the two values measured before and after the missing month is used. If more than one measurement is available each month, then an average of those values is used.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline Emissions

The following equation is used to determine baseline emissions:

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y} \quad (11)^2$$

where:

BE_y = Baseline emissions in year y (tCO₂e)

$BE_{MD,y}$ = Baseline emissions from the destruction of methane in the baseline scenario in year y (tCO₂e)

$BE_{MR,y}$ = Baseline emissions from the release of methane into the atmosphere in year y that is avoided by the project activity (tCO₂e)

$BE_{Use,y}$ = Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y (tCO₂e)

According to ACM0008, ver. 5, methane destruction in the baseline is determined by the following equation:

$$BE_{MD,y} = (CEF_{CH_4} + r \times CEF_{NMHC}) \times \sum_i (CBM_{BL,i,y} + VAM_{BL,i,y} + CMM_{BL,i,y} + PMM_{BL,i,y}) \quad (12)$$

where:

$BE_{MD,y}$ = Baseline emissions from destruction of methane in the baseline scenario in year y (tCO₂e)

i = Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses)

$CBM_{BL,i,y}$ = CBM that would have been captured, sent to and destroyed by use i in the baseline scenario in the year y (expressed in tCH₄)

$VAM_{BL,i,y}$ = VAM that would have been captured, sent to and destroyed by use i in the baseline scenario in the year y (expressed in tCH₄)

$CMM_{BL,i,y}$ = Pre-mining CMM that would have been captured, sent to and destroyed by use i in the baseline scenario in year y (expressed in tCH₄)

² Equation numbers are the same as in ACM0008

$PMM_{BL, i, y}$ = Post-mining CMM that would have been captured, sent to and destroyed by use i in the baseline scenario in year y (tCH₄)

CEF_{CH_4} = CO₂ emission factor for combusted methane (2.75 tCO₂e/tCH₄)

CEF_{NMHC} = CO₂ emission factor for combusted non-methane hydrocarbons (various; to be obtained through periodic analysis of captured methane) (tCO₂e/tNMHC)

r = Relative proportion of NMHC compared to methane

with :

$$r = PC_{NMHC} / PC_{CH_4}$$

PC_{CH_4} = Concentration (in mass) of methane in extracted gas (%)

PC_{NMHC} = Concentration (in mass) of NMHC in extracted gas (%)

The baseline scenario does not involve any capture and use of CBM, VAM, CMM or PMM in any year during the crediting period. Therefore, there is no methane destruction in the baseline, and Eq. (12) reduces to:

$$BE_{MD,y} = 0 \quad (12a)$$

Equations (13) and (14) do not apply to the project.

Methane released into the atmosphere, $BE_{MR, y}$

ACM0008 states:

“Depending on the nature of the project activity, CBM/VAM/CMM can be removed at four different stages – (1) as coal bed methane from a CBM wells prior to mining, or from underground pre-mining CMM drainage; (2) during the mining process using surface or underground post mining CMM drainage techniques, (3) during the mining process using ventilation air or (4) after the mining process by drainage from sealed goafs but before the mine is closed.

“This methane would have been emitted to the atmosphere in the baseline scenario, unless some capture and use activities form part of the baseline.”

Methane released to the atmosphere in the baseline is determined using the following equation:

$$BE_{MR,y} = GWP_{CH_4} \times \left[\sum_i (CBMe_{i,y} - CBM_{BL,i,y}) + \sum_i (CMM_{PJ,i,y} - CMM_{BL,i,y}) + \sum_i (PMM_{PJ,i,y} - PMM_{BL,i,y}) + \sum_i (VAM_{PJ,i,y} - VAM_{BL,i,y}) \right] \quad (15)$$

where:

$BE_{MR, y}$ = Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity (tCO₂e)

i = Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses)

$CBMe_{i,y}$	= Eligible CBM captured, sent to and destroyed by use i in the project for year y (expressed in tCH ₄)
$CBM_{BL,i,y}$	= CBM that would have been captured, sent to and destroyed by use i in the baseline scenario in the year y (expressed in tCH ₄)
$CMM_{PJ,i,y}$	= Pre-mining CMM captured, sent to and destroyed by use i in the project activity in year y (expressed in tCH ₄)
$CMM_{BL,i,y}$	= Pre-mining CMM that would have been captured, sent to and destroyed by use i in the baseline scenario in year y (expressed in tCH ₄)
$PMM_{PJ,i,y}$	= Post-mining CMM captured and destroyed by use i in the project activity in year y (tCH ₄)
$PMM_{BL,i,y}$	= Post-mining CMM that would have been captured, sent to and destroyed by use i in the baseline scenario in year y (tCH ₄)
$VAM_{PJ,i,y}$	= VAM sent to and destroyed by use i in the project activity in year y (tCH ₄). In the case of catalytic oxidation, $VAM_{PJ,i,y}$ is equivalent to MD_{OX} defined previously.
$VAM_{BL,i,y}$	= VAM that would have been captured, sent to and destroyed by use i in the baseline scenario in year y (tCH ₄).
GWP_{CH4}	= Global warming potential of methane (21 tCO ₂ e/tCH ₄)
CEF_{CH4}	= CO ₂ emission factor for combusted methane (2.75 tCO ₂ e/tCH ₄)
CEF_{NMHC}	= CO ₂ emission factor for combusted non-methane hydrocarbons (various; to be obtained through periodic analysis of captured methane) (tCO ₂ e/tNMHC)
r	= Relative proportion of NMHC compared to methane

with :

$$r = PC_{NMHC} / PC_{CH4}$$

$$PC_{CH4} = \text{Concentration (in mass) of methane in extracted gas (\%)}$$

$$PC_{NMHC} = \text{Concentration (in mass) of NMHC in extracted gas (\%)}$$

Since the baseline scenario only includes the capture of CBM sent to the project activity in any year during the crediting period, Eq. (15) immediately simplifies to:

$$BE_{MR,y} = GWP_{CH4} \times CBMe_{i,y} \quad (15a)$$

Emissions from power/heat generation and vehicle fuel replaced by project, $BE_{Use,y}$

ACM0008 states:

"For emissions from displacing other energy forms, it is necessary to distinguish between emissions reductions derived from the use of CBM versus CMM, because CBM emissions

reductions should only be credited once the mining area has intersected the zone of influence of the CBM well.”

$$BE_{Use, y} = ED_{CBMW, y} + ED_{CBMZ, y} + ED_{CPMM, y} \quad (23)$$

where:

- $BE_{Use, y}$ = Total baseline emissions from the production of power or heat replaced by the project activity in year y (tCO₂)
- $ED_{CBMW, y}$ = Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence in year y (tCO₂)
- $ED_{CBMZ, y}$ = Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence prior to year y (tCO₂)
- $ED_{CPMM, y}$ = Emissions from displacement of end uses by use of coal mine methane, VAM and post-mining methane (tCO₂)

The baseline scenario does not involve any capture and use of CBM, VAM, CMM or PMM in any year during the crediting period. Therefore, there is no methane destruction in the baseline, and Eq. (23) reduces to:

$$BE_{Use} = 0 \quad (23a)$$

Baseline Emissions Equation

Therefore, Eq (11) reduces to:

$$BE_y = GWP_{CH_4} \times CBMe_{i, y} \quad (11a)$$

Table 4 shows a summary of baseline emissions ($CBMe_{i, y}$) based on the methane production of the CBM pre-drainage wells and their relative shut-in dates. The following conversions factors were used to convert thousand cubic feet (mcf) of methane to metric tonnes of carbon dioxide equivalents (CO₂e):

- 0.68 kgCH₄/m³CH₄
- 35.3147 ft³/m³
- GWP_{CH₄} = 21

Table 4 – Baseline Emissions from CBM Wells

Well ID	Shut-in Date	Cumulative Methane Production (mcf)	Baseline Emissions (tCO ₂ e)
VEG State 22-30	June 1, 2006	21,122	8,541
2006 Total		21,122	8,541
VEG Federal 12-25	October 8, 2007	211,588	85,560
VEG Federal 23-25	October 8, 2007	103,669	41,921
VEG Federal 34-25	October 8, 2007	59,573	24,090
VEG Federal 43-25	October 8, 2007	82,906	33,525

Federal 21-2-41-71	October 11, 2007	82,387	33,315
2007 Total		540,122	218,410

During the monitoring period (March 27th 2006- October 31st 2007) the baseline emissions were:

	Mar-Dec 2006	Jan-Oct 2007
Actual Baseline Emissions	8,541	218,410

4.2 Project Emissions

According to ACM0008, Project emissions are defined by the following equation:

$$PE_y = PE_{ME} + PE_{MD} + PE_{UM} \quad (1)$$

where:

PE_y = Project emissions in year y (tCO₂e).

PE_{ME} = Project emissions from energy use to capture and use methane (tCO₂e)

PE_{MD} = Project emissions from methane destroyed (tCO₂e)

PE_{UM} = Project emissions from un-combusted methane (tCO₂e)

Combustion emissions from additional energy required for CBM/CMM/VAM capture and use (page 10 of ACM0008, ver. 5)

ACM0008 states:

“Additional energy may be used for the capture, transport, compression and use or destruction of CBM/CMM/VAM. Emissions from this energy use should be included as project emissions.”

These emissions are calculated using the following equation:

$$PE_{ME} = CONS_{ELEC,PJ} \times CEF_{ELEC} + CONS_{HEAT,PJ} \times CEF_{HEAT} + CONS_{Foss\ Fuel,PJ} \times CEF_{Foss\ Fuel} \quad (2)$$

where:

PE_{ME} = Project emissions from energy use to capture and use or destroy methane (tCO₂e)

$CONS_{ELEC,PJ}$ = Additional electricity consumption for capture and use or destruction of methane, if any (MWh)

CEF_{ELEC} = CO₂ emissions factor of electricity used by coal mine (tCO₂e/MWh)

$CONS_{HEAT, PJ}$ = Additional heat consumption for capture and use or destruction of methane, if any (GJ)

CEF_{HEAT} = CO₂ emissions factor of heat used by coal mine (tCO₂e/GJ)

$CONS_{Fossil Fuel, PJ}$ = Additional fossil fuel consumption for capture and use or destruction of methane, if any (GJ)

$CEF_{Fossil Fuel}$ = CO₂ emissions factor of fossil fuel used by coal mine (tCO₂e/GJ)

Since only electricity and fossil fuel consumption is used for the proposed project activity, Eq. (2) reduces to:

$$PE_{ME} = CONS_{ELEC, PJ} \times CEF_{ELEC} + CONS_{Fossil Fuel, PJ} \times CEF_{Fossil Fuel} \quad (2a)$$

Combustion emissions from the use of captured methane (page 11 of ACM0008, ver. 5)

ACM0008 states:

"When the captured methane is burned in a flare, heat or power plant, or oxidized in a catalytic oxidation unit, combustion emissions are released. In addition, if NMHC account for more than 1% by volume of the extracted CBM/CMM or more than 0.1% by volume of the extracted VAM, combustion emission from these gases should also be included."

These emissions are calculated using the following equation:

$$PE_{MD} = (MD_{FL} + MD_{OX} + MD_{ELEC} + MD_{HEAT} + MD_{GAS}) \times (CEF_{CH4} + r \times CEF_{NMHC}) \quad (3)$$

with:

$$r = PC_{NMHC} / PC_{CH4} \quad (4)$$

where:

PE_{MD} = Project emissions from methane destroyed (tCO₂e)

MD_{FL} = Methane destroyed through flaring (tCH₄)

MD_{OX} + Methane destroyed through a catalytic oxidation (tCH₄)

MD_{ELEC} = Methane destroyed through power generation (tCH₄)

MD_{HEAT} = Methane destroyed through heat generation (tCH₄)

MD_{GAS} = Methane destroyed after being supplied to gas grid or for vehicle use (tCH₄)

CEF_{CH4} = CO₂ emissions factor for combusted methane (2.75 tCO₂e/tCH₄)

= CO₂ emissions factor for combusted non methane hydrocarbons (the concentration varies and therefore to be obtained through periodic analysis)

CEF_{NMHC} of captured methane) (tCO₂e/tNMHC)

r = Relative proportion of NMHC compared to methane

PC_{NMHC} = NMHC concentration (in mass) of extracted gas (%)

PC_{CH_4} = Methane concentration (in mass) of extracted gas (%), measured on wet basis

Since the methane is destroyed after supplying to the grid, Eq. (3) reduces to:

$$PE_{MD} = MD_{GAS} \times CEF_{CH_4} \quad (3a)$$

Uncombusted methane from project activity

The project emissions from un-combusted methane are given by the following Eq. (10) of ACM0008, ver. 5:

$$PE_{UM} = [GWP_{CH_4} \times MM_i \times (1 - Eff_i)] \quad (10a)$$

where:

PE_{UM} = Project emissions from un-combusted methane (tCO₂e)

GWP_{CH_4} = Global warming potential of methane (21 tCO₂e/tCH₄, for the first commitment period)

MM_{iC} = Methane used for various end use applications (tCH₄)

Eff_{iC} = Efficiency of the methane destruction in end use applications (98.5%, as specified in ACM0008, ver. 5)

Project emissions equation

Table 5 shows a summary of total project emissions (PE_y) as defined by Equation 1. Project emissions from energy use to capture and use methane (PE_{ME}) includes emissions from electricity and fossil fuel consumption for the duration of the crediting period. There are no project emissions from energy usage this verification period because they were all accounted for during the first verification of this monitoring period.

Table 5 - Summary of Project Emissions (tCO₂e)

	2006 ¹	2007 ²	Total
Fossil Fuel Combustion-Maintenance Vehicle	0	0	0
Electric Consumption – Water Pumps	0	0	0
Electric Consumption – Compressors	0	0	0
Total emissions from energy usage (PE_{ME})	0	0	0
Emissions from methane destroyed (PE_{MD})	1,121	28,667	29,788
Emissions from uncombusted methane (PE_{UM})	129	3,284	3,412

Total Project Emissions (PE_y)	1,250	31,951	33,201
¹ March 28 – December 31, 2006			
² January. 1 – October 31, 2007			

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \quad (13)$$

During the monitoring period (January 1st- October 31th, 2007) the project emissions were:

	Mar-Dec 2006	Jan-Oct 2007
Project Emissions	1,250	31,951

4.3 Leakage

The project activity does not anticipate any leakage emissions.

4.4 NET GHG Emission Reductions and Removals

The emissions reductions are calculated to be the difference between the baseline methane emission rate and estimated project emissions resulting from the consumption of diesel and electricity. Table 6 shows the net emission reduction generated by the project activity for the monitoring period (March 28, 2006 –October 31, 2007).

Emission reductions are calculated as the difference between the baseline methane emissions and project emissions from electricity and fuel consumption at the site as follows:

$$PE_y = PE_{ME} + PE_{MD} + PE_{UM} \quad (1)$$

Table 6: Summary of Emission Reductions (tonnes CO₂e)

	2006¹	2007²	Total
Baseline Emissions	8,541	218,410	226,951
Project Emissions	1,250	31,951	33,201
Total Emission Reductions	7,291	186,459	193,750
¹ March 28 – December 31, 2006			
² January. 1 – October 31, 2007			

5 ADDITIONAL INFORMATION

There is no additional information.